

Effect of suckler cow genotype on milk yield and pre-weaning calf performance

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Milk yield and pre-weaning calf performance of spring-calving Charolais (C) and Beef × Holstein-Friesian (BF) cows was compared over 3 experiments. Cows were individually offered a restricted allowance of grass silage pre partum in Experiments 1 and 2 and *ad libitum* silage in Experiment 3. In all three experiments cows received silage to appetite for the first 34 (s.d. 16.2) days of lactation. In Experiments 1 and 2, cows and calves were grazed together during the subsequent grazing seasons. The daily milk yield of C cows was significantly lower from parturition until turnout to pasture (1.8 to 2.5 kg/day lower) and subsequently at pasture (4.5 and 3.1 kg/day lower in Experiments 1 and 2, respectively) than that of BF cows. Calves from C cows consumed more ($P < 0.01$) concentrate creep feed during the indoor period than calves from BF cows. Compared to calves from BF cows, pre-weaning daily live-weight gain was lower for calves from C cows in Experiments 1 ($P < 0.05$) and 2 ($P = 0.06$). The pre-weaning growth response per 1 kg increase in milk yield was greater for calves from C cows than those from BF cows. In conclusion, compared to BF cows the milk yield of C cows was lower resulting in increased calf concentrate intake indoors and lower pre-weaning calf daily live-weight gains.

Keywords: Genotype; milk yield; suckler cows; weaning weight

Introduction

Due to the increased proportion of suckler cows in the national herd, the replacement of Friesians by Holsteins in the dairy herd, which is undesirable from a beef point of

view, and a preference for home bred animals to reduce costs and avoid introducing disease there has been increased retention of replacements from within the suckler herd in Ireland. Coupled with a preponderance of continental sire breeds being used in the suckler herd, such a breeding

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policy will inevitably result in an increasing proportion of continental breeding in the suckler cow herd. This is likely to result in more pure-bred cows (mainly Charolais, as it is the most widely used sire breed) thereby foregoing the advantages of hybrid vigour (Simm, 1998) in addition to a potential reduction in milk production, due to a diminishing influence of dairy breeding, and consequently reduced calf pre-weaning weight gain (Drennan, 1971b; Drennan and Bath, 1976; Le Neindre *et al.*, 1976; Wright *et al.*, 1994).

The overall objective of the three experiments reported here was to determine the effect of cow genotype on milk yield and its effect on the performance of suckled calves pre-weaning.

Materials and Methods

Animals, feeding and general management

Data were obtained, over three consecutive winter periods (between December 1993 and April 1996) indoors and the subsequent summer grazing period following the first two winters, on the performance of spring-calving (commencing mid-February) upgraded ($\geq 7/8$) Charolais (C) cows with first-cross Beef (Hereford and Limousin) \times Holstein-Friesian cows (BF). Each year the cows were bred using two Charolais sires (across breeds), one by artificial insemination (A.I.) and the second by using natural mating. The Hereford \times Holstein-Friesian cows were older than the Limousin \times Holstein-Friesian cows as the latter were used for annual replacements throughout the three experiments. Therefore, the proportion of Hereford \times Friesian cows in the BF genotype declined over the three experiments. Replacement heifers (C and Limousin \times Holstein-Friesian) were bred to a Limousin bull (A.I.) to calve at 2 years of age and were introduced into the

herd at turnout to pasture. Consequently, data obtained during the indoor feeding period did not include first lactation animals while data obtained at pasture did. Hereford \times Holstein-Friesian and Limousin \times Holstein-Friesian cows were grouped as a single type (BF) for all analyses.

Cows were accommodated in individual tie-up stalls pre partum and were offered, in the first two experiments, a restricted (approximately 30 kg fresh weight daily) allowance of grass silage (*in-vitro* dry matter digestibility (DMD) 637 and 639 g/kg in Experiments 1 and 2, respectively) and in Experiment 3, grass silage (*in-vitro* DMD 686 g/kg) *ad libitum*. Following parturition in all three experiments cows received grass silage *ad libitum* (*in-vitro* DMD 740 to 767 g/kg) until turnout to pasture.

Cows were removed from their stalls prior to parturition (generally 1 to 4 days) and placed in straw-bedded calving pens. After parturition cows remained in the pens for a minimum of 4 days with the calf having free access to the dam. The early calving cows (approximately the first 50 to 70% of cows) were returned to the stalls with their calves placed behind them in individual pens. Calves were offered a barley/soyabean based concentrate creep feed from approximately 3 weeks of age until turnout to pasture and had twice daily (approximately 0800–0900 and 1600–1630) access to their dams for suckling. Later calving cows and their calves were grouped together with 2 to 4 cows per pen. During the indoor period, cow milk yield and the corresponding calf average daily gain were obtained from the early calving-cows and their calves. Concentrate creep intake by calves was only recorded in Experiment 1.

At pasture cows and their calves were blocked by genotype (C, Limousin \times

Holstein-Friesian and Hereford × Holstein-Friesian) across four grazing systems (an ongoing grazing management system experiment) each with 15 cows (McGee, Drennan and Caffrey, 1998). Cows were turned out to pasture in two groups to facilitate balancing treatments in the grazing experiment. Also additional cows and their calves were introduced to the study where required to balance numbers. The swards consisted predominantly of perennial ryegrass and were rotationally grazed. All calves were abruptly weaned in autumn. Due to a severe shortage of grass as a result of drought, calves were weaned approximately 5 weeks earlier in Experiment 2. Details of key dates are summarised in Table 1.

Calf records

Calf weight was recorded within 12 h of birth. Calves were weighed again at turnout to grass and every 4 weeks thereafter until weaning.

Milk yield estimation – Experiment 1

Cow milk yield was estimated indoors and at pasture using the weigh-suckle-weigh technique. Indoor estimates were obtained for 11 C and 21 BF cows from approximately the third to the eighth week of lactation depending on calving date. Initially estimates were obtained on two consecutive days (to perfect the technique and examine its repeatability) at approximately weekly intervals while later

estimates were over just one day and at weekly intervals resulting in 3 to 11 estimates per cow. The procedure indoors involved a 15.5- to 16-h separation period after which the calves were weighed to the nearest 1.0 kg before and after suckling and the weight difference taken as yield of milk. This was repeated 7.5 to 8.0 h later and both weight differences were combined to give a 24-h yield estimate. This procedure did not represent an unusual situation to the animals as normal management resulted in calf separation from the cows with twice daily access and hence, a purposeful preliminary suckling out was not required. Six outdoor estimates were obtained from 23 C and 36 BF cows. The first, or preliminary estimate (May), was carried out on half the cows twice to establish and refine the technique while the remaining 5 estimates were carried out on all the cows at approximately 28-day intervals (June to October inclusive). For each estimate the procedure was carried out over 4 days using 15 cows and calves per day. Suckling was prevented by using a calf muzzle so that calves were present with the dam at all times to minimise alterations in the grazing behaviour of the dam. Following an initial suckling-prevention period of 8 h and a preliminary suckling out, calves were re-muzzled and weight changes before and after suckling were recorded 16.5 to 17 h later. The difference between the pre- and post-suckling weights was adjusted to a 24-h basis providing an

Table 1. Key dates for Experiments 1, 2 and 3

| Event | Experiment 1 | Experiment 2 | Experiment 3 |
|------------------|--------------|--------------|--------------|
| Mean calving | Mar 17 | Mar 14 | Mar 21 |
| Turnout to grass | | | |
| Group 1 | Apr 14 | Apr 12 | Apr 4 |
| Group 2 | May 5 | Apr 25 | – |
| Calf weaning | Oct 26 | Sept 21 | – |

estimate of daily milk production. Suckling was deemed complete when the calf was observed moving quickly from teat to teat. If any doubt occurred the udder was checked by hand stripping. The calves were weighed immediately after suckling and kept moving between sucking and weighing to discourage urination or defecation. At all stages data from any cow not suckled out fully was omitted from the data set.

Milk yield estimation – Experiment 2

Milk yield was estimated indoors and at pasture as described in Experiment 1. Indoor estimates were obtained for 13 C and 29 BF cows from approximately the third to the seventh week of lactation depending on calving date resulting in one to six estimates per cow at approximately weekly intervals. Separation periods indoors were approximately 15 h and 9 h and calves were weighed to the nearest 0.2 kg before and after suckling. Outdoor estimates were obtained from 22 C and 37 BF cows and consisted of three estimates (June, August and September). The suckling recording period was 16.0 to 16.5 h (following an 8 h suckling-prevention period and a preliminary suckling out).

Milk yield estimation – Experiment 3

Milk yield estimates were as described for Experiment 2 and were collected from 13 C and 16 BF cows. Estimates per animal ranged from 1 to 4 and applied to the indoor period only.

Statistical analysis

Data were subjected to analysis of variance using PROC GLM of SAS (2001). Terms included in the model for cow data were genotype and terms included in the model for calf data were genotype of dam, sex of calf and sire of calf. Grazing

system was included as a blocking term for all data obtained at pasture. Calving day and lactation number of the dam were used as covariates in all models. Least squares means are reported with standard errors. To determine the effect of time, where repeated measures were carried out on the experimental unit, a repeated measures analysis of variance was carried out using PROC MIXED of SAS (2001). Regressions of calf live-weight gain (g/day) on milk yield (kg) were also carried out using PROC GLM and a contrast statement was used to determine significant differences between genotypes in the regression coefficient. Included in the models were terms for genotype of dam, sex of calf, sire of calf and grazing system.

Results

Milk yield and calf performance

Mean milk yield and calf performance indoors and at pasture are presented in Table 2. Milk yields at pasture are presented in Figure 1. In the three experiments C cows produced significantly less milk than BF cows from parturition until turnout to pasture. The increase in milk yield after turnout to pasture was greater for BF cows than C cows in both Experiments 1 ($P = 0.06$) and 2 ($P < 0.05$). At pasture, milk yield was lower ($P < 0.001$) for C cows than BF cows at all measuring times in both Experiments (Figure 1). There was a significant decline in milk yield throughout the grazing season in both Experiment 1 ($P < 0.05$) and Experiment 2 ($P < 0.001$).

Calf birth weight was similar for both genotypes in all 3 experiments (Table 2). Compared to calves from BF cows the live-weight gain of calves from C cows from birth to turnout to grass was significantly lower in all 3 experiments. In Experiment 1 calves from C cows had a higher daily concentrate creep intake (244

Table 2. Least squares means (s.e.) for effect of cow genotypes on milk yields and calf growth in each of three experiments

| | Experiment 1 | | | Experiment 2 | | | Experiment 3 | | |
|--|-----------------------|--------------|------|--------------|--------------|------|--------------|-------------|------|
| | Genotype ¹ | | Sig. | Genotype | | Sig. | Genotype | | Sig. |
| | C | BF | | C | BF | | C | BF | |
| Cow milk yield (kg/day) | | | | | | | | | |
| Indoors | 7.4 (0.52) | 9.2 (0.37) | ** | 7.3 (0.45) | 9.6 (0.31) | *** | 6.6 (0.35) | 9.1 (0.32) | *** |
| Post-turnout to pasture ² | 8.3 (1.04) | 12.1 (0.74) | ** | 8.4 (0.60) | 12.3 (0.41) | *** | — | — | — |
| At pasture | 7.6 (0.44) | 12.1 (0.35) | *** | 6.9 (0.39) | 10.0 (0.30) | *** | — | — | — |
| Calf performance | | | | | | | | | |
| Birth weight (kg) | 45.5 (1.42) | 43.3 (1.21) | | 44.7 (1.23) | 43.7 (0.98) | | 47.4 (1.74) | 46.1 (1.58) | |
| Weight at turnout (kg) | 71.2 (2.41) | 77.1 (2.06) | * | 70.0 (2.32) | 74.3 (1.85) | | 76.0 (3.70) | 81.1 (3.36) | |
| Weaning weight (kg) | 275.8 (7.07) | 297.3 (6.03) | * | 259.8 (6.37) | 272.0 (5.14) | | — | — | |
| Daily gain birth to turnout ³ (g) | 660 (58.7) | 830 (44.3) | * | 765 (52.1) | 964 (34.5) | ** | 715 (55.1) | 955 (50.0) | ** |
| Daily gain at pasture (g) | 1099 (29.1) | 1192 (24.8) | * | 1192 (35.9) | 1249 (29.0) | | — | — | |
| Daily gain birth to weaning (g) | 1028 (28.0) | 1138 (23.9) | ** | 1119 (31.9) | 1191 (25.7) | | — | — | |

¹C = Charolais, BF = Beef × Holstein-Friesian.

²First milk yield measurement after turnout to pasture for cows recorded indoors.

³Data for calves from the early-calving cows only.

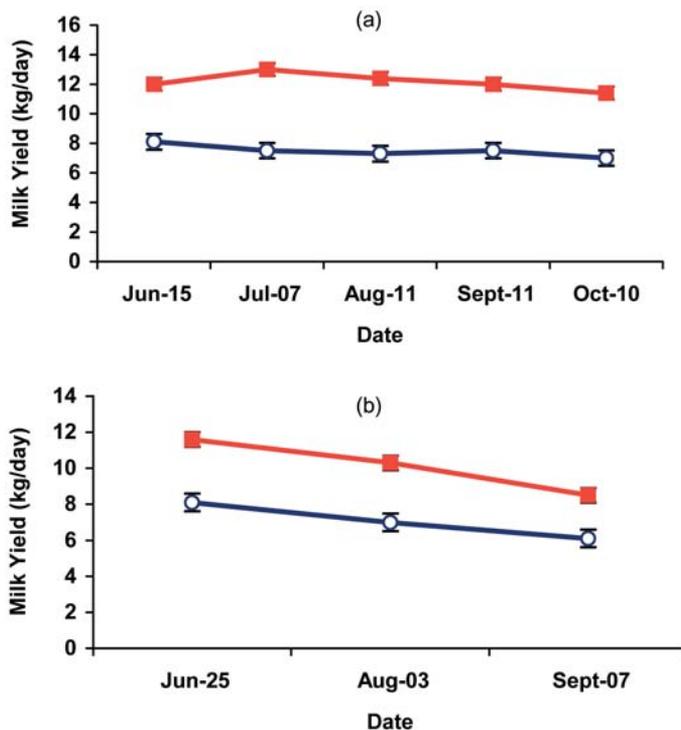


Figure 1: Milk yield (\pm s.e.) of Charolais (—○—) and Beef \times Holstein-Friesian (—■—) cows at pasture: a) Experiment 1, b) Experiment 2.

vs. 108 g, $P < 0.01$) during the indoor period than calves from BF cows.

In Experiments 1 and 2, calves from C cows had lower live-weight gain at pasture than calves from BF cows although the difference was only significant ($P < 0.05$) in Experiment 1. Live-weight gain from birth to weaning was lower for calves from C cows than for those from BF cows in Experiments 1 ($P < 0.05$) and 2 ($P = 0.06$). Consequently, calves from C cows were lighter at weaning in Experiments 1 ($P < 0.05$) and 2 ($P = 0.10$).

The regression coefficients for calf live-weight gain on milk yield for C cows and BF cows are presented in Table 3. In Experiment 1 the calf growth response associated with a 1 kg increase in cow milk yield was significantly higher in calves

from C cows than calves from BF cows during the indoor, pasture and pre-weaning periods. The difference between genotypes in regression coefficients during the indoor period was not significant in Experiments 2 or 3. At pasture in Experiment 2, calves from BF cows tended ($P = 0.06$) to have a lower regression coefficient, which reached significance ($P < 0.05$) for the pre-weaning period, than calves from C cows.

Discussion

Milk yield

The lower milk yield of the C cows compared to the BF cows agrees with previous reports that show beef \times dairy breeds usually have higher milk yields than beef

Table 3. Regression coefficient (g/kg) of calf live-weight gain on milk yield for Charolais (C) and Beef × Holstein-Friesian (BF) cows for various growth periods in each experiment

| Experiment | Period | Genotype | | Significance |
|------------|-------------|---------------------------|-------------|--------------|
| | | C | BF | |
| 1 | Indoors | 105.6 (48.1) ¹ | 46.0 (21.3) | * |
| | Pasture | 51.5 (22.7) | 20.2 (9.1) | * |
| | Pre-weaning | 55.4 (20.7) | 17.6 (8.3) | ** |
| 2 | Indoors | 84.7 (47.3) | 70.7 (21.0) | |
| | Pasture | 65.1 (31.6) | 27.2 (12.1) | |
| | Pre-weaning | 63.7 (27.1) | 24.1 (10.4) | * |
| 3 | Indoors | 112.4 (87.0) | 86.2 (38.1) | |

¹() = s.e.

breeds (Wright *et al.*, 1994). The milk yield of the C cows both indoors and at pasture is generally consistent with most literature values (e.g. Petit and Lienard, 1988; Petit and Agabriel, 1993; Agabriel *et al.*, 1995) although higher than some reports (Le Neindre and Petit, 1975). The similar milk yield of the C cows to reports mainly concentrated in France suggests that the maternal performance of the cows used in this study was similar to that in France where maternal values (such as milk yield) are incorporated into the national breeding policy. The milk yield obtained indoors for the BF cows is broadly in line with values obtained indoors in other studies using spring-calving cows (Hodgson *et al.*, 1980; Baker, Le Du and Barker, 1982). The milk yield obtained at grass in the present study is at the upper end of reported values with BF cows (and suckled cows in general) but similar to values obtained by Hodgson *et al.* (1980), Baker, Le Du and Alvarez (1981b), Baker, Barker and Le Du (1982), Wright *et al.* (1994) although higher than those reported by Wright and Russel (1987) and Drennan and More O'Ferrall (1987).

Inconsistencies exist in the literature on the suitability of the main methods to estimate suckler cow milk yield, i.e. machine and/or hand milking with or without the use of oxytocin compared to weigh-suckle-

weigh with or without the use of oxytocin. Many of the studies cited above used non-suckling methods. The weigh-suckle-weigh procedure was used in the present study as it is the most natural method and is easier to implement. Unlike most studies whereby this procedure involves calf separation from the dam, the calves in the present study were in the presence of their dams at all times during the milk-yield estimation process at pasture. The segregation of cows from their calves may disrupt their normal grazing and behavioural patterns (Somerville and Lowman, 1980). Cows in the present study displayed no abnormal behaviour during the milk-yield estimation process and consequently, values obtained should be more accurate.

On a number of occasions during the indoor period and immediately following turnout to pasture, suckling to completion was not attained and these figures were not included in the data set. This was more common in BF cows than C cows and thus the potential milk yield of the former genotype was probably underestimated, especially in the indoor period. French authors have reported that from shortly after birth the milk intake of a calf is limited by the milk production of its dam (Le Neindre and Vallet, 1992) while other studies have suggested that milk production is limited by the capacity of the

calf (Drennan and More O'Ferrall, 1987; Sinclair *et al.*, 1994). The former would generally apply to studies with lower-yielding beef cows while the latter applies to studies with higher-yielding beef \times Friesian cows, as in the present study. Suckling the udder to completion was easily attained during the later estimates at pasture. Assuming that the suckling ability of calves from both genotypes is similar, the greater milk intake during the indoor period by the calves from BF cows (which could be considered almost to appetite) compared to the calves from C cows highlights the shortfall (1.8 to 2.5 kg) the latter calves endured during the pre-ruminant stage.

The greater concentrate creep intake indoors by calves from C cows than those from BF cows in Experiment 1 would be expected due to the lower milk yield of their dams. Where milk supply is restricted calves eat more grass, forage or concentrate (Wright and Russel, 1987; McMorris and Wilton, 1986).

The higher milk production at grass compared to indoors for both genotypes agrees with reports in the literature which show that milk yield increases rapidly following turnout to pasture (Wright, 1988; Petit *et al.*, 1992). The magnitude of the increase in the BF cows agrees with increases reported by Drennan and Bath (1976) and Hodgson *et al.* (1980) while that of the C cows is lower than reports with spring-calving cows. This suggests that milk production indoors for both genotypes was limited by nutrition but possibly to a greater extent in BF cows than C cows as the magnitude of the increase for the former was much greater following turnout to pasture.

The decline in milk yield as lactation progressed was evident in Experiments 1 and 2. In Experiment 1 milk yield of BF cows peaked at the second measurement at pasture (day 119 of lactation) and then

declined whereas milk yield of the C cows generally declined from the first measurement at pasture. While milk yields in June were comparable for Experiments 1 and 2, the greater magnitude of the decrease in milk yield in Experiment 2 compared to Experiment 1, can be associated with the poor pasture supply due to drought conditions during the second experiment. This result is consistent with Wright and Russel (1987) who found that the persistency of lactation was adversely affected when cows grazed to a lower post-grazing height. Theoretically, the decrease in milk supply should be delayed somewhat as the year advances and grass growth declines as the cow will attempt to maintain milk production by mobilising body reserves (Hodgson *et al.*, 1980; Baker *et al.*, 1981b; Agabriel *et al.*, 1995). However, with prolonged under-nutrition milk yield will be adversely affected. Cows on high stocking rates or low herbage allowances have lower milk yield and greater cow live weight and (or) condition loss (or lower weight and condition score gains) than cows on low stocking rates or high herbage allowances (Drennan, 1971 a and b; Baker, Alvarez and Le Du, 1981a; Wright *et al.*, 1994; McGee *et al.*, 1998). This would explain the lower milk yields, especially in BF cows, obtained at pasture in Experiment 2.

If milk supply to the calf decreases, grass intake is increased but this cannot usually offset the decline in growth resulting from decreased milk intake (Wright and Russel, 1987). Despite the lower milk yield and poorer grass supply, calf average daily gain at pasture was in fact higher in Experiment 2 for both genotypes and can probably be attributed to the earlier weaning date/age.

Relationship between milk yield and calf growth

The positive relationship between milk yield and calf daily gain is widely recognised. The

regression coefficients of calf live-weight gain pre-weaning on average milk yield at pasture in the present study fall within the range for moderate- to high-yielding spring-calving cows grazing temperate pasture (Drennan and Bath, 1976; Baker *et al.*, 1981b). The higher regression coefficients between milk yield and calf growth rate in calves from C cows than BF cows partially reflects the declining growth response to increased milk yield. McMorris and Wilton (1986) reported that as milk yield increased the corresponding increase in weaning weight decreased when examined across a relatively wide range of milk yields. Similarly, Mallinckrodt *et al.* (1993), working with low milk-yielding Hereford cows and high yielding Simmental cows, found that the regression coefficient of calf weaning weight on average daily milk yield was higher for the Hereford.

In conclusion, compared to the C cows the higher milk yield of the BF cows resulted in their calves generally having a higher average daily gain indoors, at pasture and pre-weaning, and consequently a heavier live weight at weaning. A primary objective of suckler beef production should be to produce a heavy weanling per cow annually. Evidence shows that this live weight difference at weaning is largely retained until slaughter (Drennan and McGee, 2004; Drennan, McGee and Keane, 2005). Accordingly, consideration should be given to potential milk yield when selecting suckler dams.

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