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Genetic relationships between calving interval and linear type traits in South African Holstein and Jersey cattle

M.L. Makgahlela#, B.E. Mostert and C.B. Banga
ARC-Animal Production Institute, Private Bag X2, Irene 0062, South Africa

Abstract

Genetic correlations between first calving interval (CI) and linear type traits in South African Holstein and Jersey cattle were estimated to assess the possibility of using type information as selection criteria for CI. All linear type traits routinely evaluated under the National Genetic Evaluation Programme (18 for Jersey and 17 for Holstein) were considered. Data were obtained from the National Dairy Animal Recording Scheme and comprised records of 30 503 Holstein cows in 640 herds and 27 360 Jersey cows in 460 herds. Multiple-trait animal models were used to estimate parameters, based on the restricted maximum likelihood (REML) methodology. Fixed effects in the model varied depending on the individual trait. Linear type traits reflecting body size generally had much higher correlations with CI than udder characteristics. Genetic correlations of CI with body size traits were mostly positive in both breeds, ranging from 0.04 ± 0.16 with bone structure to 0.51 ± 0.08 with body depth, dairy strength and rear leg set. Correlations between CI and body depth (0.51 ± 0.08), angularity (0.32 ± 0.08) and rump angle (0.32 ± 0.12) indicate that cows with deep, more angular bodies and low pins have longer CI. Genetic correlations with udder type traits were generally low, ranging from -0.01 ± 0.20 with udder width to 0.25 ± 0.11 with rear teat placement. The highest genetic correlations with CI were for rear leg rear view (-0.70 ± 0.34), body depth (0.51 ± 0.08), dairy strength (0.51 ± 0.09), rear leg set (0.51 ± 0.06), foot angle (-0.44 ± 0.04) and rump angle (0.32 ± 0.05) in the Jersey and rump height (0.31 ± 0.08), angularity (0.32 ± 0.08) and body depth in the Holstein (0.51 ± 0.08). These traits may therefore be used in the analysis of CI to carry out early prediction of fertility and increase the accuracy of evaluation.

Keywords: Cow fertility, calving interval, type traits
Corresponding author. E-mail: mmakgahlela@arc.agric.za

Introduction

Most dairy cattle breeding objectives around the world have in the past focused exclusively on production traits. At the same time, the dairy industry has seen a severe phenotypic and genetic deterioration in cow fertility, mainly due to unfavourable genetic correlations between fertility and milk production (Kadarmideen, 2004; Pryce *et al*., 2004; VanRaden *et al*., 2004; Makgahlela *et al*., 2007). This decline has heightened the need to include fertility in breeding objectives for dairy cattle. Accurate genetic prediction of fertility is, however, difficult because of its low heritability (Pryce *et al*., 1997; 1998; Kadarmideen, 2004; Makgahlela *et al*., 2007). Calving interval, an indicator of cow fertility, was recently added to the list of traits receiving routine genetic evaluations under the South African Genetic Evaluation Programme. Therefore, the objective of this study was to estimate genetic correlations between first calving interval (CI) and linear type traits in South African Holstein and Jersey cattle, in order to assess the possibility of using type information to improve the prediction of CI.

Materials and Methods

Calving data were obtained from the National Dairy Animal Recording Scheme and type information was provided by the respective breed societies. The linear type traits considered in this study are routinely evaluated under the National Genetic Evaluation Programme (18 for Jersey and 17 for Holstein) (WHFF, 2008). All data were edited according to the standards and procedures of the South African National Genetic Evaluation Programme. The final data set comprised records of 30 503 Holstein cows in 640 herds and 27 360 Jersey cows in 460 herds. The cows were daughters of 2 672 and 2 433 different sires, respectively for

Holsteins and Jerseys. Parameter estimates were obtained by REML procedures, using multiple-trait animal models of the following general form:

$$y = Xb + Zu + e$$

where: y is a vector of observations; X is an incidence matrix relating observations to fixed effects (herd-year-season of calving, age at calving, age at classification, days in milk); b is a vector of fixed effects; Z is an incidence matrix relating observations to random animal effects; u is a vector of animal additive genetic effects; e is a vector of random residual effects. Fixed effects in the model varied according to traits.

Results and Discussion

Estimates of genetic correlations between calving interval and linear type traits for both Holstein and Jersey cattle are presented in Table 1. There were generally stronger genetic relationships between CI and type traits in the Jersey than in the Holstein breed. Udder traits on the whole had low correlations with CI in both breeds. Linear type traits reflecting body size in general, had much higher correlations with CI than udder characteristics.

Table 1 Estimates of genetic correlations ± se between calving interval and linear type traits in South African Holstein and Jersey cattle

Trait	Breed	
	Holstein	Jersey
Rump height (RH)	0.31 ± 0.07	-
Wither height (WH)	-	0.24 ± 0.09
Chest width (CW)	0.07 ± 0.14	0.25 ± 0.14
Body depth (BD)	0.51 ± 0.08	0.51 ± 0.12
Angularity (ANG)	0.32 ± 0.08	-
Dairy strength (DS)	-	0.51 ± 0.09
Rump angle (RA)	-0.18 ± 0.05	0.32 ± 0.12
Rump width (RW)	0.14 ± 0.06	-
Thurl width (TW)	-	0.27 ± 0.11
Rear legs set (RLS)	0.24 ± 0.06	0.51 ± 0.12
Foot angle (FA)	-0.18 ± 0.10	-0.44 ± 0.04
Rear leg rear view (RLRV)	-0.22 ± 0.14	-0.70 ± 0.34
Bone structure (BS)	-	0.04 ± 0.16
Fore udder attachment (FUA)	0.18 ± 0.08	0.13 ± 0.13
Rear udder height (RUH)	0.16 ± 0.07	0.16 ± 0.12
Udder width (UW)	-0.01 ± 0.20	0.15 ± 0.12
Median ligament (ML)	0.13 ± 0.10	0.03 ± 0.06
Udder depth (UD)	0.08 ± 0.04	-0.11 ± 0.11
Fore teat placement (FTP)	0.02 ± 0.04	0.15 ± 0.11
Rear teat placement (RTP)	0.25 ± 0.11	-0.03 ± 0.14
Fore teat length (FTL)	-0.07 ± 0.01	-0.03 ± 0.02

The highest genetic correlations with CI were obtained for rump height (RH) (0.31 ± 0.07), angularity (ANG) (0.32 ± 0.08) and body depth (BD) (0.51 ± 0.08) in the Holstein. Thus, tall Holstein cows with deep and angular bodies tended to have longer CI. In the Jersey, rear leg rear view (RLRV) (-0.70 ± 0.34), BD (0.51 ± 0.08), dairy strength (DS) (0.51 ± 0.09), rear leg set (RLS) (0.51 ± 0.06), foot angle (FA) (-0.44 ± 0.04) and rump angle (RA) (0.32 ± 0.05) had the highest genetic correlations with CI. This indicates that deep angular bodies, steep rump angles and low foot angles are associated with longer calving interval. These results indicate that RH, BD, ANG, DS, RW, CW, WH, RLS, FA and RLRV may help improve the accuracy of breeding value prediction for CI. Type traits are mostly recorded during first lactation; thus, information on animals that are culled before completing their first lactation, or that have not calved for the second time will also be incorporated into genetic evaluation of CI. Although estimates of genetic correlations and standard errors for most type traits were acceptable, high errors of prediction were observed for traits such as RLRV (-0.70 ± 0.34), udder width (-0.01 ± 0.20) and chest width (0.07 ± 0.14). Traits like RLRV must therefore be used cautiously because of their high standard errors for genetic correlations.

The magnitude and direction of the genetic relationships between CI and several structural type traits obtained in the current study were in agreement with those reported by Haile-Mariam *et al*. (2004) and Dal Zotto *et al*. (2007). Pryce *et al*. (2000) and Wall *et al*. (2005), however, found low genetic correlations between CI and structural type traits. Genetic correlations between CI and udder type traits in this study were, nevertheless, smaller than those reported by Dal Zotto *et al*. (2007). The reason for the differences in magnitude of these correlations may partly be due to inconsistencies in measuring the same trait in different countries.

Conclusions

A considerable number of linear type traits have significant genetic relationships with CI in South African Holstein and Jersey cattle. Therefore, a multivariate procedure that includes CI and these traits (i.e. RH, BD, ANG, DS, RW, CW, WH, RLS, FA and RLRV) may be used to carry out more accurate prediction of breeding values of bulls for fertility.

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