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Performance of lactating suckler cows of diverse genetic merit and genotype under a seasonal pasture-based system

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Abstract

The objective of this study was to investigate the effect of genetic merit of the national Irish maternal index and genotype (i.e. beef vs. beef × dairy [BDX]) of beef cows and subsequent performance of their progeny. With the exception that high genetic merit cows produced 0.57 kg more milk and tended to have 0.04 of a lower body condition score (BCS), no significant differences were observed between cows of diverse genetic merit. Differences between contrasting cow genotype were apparent. Beef cows were 50 kg heavier and had a BCS 0.27 greater than BDX cows. The BDX cows produced 1.67 kg more milk and had a greater 24-d submission rate than beef cows. Calves generated from BDX cows were 19 kg heavier at weaning and were worth €51 more than progeny generated from beef cows. Beef cow progeny, however, had 0.77 of a greater conformation score at slaughter than BDX. While differences were observed across cows of different replacement strategies, results from the current study showed that genetic selection for national maternal index had no effect on the overall performance of suckler cows in a pasture-based spring-calving system.

Keywords

Breed • genetic merit • pasture • progeny • suckler

Introduction

Approximately 70% of beef herds in Ireland operate low input pasture-based production systems where cows calve in the spring period of February to May (Berry & Evans, 2014). Grass growth commences in March, peaks in May and then declines to November (Drennan *et al.*, 2005). Therefore, in a seasonal production system such as Ireland, calving coincides with the start of grass growth. This system of production is based on utilising high levels of grass at grazing, with grassland contributing up to 97% of the total ruminant diet (Keating & O'Kiely, 2000), as well as being the main feed source (grazed or conserved) for suckler beef systems in Europe (Lawrence *et al.*, 2012). Beef cows should produce a calf with a good weight for age and exhibit high levels of reproductive efficiency from low input pasture-based systems (McGee *et al.*, 2005a; Murphy *et al.*, 2008a). Success of the system is then driven by key variables such as stocking rate, turnout date and mean calving date (Crosson *et al.*, 2014).

The national Irish beef herd comprises 75% beef breeds and 25% beef breed × dairy breed (BDX) sucklers (McCabe *et al.*, 2018). Typically beef cows are a terminal type female, predominantly late-maturing crossbred (DAFM, 2016/17) with Limousin (LM) crossbred cows being the dominant breed at 37% of the national herd, followed by Charolais (CH), Aberdeen Angus (AA) and Simmental (SI) at 20%, 12% and 10%, respectively. Inefficiencies within the Irish beef suckler herd relating to milk yield and reproductive performance have been clearly acknowledged (Berry & Evans, 2014). This facilitated the need for development of a specialised national genetic index (ICBF, 2017) using Irish maternal genetic evaluations to assist producers in identifying animals suitable for breeding replacements that would be superior for maternal traits (McHugh *et al.*, 2014). Kluyts *et al.* (2004) stated that development of breeding objectives must be centred around accurate information on the environment, markets and traits of interest and should be followed by strong actions to develop

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meaningful breeding goals that will effectively improve animal genetics. The important role of maternal traits within cattle breeding goals has been outlined by Cartwright (1970) and Koch (1972), with maternal breeding programmes previously established internationally to facilitate their selection (Ménissier *et al.*, 1982; Trus and Wilton, 1988; Roughsedge *et al.*, 2005).

Previous studies have investigated components of suckler cow production systems such as replacement heifer management (Funston & Deutscher, 2004), calving and reproductive performance (Drennan & Berry, 2006), cow mortality (Mõtus & Emanuelson, 2017), the effect of milk yield on progeny performance, both pre-weaning (McGee *et al.*, 2005a; Murphy *et al.*, 2008a) and post-weaning (Fiss & Wilton, 1993), suckler cow feed intake and performance (Lawrence *et al.*, 2013), and economic efficiency (Taylor *et al.*, 2018). Managing heifers to calve for the first time at 2 yr of age was reported to be the most efficient and economical strategy for primiparous cows (Crosson & McGee, 2012). Suckler cow genotype comparisons demonstrated that due to greater milk yields, BDX cows, particularly LM × Holstein-Friesian (FR), produced heavier weanlings, with this advantage following through to slaughter (Murphy *et al.*, 2008b). Differences in reproductive performance between cow genotypes have varied across studies, some reported beef cows to be superior (Osoro & Wright, 1992) and others reported BDX cows to be superior (Newman & Deland, 1991), with Drennan & Berry (2006) stating that reproductive performance is more dependent on management and nutrition than breed type. To date, however, no study has compared a suckler cow–calf system in its entirety, including progeny weaning and slaughter data.

The Replacement Index established in Ireland, as described by McCabe *et al.* (2017), serves as a tool to assist farmers in breeding goals to optimise suckler beef production and to retain the most profitable females for breeding, but to date has not been validated at farm level. Therefore, the objective of this study was to determine the effect of genetic merit and genotype on overall cow and calf performance within a calf-to-weanling and a calf-to-beef pasture-based system over a 4-yr period.

Materials and methods

This experiment was carried out at Teagasc, Grange Beef Research Centre, County Meath, Ireland. Animal procedures undertaken in this experiment were approved by the Teagasc Animal Ethics Committee and licensed by the Health Products Regulatory Authority in accordance with the protection of animals used for scientific purposes (Directive 2010/63/EU). This study began in spring 2013 when heifers were bred for the first time, with data generated over four grazing seasons, 2014–2017.

Beef heifers of diverse genetic merit for maternal traits were selected for the study at c. 8 mo of age (MO) from beef suckler and dairy herds, with the aim of being bred for the first time at c. 15 mo. Heifers from the suckler herd were bred from either AA, Hereford (HE), LM, CH, SI or Belgian Blue (BB) cows and FR cows only from the dairy herd. Heifers were generated from AA or LM sires of high reliability (>70%) for the Replacement Index. Common sires were used on the beef and dairy herd. In total, 199 cows over four lactations were available: 109 high genetic merit (HIGH), 90 low genetic merit (LOW); 102 beef and 97 BDX cows. The Replacement Index value for HIGH and LOW when the study commenced was €117 (±€30) and €56 (±€31), respectively, and remained constant for the duration of the study. The mean predicted transmitting ability (PTA) for HIGH and LOW groups for the main traits of interest is outlined in Table 1.

Cows were housed in early November for the non-lactating winter period in a conventional slatted indoor housing system. Cows were grouped in pens of seven based on their expected calving date and offered a moderate quality grass silage *ad libitum* diet plus dry cow minerals (David Taylor Animal Nutrition, Westmeath, Ireland) at a rate of 100 g/d.

Cows and their calves were turned out to pasture during March and April, and grazed in four groups: two beef and two BDX. Groups were managed on a rotational grazing system as described by O'Donovan *et al.* (2002) on a predominantly perennial ryegrass (*Lolium perenne*) sward. Mineral supplementation was supplied to groups in 2014 and 2015 via mineral lick block (Co-op Source, Cork, Ireland) and then via Terra Liquid Mineral Dispensing Unit in the water supply (Terra Liquid Minerals, Athy, Co. Kildare, Ireland) during 2016 and 2017 for long-term supply of trace elements, including calcined magnesite, and vitamins to aid in long-term mineral balance and also during periods of fast grass growth to assist in reducing the risk of hypomagnesaemia.

Calving performance

Cows were removed from the slatted housing to individual straw-bedded pens 1 d prior to calving on the basis of their expected calving date and visible indication of the onset of calving (Wehrend *et al.*, 2006). Calving difficulty was recorded on a scale of 1–4, as outlined by McHugh *et al.* (2014), post-parturition along with calf details such as sex, birth weight and perinatal mortality, which was defined as calves that died within 48 h of birth. Total calf mortality was defined as any calf that died from birth to weaning. Due to an outbreak of cryptosporidium, calf mortality data from year 1 (2014) were not included in the analysis resulting in 371 data records available. Cows remained in individual pens with their calf for

Table 1: Replacement Index value breakdown and mean predicted transmitting ability descriptive statistics for high and low genetic merit animals

	Genetic merit		Difference High vs. Low
	High	**Low**	
Replacement Index (€)	117 ± 30	56 ± 31	61
Maternal cow traits (€)	408 ± 166	115 ± 186	293
Maternal progeny traits (€)	173 ± 90	162 ± 78	11
Calving difficulty score (%)	3.32 ± 1.42	4.87 ± 1.66	1.55
Cow weight (kg)	14.23 ± 13.08	23.70 ± 14.16	9.5
Gestation length (d)	0.58 ± 1.52	1.71 ± 1.33	1.13
Age at first calving (d)	−16.35 ± 9.49	−7.95 ± 7.93	8.4
Maternal weaning weight (kg)	11.67 ± 5.27	5.74 ± 5.87	5.93
Direct carcass weight (kg)	6.77 ± 8.83	10.15 ± 7.67	3.38
Feed intake (kg)	0.003 ± 0.204	−0.033 ± 0.196	0.036

a minimum of 2 d before either being moved to group pens with a creep area or turned out to pasture.

Reproductive performance

Fertility data were available from a total of 429 observations. Breeding commenced in late April each year and continued for 13 wk. Tail paint and vasectomised bulls were used as heat detection aids to facilitate artificial insemination (AI). An experienced AI technician was used throughout the course of this study. In the first two breeding seasons (2013 and 2014), AI was utilised for the first 6 wk of the breeding season with stock bulls introduced thereafter. Bulls were allocated to one grazing group per week and rotated subsequently. In 2015 and 2016, 9 wk of AI was conducted with stock bulls introduced for the final 4 wk. Semen quality for each sire used was tested as outlined by Prendiville *et al.* (2011). Only AA and LM sires that were in the top 20% for the Irish national terminal index were used. Cows not observed in oestrus after 28 d inseminated were scanned via transrectal ultrasonography using an Aloka 210D * II, 7.5 MH3 scanner (Aloka Ltd., Tokyo, Japan) to confirm pregnancy status. Subsequently, all cows were examined again at day 60 post-insemination and at 150 d after the start of the breeding season. All cows scanned not pregnant at 150 d were culled from the study after weaning was completed.

Measures of reproductive efficiency utilised included: submission rate in the first 24 d of the breeding season (Serv24), calving to service interval (CSI), pregnancy rate to first service based on ultrasonic imaging at day 150 (PREG1), proportion of cows pregnant in the first 6 wk of the breeding season based on ultrasonic imaging at day 150 (6wkICR), proportion of cows pregnant at the end of the breeding season based on the ultrasonic imaging at day 150 (PREGRATE), calving to conception interval based on results of ultrasonic imaging at day 150 (CCI), number of services per cow (NoSERV) and calving interval (CIV).

Production performance

Cow live weight (body weight [BW]) was recorded every 3 wk using a calibrated "Titan Weigh Crate" (O'Donovan's Engineering, Cork, Ireland) combined with Tru-Test software (Auckland, New Zealand). Body condition score (BCS) was measured concurrently to BW by a single evaluator on a scale of 0–5 (Lowman *et al.*, 1976). Cow BW and BCS were also recorded at calving and when the breeding season commenced. Estimates of cow milk yield were determined twice in 2014 (at 120 ± 23.5 and 156 ± 23.5 d in milk [DIM]), and three times in 2015 (at 52 ± 5.6, 131 ± 34.5 and 184 ± 23.1 DIM) and 2016 (at 50 ± 4.9, 127 ± 30.5 and 171 ± 28.7 DIM) using the weigh-suckle-weigh technique (McGee *et al.*, 2005a) as modified by McCabe *et al.* (2017).

Progeny performance

Data were available on 424 calf birth weights and 389 weaning weights (WWs). Calf performance was monitored according to average daily gain (ADG) which was determined after each 3-wk weighing. Calves were allowed access to "creep graze" (Drennan, 1971; Drennan & McGee, 2009) 4 mo prior to weaning, and were offered 1 kg concentrate DM per day prior to separation from the cow. Calves were weaned using the gradual weaning technique (Enríquez *et al.*, 2011). Calf WW was recorded at an average of 227 ± 29 d of age over four lactations. Calf quality was assessed at weaning on a scale of 1–5 (1 = very poor; 5 = exceptional) as well as calf docility (1 = very quiet; 5 = very difficult) by a trained technician according to the scale outlined in the Irish Suckler Cow Quality and Welfare Scheme 2008 (ICBF, 2013). Calf value was determined for 3 yr, from 2015 to 2017, by three independent assessors who were representative of the export and auctioneering markets of the Irish beef industry.

Carcass data were available from 284 calves born from 2014 to 2016. A 2 (gender) × 2 (slaughter ages) factorial arrangement of treatments was assigned. Heifers were either slaughtered at 19MO finished off pasture or at 21MO finished indoors on a grass silage *ad libitum* diet supplemented with 5 kg concentrates DM/d for 72 d pre-slaughter. Male calves were castrated in mid-October each year and slaughtered as steers at either 21MO or 24MO and followed the same finishing system as 21MO heifers. Carcass conformation and carcass fat were scored using the European Union beef carcass classification (EUROP) grades transformed into a 1–15-point linear scale as outlined by Hickey *et al.* (2007).

Sward measurements

Throughout the grazing periods of March to November, sward measurements and analysis were carried out as described by McCabe *et al.* (2019). Briefly, 40 pre- and post-grazing sward heights per paddock were determined using a rising plate meter (Filip's Manual Plate Meter, Jenquip, New Zealand). Herbage yield was determined and chemical analysis conducted *in vitro* for acid detergent fibre (ADF; Clancy and Wilson, 1966), crude protein (CP), neutral detergent fibre (NDF), organic matter digestibility (OMD; Morgan *et al*., 1989) and ash.

Statistical analysis

The effect of genotype (beef or BDX), cow genetic merit (HIGH or LOW) and the interaction between genetic merit and genotype on BW, BCS, calving difficulty and calving day of year, calving to first service (CFS), CCI, CIV, NoSERV, calves per cow, milk yield and progeny performance traits was estimated using a linear mixed model in PROC HPMIXED (version 9.3; SAS Inst. Inc., Cary, NC, USA). Cow genetic merit (HIGH or LOW), genotype (beef and BDX), their interaction, cow breed (AA and LM), calf sex, year and parity were included as fixed effects in all models. The sire of the calf PTA for carcass weight was also included as a fixed effect in the model for WW, ADG, carcass weight and kill-out proportion. Sire of the calf PTA for carcass conformation was also included in the model for carcass fat and conformation and sire of the calf PTA for calving difficulty was included in the model for calving difficulty. For calf value, evaluator was included as a fixed effect and age was included in the model for all calf performance and carcass traits. Cow was included as a random effect which also accounted for the repeated records per cow.

The effect of genotype (i.e. BDX or beef cows), cow genetic index (HIGH or LOW) and their interaction on age at first calving (AFC) was quantified using a fixed-effects model in PROC GLM (version 9.3; SAS Inst. Inc., Cary, NC, USA). Cow genetic merit (HIGH or LOW), genotype (beef and BDX), the interaction between genetic merit and genotype, breed (AA and LM), calf sex and year were included as fixed effects in all models.

Binary variables of perinatal mortality, total mortality, Serv24, PREG1, 6wkICR, PREGRATE and survival were analysed using logistic regression in PROC GENMOD (version 9.3; SAS Inst. Inc., Cary, NC, USA). Cow genetic merit (HIGH or LOW), genotype (beef and BDX), the interaction between genetic merit and genotype, breed (AA and LM), calf sex, year and parity were included as fixed effects in all models.

Results

Sward measurements

Pre- and post-grazing sward surface heights, pre-grazing herbage yield and chemical composition of the herbage throughout the grazing seasons of the current study are presented in Table 2.

Calving performance

No difference was observed across genotype or genetic merit for calving date; mean calving date was 18 March. Calf birth weight and calving difficulty were also similar across genotype and genetic merit (Table 3), with all cows averaging calf birth weight of 44 kg and a calving difficulty score of 1.70. No difference was observed between HIGH and LOW or beef and BDX cows for perinatal or total calf mortality (Table 4).

Table 2: Pre- and post-grazing sward surface heights, pre-grazing herbage yield and chemical composition of grass offered to cows

Item	Mean	s.d.
Pre-grazing sward surface height (cm)	11.9	2.57
Post-grazing sward surface height (cm)	4.7	1.1
Pre-grazing herbage yield (kg DM/ha)	2206	738.5
Crude ash (g/kg DM)	104	15.9
CP (g/kg DM)	199	30.5
ADF (g/kg DM)	243	39.7
OMD (g/kg OM)	780	48.4
NDF (g/kg DM)	492	101
UFL/kg DM[1]	0.95	

[1]1 UFL is defined as the net energy content of 1 kg of standard barley for milk production (O'Mara, 1997).
ADF = acid detergent fibre, CP = crude protein, NDF = neutral detergent fibre, OM = organic matter, OMD = organic matter digestibility.

Table 3: Effect of cow genetic merit, genotype and their interaction on calving date, calf birth weight, calving difficulty and reproductive performance

	Genetic merit (GM)			Genotype (G)			*P* value		
	High	Low	s.e.[1]	BDX[2]	Beef	s.e.[1]	GM	G	GM × G[3]
Calving date	16 March	17 March	2.3	15 March	19 March	2.3			
Calf birth weight (kg)	44	45	0.6	44	45	0.69			
Calving difficulty score (1–4)	1.69	1.71	0.094	1.63	1.77	0.093			
Age at first calving (d)	759	758	3.9	755	762	3.7			
Calving to first service (d)	61	63	1.8	62	62	1.8			
Calving to conception (d)	77	77	1.5	77	76	1.5			
Number of services/cow	1.74	1.58	0.079	1.70	1.62	0.079			
Calving interval (d)	363	362	1.57	362	362	1.5			
Calves per cow (no.)	2.57	2.53	0.029	2.55	2.55	0.028			

[1]Weighted standard error of the mean.
[2]Beef × dairy cows.
[3]Genetic merit × genotype interaction.

Table 4: Cow genotype, genetic merit and their interaction odds ratios (upper and lower confidence intervals in parenthesis) with the associated *P* value, for calf mortality, reproductive variables and cow survival

	Genetic merit (GM)[1]		Genotype (G)[2]		GM × G[3]
	Odds ratio	*P* value	Odds ratio	*P* value	*P* value
Perinatal mortality	0.39 (0.12, 1.21)		0.42 (0.13, 1.31)		
Total mortality	0.66 (0.31, 1.38)		0.72 (0.34, 1.50)		
Submission rate (24 d)	1.37 (0.89, 2.09)		2.01 (1.32, 3.04)	**	
Pregnant to first service	0.73 (0.49, 1.10)		0.87 (0.59, 1.29)		
Six-week in-calf rate	0.92 (0.61, 1.40)		1.20 (0.80, 1.79)		
Pregnancy rate	1.26 (0.69, 2.33)		1.51 (0.83, 2.74)		
Cow survival	1.13 (0.70, 1.83)		1.33 (0.84, 2.12)		*

[1]Relative to a low genetic merit cow for each trait.
[2]Relative to a beef cow for each trait.
[3]Genetic merit × genotype interaction.
* = $P < 0.05$, ** = $P < 0.01$.

Reproductive performance and survival

Cows calved for the first time at 24.5MO (Table 3; $P > 0.05$). Calving interval was similar across both genotype and genetic merit. An interaction between genetic merit and genotype was observed for cow survival, with BDX LOW cows 1.35 times (95% confidence interval: 1.70–2.60; $P < 0.05$) more likely to survive to the subsequent lactation compared to BDX HIGH cows. No difference was found across beef cows of contrasting genetic merit (Table 4).

No difference was observed between genotype and genetic merit for any of the following reproductive variables investigated: CFS, CCI, NoSERV, calves per cow (Table 3), PREG1, 6wkICR or PREGRATE (Table 4). While Serv24 was similar for HIGH and LOW groups, BDX cows had a greater submission rate in the first 24 d than beef cows ($P < 0.01$).

Production performance

No difference was observed in BW between HIGH and LOW cows. However, BCS tended ($P = 0.063$) to be 0.04 units greater for LOW than HIGH cows (Table 5). Beef cows were 50 kg heavier and had a 0.27 greater BCS than BDX cows ($P < 0.001$). Corresponding differences between beef and BDX cows were 35 kg and 0.16 of a BCS at calving ($P < 0.001$) and 41 kg and 0.21 of a BCS at the onset of the breeding season ($P < 0.001$).

Table 5: Effect of cow genetic merit, genotype and their interaction on production performance

	Genetic merit (GM)			Genotype (G)			*P* value		
	High	Low	s.e.[1]	BDX[2]	Beef	s.e.[1]	GM	G	GM × G[3]
Live weight – year (kg)	659	663	8.8	636	686	8.0		***	
Live weight – calving (kg)	629	626	7.7	610	645	7.2		***	
Live weight – breeding (kg)	633	632	9.2	612	653	8.3		***	
BCS – year (0–5)[4]	2.92	2.96	0.018	2.80	3.07	0.017	=0.063	***	
BCS – calving (0–5)[4]	2.39	2.42	0.017	2.33	2.49	0.016		***	
BCS – breeding (0–5)[4]	2.81	2.83	0.023	2.71	2.92	0.022		***	
Milk yield (kg)	8.19	7.62	0.152	8.74	7.07	0.162	**	***	

[1]Weighted standard error of the mean.
[2]Beef × dairy cows.
[3]Genetic merit × genotype interaction.
[4]Body condition score range: 0 = emaciated, 5 = extremely fat.
** = $P < 0.01$, *** = $P < 0.001$.

The HIGH cows produced 0.57 kg/d more milk than the LOW cows ($P < 0.01$), and an additional 1.67 kg was produced by BDX over the beef cows ($P < 0.001$).

Progeny performance

For all progeny performance traits investigated, both pre-weaning and carcass traits, no differences were observed across cow genetic merit (Table 6). Calves generated from BDX cows had a 0.08 kg greater ADG ($P < 0.001$) during the calf rearing period and were 19 kg heavier at weaning than calves from beef cows ($P < 0.001$). Calf quality and docility were similar for both BDX and beef cow progeny. An interaction was observed between genetic merit and genotype for calf value, where progeny from beef HIGH achieved an additional €37 at weaning than beef LOW ($P < 0.05$). No difference was observed between progeny of BDX cows of contrasting genetic merit. Progeny produced from beef cows had 0.77 greater conformation ($P < 0.001$) than BDX cows. However, all other carcass traits were similar across genotype (Table 6).

Discussion

The majority of calves in Ireland are suckled during the first grazing season and weaned at c. 8MO in October/November before housing for the winter (Drennan *et al.*, 2005). Suckler beef systems can be generally dichotomised into two systems

Table 6: Effect of cow genetic merit, genotype and their interaction on progeny performance

	Genetic merit (GM)			Genotype (G)			*P* value		
	High	Low	s.e.[1]	BDX[2]	Beef	s.e.[1]	GM	G	GM × G[3]
Calf weaning weight (kg)	295	295	4.1	304	285	4.1		***	
Average daily gain (kg/d)	1.14	1.12	0.015	1.17	1.09	0.015		***	
Calf quality (1–5)	3.36	3.29	0.067	3.31	3.34	0.067			
Calf docility (1–5)	1.63	1.65	0.037	1.66	1.62	0.037			
Calf value (€)	729	712	11.2	746	695	9.4		***	*
Slaughter live weight (kg)	648	646	7.2	649	645	7.1			
Carcass weight (kg)	350	349	3.8	349	350	3.7			
Conformation score (1–15)	7.50	7.57	0.140	7.15	7.92	0.138		***	
Fat score (1–15)	9.32	9.14	0.164	9.38	9.03	0.157			
Kill-out proportion (g/kg)	541	542	0.4	540	544	0.3			

[1]Weighted standard error of the mean.
[2]Beef × dairy cows.
[3]Genetic merit × genotype interaction.
* = $P < 0.05$, *** = $P < 0.001$.

depending on the outcome of the progeny, whether sold live, predominantly as weanlings, for further feeding (calf to weaning) or sold as finished animals for slaughter in a calf-to-beef system (Taylor *et al.*, 2018). Within all systems, profitable suckler cow production is dependent on cows exhibiting high levels of reproductive efficiency while producing a heavy calf from a predominantly grazed grass diet (Crosson *et al.*, 2014), thus increasing beef live weight output per hectare which is a key driver of profitability (Taylor *et al.*, 2018). Therefore, the objective of this study was to evaluate the performance of beef suckler cows diverse in genetic merit for maternal traits and also to determine if differences in progeny performance exist, whilst also comparing the performance of two contrasting replacement strategies (cow genotypes) under pasture-based systems.

Calving performance

Calving difficulty is a consequence of calf birth weight being incompatible with the pelvic opening of the cow or too great a proportion of the cows' own BW (Naazie *et al.*, 1989; Zaborski *et al.*, 2009). The absence of significant differences in calf birth weight across contrasting cow genotypes in the current study may therefore have resulted in the lack of calving difficulty observed. This is in contrast to previous studies that outlined greater potential for beef cows to incur calving difficulty than BDX cows (Hickson *et al.*, 2006; McCabe *et al.*, 2018), or studies by Barlow *et al.* (1994) and Murphy *et al.* (2008a) which deemed them intermediate between certain beef breeds.

In contrast to the results from the current study, the Irish national suckler herd reported calf perinatal mortality of approximately 9% (McCabe *et al.*, 2018), while Baker *et al.* (1990) reported that the average calf survival across nine beef and two dairy breeds in New Zealand was 8%. Calf mortality has been reported to be influenced by cow breed; Laster & Gregory (1973) and Baker *et al.* (1990) reported 5.5% and 4% for BDX relative to 14.5% and 14% for CH crossbred cows, respectively. However, results from the current study are in agreement with those reported by Reynolds *et al.* (1986) who found no difference across a range of beef and BDX breeds. Azzam *et al.* (1993) reported that calf mortality is five times more likely to occur where a cow encountered calving difficulty as opposed to those that required no assistance. Similarly, McCabe *et al.* (2018) found that when dystocia was included in the model for perinatal mortality using logistic regression in PROC GENMOD, it rendered no difference in perinatal mortality, highlighting that difficulties incurred during calving have the biggest impact on subsequent calf survival.

Reproductive performance and survival

Age at puberty and farm management decisions are two components that influence AFC. McHugh *et al.* (2014) outlined that many Irish producers elect for heifers to calve at 36 mo rather than managing heifers to become pubertal for breeding at 15 mo (Patterson *et al.*, 2000). This practice exists across Europe, where Dákay *et al.* (2006) observed a range of 2.03–3.51 yr for AFC across a variety of beef breeds in Hungary. However, research by Pinney *et al.* (1972) and Chapman *et al.* (1978) showed that heifers with an AFC of 24 mo weaned 0.4 and 0.9 more calves over their lifetime than those with an AFC of 36 mo. Newman & Deland (1991) showed that BDX heifers calve approximately a week earlier than beef, which Prendiville & McHugh (2014) have attributed to an earlier onset of puberty. However, this difference was not observed in the current study.

The practice of culling cows for being non-pregnant or failure to wean a calf mainly dictates survival rates of sucklers (Morris *et al.*, 1993), followed by calving success indicators such as AFC, dystocia, stillbirth or abortion (Mõtus & Emanuelson, 2017). The lack of significant differences across these traits in the current study may explain the comparable cow survival rates observed in the present study.

Disparities exist in the literature as to whether BDX or beef cows are superior in terms of reproductive efficiency. Nelson & Beavers (1982) highlighted that mature BDX cows had superior reproductive performance to mature beef cows, Butson *et al.* (1980) reported them comparable and Drennan & Berry (2006) stated that nutrition was the limiting factor rather than breed. Reproductive efficiency in suckler cows is defined as achieving high submission rates and high conception rates per service (Crowe, 2008). The BDX cows in the current study were superior in terms of submission rate in the first 24 d; however, overall pregnancy rate was similar across genotypes. As outlined by Recoules *et al.* (2013), reproductive performance of the sucker herd is dependent on cow nutrition, with postpartum ovarian activity being the product mainly of pre-partum nutrition. Cows in the current study had a suitable BCS at calving (between 2 and 3) to achieve 80% probability of calving within the first 42 d of the following calving season (Drennan & Berry, 2006), maintaining their maternal productivity.

Production performance

Chemical composition of the grass herbage available to all animals was of high quality (McEvoy *et al.*, 2010). Consistent with the findings of the present study, Murphy *et al.* (2008a) reported a 64-kg and 0.45-BCS score difference at housing and a 49-kg and 0.37-BCS score difference after calving for LM cows compared to LM × FR. The lower BCS of BDX is a direct breed consequence as dairy breeds are more likely to deposit fat in the abdominal cavity while beef breeds deposit fat subcutaneously (Truscott *et al.*, 1983). In agreement with Murphy *et al.* (2008a) and McGee *et al.* (2005b), the greater BW gain of beef cows at pasture than BDX cows may be a result of their lower milk yield and energy requirements.

While BDX cows exhibited superior production performance in terms of calf WW than beef cows in the current study, McCabe *et al.* (2018) reported that the greater production levels of BDX cows and subsequent extrapolated efficiency measures were attributed to a requirement for greater intakes. Fraga *et al.* (2016) and Minick *et al.* (2001) have corroborated how selection for milk can result in increased milk yield, which was observed in the additional 0.57 kg for HIGH cows in the present study.

Progeny performance

Weaning weight is a product of production system implemented and the age at which calves are weaned. Average WW using livestock auctions and commercial farm data reported by McHugh *et al.* (2011) is 1 kg lighter than WW recorded in the current study for BDX progeny, while Syrucek *et al.* (2017) reported WW of male calves in the Czech Republic similar (289 kg) to beef progeny in the current study. French specialised beef cattle breeds of CH, LM, Blonde d'Aquitaine and Maine-Anjou calf WW ranged from 15 to 38 kg lighter than the average WW in the current study (Phocas & Laloë, 2004). As no difference was observed in the quality of the progeny, the greater WW is reflected in the greater value of BDX progeny (McHugh *et al.*, 2011).

Previous work has shown that live weight differences at weaning are likely to remain to slaughter (Drennan & McGee, 2004; Murphy *et al.*, 2008b). Results from the current study are in contrast with these findings as no difference in BW at slaughter was observed between progeny of beef and BDX. While Drennan & McGee (2004) and Murphy *et al.* (2008b) deemed the progeny of beef cows to be unable to compensate for the difference post-weaning, differences in feed efficiency between beef and BDX animals (Archer *et al.*, 1999) may be one explanation for improved performance of beef progeny post-weaning. Lewis *et al.* (1990) demonstrated that when progeny received lower levels of milk in the pre-weaning phase, a period of compensatory growth occurred post-weaning. The superior carcass conformation attained by progeny from beef cows in the present study compared to BDX progeny is in agreement with that found by Kirkland *et al.* (2004) and Drennan *et al.* (2008).

Previous research conducted by McHugh *et al.* (2014) demonstrated that genetic selection for improved maternal performance would materialise in an improved phenotypic performance. However, results from the current study clearly demonstrate that genetic selection for maternal traits utilising the Replacement Index had no main significant effect on overall performance. This may be attributed to how the national validation study examined phenotypic performance from Irish beef herds on an individual trait basis, where herd-year-season contemporary groups were also formed separately for each trait. In contrast, the current study followed the same animals through their lifetime performance for all traits examined and while ranked on overall genetic index value, were not necessarily of the same ranking for each individual trait. It must also be noted that despite the large dataset utilised in the national validation study, McHugh *et al.* (2014) stated that the incremental change in the phenotype per unit change in EBV (estimated breeding value) was not always as large as expected. Therefore, it is unsurprising that the considerably smaller statistical power of the experimental herd in this study was unable to detect significant statistical differences. Nonetheless, utilising genetic indexes in the suckler herd is an important resource, as demonstrated by Clarke *et al.* (2009).

Conclusion

Replacement strategy (cow genotype) has one of the biggest impacts on profitability within the suckler beef herd. Results from the current study showed that suckler cows of contrasting genotype performed similarly across a multitude of traits, with those generated from crossbreeding with dairy cows producing heavier calves at weaning via greater levels of milk production.

Results from the current study showed that genetic selection for maternal traits utilising a national maternal index (Replacement Index) had no effect on the overall performance of suckler cows in a pasture-based spring-calving system. Nonetheless, utilising genetic indexes in the suckler herd is an important resource and phenotypic performance generated from the current study can be included in future genetic evaluations to improve the reliability of genetic values.

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Conflicts of interest

The authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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