Genetic Evaluation of Female Fertility in Non-Holstein Cows in the UK

E. Wall, M. Coffey and R. Mrode

EGENEs and Dairy Cattle Breeding, Sustainable Livestock Systems, SAC, Bush Estate, Penicuik, Midlothian, EH26 0PH, UK

Abstract

The aim of this study was to examine the feasibility of using nationally recorded data for calving, insemination and milk information to produce fertility genetic evaluations for non-Holstein breeds of dairy cows. Data and pedigree were extracted for first lactation Ayrshire (AYR), Guernsey (GUE) and Jersey (JER) cows from national milk recording organisation databases. After data validation, almost 25,000 individual first lactation AYR cow records were shown to have a mean calving interval of 395 days and an average of 1.61 inseminations per calving. Over 23,000 GUE cow records were shown to have a mean first calving interval of 395.5 days and an average of 1.77 inseminations per calving. Over 41,500 first lactation JER cow records were shown to have a mean calving interval of 389 days and an average of 1.65 inseminations per calving. Initial genetic evaluations showed that there is wide genetic variation, and therefore scope for selection, in fertility traits in all three breeds. There was a genetic decline in fertility seen in some breeds, equating to 38p per cow per year in the AYR breed, 40p in the GUE breed and 28p per cow per year in the Jersey breed. These costs are cumulative and include only the fertility management costs and not the associated culling costs. This study shows that routine extraction and genetic evaluation of female fertility in non-Holstein dairy cows is possible and will allow the breeds to include fertility in their future selection decisions.

Introduction

Fertility has been shown to have an unfavourable genetic relationship with milk production in Holsteins (e.g., Pryce *et al.*, 2000; Veerkamp *et al.*, 2001) so continued selection for milk production will exacerbate the decline in fertility in the absence of information on daughter fertility. The only way to reverse this genetic trend is to breed dairy cows additionally for fertility. But dairy farmers have historically had no access to fertility information when they purchase semen. It is therefore vital that fertility is included in selection programmes and that farmers can choose to inseminate their cows with semen from bulls with positive PTAs for daughter fertility. Although of low heritability, fertility traits have been shown to have sufficient genetic variation and have recently been made available nationally for the Holstein-Friesian breed (Wall *et al.*, 2003). The aim of this study was to make such indices available to the breeding industry in the form of proofs for fertility for the Ayrshire (AYR), Guernsey (GUE) and Jersey (JER) breeds of dairy cattle in the UK.

Material and Methods

Fertility and production information were extracted from the national Milk Recording Organisations' databases. In summary the data available included direct measures of fertility including calving interval (CI), days to first service (DFS), non-return (conceived) 56 days post first insemination (NR56) and number of recorded inseminations for cows with a second calving (INS), and an indirect fertility measure of milk yield at day 110 of lactation (MILK). The data were validated and edited according to the rules applied for the Holstein breed (Wall *et al.,* 2003).

Insemination, calving and milk yield information was extracted for first lactation animals including data until the end of December 2006 for GUE, AYR and JER cattle. These data were validated and cow identities validated against the national genetic evaluation for milk production in the three breeds. A three generation animal pedigree was extracted for each of the three breeds.

Multi-trait BLUP breeding values were estimated with a linear animal model using the same methods currently applied to routine national evaluations of fertility in Holstein-Friesian cattle. The genetic parameters used in the Holstein-Friesian breed for the traits in the analysis were used in the evaluation of fertility in the non Holstein breeds. For details on parameters and models used for Holstein-Friesians, please see Wall *et al.* (2003).

Results and Discussion

Table 1 shows the size of the data and pedigree files extracted for the three breeds with GUE dataset being smaller than the AYR, and JER being the largest.

Table 1. Number of cows included with phenotypic records and number of animals included in the pedigree files for female fertility.

	GUE	JER	AYR
Data (No. of 1st lactn cows)	23,258	41,593	25,102
Pedigree (Total no. of animals)	48,061	83,662	64,894

Table 2 describes the phenotypic data for each of the 3 breeds. The proportion of missing data for the traits was comparable across the breeds, with the minor breeds having a slightly higher proportion of fertility data than the Holstein-Friesians (e.g., 69% of Holstein-Friesians had a CI vs. 75% in the JER breed; see Wall *et al.,* 2003). The JER had a lower mean CI than the other breeds (389 days vs. 395 days) with a significantly lower CI than the AYR and GUE breed. The JER were also significantly younger at first calving that the AYR and GUE breed. There were significant differences between all three non-Holstein breeds in terms of the number of inseminations per successful calving (CINS) with the JER breed requiring more services per calving, followed by the GUE and AYR requiring the least services per calving.

Table 2. Summary statistics of GUE, JER and AYR data (May 2007) used in BLUP runs.

	AYR		GUE		JER	
	Rec %	Mean (sd)	Rec %	Mean (sd)	Rec %	Mean (sd)
CI (days)	74	394.91 (52.42)	74	395.51 (53.68)	75	389.15 (53.44)
MILK (kg)	100	19.07 (4.65)	100	16.75 (4.57)	100	16.16 (4.44)
DFS (days)	89	85.04 (31.65)	92	79.86 (29.51)	93	82.12 (29.87)
NR56 (0/1)	89	1.70 (0.46)	92	1.64 (0.48)	93	1.68 (0.47)
CINS (count)	70	1.61 (0.94)	71	1.77 (1.14)	73	1.65 (1.00)

The mean, standard deviation and range of sire PTAs for the for fertility traits (and fertility index), after base adjustment, are presented in Table 3 for the 1,065 AYR bulls, 784 GUE bulls and 1,604 JER bulls and with daughters in the analysis dataset and a fertility index reliability of 10% or more. These results are presented on their own specific breed base and are therefore not comparable across breeds.

Table 3 shows that bull PTAs for CI had a range of 19 days for AYR, 34 days for GUE and 24 days for JER but 95% of the observations lie in the range of –4 to +4, -5 to +5 and -5 to +5 respectively. NR56 had a range of 36.2 for AYR, 14.5 for GUE and 28.6 for JER meaning the difference between the worst and the best bulls for NR56 is that 36% more daughters in AYR, 14.5% in GUE and 29% more daughters in JER do not return to service within 56 days.

Table 3. Range of fertility proof PTAs and overall fertility index in AYR, GUE and JER breeds.

		CI	DFS	NR56	CINS	FI
	Mean	-0.48	-0.49	0.25	-0.00	0.55
	sd	2.39	1.78	2.05	0.04	3.54
AYR	Range	19.20	36.72	36.24	0.63	55.55
	Min	-11.04	-21.28	-15.68	-0.39	-21.05
	Max	8.15	15.44	20.56	0.24	134.51
	Mean	-0.34	-0.19	0.72	-0.01	1.22
	sd	2.98	1.41	1.75	0.06	3.346
GUE	Range	34.12	11.52	14.48	0.71	30.37
	Min	-17.95	-6.21	-7.21	-0.34	-16.26
	Max	16.17	5.30	7.27	0.36	14.11
	Mean	-0.65	-0.48	0.26	-0.00	0.61
	sd	2.63	1.56	2.05	0.04	3.64
JER	Range	23.56	12.99	28.63	0.43	45.97
	Min	-9.94	-7.96	-21.52	-0.17	-32.15
	Max	12.63	5.04	7.114	0.26	13.83

Figures 1 shows that there has been a genetic decline in fertility in all three breeds over the past 20 years. In the AYR breed CI has been increasing at a rate of 0.22 days per year (r^2 = 0.67), NR56 has been decreasing at a rate of -0.2% per year (r^2 = 0.78) which when combined means that FI has been decreasing at a rate of £0.38 days per year (r^2 = 0.80). In the GUE breed CI has been decreasing at a rate of 0.36 days per year (r^2 = 0.60), NR56 has been decreasing at a rate of -0.16% per year (r^2 = 0.53) which when combined means that FI has been decreasing at a rate of £0.40 days per year (r^2 = 0.44). In the JER breed CI has been decreasing at a rate of 0.16 days per year (r^2 = 0.45), NR56 has been decreasing at a rate of -0.14% per year (r^2 = 0.62) which when combined means that FI has been decreasing at a rate of £0.28 days per year (r^2 = 0.67). The genetic decline in the FI in the AYR, GUE and JER is less than the £0.70 per cow per year seen in the Holstein-Friesian breed (Wall *et al.*, 2003).

Assuming 50% of cows from the three breeds take part in milk recording, there are approximately a total 37,000 AYR, 13,000 GUE and 45,000 JER cows alive in the UK (May 2007). Therefore the genetic decline in female fertility is costing the AYR, GUE and JER breed a minimum of £14,060, £5,200 and £12,600 respectively per year. These costs include only the management costs involved in controlling the genetic (not overall phenotypic) decline in fertility as the genetics and costs incurred due to culling for poor fertility are contained in the breeding value and relative economic value of lifespan. It is also important to remember that these costs accumulate year on year.

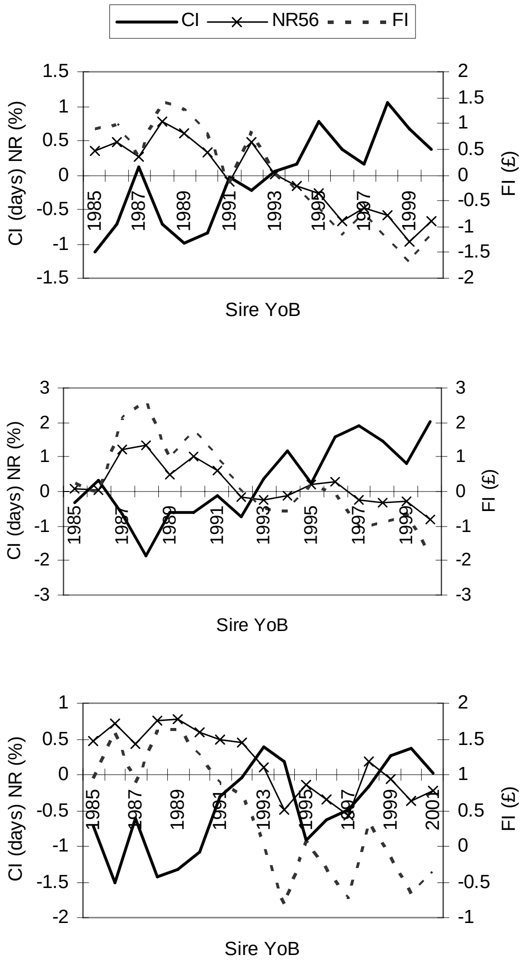

Figure 1. Genetic trends in calving interval, non-return rate fertility index in AYR (top), GUE (middle) and JER (bottom) sires.

Conclusions

This study shows that routine extraction and genetic evaluation of female fertility in non-Holstein dairy cows is possible. Initial estimation of breeding values show that the female fertility traits in the three breeds show genetic variation and therefore will allow the breeds to include fertility in their future selection decisions. These results will be submitted to the Interbull test run for female fertility in September 2007. Future work to enhance the genetic evaluation model may entail calculating breed specific genetic parameters (when possible) and/or across breed evaluation of female fertility.

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