South African Journal of Animal Science 2004, 34 (Supplement 2)

Peer-reviewed paper: Joint South African Society for Animal Science/Grassland Society of Southern Africa Congress

Genetic analyses for conformation traits in South African Jersey and Holstein cattle

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Abstract

(Co)variance components for linear type traits of South African Jerseys and Holsteins were estimated. Heritability estimates are mostly in agreement with other studies although some estimates for the Jersey population are lower. Genetic trends for conformation traits of the South African Holstein show that cows are becoming taller and more angular, while udder traits have also improved. Teat lengths are becoming shorter in both breeds. Genetic trends of the Jersey indicate little or no selection for conformation traits, except for traits highly correlated with production, i.e. rear udder width, rear udder height and dairy form.

Keywords: Type traits, heritability, genetic trend
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Introduction

Genetic selection has increased production levels of dairy cows considerably. However, animals that have been selected for high production efficiency seem to be more at risk for behavioural, physiological and immunological problems. Genetic selection may therefore lead to loss of the homeostatic balance (Rauw *et al.*, 1998). This may be prevented by selection for more than production traits alone. Selection for conformation traits can be used to improve stayability, fertility and disease resistance (Rogers *et al*., 1999; Royal *et al*., 2002; Schneider *et al*., 2003).

The objective of this study was to estimate genetic (co)variances for linear type traits of South African Holstein and Jersey cattle, in order to estimate breeding values for the dairy industry. Genetic trends of conformation traits were also compared.

Material and Methods

Jersey conformation data were obtained from Jersey SA for cows linearly classified for body structure and udder traits between 1984 and 2000. Body structure traits measured on first lactation Jersey cows were wither height (WH); chest width (CW); body depth (BD); dairy form (DF); rump angle (RA); thurl width (TW); rear leg (RL) and foot angle (FA). Udder traits included fore udder attachment (FUA); rear udder height (RUH); rear udder width (RUW); udder cleft (UC); udder depth (UD); front teat placement (FTP) and teat length (TL). Data were excluded if cows were younger than 17 months or older than 36 months at calving, or younger than 18 months or older than 40 months when classified. For variance component estimation both parents had to be known. Cows had to have measurements for all traits. Only contemporary groups with more than five animals and with progeny of at least two sires were kept. The final data set consisted of 7 959 records.

Holstein conformation data were obtained from the SA Holstein Society for cows classified between 1986 and 2002. Body structure measures on first lactation Holstein cows were rump height (RH); body depth (BD); angularity (ANG); rump angle (RA); rump width (RW); rear leg side (RLS) and foot angle (FA). Udder traits included fore udder attachment (FUA); rear udder height (RUH); median ligament (ML); udder depth (UD); front teat placement (FTP) and front teat length (FTL). Data were excluded if cows were younger than 17 months or older than 39 months at calving, or younger than 18 months or older than 40 months when classified. Sires had to have at least 10 progeny in three contemporary groups. Only contemporary groups with more than five animals and progeny of at least three sires were kept. Only herds with data in at least 10 years were kept. As the data set was still too large, 3 100 contemporary groups were randomly selected using SAS (2000). For variance component estimation, cows had to have measurements for all traits. Both parents had to be known. The final data set consisted of 19 838 records, after ensuring that all above requirements were met. Fixed effects tested using PROC GLM of SAS (2000) were herd-classification date- classifier (HYSC); age at calving (AC), age at calving^2 (AC^2); days in milk (DIM); days in milk^2 (DIM^2); age at classifying (ACL) and age at classifying^2 (ACL^2).

The following model was applied to all traits for estimation of variance components:

$$\mathbf{y = Xh + Zu + e}$$

Where **y** is a vector of type records; **h** is a vector of fixed effects; **u** is a vector of random additive genetic effects of animals. **X** and **Z** are incidence matrices associating **h** and **u** with **y**; and **e** is a vector of random residual effects. (Co)variance components were estimated using VCE4 (Groeneveld, 1994). Univariate and bivariate analyses for all combinations of traits were computed. Due to computational limitations, it was not possible to do a single multitrait analysis involving all traits. Two separate multitrait analyses incorporating the body structure traits and the udder traits were therefore computed.

For the estimation of breeding values, genetic groups were included to account for differences in mean genetic merit of unknown ancestors by birth year. The pedigree file for the estimation of breeding values consisted of 543 289 Jersey and 895 558 Holstein animals, and the data files included the measurements of 37 783 Jersey and 166 476 Holstein cows.

Results and Discussion

Due to the data size, breeding value estimation was done in two multivariate analyses, i.e. traits relating to body structure and traits relating to the udder. Bending was required to obtain positive definite matrices for the Jersey data.

Table 1 Traits, fixed effects used in models and heritability estimates for Holstein (H) and Jersey (J) cattle

Trait*									h^2 ± s.e.	
Holstein	**Jersey**	**HYSC**	**AC**	**AC^2**	**ACL**	**ACL^2**	**DIM**	**DIM^2**	**Holstein**	**Jersey**
Body structure										
RH	WH	H,J			H,J	H,J	H		0.47 ± 0.02	0.20 ± 0.03
-	CW	J			J	J			-	0.08 ± 0.02
BD	BD	H,J			H,J	H,J	H,J	H,J	0.22 ± 0.02	0.18 ± 0.02
ANG	DF	H,J			J	J	H,J	H,J	0.18 ± 0.01	0.13 ± 0.02
RA	RA	H,J					H,J	J	0.29 ± 0.02	0.16 ± 0.02
RW	TW	H,J	H,J	H,J	H	H	H,J	J	0.17 ± 0.01	0.09 ± 0.02
RLS	RL	H,J					H,J	H,J	0.06 ± 0.01	0.07 ± 0.02
FA	FA	H,J			J	J	H,J	H,J	0.08 ± 0.01	0.11 ± 0.02
Udder traits										
FUA	FUA	H,J	H,J	H,J	H	H			0.14 ± 0.01	0.07 ± 0.02
RUH	RUH	H,J	H,J	H,J			H,J	H,J	0.15 ± 0.01	0.15 ± 0.02
-	RUW	J	J	J			J		-	0.17 ± 0.02
ML	UC	H,J					H,J	H,J	0.09 ± 0.01	0.09 ± 0.02
UD	UD	H,J			H	H	J		0.20 ± 0.02	0.14 ± 0.02
FTP	FTP	H,J					H,J	H,J	0.23 ± 0.18	0.17 ± 0.02
FTL	TL	H,J			J		H,J	H,J	0.33 ± 0.02	0.27 ± 0.03

*For trait abbreviations, see text; HYSC: Herd – Classification date – Classifier; AC: Age at calving; ACL: Age at classifying; DIM: Days in milk.

Heritability estimates are mostly in agreement with other studies, although some estimates for the Jersey population are lower than literature estimates (see Van Niekerk *et al*., 2000 for a comparison). With regards to body structure traits, Holstein breeders have selected taller, more angular cows (Figure 1), as in the US and other countries (Rogers *et al*., 1999). According to Pryce *et al*. (2000), taller, more angular cows have longer calving intervals, as they reported genetic correlations between calving interval and stature and angularity as 0.33 and 0.47, respectively. Genetic trends for the other body structure traits show no directional selection, except for BD during the last five years. These traits (RA, RW, RLS and FA) all have intermediate optima, which probably explain the lack of genetic trends. The Jersey breed also shows a positive genetic trend for DF for the whole period and for WH between 1995 and 2000, although not at the same rate as the Holstein (Figure 3). All other body structure traits show no genetic trends, as expected.

Most udder traits, on the other hand, have positive extreme optima, and should therefore have positive trends. Exceptions are teat length, and possibly udder depth, as extreme udder depth might be an indication of a small udder, which is not conducive to high production. Holstein breeders have successfully selected for higher scores in all udder traits except teat length (Figure 2). Both Holstein and Jersey breeders have selected for shorter teat lengths. The reason for this is not known. Udder depth's trend is not as steep as the other traits for Holstein, and slightly negative for Jersey. Only RUW and RUH showed a marked positive trend in the Jersey, which, according to Van Niekerk *et al*. (2000) are highly correlated with production traits (r_g of milk production with RUW and RUH are 0.84 and 0.70, respectively). The genetic trends are therefore probably a result of correlated responses to selection for increased production.

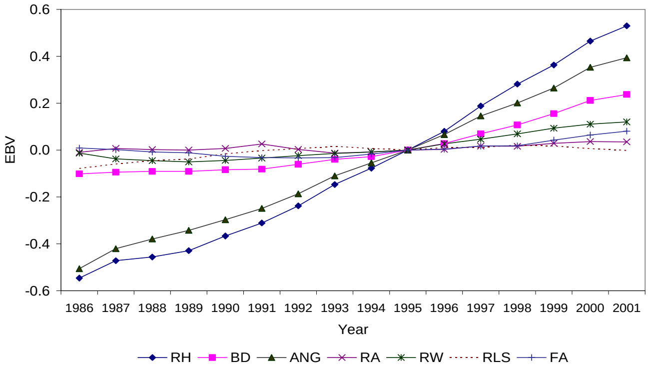

Figure 1 Genetic trend for body structure traits of Holsteins

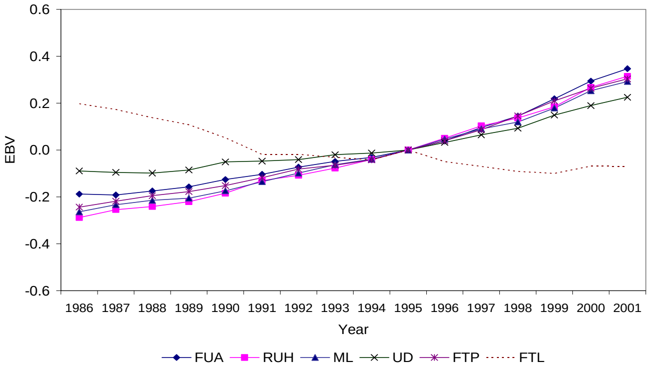

Figure 2 Genetic trend for udder traits of Holsteins

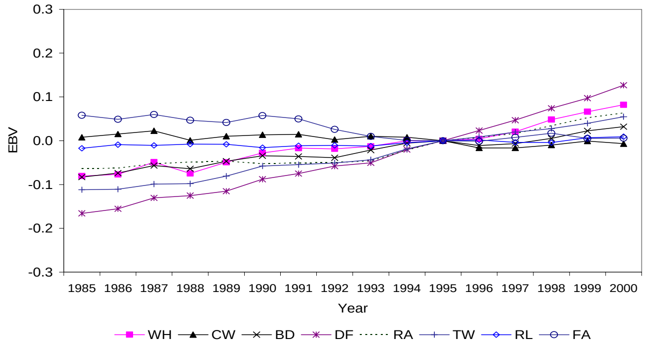

Figure 3 Genetic trends for body structure traits of Jerseys

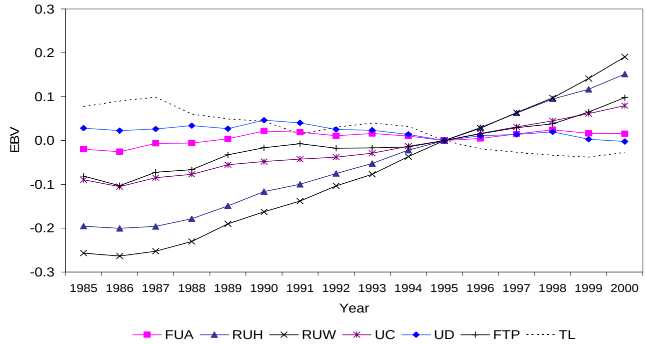

Figure 4 Genetic trends for udder traits of Jerseys

Conclusions

Genetic trends for conformation traits of the South African Holstein show that cows are becoming taller and more angular, while udder traits are also improved. Teat lengths are becoming shorter, both in the Holstein and Jersey breeds. Conformation traits of the South African Jersey generally show no genetic trend, except for traits highly correlated with production, i.e. RUW, RUH and DF. This indicates that breeders are concentrating on production, rather than type.

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