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Heritabilities of reproductive traits in a beef cattle herd using multitrait analysis

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Introduction

Reproduction is a critically important aspect of overall efficiency in the livestock industry. However, reproduction is a complex process with many components. Several such components have been used as measures of reproductive performance. Calving interval (CI), calving rate, services per conception, age at first calving (AFC), days to calving and calving date (CD) are some of the components of the female "reproductive complex" that have been considered. Animal geneticists are beginning to explore the possibility of separating components of the female "reproductive complex" into subsets that are both relatively easy to measure and have higher heritabilities. CI has traditionally been the predominant measure of reproduction during the productive life of the animal, particularly in dairy cattle (Rege & Famula, 1993). However, in beef operations, a relatively short breeding season is usually employed, so CI does not provide any additional information to CD and has lower repeatability and heritability (Bourdon & Brinks, 1983). Beef cattle in South Africa, as in other countries, are mated during a limited breeding season. Bourdon & Brinks (1983), Marshall *et al.* (1990) and MacGregor (1995) have found CI to be a biased measure of reproductive performance, due to it's negative association with CD, which results in cows calving early having the longest CI. Direct selection for shorter CI could also result in indirect selection for later age at puberty, since cows with the shortest CI are often those whose calves were born late in calving seasons. Bourdon & Brinks (1983), Buddenberg *et al.* (1990), Lòpez *de* Torre & Brinks (1990), Marshall *et al.* (1990), and MacGregor (1995) suggested CD as the preferred reproduction measurement for numerous reasons applicable to a restricted breeding season. These include lower birth weights, reduced incidence of dystocia, higher weaning and yearling weights and higher reconception rates. The objectives of this study were to obtain heritabilities (for CI, CD and AFC) and genetic correlations between these three traits.

Materials and Methods

Data used in this study were obtained from the multibreed synthetic beef cattle herd of the Johannesburg Metropolitan Council. After incomplete and biased records were removed, the data set contained 41 849 observations of 13 049 reproductive animals (dams and heifers) between 1979 and 1993. There were 25 684 base animals in the pedigree file. Paterson (1978; 1981) and MacGregor (1999) described the conditions under which these animals were kept and the management practices applied. Three traits were evaluated, namely calving interval (CI), calving date (CD), and age of first calving (AFC). CI was calculated as the interval in days between the subsequent and previous calving dates. CD was coded as the number of days from the onset of the calving season (1 June i.e.) until the dam calved. A penalty score for CD was given to those animals that did not calf during a particular year. The cow having the highest calving date value in a year was identified and 21 days were added to her CD value. This value was assigned to all non-calvers for that particular year (Johnson & Bunter (1996); MacGregor (1999)). A restricted maximum likelihood procedure with a multivariate animal model (using REML VCE 4.2.5 package of Groeneveld, 1998) was used to analyse the data. All traits were considered as a trait of the calf. The following effects were included in the model: year of birth (15 levels), month of birth (12 levels) and genotype (352 levels) as fixed effects and dam age as a covariate of CI and AFC. For CD, dam age was not significant in the initial analysis, therefore the rest of the effects were included in the operational model. Interactions were not significant in the initial analysis and therefore were ignored in the operational model.

Results and Discussion

Table 1 presents the heritabilities (h^2) and genetic correlations (r_g). Above the diagonal are the genetic correlations between traits and on the diagonal are the heritabilities.

Table 1 Heritabilities and genetic correlations for reproductive traits

	CI	CD	AFC
CI	0.016 ± 0.002	0.025 ± 0.134	0.468 ± 0.089
CD		0.442 ± 0.008	0.600 ± 0.019
AFC			0.464 ± 0.012

The heritability of CI corresponds with that found in the literature. Koots *et al*. (1994a) reported in his review a h^2 of 0.01 for CI (based on three estimates). López *de* Torre & Brinks (1990) found a h^2 of 0.02. The h^2 for CD, on the other hand, is unexpectedly high and may be biased. Koots *et al*. (1994a) reported a mean h^2 of 0.08 for CD (based on seven estimates). However, Meacham & Notter (1987), López *de* Torre & Brinks (1990) and Rege & Famula (1993) also obtained higher h^2 values of 0.16, 0.17 and 0.16, respectively. Buddenberg *et al*. (1990), assigned a penalty score for CD to all non-calvers and obtained a h^2 value for CD in first calvers of 0.39. Thus, the penalty score effect may be the reason for the higher h^2 value for CD obtained in this study. Rege & Famula (1993), found a low negative r_g of –0.06 between CI and CD while Koots *et al*. (1994b) reported a r_g of –0.83 between CI and CD. The r_g between CI and CD in this study was not significant. AFC's h^2 of 0.464 also corresponds with some of the h^2 values found in the literature. Kassab (1995), Singh *et al*. (1996) and Magana & Segura (1997) obtained h^2 values of 0.46, 0.36 and 0.46, respectively for AFC. Singh *et al*. (1996) also found a r_g of 0.68 between AFC and CI. The h^2 values for AFC and CD are both high and thus the preferred traits to use in a selection programme, rather than CI. The r_g between AFC and CI, and AFC and CD are moderate. Thus, selection for AFC could lead to an improvement in both CD and CI. Selection for CD could also lead to an improvement in AFC. AFC and CD are both traits that are easy to measure and both can be measured early in an animal's productive life. Selection for CD does have additional advantages over CI and AFC, as was discussed by Bourdon & Brinks (1983), Buddenberg *et al.* (1990), Lòpez *de* Torre & Brinks (1990), Marshall *et al.* (1990) and MacGregor (1995).

Conclusions

The h^2 of CD and the r_g between CD and AFC found in this study, and the additional advantages of CD, suggest that CD is the preferable trait to include in a reproduction selection programme rather than AFC and CI.

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