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Influence of genetic merit and environment on somatic cell counts of Holstein–Friesian cows

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Abstract

Financially, mastitis is one of the most important diseases affecting dairy cattle in the United Kingdom. Seven commercial farms were monitored over a 2.5 year period and data from 1040 cows were included in a study that examined both straw yard and cubicle housing systems. The influence of genetic merit for milk production (PIN_{95} and PTA_{f+p}) on somatic cell counts (SCC) as an indicator of mastitis under commercial farm conditions was assessed. The mean genetic potential (£PIN_{95}) was 39.0 (±0.80) and the mean 305-day milk yield (kg) was 7980 (±54.2). In all, 5618 monthly records of SCC and 1040 records of 305-day SCC were included in the analysis. A multiple regression model was used to assess the influence of genetic merit and the level of concentrate intake on SCC (the $\log_{10}$ transformation was used) under the two housing systems.

Significant interactions between genetic merit and housing system, and concentrate intake and housing system were found. Log_{10} SCC increased with genetic merit when cows were housed in straw yard accommodation, but decreased when cows were housed in cubicle accommodation. The increase in SCC with concentrate feeding was higher for straw yards. For parity 2 animals, there was a significant positive correlation between PIN_{95} and SCC ($r_p = 0.184$, $P = 0.003$) but the correlations between 305-day milk production and SCC were negative for animals greater than parity 2.

Keywords: SCC; Environment; Genetic merit; On-farm; Holstein–Friesian

1. Introduction

The cost of mastitis to the dairy industry in the United Kingdom is associated with lost yield, discarded milk, cost of veterinarian and treatment, herdsman's time, extended calving intervals and extra services per conception, and culling (Whitaker et al., 1983; Collick et al., 1989; Kossaibati and Esslemont, 1995; Dodd and Booth, 2000; Weaver, 2000). Mastitis accounts for 10.1% of cull cows and has an estimated cost of £218 (€330) per case (Kossaibati and Esslemont, 1995). A positive genetic correlation between both milk production and somatic cell counts (SCC), and milk production and mastitis, suggests that with selection for milk yield, SCC and cases of mastitis will increase (Emanuelson et al., 1988; Mrode et al., 1998).

In a review, Mrode and Swanson (1996) reported average heritabilities of ~0.11 for SCC and 0.04 for mastitis. Mrode et al. (1998) and Pryce et al. (1999) subsequently confirmed these results, which indicated that the heritability of SCC, although low, is higher than that for mastitis. The genetic correlation (r_g) between SCC and mastitis incidence was estimated as ~0.7, showing the relatively high and positive genetic correlation between the two traits (Mrode and Swanson, 1996). Other

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authors have estimated the r_g for SCC and mastitis as only 0.3 (Weller et al., 1992), although they attributed the low r_g between SCC and mastitis to the inaccurate recording of clinical mastitis on farms. SCC can therefore be used as an indirect indicator of mastitis (Rogers, 1991) although, as somatic cell count is elevated by irritations to the udder and by factors such as lactation number, stage of lactation, season and milk yield, as well as a series of management factors (Emanuelson and Persson, 1984), the use of SCC as an indicator of mastitis does have some weak points.

The research objective of the present study was to estimate, using data collected from commercial farms, the influence of genetic merit and environment factors (characterised as housing and level of nutrition) on SCC and to assess whether there was a significant interaction between genetic merit and environment factors. PIN_{95} values were used as indicators of genetic merit (for milk production), PIN being a single financial value combining PTA scores for milk, fat and protein yields. The genetic base for PIN was taken as 1995. Significant interactions between genetic merit for milk production and either housing, or level of nutrition may indicate that high merit cows need different management in order to maintain acceptable SCC levels.

2. Materials and methods

Records from 1040 cows were collected during routine on-farm monitoring of seven commercial dairy farms and SCCs were obtained from national milk recording data sheets. Five thousand nine hundred and sixty-seven monthly test-days (of which 5618 were included in the analysis) and one thousand and forty 305-day SCC records were used to look at the influence of genetic merit and environment on mastitis. Data from cows completing 200 days of lactation and calving between August 1997 and April 1998 (1997), and August 1998 and April 1999 (1998) were included in the analysis. Table 1 shows the mean 305-day milk production, level of concentrate feeding and genetic potentials for the cows.

3. Monthly SCC model

A general linear model (Proc GLM, SAS, Version 6, Littell et al., 1991) (Monthly test-day SCC Model) was used to analyse monthly test-day somatic cell counts records and included the fixed effects of year (Yr: Year 97, August 1997–April 1998; or Year 98, August 1998–April 1999) and season (S: 1, winter; 2, spring; and 3, autumn) of calving, month of recording (MOR, calendar month), parity (P: P1, first; P2, second; and P3, third and above) and stage of lactation (St, 0–29, 30–59, 60–89... 180–210 days), and the interaction between stage and parity (St*P). The model also contained parameters to describe the herd environment such as housing system (Hs, cubicle or straw yard) and concentrate intake (kg/day) (C), and an indicator of genetic merit (PIN_{95}). The linear regression was carried out on Log_{10} SCC.

The Log_{10} SCC was calculated from the SCC records where actual SCC was divided by 1000:

$$Log_{10}SCC = \log_{10}(SCC/1000)$$

Table 1
Mean 305-day milk production

	Overall		Cubicles		Yard	
	X	sd[a]	*X*	sd[a]	*X*	sd[a]
Milk production (305-day)						
Milk yield (kg)	7980		8601	1583	6789	1328
Fat yield (kg)	318	74.9	348.3	64.9	269.4	63.4
Protein yield (kg)	261	57.4	286.4	51.2	221.0	42.0
Milk composition						
Fat (%)	4.03	0.466	4.083	0.464	3.962	0.460
Protein (%)	3.31	0.199	3.351	0.200	3.264	0.184
Intake						
Concentrate offered (kg/day)	7.70	1.910	8.89	1.284	5.825	1.031
Genetic potential						
$\leqslant PIN_{95}$	38.9	25.39	48.23	22.83	24.16	22.02
Records used						
Monthly test-day	5618					
305-day	1040		635		405	
Somatic cell count						
SCC	144.6	183.8	137.9	191.7	155.1	170.5
LnSCC	1.969	0.378	1.935	0.384	2.022	0.363

[a] sd, standard deviation.