Performance and feed intake of five beef suckler cow genotypes and pre-weaning growth of their progeny

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The effect of beef suckler cow genotype on feed intake, performance, milk yield and on pre-weaning growth of their progeny was determined over four lactations. The five cow genotypes examined were Limousin (L), Charolais (C), Limousin × Holstein-Friesian (LF), Limousin × (Limousin × Holstein-Friesian) (LLF) and Simmental × (Limousin × Holstein-Friesian) (SLF). The herd calved in spring and the progeny spent from April until weaning (October/ November) at pasture with their dams. Live weight (kg) at the start of the indoor winter period was greater (P < 0.001) for C (702) than L (616) cows who in turn were heavier than LF (552) and LLF (574), with SLF (582) being intermediate. Silage dry matter (DM) intake (kg /day) was greater (P < 0.01) for C and SLF cows than L and LLF, whereas LF were intermediate. Dry matter intake (kg/day) of zero-grazed grass did not differ (P > 0.05) between the genotypes but followed a similar trend to grass silage intake. The decrease in live weight over the indoor winter period was greater (P < 0.01) for L and C cows than for LLF and SLF, whereas LF were intermediate. The increase in live weight during the grazing season was greater (P < 0.01) for C cows than all except L, which were intermediate. Calving difficulty score was greater (P < 0.01) for C cows than LLF, L and SLF, whereas LF were intermediate. Birth weight of calves from LF cows was lower (P < 0.001) than C with L being intermediate, but greater than LLF, with SLF being intermediate. Milk yield (kg/day) was higher (P < 0.001) for LF (9.7) and SLF (8.7) cows than the other genotypes (5.5 to 7.0), which did not differ significantly. Pre-weaning live-weight gain was greater (P < 0.001) for progeny of LF cows than all other genotypes except SLF, which in turn were greater than L and C, with LLF being intermediate. In conclusion, calf pre-weaning growth was higher for cow genotypes with higher milk yield, which was also associated with higher cow DM intake.

Keywords: feed intake; milk yield; pre-weaning growth; suckler cow genotype

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Introduction

The cow herd uses approximately 0.85 and 0.66 of the total energy requirement in calf-to-weanling and calf-to-beef systems, respectively, with about two-thirds and one half, respectively, of the total energy consumed going towards maintaining the cow herd (e.g., Montano-Bermudez and Nielsen, 1990). Feed is the main variable cost on suckler beef farms and cow winter feed costs are a major proportion of feed cost (Drennan and McGee, 2004). Cow intake capacity is largely dependent on body size and milk production (Petit *et al.,* 1995), which vary according to breed.

The Irish suckler-cow herd is made up of a wide range of breeds and crosses of varying degrees of beef and dairy breeding (Drennan, 1999). Suckler cow numbers almost trebled in Ireland during the past 25 years and they now comprise approximately half of the national cow population of 2.2 m (CSO, 2006). The increased size of the national beef herd relative to dairy cow herd has meant that proportionately fewer of the replacement breeding heifers are now from the dairy herd. This process has been accelerated by the dominance of Holstein ancestry in the national dairy herd since the progeny of these cows produce carcasses of lower beef value (McGee *et al.*, 2005c; Drennan, 2006). Progressively, bulls of late-maturing "continental" breeds have predominated and some 0.85 of suckler cows are now bred to such sires (CMMS, 2006). This breeding policy will inevitably result in the genotype of many suckler cows being composed almost exclusively of continental beef breeds and in many cases, of a single breed. A reduction in the proportion of dairy genes in the dam genotype results in decreased milk production and, therefore, a lower calf weaning weight (McGee, Drennan and Caffrey, 2005b). A further consequence of within herd reten-tion of replacements where only one sire breed is used is the loss of hybrid vigour (Simm, 1998). Fallon and Drennan (1999) concluded in their review that a 13% advantage in weight of calf weaned per cow put to the bull could be expected from using a crossbred suckler cow as opposed to a purebred cow. This advantage results from a combination of improved fertility, lower calf mortality and higher pre-weaning live-weight gain.

The objective of this study was to determine the effect of cow genotype on performance, feed intake and milk yield and on the pre-weaning growth of their progeny. Post-weaning growth, ultrasound measurements, muscularity and skeletal scores, slaughter traits and carcass composition are presented by Murphy *et al.* (2008).

Materials and Methods

Herd management

The Grange spring-calving suckler herd was used over 4 consecutive years (2001 to 2004). The five cow genotypes examined were: Limousin (L), Charolais (C), Limousin × Holstein-Friesian (LF), Limousin × (Limousin × Holstein-Friesian) (LLF) and Simmental × (Limousin × Holstein-Friesian) (SLF).

In year 1 the herd comprised first parity cows, while first and second parity animals were present in year 2. This herd was retained in years 3 and 4 when first parity cows were introduced for the crossbred genotypes only. An easy-calving Limousin sire was used on all maiden heifers and they were bred by artificial insemination (A.I.) to calve at 2 years of age. In each subsequent year, two different Charolais sires (A.I.), differing in Expected Progeny Difference for conformation score, were used on the mature cows. Mature cows were offered grass silage only, *ad libitum,* during the indoor winter period, whereas first

parity animals received in addition 1.5 kg of concentrates from parturition until commencement of the grazing season. The progeny had a mean birth date of 4 April (s.d. 28.2) and a mean turnout date of 24 April (s.d. 18.8). They remained at pasture with their dams until weaning. All animals had free access to water. The calves were weaned on 16 November, 24 October, 11 November and 19 October in years 1, 2, 3 and 4, respectively, and were subsequently housed in a slatted-floor shed.

On the grassland area, a total of 76 paddocks were grouped into 19 sets of four (matched for location and soil type) of equal size and randomly assigned to one of two production systems (Semi-intensive and Extensive) to give two replicates per system as described by Drennan, Fallon and Davis (2004). The cows and their progeny therefore grazed in four separate herds. Cows from each of the five genotypes were randomly allocated across the four herds as they calved. Within each production system, planned grazing and grass conservation programmes were operated to provide adequate grazed grass and grass silage for the cow herd and their progeny to slaughter. The herds were rotationally grazed on a predominantly perennial ryegrass *(Lolium perenne)* sward. The silage harvesting strategy was designed to produce high nutritive value first-harvest grass silage for the progeny and moderate nutritive value second-harvest silage for the cows. The cutting date of the second harvest was delayed to produce a higher yield, of lower digestibility silage as this is adequate for spring-calving suckler cows with relatively modest energy requirements for production (i.e., not lactating for most of the indoor winter period) (Drennan and McGee, 2004). The cows were vaccinated 1 to 3 months pre-calving against *Escherichia coli*, rotavirus and corona virus and post-calving for *Leptospirosis* and bovine viral diarrhoea. The calves were treated for lung and gastrointestinal worms during the pre-weaning grazing season and at housing.

Cow feed intake

In year 2, individual intake of zero-grazed grass was recorded for the cows over 4 consecutive days (following 3 days acclimatisation) between 19 July and 30 August. Intake was recorded on cows from each of the four herds separately using a minimum of 15 animals (at least 3 animals from each of the 5 genotypes). The cows were individually tied at random in a slatted floor house. Their calves were located in an adjoining pen with grass offered *ad-libitum* and restricted to twice-a-day suckling. Fresh grass was mowed each morning (0800) and baled using a round baler to facilitate easy transport. Grass was offered with the objective of providing at least 0.1 (proportionately) in excess of the previous day's intake. The weight of grass offered and refused was recorded daily and the refusals were discarded daily.

Individual intake of silage was measured over a 3-week period in years 3 (4 days per week (14 Feb to 7 Mar)) and 4 (7 days per week (24 Nov to 15 Dec and 9 to 30 Jan)). In year 3 all the cows were tied at random in a slatted floor house and in year 4 the cows were either individually tied or accommodated individually in pens bedded with wood chip. The same proportion of each genotype was allocated at random to each accommodation type. Silage was offered to at least 0.1 (proportionately) in excess of intake. Refusals were weighed and discarded daily and twice weekly in years 3 and 4, respectively.

Samples of grass and grass silage were obtained daily for dry matter (DM) determination and chemical analysis. Representative samples retained for

chemical analysis were stored at –20 ºC, and subsequently thawed and composited to give 2 samples per 4 (grass and grass silage in year 3) or 7 (grass silage in year 4) day recording period. Silage juice extracts were stored at –20 ºC prior to analyses. The DM of the grass and grass silage was determined by drying at 98 ºC for 15 h and 40 ºC for 48 h, respectively, and samples for chemical analysis were dried at 40 ºC for 48 h and ground through a 1 mm screen. Chemical analyses (pH, ammonia-N, crude protein and ash) and in vitro dry matter digestibility were carried out using methods described by McGee, Drennan and Caffrey (2005a).

Cow live weight, body condition score and calving difficulty score

Cow live weight was recorded at 21 day intervals over the entire year and additionally at post-calving, turnout to pasture, weaning and housing. Live weight of the progeny was recorded at birth and subsequently at the same time as the cow live weight. To minimise gut-fill effects, live weight was recorded in the morning prior to feeding the silage or prior to movement to a new paddock. The live weight used to express intake relative to live weight was the mean of weights taken at the start and end of the feed intake recording period. Body condition score of the cows was assessed at the same time as live weight by the same operator throughout using the method of Lowman, Scott and Somerville (1976). Calving difficulty (Scale: 1 = unassisted to 5 = caesarean section) was also recorded (Drennan and McGee, 2004).

Milk yield

In years 2, 3 and 4, milk yield was estimated using the weigh-suckle-weigh technique as described by McGee *et al.* (2005b) at, on average, day 133 (s.d. 29.9) of lacta-

tion. Two to three estimates per cow were obtained on consecutive days. The recording period in year 2 coincided with the zero-grazed grass intake period, whereas in years 3 and 4 the cows remained at pasture. In order to facilitate measurements in years 3 and 4, the calves were housed in a slatted floor shed and their dams remained at pasture for the separation periods. On the morning before commencing milk yield estimation, the calves were separated from their dams and then allowed access to them that evening to ensure that the cows were thoroughly suckled out prior to recording the following morning. They were subsequently allowed access to the cows in the morning and evening and were weighed to the nearest 0.1 kg before and after suckling. Suckling was deemed complete when the calf was observed moving quickly from teat to teat. If there was any doubt the udder was checked by hand stripping. Following suckling the calves were "kept moving" to discourage urination or defecation prior to weighing. The separation period was 16.5 h between evening and morning suckling and 7.5 h between morning and evening suckling. Both differences were combined to give a 24 h milk yield. Milk yield data for any cow that was not fully suckled out was excluded from the results.

Ultrasound, muscularity and linear measurements

In vivo measurements of the depth of the *m. longissimus dorsi* muscle and overlying fat cover were determined in the cows pre-calving (February) (year 3) and in the calves at weaning (years 2 and 3) using ultrasound scanning equipment ((Aloka 500v ultrasound unit (Animal Ultrasound Services Inc., Ithaca, New York, USA) or Dynamic Imaging Concept MLV unit, (Dynamic Imaging Ltd., Livingston, Scotland)) equipped with a 12.5 cm long

3.5 MHz linear array transducer probe. Fat and muscle depths were determined at the 13th rib and at the 3rd lumbar vertebrae. The mean of measured fat depths at points that were approximately 0.2, 0.4, 0.6 and 0.8, proportionately, across the width of the muscle at the 13th rib and at points 0.25, 0.50 and 0.75, proportionately, across the width of the muscle at the 3rd lumbar vertebra were used to give a fat depth for each position, whereas muscle depth consisted of one reading at the deepest point of the muscle at both positions.

A visual muscular score (mean of the roundness of the hind-quarter, width of hind-quarter and width/depth of loin using a scale of 1 to 15 (Collins, personal communication)) was assigned to all cows post-housing (years 1, 2, 3 and 4) and to calves at birth and weaning (years 1, 2, 3) using two trained operators on each occasion. Additionally, the calves were scored for muscularity, by a trained operator, on a 1 to 15 point scale at weaning using the Irish Cattle Breeding Federation (ICBF) scoring system (ICBF, 2002).

Four skeletal measurements were obtained on the calves at birth (years 1, 2, 3 and 4) (chest circumference, chest width, pelvic width and head width) and 10 measurements were obtained on the cows post-housing in year 3 (height at withers and pelvis, chest circumference, depth and width, pelvic length and width, hip width, hind-quarter length and back length) as described by Doorley (2001).

Statistical analysis
Where data were available over more than one year, analysis of variance was car-ried out as a repeated measures analysis using the MIXED procedure of SAS (SAS, 2001). The fixed effects in the model for data relating to the cow were cow genotype, parity, year, grazing system and the interactions cow genotype × parity and cow geno-type ×

year. Individual animal within genotype was included as a random variable and calving day was included as a covariate. Data pertaining to the progeny had an additional term for calf gender and sire (parity) rather than parity and the interaction term included was cow genotype × parity. Least square means were compared using the Tukey-Kramer multiple range test within SAS. Regressions of calf live-weight gain (g/day) on milk yield (kg) were carried out using the GLM procedure and the CONTRAST statement was used to determine significant differences between genotypes for the regression coefficient. Included in the model were terms for cow genotype, calf gender and parity.

Results
Cow feed intake
The chemical composition and nutritive value of the grass and grass silage are given in Table 1. Grass DM intake was not significantly different between the genotypes (Table 2) but, when expressed relative to live weight, was greater (P < 0.01) for LF and SLF than for L and C cows, with LLF being intermediate. Silage DM intake for years 3 and 4 combined was greater (P < 0.01) for C and SLF cows than L and LLF cows, with LF being intermediate, but intake relative to live weight did not differ significantly between the genotypes. However, there was a cow genotype × year interaction for both absolute and relative intake.

Cow live weight and body condition score
Live weight at housing and post-calving was greater (P < 0.001) for C cows than for the other genotypes (Table 3). The live weight of L cows at housing was significantly greater than for LLF and LF, with SLF being intermediate, whereas post-calving, live weight of L and SLF was greater than LF, with LLF being intermediate. The decrease in live weight over the indoor winter period was

Table 1. Chemical composition and dry matter digestibility of zero-grazed grass and grass silage offered to cows during the feed intake recording periods in years 2, 3 and 4

Component	Grass	Grass silage	
	Year 2	Year 3	Year 4
Dry matter (DM) (g/kg)	173	167	218
pH	–	3.9	3.8
NH3-N (μg/mL)	–	570	640
Crude protein (g/kg DM)	158	146	139
Ash (g/kg DM)	96	89	90
In vitro DM digestibility (g/kg)	772	658	667

Table 2. Least squares means for dry matter intake and intake expressed relative to live weight of five beef cow genotypes

Variable	Cow genotype[1]					s.e.[2]	Sig.
	LF	LLF	L	C	SLF		
	Grass (Year 2)						
No of animals	11	12	12	12	12		
Daily intake (kg)	11.0	10.4	9.9	12.5	11.6	0.88	
Daily intake relative to live weight (g/kg)	22.5[b]	19.4[ab]	17.5[a]	18.3[a]	21.2[b]	1.27	**
	Silage (Years 3 & 4)						
No of animals	26	22	24	24	28		
Daily intake[3] (kg)	8.3[ab]	7.8[a]	7.0[a]	8.7[b]	9.2[b]	1.04	**
Daily intake relative to live weight [4] (g/kg)	14.6	13.2	11.0	11.3	15.6	1.90	

[abc] Within rows, means without a common superscripts differ significantly (P < 0.05).
[1] LF = Limousin × Holstein-Friesian, LLF = Limousin × (Limousin × Holstein-Friesian), L = Limousin, C = Charolais and SLF = Simmental × (Limousin × Holstein-Friesian).
[2] Maximum s.e.
[3] Genotype × year interaction (P < 0.01): means in year 3 were 7.2[a], 7.4[a], 6.8[a], 8.5[b] and 8.1[ab], and in year 4 were 9.8[b], 9.0[ab], 7.2[a], 9.4[b], 10.5[b] for LF, LLF, L, C and SLF cow genotypes, respectively.
[4] Genotype × year interaction (P < 0.001): means in year 3 were 12.4[ab], 11.7[a], 11.0[a], 11.5[b] and 13.2[b], and in year 4 were 16.5[b], 14.9[ab], 10.9[a], 11.7[a] and 18.0[a] for LF, LLF, L, C and SLF, respectively.

greater (P < 0.01) for L and C cows than for LLF and SLF, with LF being intermediate. The increase in live weight during the grazing season was greater (P < 0.01) for C cows than LF, LLF and SLF, with L being intermediate. Annual live-weight change did not differ between the cow genotypes but there was a cow genotype × parity interaction with re-ranking of the genotypes within each parity.

Body condition score at housing was lower (P < 0.01) for LF cows than LLF, L and SLF, with C cows being intermediate. Body condition score at calving was lower (P < 0.001) for LF than the other cow genotypes, which did not differ (P > 0.05). Body condition score changes did not differ significantly between the cow genotypes.

Cow muscularity, linear and ultrasound measurements
Post-housing, C and L cows had a greater (P < 0.001) visual muscular score (Signet)

Table 3. Least squares means for live weight, body condition score and changes, *m. longissimus dorsi* muscle and fat measurements, gestation length, calving difficulty score and milk yield of five cow genotypes

Variable	Cow genotype[1]					s.e.[2]	Sig.
	LF	LLF	L	C	SLF		
Live weight (kg) at							
Housing	552[a]	574[a]	616[b]	702[c]	582[ab]	10.3	***
Post calving	526[a]	553[ab]	575[b]	662[c]	556[b]	10.5	***
Live-weight change (kg)							
Winter (Indoor)	−43[ab]	−26[a]	−52[b]	−52[b]	−32[a]	6.0	**
Grazing season	79[a]	74[a]	84[ab]	101[b]	69[a]	6.4	**
Annual[3]	35	48	33	48	41	5.5	
Body condition score (units, scale 0–5)							
Housing	2.26[a]	2.73[b]	2.71[b]	2.46[ab]	2.66[b]	0.118	**
Post calving	2.17[a]	2.65[b]	2.54[b]	2.62[b]	2.63[b]	0.103	***
Body condition score change							
Winter (Indoor)	−0.15	−0.25	−0.37	−0.04	−0.23	0.116	
Grazing season	−0.03	0.12	0.26	0.13	0.21	0.117	
Annual	−0.21	−0.11	−0.11	0.09	−0.04	0.107	
Visual muscular score (Signet; 1 to 15)							
Housing	5.5[a]	6.8[b]	8.0[c]	7.8[c]	6.2[b]	0.20	***
Ultrasonic measurements							
Muscle depth (cm) at							
13th rib	7.62[a]	7.96[a]	8.81[b]	8.35[ab]	7.03[a]	0.440	**
3rd lumbar vertebra	5.63[a]	6.47[bc]	7.26[d]	6.69[c]	5.98[ab]	0.180	***
Fat depth (mm) at							
13th rib	2.5[a]	3.2[b]	2.5[a]	1.7[a]	2.9[ab]	0.40	*
3rd lumbar vertebra	3.2[b]	3.3[b]	2.5[a]	1.7[a]	3.0[ab]	0.48	*
Gestation length (days)	291	288	290	290	290	1.5	
Calving difficulty score (1 to 5)	1.89[ab]	1.39[a]	1.64[a]	2.23[b]	1.61[a]	0.212	**
Milk yield (kg/day)	9.7[b]	7.0[a]	5.5[a]	6.9[a]	8.7[b]	0.47	***

[1,2] See footnotes Table 2.
[3] Genotype × parity interaction (P < 0.05); means for LF, LLF, L, C and SLF cow genotypes, respectively: Parity 1; 35.0, 41.7, 12.9, 89.3, 57.6: Parity 2; 25.6, 56.6, 34.5, 35.2, 32.0: Parity 3; 36.2, 41.1, 55.1, 26.3, 55.8: Parity 4; 43.3, 51.6, 28.7, 39.9, 16.7.
[abcd] See footnotes Table 2.

than SLF and LLF, who were greater than LF cows (Table 3). Live animal body measurements of the cows post-housing did not differ between the genotypes except for chest circumference, which was greater (P < 0.05) for C cows than LF, LLF and SLF, with L being intermediate and hind-quarter width, which was greater (P < 0.05) for C than the other genotypes, which did not differ (data not presented). Muscle depth at the 13th rib was greater (P < 0.01) for L than LF, LLF and SLF with C being intermediate (Table 3). Muscle depth at the 3rd lumbar vertebra was greater for L than the other genotypes. Values for C were higher than SLF with LLF being intermediate, and LLF was higher than LF with SLF being intermediate. Fat depth at the 13th rib was higher (P < 0.001) for LLF than LF, L and C with SLF being intermediate, whereas at the 3rd lumbar vertebra values

were higher for LF and LLF than L and C, with SLF being intermediate.

Gestation length, calving difficulty score and milk yield

Gestation length was not significantly affected by cow genotype (Table 3). Calving difficulty score was greater (P < 0.01) for C cows than LLF, L and SLF, with LF being intermediate. Milk yield of LF and SLF cows was similar and greater (P < 0.001) than LLF, LF and C cows, which did not differ significantly.

Calf birth weight and pre-weaning growth

Birth weight of calves from LF cows was lower (P < 0.001) than C with L being intermediate, but greater than LLF, with SLF being intermediate (Table 4). Weaning weight was greater (P < 0.001) for the progeny of LF and SLF cows than progeny from LLF and L, with C cows progeny similar to all genotypes except LF. Daily gain from birth to weaning was greater (P < 0.001) for progeny of LF cows than progeny of all other genotypes except SLF, which in turn, were greater than progeny of L and C cows, with LLF being intermediate.

The regression coefficients (g/kg) (s.e.) of calf live-weight gain from birth to weaning on milk yield were 41 (11.4), 52 (12.7), 51 (14.8), 59 (14.4) and 45 (9.3) for LF, LLF, L, C and SLF cows, respectively, and did not differ significantly between the cow genotypes.

Table 4. Mean values for body muscular scores and measurements at birth, live weight and gains and muscular scores and ultrasonic scanning at weaning for progeny of five cow genotypes

Variable	Cow genotype[1]					s.e.[2]	Sig.
	LF	LLF	L	C	SLF		
Calf measurements at birth							
Muscular score (Signet, scale 1–15)	5.2[ab]	4.8[a]	5.6[b]	5.6[b]	5.2[ab]	0.26	**
Chest circumference (cm)	81.5[b]	78.2[a]	81.0[ab]	81.7[b]	80.1[a]	1.06	*
Chest width (cm)	17.1[ab]	16.5[a]	17.5[b]	17.5[b]	16.6[a]	0.34	***
Pelvic width (cm)	21.8	21.5	21.7	22.4	22.3	1.00	
Head width (cm)	12.6[ab]	12.3[a]	12.5[a]	13.0[b]	12.5[a]	0.19	**
Calf live weight (kg) at							
Birth	47.9[b]	43.4[a]	48.7[bc]	50.5[c]	46.2[ab]	1.34	***
Weaning	285[c]	254[a]	243[a]	258[ab]	271[bc]	6.7	***
Pre-weaning gain (g/day)	1123[c]	997[ab]	918[a]	982[a]	1067[bc]	30.6	***
Muscular score at weaning scale (1–15)							
Signet	6.8	6.4	7.1	6.8	6.8	0.30	
ICBF	7.8	7.8	7.9	8.1	8.1	0.34	
Ultrasonic measurements at weaning							
Muscle depth (cm) at							
13th rib	6.90	7.03	7.27	7.07	7.03	0.244	
3rd lumbar vertebra	5.54	5.62	5.44	5.54	5.43	0.194	
Fat depth (mm) at							
13th rib	1.4	1.3	1.1	1.1	1.3	0.17	
3rd lumbar vertebra	1.3	1.1	1.0	1.0	1.2	0.17	

[abc] See footnotes Table 2.
[1,2] See footnotes Table 2.

Calf muscularity, linear and ultrasound measurements

The progeny of L and C cows had greater (P < 0.01) muscular scores (Signet) at birth than LLF, with LF and SLF being intermediate (Table 4). At birth, chest circumference was greater (P < 0.05) for progeny of C and LF cows than of LLF and SLF, with L being intermediate. Chest width was greater (P < 0.001) for the progeny of C and L cows than LLF and SLF, with LF being intermediate. Head width was greater (P < 0.01) for the progeny of C cows than LLF, L and SLF, with LF being intermediate. There was no significant effect of cow genotype on the pelvic width of calves.

At weaning, calf muscular scores for either the Signet or ICBF scoring system and ultrasonic measurements of *m. longissimus* muscle or fat depths did not differ significantly between the cow genotypes (Table 4).

Discussion

Due to the wide range in breed and genotype in the suckler cow population in Ireland direct comparisons between all the genotypes in the present study is of interest. The study was designed to quantify the effects of firstly, a stepped increase in the proportion of late-maturing "continental" breeding in the dam (LF *v* LLF *v* L), se condly, purebred *v* crossbred (C, L *v* LF, LLF, SLF) dams, and thirdly, three-quarter "continental" breed dams of contrasting genetic potential for milking ability (LLF *v* SLF) within the context of animal populations and breeding approaches in Ireland.

Feed intake

The ranking in feed intake between the genotypes was broadly similar for grass silage and grass. Although not significant,

there was a numerical decrease in the intake of grass and grass silage as the proportion of L ancestry increased from 0.5 to 1.0, indicating a higher intake capacity of dairy compared to beef breeds. Montano-Bermudez, Nielsen and Deutscher (1990), using cows of similar size, found that energy requirements for maintenance were proportionately 0.12 greater per unit metabolic weight for beef cows of high or medium milk production than those of low milk production. Differences in milk production explained 23% of the variation in maintenance requirements suggesting that important differences exist beyond those associated with milk production potential. The higher intake of grass silage by C and SLF cows in the present study can be attributed to their live weight and/or milk production potential (Petit *et al.*, 1992). In accord with the present findings, McGee *et al.* (2005a) also reported that grass silage intake did not differ significantly between Charolais and beef × Friesian cows. The higher feed intake of C cows than L partially reflects their greater live weight, but research has shown that even after accounting for differences in weight (and milk yield) the intake capacity of Limousin is less than Charolais cows (Petit *et al.,* 1992). The higher intake of grass silage for SLF than LLF is consistent with other studies at this centre involving Simmental × Holstein-Friesian and Limousin × Holstein-Friesian cows (McGee and Drennan, 2008). This reflects the higher energy requirements and associated higher intake capacity of the Simmental than Limousin breed (Drennan, McGee and Grogan, 2005).

Live weight and body condition score

In accord with other studies, Charolais cows had a greater live weight than cows of L or S breeding (Fredeen *et al.*, 1987; Jenkins and Ferrell, 1994) and beef ×

Friesian cows (McGee *et al.,* 2005a). In terms of beef systems, spring-calving suckler cow nutrition generally involves feed restriction and mobilisation of body reserves during the winter (indoor) period when feed costs are more expensive, and recovery of body reserves during the subsequent grazing season when feed costs are lower (Petit *et al*., 1995). Consequently, the degree to which cow genotypes differ in mobilisation and deposition of body reserves is important. The greater weight loss, during the winter indoor period, of L and C cows than LLF and SLF genotypes partially reflects their greater live weight and associated maintenance requirements. The lower live-weight gain at pasture of LF and SLF genotypes compared to L and C cows is probably a reflection of their higher milk yield but also a greater compensatory-growth-like recovery by the L and C cows because of greater weight losses during the winter (Drennan and McGee, 2004). In agreement with the present study, McGee *et al.* (2005a) reported greater live-weight loss during the winter and greater live-weight gain during the grazing season for Charolais than beef × Friesian cows. The LF cows had a lower body condition score than the other genotypes although changes in body condition score did not differ. Whereas body condition score estimates the subcutaneous fat cover, dairy breeds are known to deposit more of their fat in the abdominal cavity than do beef breeds, which deposit more of their fat subcutaneously (Truscott, Wood and Macfie, 1983).

Gestation length, calving difficulty score and birth weight

Cow genotype differences in calving difficulty score were not due to differences in gestation length as it was similar for all genotypes. In a review by Meijering

(1984), birth weight was more closely correlated with calving difficulty score than with gestation length. However, this author did point out that any phenotypic relationship between gestation length and dystocia or stillbirth is mediated by birth weight and was no longer significant when birth weight was included as a covariate. Calving difficulty score for the cow genotypes followed a similar pattern to head and chest measurements of the calves at birth. The dimensions for the latter traits for the progeny of C cows along with their greater birth weights, may partially explain their greater calving difficulty score.

In accord with the present findings for LF and C cows, McGee *et al.* (2005a) and Keady *et al.* (2004) reported that dystocia scores were similar for beef ×Friesian and Charolais cows. Fredeen *et al.* (1982a) reported fewer assisted births for Limousin-cross cows than for Charolais cross and Simmental-cross cows, whereas in the present study both L and SLF cows had a lower calving difficulty score than C cows.

In contrast to the present study, where calves from C cows were heavier at birth than those from all other genotypes except L, McGee *et al.* (2005a) reported no difference in the birth weight of calves from Charolais or beef × Friesian cows. Fredeen *et al.* (1982b) concluded that the progeny of Charolais-cross cows had greater birth weights than those from Simmental-cross, which in turn were greater than progeny of Limousin-cross cows.

Milk yield and calf pre-weaning growth

The higher milk yield of LF cows than the purebred continental breed cows agrees with the findings of other studies comparing beef × dairy and beef breed cows (Wright *et al.*, 1994; McGee *et al.,* 2005b). In a review, McGee (1997) concluded that of the main beef breeds used in Ireland,

the Simmental breed had a higher milk yield than other beef breeds and this supports the present results, where SLF cows had a higher yield than LLF cows. Although not significant, the numerically higher milk yield of C than L cows is in the same direction as previously reported (Petit and Lienard, 1988; Jenkins and Ferrell, 1992).

In agreement with the present study, McGee *et al.* (2005b) showed that the progeny of beef × Friesian cows had greater pre-weaning live-weight gain than progeny of Charolais cows. The lower pre-weaning gain for progeny of L and C cows than SLF cows concurs with the findings in other studies (Notter *et al.,* 1978; Fredeen *et al.,* 1982b; Gregory, Cundiff and Koch, 1992). In accord with the results of Gregory *et al.* (1992) cow genotypes ranked similarly for daily milk yield and calf pre-weaning daily live-weight gain. The regression coefficients of calf live-weight gain pre-weaning on milk yield did not differ significantly between the genotypes, although they were numerically lower for the higher yielding genotypes. Similarly, McGee *et al.* (2005b) reported lower regression coefficients of live-weight gain on milk yield for progeny of beef × Friesian cows than Charolais cows.

Calf linear, muscularity and ultrasound measurements

The significantly higher visual muscular scores of the L and C progeny at birth were not as evident at weaning. This may reflect the differences between the dam genotypes in milk yield and thus, calf nutrition pre-weaning, by preventing these animals from expressing differences in muscular development. The absence of an effect of cow genotype on ultrasonic fat depth of the progeny may be explained by the fact that the proportion of continental breeding in all the progeny was 0.75 or greater.

Conclusions and implications

This study provides information on the impact of various cow herd replacement policies on the cow-calf component of a suckler beef system and the results highlight the importance of cow milk production potential. The data demonstrate the superiority of crossbred cows with good maternal (milk) traits in terms of producing progeny with a higher weaning weight, which was however, associated with a higher dry matter intake by the cow. Nevertheless, in spring-calving, lowland pasture situations, good reproductive performance has been achieved from cow genotypes with high milk production potential. The advantages of hybrid vigour, due to enhanced reproductive performance and lower calf mortality is generally found to be proportionately ∼0.08 in terms of weight of calf weaned per cow, per annum. This would further favour the crossbred dam genotypes over purebreds. Thus, it is desirable that the replacement programme in a suckler herd should have cross breeding in addition to milk production potential as important considerations.

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