Preliminary Evaluations of Production Traits in Mixed Breed Populations in the United Kingdom

R. Mrode, M. Coffey, R. Sawalha and E. Wall
SAC, EGENES, Sir Stephen Watson Building, Bush Estate, Penicuik, EH26, 0PH, UK

Introduction

Crossbreeding has not been widely practiced in the United Kingdom (UK) in an organised manner. In the 1970's the majority of crosses were those made between the Holstein and the Friesian and this has increased with time due to the increasing importation of semen from North America. In non-Holstein/Friesian breeds such as the Shorthorn and the Ayrshire, earlier attempts at crossing were for increased production and were usually with the Holstein breed. However, in recent times, concerns with the decline in fitness traits in the Holstein breed and more emphasis placed on broader breeding goals has resulted in some Holstein farmers crossing their animals with non-Holstein/Friesian breeds. The current evaluation in the UK only includes Holstein/Friesian crosses which are adjusted for heterosis and recombination loss. Lack of genetic evaluations for other cross breed animals have been cited by farmers in the UK as one possible reason for not embarking on a more widespread and organised cross breeding program. Thus the purpose of this paper is to evaluate the quality of available cross breed data in the UK and undertake preliminary genetic evaluations for all breeds, including some breeds which are currently not evaluated.

Materials and Methods

The data consisted of 7,343,465 cows with yield records for milk, fat and protein in the first 3 lactations. The cows had 7, 638,854 305-day lactations records prior to 1992 and 80,854,493 test days (TD) records from 1992 onwards. Thus there were 97,344 more cows with 1,621,170 TD records in the mixed breed run compared with the sum of cows and TD records in the within breed evaluations. The breed composition of cows with data consisted of 42% Holstein (Hol), 3.2% Friesian (cows with at most 12.5% Holstein genes), 3.1% Ayrshire (Ayr), 2.0% Jerseys (Jer), 1.2 % Guernsey (Gue), < 1% for Shorthorn (Sho), Brown Swiss (Bsw), Montebeliarde, Normande and Meuse-Rhine-Issel (Mri), 17.9% crosses with coefficients of heterosis ≥ 50 % and 29% grading up (coefficients of heterosis ≥ 25% < 50%). The majority of the crosses were between the non-Holstein/Friesian and the Holstein rather than among the non-Holstein/Friesian breeds. Consequently heterosis and recombination loss were calculated for 3 types of crosses: Holstein with Friesian (Hol x Fri), Holstein with non-Friesian (Hol x non-Fri) breeds and Friesian with other non-Holstein (Fri x non-Hol) breeds.

A singe trait multiple lactation random regression model described by Mrode *et al.* (2005) was used for the analysis of the data. The coefficients for heterosis and recombination loss were fitted in the model as covariates. The formation of unknown parent groups was modified to include breed in addition to pedigree path, country of origin and year of birth. The adjustment for heterogeneous variance (Hov) was modified to account for breed differences. Based on prior analysis of breed means and standard deviations and for simplicity of implementation, Hol and Fri cows were treated as one group and other non-Hol/Fri breeds were treated as another group in the adjustment for Hov. Crosses were allocated to either of the two groups based on breed codes assigned by the breed association or milk recording organisation. The variances of the non-Hol breeds were scaled to that of the Hol and the estimates of genetic parameters for the Hol breed were employed in the evaluation of all breeds.

On convergence, within breed bases were computed from the evaluations of cows born in 2000 with coefficients of heterosis less than 50%. Expression of PTAs for each breed involved deviation from the breed base mean and scaling of a ratio of the breed standard deviation and that of the Holstein (VanRaden *et al.,* 2007).

Results and Discussion

Computation time for the mixed breed data set took about 5 hours for one trait across the 3 lactations. This is just 1 hour more than the time used usually for the within breed analysis of the Hol data. Thus the mixed breed evaluations resulted in less computation time compared with the sum of about 7 hours used for a single trait for all breeds in the within breed evaluations.

The breed composition of the Hol over time is illustrated in Figure 1, with cows having at least 25% coefficients of heterosis classified as crosses. The percentage of Hol x Fri cross increased from 10% in 1970 to about 66% in 1986 and has declined steadily in more recent years to about 10% in 2005. At the same time, percentage of Hol x non-Fri crosses increased from about 10% in 1991 to 27% in 2004. The percentage of Fri x non-Hol crosses peaked at 16% in 1971 and has declined to 0% by 1994. In general, it seems that more recent crosses are between the Holsteins and non-Friesian breeds and this may have been driven by the desire to increase fitness traits in the resulting animals. The most common non-Friesian breeds used in recent years are the Red cattle breeds (Swedish Red, Danish Red, Ayr, Norwegian Red), followed Mri, Bsw and Jer. A similar figure for the Ayr breed (not shown), indicated that the major crossing has been to the Holstein breed, which accounted for 11% of the breed in 1994, peaked at 21% in 2000 and declined to about 13% in 2005. The main drive for crossing here is for increased production traits in the Ayr rather than fitness traits.

The estimates of heterosis for each of the 3 type of crosses by lactation are given in Table 1. In generally, estimates increased with lactation and those for the Hol x Fri cross were similar to previous estimates.

The correlation of PTAs for bulls with at least 20 daughters from the mixed breed run compared to with within breed run are given in Table 2. The results indicate very little changes in Holstein bull PTA in the mixed breed run compared with the within breed evaluations with correlations at about 0.99. There were slightly more changes in bull proofs with the Jer and Gue with correlations ranging from 0.94 to 0.99. However larger changes were observed for the Ayr and Sho, where there has been substantial crossing with the Hol/Fri breed with correlations ranging from 0.82 to 0.96.

In general, the largest changes in PTAs in the mixed breed run were for bulls used extensively in crosses. For instance, there were 68 and 40 bulls respectively with changes of at least 100kg in Milk PTA in the mixed breed run compared to the official run in the Holstein and Ayrshire breeds. The 68 bulls for the Holstein have an average percentage increase of 97, 45 and 5% in the number of daughters, herds and reliability in the mixed breed compared to the official run. These were bulls used extensively in crosses with non-Hol/Fri breeds. The average increase in the number of daughters, herds and reliability for the 40 Ayrshire bulls were 17%, 9% and 3% respectively.

The average increase in reliability for all bulls with at least 20 daughters were about 1 to 2% in the mixed breed evaluations compared with the within breed runs. However in the Hol, Ayr, Jer and Gue breeds, about 23, 21, 26 and 14% of these bulls respectively had an increased reliability of at least 3%. The bulls used extensively in crosses had the largest increases in reliability.

The estimates of genetic trends for the mixed breed evaluations were in general very similar to those from the official within breed run. From the mixed breed evaluations, the contribution of the different crosses to the overall genetic trend can be computed. Such a graph for the Hol/Fri and Ayr breeds are given for the genetic trend in milk yield in Figures 3 and 4, where animals with coefficients of heterosis of at least 25 % have been classified as crosses. In the Hol, there was a gradual decline in the Hol x Fri crosses but this was accompanied by an increasing trend in the Hol/non-Fri crosses and the Fri/non-Hol crosses in the early years. In more recent years, the major contributions to the positive trend are the Hol/non-Fri crosses and the pure Holstein animals.

In the Ayr breed, the genetic trend from the Ayr x Hol cross has increased from about 1996 and stabilised to a mean of about 36kg PTA milk per year from 1999. This cross is mostly responsible for the positive genetic trend observed in the breed until 2002. The use of foreign Ayr breeds such as those from North American have resulted in a more positive trend in the Ayr breed in more recent years.

Conclusion

Mixed evaluations in the UK is feasible, convergence was fairly rapid and seems more efficient in computational time compared with running each breed separately. The largest PTA changes were in the non-Hol/Fri breeds. More recent crossing is between the Hol and non-Fri breeds. The classification of crosses to 3 categories will be reviewed given the lack of Fri x non-Hol crosses in recent years. From the mixed breed evaluations a better understanding of the observed genetic trend can be gained from the contributions from different crosses. It is planned that the study will be extended to non-production traits.

Acknowledgement

Authors gratefully acknowledge the support of Dairy Co for funding this research and Marco Winters for useful discussion.

References

Mrode, R., Brotherstone, S., White, I., Swanson, G., Coffey, M., Jones, H. & Thompson, R. 2005. Random regression model for the genetic evaluation of production traits of dairy cattle in the UK. *Interbull Bulletin 33*, 211-314.

VanRaden, P.M., Tooker, M.E., Cole, J.B., Wiggans, G.R. & Megonigal, J.H., 2006. Genetic evaluations for mixed breed populations. *J. Dairy Sci. 90*, 2434-2441.

Table 1. Estimates of 100% heterosis on a 305 day phenotypic yield basis per lactation.

Lactation	Breed Cross	Milk	Fat	Protein
1	Hol x Fri	71	5.8	4.0
	Hol x non-Fri	75	6.0	4.4
	Fri x non-Hol	60	5.1	3.3
2	Hol x Fri	88	6.7	5.1
	Hol x non-Fri	95	6.9	5.5
	Fri x non-Hol	74	5.9	4.2
3	Hol x Fri	110	7.0	5.8
	Hol x non-Fri	106	7.1	5.4
	Fri x non-Hol	105	6.1	4.9

Table 2. Correlations for bull PTAs from the mixed breed and within breed evaluations.

Breed	Milk	Fat	Protein
Holstein/Friesian	0.99	0.99	0.99
Shorthorn	0.94	0.94	0.89
Ayrshire	0.96	0.92	0.85
Jersey	0.97	0.99	0.94
Guernsey	0.96	0.96	0.97

Figure 1 Breed composition of the Holstein/Friesian breed classifing cows with > 25% cofficient of heterosis as crosses

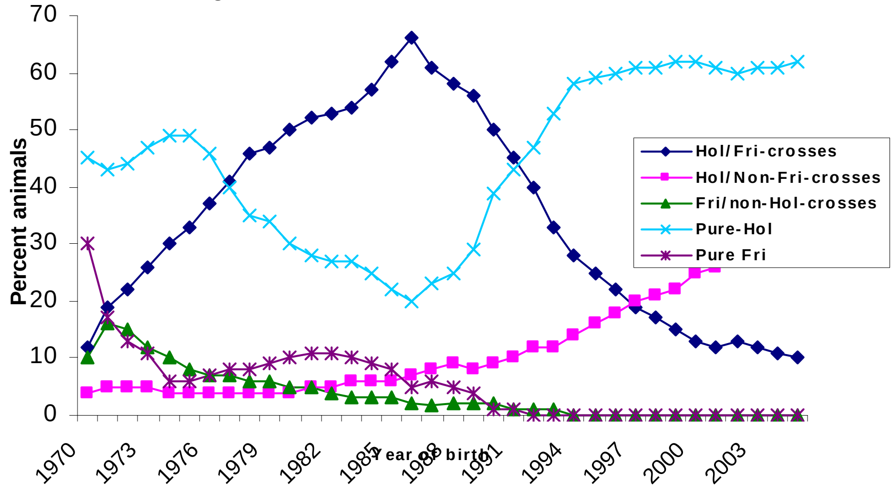

Figure 2. Proportion of Holstein/Friesian milk cow genetic trend in the mixed-breed run contributed by the various crosses

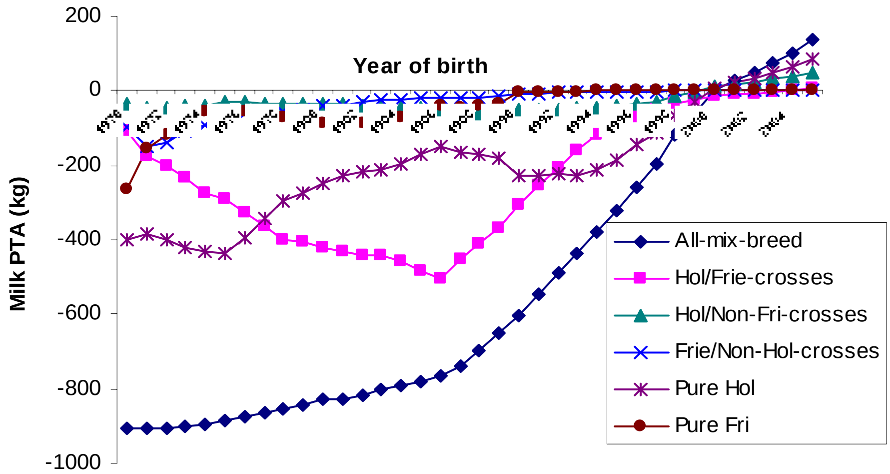

Figure 3. Proportion of Ayrshire cow milk genetic trend from the mixed breed run contributed by the vaious crosses