

Breed difference and heterosis estimates for milk production and udder health among Holstein, Friesian and Norwegian Red dairy cattle

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Introduction Crossbreeding provides a means to increase the health and efficiency of animals, by introducing favourable genes from other breeds, by removing inbreeding depression, and by maintaining the gene interactions that cause hybrid vigour (VanRaden and Sanders, 2003). The Norwegian Red (NR) is a potentially useful breed for crossbreeding under Irish conditions (Walsh *et al.*, 2008). A large farm participatory study was established to determine the benefit of crossbreeding with the NR and to generate data to enhance breeding value estimation for the NR breed and crossbreds in Ireland.

Material and methods Data were available from the farm participatory study described by Begley *et al.* (2009). The design was a contemporary comparison; both parent breeds and crosses between them were present on each farm. During the spring of 2004, NR semen from 10 proven AI sires was distributed to generate crossbred females. In June 2004, 393 purebred NR heifer calves were imported to Ireland. All heifers calved for the first time during the spring of 2006. To augment this dataset, herds containing both HF and NR genetics were also identified from the national database. A number of data edits and restrictions were carried out and were comparable to those used in the national genetic evaluations. All herds were milk recorded and thus 305 d milk yield and Somatic cell count data were available from the ICBF. Somatic cell count data were transformed to SCS for normalization of the residuals. A herd-year-season (HYS) variable was created as the combination of herd and date of calving. Each HYS contained records from at least one cow containing a minimum of 50% NR genetics. In Ireland, the Holstein (HO) and Friesian (FR) are considered to be distinct breeds for the purpose of genetic evaluations. The final dataset contained a total of 5,874 cows (8,614 lactations), including 2207 Holstein, 449 NR, 33 FR, 2479 HO×FR and 660 NR×HO, 46 NR×FR. A total of 3,747, 1009 and 790, HO, FR and NR breed equivalents were represented in the dataset. The figures in brackets relate to the breed fraction equivalents. Pedigree data were collated and breed and heterosis effects were estimated by regressing the breed fractions (NR, HO and FR) and proportion of heterozygosity, respectively, on the phenotypic data using the statistical package DMU (Madsen and Jensen, 2008).

$Y = \text{HYS} + \text{age}(\text{parity}) + \beta_1\text{NR} + \beta_2\text{FR} + \beta_3\text{HO}\times\text{FRh} + \beta_4\text{NR}\times\text{HO} + \beta_5\text{NR}\times\text{FRh} + \text{permanent environmental effect} + \text{animal effect} + e$

Parity and HYS were considered as fixed effects, while age at calving was nested within parity. The other effects in the model were included as random effects.

Results The HO the NR had numerically lower 305 d yields of milk (-151 kg), fat (-8.61 kg) and protein (-3.84 kg). However, these were not significantly different. The FR was observed to have lower milk yield (-284 kg; $P < 0.05$), and lower protein yield (-8.13 kg; $P < 0.05$) compared to the HO. Statistically significant heterosis estimates, were observed for 305 d milk yield for the NR×HO, (+120 kg), fat yield (+5.88 kg) and protein yield (+5.09 kg). A genetic superiority for udder health, as indicated by SCS (-0.15), was observed for the Norwegian Red compared to the Holstein. Heterosis for SCS (-0.003), was not significant.

Table 1 Breed and heterosis estimates for milk, fat, protein yield and SCS based for FR, NR, HO×FR, NR×FR and NR×HO compared to the HO

	Milk	SE ¹	<i>P</i> -value ²	Fat (kg)	SE	<i>P</i> -value	Protein (kg)	SE	<i>P</i> -value ¹	SCS	SE	<i>P</i> -value
Average	5795			232			202			1.98		
FR	-284	131.45	<0.05	-1.25	4.965	0.80	-8.13	4.077	<0.05	-0.07	0.048	0.14
NR	-151	92.98	0.10	-8.61	3.388	<0.01	-3.84	2.795	0.17	-0.10	0.029	<0.001
HO×FR	+124	79.61	0.12	+1.02	3.059	0.74	+3.52	2.507	0.16	+0.02	0.311	0.95
NR×FR	+176	170.06	0.30	+3.59	6.495	0.58	+6.13	5.338	0.25	+0.06	0.064	0.35
NR×HO	+120	53.13	<0.05	+5.88	2.001	<0.01	+5.09	1.646	<0.01	-0.003	0.0191	0.87

Conclusions This study provided an insight into the relative production potential and udder health characteristics of HO, FR, NR, HO×FR, NR×FR and NR×HO dairy cows under Irish production circumstances. Heterosis estimates observed in the current study demonstrate that the NR×HO cows are capable of producing milk yields similar to that of HO cows under grazing conditions. HO×FR cows are expected on average to milk a little less. The variation in heterosis levels observed between the breeds highlight the potential requirement for specific heterosis coefficients to be included in routine genetic evaluations in Ireland.

References

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