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Reproductive performance of Holstein-Friesian cows differing genetically in live weight

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ABSTRACT

The reproductive performance of two genetic lines of Holstein-Friesian cows bred for heavy (H) or light (L) mature live weight (LW) was evaluated from 1992 to 1997. The interval calving to ovulation was shorter ($P < 0.05$) for H cows (28 ± 3.2 days) than for L cows (L: 31 ± 2.5 days), but the difference between the lines in the interval calving-first heat was not significant (H: 50 days; L: 43 days). However, in the cows older than 2 years old, the H cows had a lower conception rate at first service than the L cows (H: 58% vs. L: 70%) which extended the conception and calving pattern of the H cows. The possible reasons for those differences in the reproductive performance are discussed as topics for further research.

Keywords: dairy cows; live weight; Holstein-Friesian; reproductive performance; conception rate.

INTRODUCTION

In New Zealand, milk production is based on a high pasture utilisation which is achieved using a relatively high stocking rate under a seasonal system of milk production (Holmes, 1990). Under this scenario, because of the maintenance costs, size of the cows was identified as a component affecting the final efficiency of the dairy systems in New Zealand (Ahlborn and Dempfle, 1992; Holmes *et al*., 1993). Live weight of the cows is now given a negative weight in the new overall objective of increasing the value of milk solids produced per tonne of DM eaten (Livestock Improvement Corporation, 1996).

The reproductive efficiency of the herd is crucial to the success of a seasonal system of milk production (Macmillan and Clayton, 1980). The system's productivity is based on a compact calving pattern (Macmillan *et al*., 1984), and therefore on the achievement of a high submission rate and a high conception rate to a single service during the mating period (Xu and Burton, 1996). The correlated effects of genetic selection for or against any characteristic on the reproductive efficiency of the dairy cows must be considered in this situation. However, the information reported in the literature about the effects of size on the reproductive performance of the dairy cow is scarce. Recently, after 30 years of divergent selection for size in Minnesota, Hansen *et al*., (1998) reported that the large line of cows required more services per conception than the small line. Other authors (Badinga *et al*., 1985; Markusfeld and Ezra, 1993) reported similar antagonism between size and conception rate. Conversely, negative genetic correlations (-0.23) were reported between calving intervals, and size and stature of the dairy cows in Canada (Dadati *et al*., 1986).

The aim of the present study was to compare the reproductive performance of Holstein-Friesian cows from the heavy and light live weight selection lines developed at Massey University.

MATERIALS AND METHODS

Details of the two lines of Holstein-Friesian cows and of their development are given by Garcîa-Muñiz *et al*., (1998a 1998b). The reproductive performances of the L-line (n = 131 cow-years) and the H-line (n = 132 cow-years), managed as one herd, were compared during the period from 1992 to 1997. The information was used to estimate the reproductive parameters suggested by Grosshans *et al*., (1996) for evaluating the fertility traits of dairy cows in New Zealand. In addition, the calving to ovulation interval (C-Ov) was estimated for 124 cows (H = 58; L = 66) from the progesterone (P_4) concentration in milk samples taken thrice weekly in 1996 and twice weekly in 1997. Ovulation without behavioural oestrus was defined to have occurred 5 days before P_4 concentration in milk was above 2.5 ng/ml for at least two consecutive samples (McDougall, 1994).

Since the reproductive data were not normally distributed and some of the cows had censored information (were treated with Controlled Intravaginal Drug Release Devices (CIDR™, InterAg-New Zealand) before the planned start of mating, were empty after the mating period or were induced during the calving period) the LIFETEST procedure (SAS, 1995) was used in the analysis of the variables C-Ov, Calving-First heat (C-H), Planned Start of Mating-Conception (PSM-Con), Planned Start of Mating-First Service (PSM-1Serv) and Planned Start of Calving-Calving Date (PSC-C). Calving date, age and year were tested in all the models. Categorical variables were analysed using PROC FREQ (SAS, 1995).

RESULTS

The H and L-cows providing the reproductive data for this study were the offspring of 12 sires with high breeding value (BV) for live weight (LW) and 12 sires with low BV for LW. Their average mature weight estimated by growth

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TABLE 1: Means (± standard errors) for the intervals: calving-ovulation (C-Ov), calving-first heat (C-H), planned start of mating-first service (PM-1Serv), planned start of mating-conception (PSM-Con) and planned start of calving-calving (PSC-C) of genetically heavy or light Holstein-Friesian cows

		Genetic line		
Interval (days)	No. of cowyears	Light	Heavy	Significance[2]
C-Ov[1]	124	31 ± 2.5	28 ± 3.2	*
C-H	260	43 ± 2.0	50 ± 6.0	NS
PSM-1Serv	234	11 ± 1.0	12 ± 1.0	NS
PSM-Con	234	21 ± 1.8	25 ± 2.0	NS
PSC-C	260	22 ± 1.6	25 ± 1.7	NS

[1] Data from 124 cows (H: 58; L: 66) collected during 1996 and 1997.
* Log-Rank Test P < 0.2; Wilcoxon Test P < 0.05.

curve analysis were 516 kg and 470 kg for the H and L cows, respectively (See García-Muñiz *et al*., 1998b, this volume). The H cows had shorter C-Ov intervals than the L cows (Table 1), with the difference more marked in 1996. The percentage of first ovulations which were accompanied by oestrus behaviour was higher (P < 0.05) for the L (40%) than for the H cows (30%). The two lines of cows showed similar C-H intervals (Table 1), but the H cows > 2 year old tended to present longer C-H intervals than the L cows > 2 year old (L = 38.1 ± 3.0 vs. H = 50.8 ± 6.3 days, P < 0.1). The percentage of cows treated with CIDRs was the same for the two lines (8%).

No significant differences were detected between the lines in the pattern of the PSM-1serv, the PSM-Con and PSC-C intervals (Table 1), nor in the proportion of empty cows at the end of the mating period (L = 7% vs. H = 5.7%). However, the difference in PSM-Con interval for the 2 year old cows approached significance (L 2 year old cows = 18.4 ± 2.9 vs. H 2 year old cows = 26.3 ± 3.53 days, P<0.1). Similarly, although the length of gestation was the same for the two lines (280 days), the difference in PSC-C for the three year old cows approached significance (L: 23.7 ± 3.2 days; H: 31.8 ± 3.3 days, P = 0.06), and in the cows >3 year old cows, the H cows also tended to show longer PSC-C intervals than the L (L: 25.2 ± 2.0 days; H: 30.4 ± 2.1 days; P = 0.15). Furthermore, the percentage of H cows which were induced was significantly higher than that of L cows (H: 9.1% vs. L: 1.5%; P < 0.05). These differences occurred despite the fact that the first calving heifers of the two lines presented similar PSC-C intervals (L heifers = 15.6 ± 2.3 vs. H heifers = 15.0 ± 2.1 days).

This tendency for a more prolonged conception and calving pattern shown by the H mature cows was caused by their lower conception rate at first service compared to the L cows (Table 2). Consequently, in cows > 3 years old, more L cows than H cows tended to conceive in the first 21 days of mating period and to calve in the first 21 days of the calving period (Table 2). However, there was considerable variation between years in the conception rate at first service of the two lines, especially for the H cows (Table 2).

DISCUSSION

The L cows tended to have longer C-Ov intervals, but similar C-H intervals compared to the H cows. The values reported for these two intervals and the two lines are similar to those published for grazing cows (McDougall, 1994, Xu and Burton, 1996; Macmillan and Clayton, 1980). The difference in C-Ov interval between the lines, especially in 1996, may have been associated with differences between the two lines in body condition score change and energy balance in early lactation. In 1996, the decrease in body condition score to week 5 was slightly larger in the L-cows than in the H-cows, and a higher proportion of cows from the L-line were calculated to be in larger negative energy balance (> -10 MJ/day) than those from the H-line (Laborde, 1998).

In 1996 C-Ov was negatively related to body condition score at calving and at 40 days, but no such relation was apparent for PSM-Con. Extended C-Ov intervals have been related to nutrition level post-calving (Butler and Smith, 1989; McDougall, 1994) and the duration and depth of the post-calving negative energy balance of the dairy cows (Butler and Smith, 1989). On the other hand, the different pattern of the C-Ov and the C-H intervals between the lines may have been caused by the fact that only 30% of the H cows were detected in oestrus at first ovulation, compared to 40% of the L line.

TABLE 2: Percentage of total cows from each genetic line calving in the first 21 days of the calving period, conceiving during the first 21 days of the mating period and conceiving at first service in 1992-1997, and separately for 1994, 1995, 1996, 1997 (the years with the largest number of cows available)

		Year and number of cows per line				
		1992-97	1994	1995	1996	1997
Item	Line	(n = 260)	(n = 19 H + 14 L)	(n = 23 H + 14 L)	(n = 32 H + 32 L)	(n = 45 H + 44 L)
% cows calving 1st 21 days	L	66†	50	83*	71†	56
	H	53†	56	56*	47†	53
% cows pregnant 1st 21 days	L	71†	71†	83*	67	76
	H	60†	58†	52*	56	72
% cows pregnant at 1st service	L	70*	79†	74*	62	77
	H	58*	63†	43*	53	73

Significance of the difference between the two lines † P < 0.1 * P< 0.05

The PSM-1serv and PSM-Con intervals were the same for both lines, significantly shorter than those reported by Grosshans *et al.*, (1996), but similar to those reported by other authors in New Zealand (Xu *et al.*, 1995). However, the > 2 year old H-cows had a less compact calving pattern and a higher ratio of induction than the > 2 year old L-cows in all the years because of their lower conception rate at first service. The average value for cows pregnant to first service (CR) in New Zealand is around 60%, with some farmers achieving 75% (Xu *et al*., 1995). Although the CR of the two lines is in the range of these values, the values for the L cows were consistently higher than those of the H cows. A negative relationship between size of the dairy cows and conception rate was also reported by other authors (Badinga *et al.*, 1985; Markusfeld and Ezra,1993; Hansen *et al*., 1998). Conversely, negative (-0.23) genetic correlations were reported between calving intervals, and size and stature (Dadati *et al*., 1986).

The reasons for the suspected antagonism between size and conception rate are unclear. Conception rate is a variable affected by multiple factors (Xu and Burton, 1996). In a previous study, larger and heavier cows usually lost more LW after calving (Markusfeld and Ezra, 1986), but in the present study, at least for the 1996 season, BCS at mating, BCS change between calving and mating, and LW change between calving and mating did not affect the PSM-Con interval (Laborde, 1998). In another study, the heavier cows had a greater incidence of periparturient diseases which affected the conception rate of the cows (Badinga *et al*., 1985). For the cows in the present study the incidence of difficult calvings was not different for H and L cows (García-Muñiz *et al*., 1998a).

Conception rate at first service is increased by a longer period between calving and first mating (Butler and Smith, 1989), and the occurrence of at least one heat before mating (Macmillan and Clayton, 1980). However, in the current case, the mean Calving-First service interval (L: 83 days vs. H: 80 days) and the percentage of cows which were anoestrus at the PSM date were similar for both lines. Furthermore, the average non return rates achieved by the H and L bulls used in the present study were the same for both lines (69 %), as determined from their widespread use throughout New Zealand (Livestock Improvement Corporation, 1997; unpublished data).

In summary, the reproductive data analysed for the period 1992-1997 suggest that the L-cows achieved a slightly better reproductive performance than the H-cows mainly because of slightly higher CRs from >3 years old cows. However, this conclusion should be taken with caution because the reproductive results changed significantly between years. Therefore, more information is required from subsequent seasons, before any definite conclusion is reached about the reproductive performance of the two lines of cows.

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