End of Project Report

EVALUATION OF CATTLE OF VARYING DAIRY GENETIC MERIT FOR BEEF

Specific title: Evaluation of New Zealand and European-American Holstein-Friesians and Belgian Blue x Holstein-Friesians for Beef Production

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Summary

Various strains of Holstein-Friesian cattle have been imported into Ireland in recent years. The objective of this study was to evaluate for beef production the male progeny of New Zealand (NZ) and European-American (EU) Holstein-Friesians, and Belgian Blue x Holstein–Friesians (BB). The NZ animals were imported from New Zealand as embryos which were implanted into Irish heifers. The EU animals were the progeny by artificial insemination (AI) of high genetic merit Irish cows and high genetic merit European-North American-bred bulls. The BB animals were the progeny both by AI and natural mating of Belgian Blue bulls and Holstein-Friesian cows on commercial farms. A total of 96 spring-born male cattle (32 per genotype) were reared from calfhood to slaughter. They spent their first summer together at pasture and they were then blocked on weight to a 3 genotypes (NZ, EU and BB) x 2 production systems (bulls and steers) x 2 slaughter weights (550 and 630 kg) factorial experiment. After slaughter, carcasses were graded and the ribs joint was dissected into subcutaneous fat, intermuscular fat, muscle and bone.

For NZ, EU and BB, respectively, mean daily gains from arrival to slaughter were 773, 822 and 850 g, mean carcass weights per day from arrival were 425, 459 and 528 g, mean kill-out proportions were 496, 508 and 554 g/kg and mean carcass weights were 284, 302 and 339 kg. Carcass conformation score, carcass fat score, fat depth and *m. longissimus* area did not differ significantly between NZ and EU, but BB had higher values for carcass conformation and *m. longissimus* area and lower values for the fatness indicators. Compared with NZ, EU had more muscle and bone and less fat in the ribs joint, while BB had more muscle and less fat and bone than the dairy strains. Bulls had significantly higher slaughter and carcass weights per day from arrival than steers and also had a higher proportion of muscle and a lower proportion of fat in the ribs joint. Delaying slaughter increased slaughter and carcass weights but there was no significant effect on ribs joint composition. It is concluded that EU were slightly superior to NZ for beef production and BB were considerably superior to both dairy strains. Rearing as bulls rather than as steers improved carcass traits and retaining animals to a heavier slaughter weight improved carcass compactness with little effect on ribs joint composition.

Introduction

Since the mid 1980s the rate of genetic improvement in Irish dairy cattle has increased markedly mainly through the importation of Holstein genes from continental Europe and North America (O'Connell *et al.,* 2000). This has increased milk production potential but has reduced reproductive performance (Buckley *et al.,* 2000). Selection for improved dairy merit in the European and North American Holstein-Friesian cow populations has been mainly carried out under high levels of concentrate feeding. In contrast, selection for improved dairy merit in New Zealand has been on grass-based production systems similar to those in Ireland. Thus, dairy cows of New Zealand origin may be more suited to Irish production systems than cows of European and North American origin.

In Ireland, all the male progeny of dairy cows are raised for beef production so the beef traits of dairy calves are important. As the intensity of selection of Holstein-Friesians for dairy characteristics has increased beef carcass conformation has deteriorated.

To improve carcass conformation and other beef traits of dairy calves, dairy cows surplus to those required to produce replacement heifers are crossed with beef sires. The Belgian Blue is often preferred to other late maturing breeds because of its shorter gestation length and the belief that the carcass conformation of its progeny is better. In 1998, a research project was initiated at the National Dairy Research Centre, Moorepark to compare cows of New Zealand and European-North American descent for milk production and fertility traits.

The objectives of the present study were (1) to compare the growth and carcass traits of two dairy strains of contrasting origin (New Zealand (NZ) and European-North American (EU)), with Belgian Blue x Holstein-Friesians (BB), (2) to compare these breed types reared as bulls and steers, and (3) to compare the effects of two slaughter weights on these breed types and genders.

Materials and Methods

Animals

The NZ animals were of the highest possible genetic merit expressed in "breeding worth" according to the New Zealand genetic evaluation system. The dams were sourced from the Livestock Improvement Corporation in New Zealand and Jersey genes contributed no more than proportionately 0.125 of their genetic make-up. The mean pedigree indices of the five bulls to which the cows were mated were 32 kg milk, 8.8 kg fat, 3.4 kg protein, 0.15 g fat/kg milk and 0.05 g protein/kg milk (Dillon, personal communication). Embryos from these matings in New Zealand were recovered, transported to Ireland and implanted into recipient heifers in Moorepark.

The EU animals were produced by inseminating the top 150 genetic merit cows in the Moorepark herd with semen from five high genetic merit Holstein-Friesian bulls of European-North American descent. The mean pedigree indices of the five bulls were 282 kg milk, 9.0 kg fat, 10.7 kg protein, -0.03 g fat/kg milk and 0.02 g protein/kg milk (Dillon, personal communication).

The BB calves were mainly the progeny by artificial insemination (AI) of two Belgian Blue bulls with breeding values representative of the five AI bulls then approved for widespread use Ireland. From records of inseminations, dairy farmers who had used these bulls were identified. Some of additional calves were sourced from dairy farms who had Belgian Blue stock bulls. The objective was to source a group of calves representative of Irish Belgian Blue x Holstein-Friesians. Calves were inspected, purchased and tagged immediately after birth but remained on their farms of origin until after registration. They were then transferred to Grange for use in the present project.

Management

Calves were reared according to standard procedures. On arrival in Grange they were penned individually and the dairy strains were offered a total of 25 kg milk replacer (196 g/kg fat) over the first 56 days. Because BB were older and heavier at arrival, they were offered only 15 kg milk replacer over 35 days. Hay was available *ad libitum* at all times. Calf concentrates (750 g/kg coarsely rolled barley, 170 g/kg soyabean meal, 55 g/kg molasses and 25 g/kg mineral/vitamin premix) were offered up to a maximum of 2 kg per head daily and a total allowance of 100 kg per calf. All calves were turned out to pasture together on May 6, 1999 and grazed ahead of yearling steers in a leader/follower rotational grazing system. At 3, 8 and 13 weeks after turnout they were treated with ivermectin (Ivomec, MSD Agvet) by injection for the control of internal parasites.

On September 20, any calves in excess of 32 per genotype were culled on the basis of extremes of liveweight and/or birth date. This was to facilitate the allocation of equal numbers of relatively uniform animals per treatment. The 96 experimental animals were blocked on weight within genotype and allocated to four equal groups per genotype. These were then assigned to a 3 (genotypes) x 2 (production systems) x 2 (slaughter weights) factorial experiment. The two production systems were young bulls and steers and the two target slaughter weights were Light (L:550 kg) and Heavy (H:630 kg). The calves for steer production were castrated immediately. All the animals remained at pasture where they were offered 1 kg/day supplementary concentrates (875 g/kg rolled barley, 60 g/kg soyabean meal, 50 g/kg molasses and 15 g/kg mineral/vitamin premix) until housing on November 4.

On housing, the animals were accommodated in pens of 8 in a slatted floor shed. The bulls were offered grass silage (212 g/kg dry matter (DM), 155 g/kg crude protein (CP) in DM, 736 g/kg *in vitro* DM digestibility (DMD), pH 3.8) *ad libitum* plus concentrates (above formulation) increasing gradually over 4 weeks to 4 kg per head daily. After a further two months they were tied in individual stalls for one month to measure individual feed intakes. For the duration of this measurement, concentrates were reduced to 2 kg per head daily. After the period of individual feeding the bulls were returned to the slatted shed and concentrates were again offered at 4 kg per head daily. This level of feeding continued until July 12 when those destined for slaughter at the Light target weight had their concentrate level increased to 6 kg/day for two months before slaughter on September 5. The bulls destined for slaughter at the Heavy target slaughter weight continued to receive 4 kg concentrates per head daily until September 25 when it was increased to 6 kg per head daily until slaughter on November 21.

During their first winter the steers were offered the same silage as the bulls plus 1 kg concentrates per head daily until turnout as yearlings on March 29. During the second grazing season they followed calves in a leader/follower rotational grazing system until October 10. They were then housed and offered grass silage (217 g/kg DM, 153 g/kg CP in DM, 731 g/kg *in vitro* DMD, pH 3.8) *ad libitum* plus 2 kg concentrates per head daily until November 21. Those destined for slaughter at the Light target weight then had their concentrate allowance increased to 6 kg per head daily until slaughter on January 31. These destined for slaughter at the Heavy target weight continued to receive 2 kg/day concentrates until March 7 when it was increased to 6 kg/day until slaughter on May 10.

Carcass assessment

After slaughter in a commercial abattoir, perinephric plus retroperitoneal fat was weighed, and cold carcass weights (hot weight x 0.98), carcass fat scores, carcass conformation scores and carcass measurements were recorded. Carcasses were chilled at 4^0C for 24 hours after which the right side was divided into a pistola hind quarter and fore quarter. The ribs joint (ribs 6 to 10) was removed and taken to the meat laboratory where it was placed in a cold room (4^0C) for 24 hours. Subcutaneous fat depth and *m. longissimus throacis et lumborum* (LTL) area were measured at the 10^{th} rib end. The ribs joint was weighed and separated into subcutaneous fat, intermuscular fat, LTL muscle, other muscle, bone plus *ligamentum nuchae*.

Statistical analyses

Data were statistically analysed using the general linear model least squares procedure. Liveweight data up to the time of allocation to treatment and feed intake data were analysed for breed effects only. Liveweight data after allocation to treatment together with slaughter and carcass data were analysed as a 3 x 2 x 2 factorial. The significance of differences between genotypes was determined by the least significant difference procedure.

Results

Animal performance

Recorded mean birth dates were January 26, February 17 and February 15 for NZ, EU and BB, respectively. Corresponding mean arrival dates in Grange were February 22, March 5 and March 21. Recorded mean birth weights were 37 and 46 kg for NZ and EU, respectively. Birth weights of BB which were sourced on commercial farms were not available. Arrival weights at Grange were 54, 52 and 64 kg for NZ, EU and BB, respectively (Table 1).

From arrival at Grange until first turn-out on May 6, mean liveweight gain was 679 g/day and mean liveweight at turn-out was 101 kg with no difference between genotypes. During the first grazing season, mean liveweight gain was 693 g/day with BB having a lower value than the two dairy strains. Mean liveweight gain from arrival to the end of the first grazing season however, did not differ significantly between the genotypes and end of first grazing season liveweights (mean 225 kg) were not significantly different. During the first winter mean liveweight gain (798 g/day) was similar for the three genotypes and consequently liveweights at second turnout (mean 341 kg) were similar. During the second grazing season BB grew faster than both dairy strains and were significantly heavier than NZ at the last weighing before first slaughter. EU grew significantly faster than NZ. Over the final period, these trends continued with the result that slaughter weight of BB was significantly greater than for EU, which in turn was significantly greater than for NZ. Intervals from recorded birth date to slaughter for NZ, EU and BB were 705, 683 and 685 days, respectively. Both from arrival to slaughter and from first turnout to slaughter, EU gained significantly faster than NZ and BB tended to gain faster than EU. Both slaughter weight and carcass weight per day from arrival and from birth were significantly greater for EU than for NZ and for BB than for EU. Silage intake measured in the first winter did not differ between NZ and EU but was significantly lower for BB.

Table 1. Liveweights, silage intakes, liveweight gains, carcass weights per day and intervals to slaughter for New Zealand (NZ) and European/American (EU) dairy, and Belgian Blue x Holstein-Friesian (BB) male cattle.

		Breed (B)			Sex (S)			Significance	
Liveweights (kg) at:	Day	NZ	EU	BB	Bulls	Steers	s.e.d.[1]	B	S
Arrival	[2]	54[a]	52[a]	64[b]	-	-	1.7	***	
First turn-out	0	105	96	101	-	-	3.0		
First housing	182	232	226	218	-	-	4.9		
Second turn-out[3]	327	344	341	339	363	319	4.2		***
Final weighing[4]	481	473[a]	486[b]	496[c]	540	430	4.2	***	***

Silage intake (kg/day)[5]	-	4.27[a]	4.14[a]	3.66[b]	-	-	0.08	***	
<u>Liveweight gains (g/day) for:</u>	<u>Days</u>								
Arrival to first turn-out	[2]	679	703	654	-	-	81.4		
First turn-out to first housing	182	700[a]	716[a]	639[b]	-	-	21.5	*	
First housing to second turn-out	145	770	789	834	942	654	25.1		***
Second turn out to final weighing[4]	154	840[a]	941[b]	1024[c]	1152	717	23.5	***	***
Àrrival to slaughter	[2]	773[a]	822[b]	850[c]	904	726	9.8	***	***
<u>No. days from:</u>									
Arrival to slaughter		678[a]	667[b]	652[c]	587	744	2.1	***	***
Birth to slaughter		705[a]	683[b]	685[b]	612	770	1.9	***	***
<u>Slaughter weight (g/day) from:</u>									
Arrival		854[a]	902[b]	950[c]	1001	803	9.0	***	***
Birth		821[a]	880[b]	902[c]	960	776	7.0	***	***
<u>Carcass weight (g/day) from:</u>									
Arrival		425[a]	459[b]	528[c]	533	409	4.9	***	***
Birth		408[a]	448[b]	501[c]	510	395	3.8	***	***

[1]For n = 32 (breed type) in this and subsequent tables
[2]Varied with breed
[3]For steers
[4]Before any animals were slaughtered
[5]Dry matter-measured on bulls during the first winter.

At all times from first housing to slaughter bulls grew significantly faster than steers and were heavier at all times except at slaughter when no difference was intended. Mean slaughter weights per day from birth for bulls and steers were 960 and 776 g, respectively with corresponding carcass weights per day of 510 and 395 g.

Slaughter and carcass traits

For slaughter weight, carcass weight and kill-out, EU had significantly higher values than NZ, and BB had significantly higher values than EU (Table 2). There was no difference between the two dairy strains in carcass conformation score or in carcass fat score but BB had significantly better conformation and lower fat scores than both dairy strains. Fat depth did not differ significantly between the genotypes. Notwithstanding the absence of differences in carcass fat score and fat depth, EU had a significantly lower weight and proportion of perinephric plus retroperitional fat than NZ, and BB had significantly lower values than EU. Area of LTL, both absolutely and scaled for carcass weight, was similar for the two dairy strains but the BB values were significantly greater.

Carcass measurements were generally greater for EU than for NZ. BB had significantly lower carcass measurements for all but leg thickness and circumference of round which were greater. Scaled for carcass weight, EU had lower values than NZ for all measurements except leg width. Compared to the dairy strains, BB had significantly lower values for all carcass measurements scaled for carcass weight.

Although slaughter weight was similar for bulls and steers, carcass weight was significantly greater for bulls because of their significantly higher kill-out proportion. Carcass conformation score was significantly higher, and carcass fat score was significantly lower, for bulls than steers. Fat depth did not differ significantly between the sex categories but steers had a significantly greater weight and proportion of perinephric plus retroperitoneal fat than bulls. Area of LTL was greater for bulls than steers but when scaled for carcass weight the difference was not significant. Scaled for carcass weight, side length, carcass depth, pistola length and leg length were all greater for steers than bulls.

Table 2a. Slaughter traits for New Zealand (NZ) and European/American (EU) dairy, and Belgian Blue x Holstein-Friesian (BB) male cattle.

	Breed (B)			Sex (S)		Slaughter weight (W)			Significance		
	NZ	EU	BB	Bulls	Steers	Light	Heavy	s.e.d.	B	S	W
Slaughter weight (kg)	572[a]	594[b]	611[c]	587	597	551	633	5.5	***		
Carcass weight (kg)	284[a]	302[b]	339[c]	312	304	283	333	3.0	***	*	***
Kill-out (g/kg)	496[a]	508[b]	554[c]	531	508	513	526	2.8	***	***	***
Conformation[1]	1.59[a]	1.59[a]	3.13[b]	2.35	1.85	2.02	2.19	0.08	***	***	
Fat score[2]	3.39[a]	3.35[a]	3.13[b]	3.04	3.55	3.11	3.47	0.07	*	***	***
Fat depth (mm)	6.6	6.3	6.2	6.0	6.7	5.6	7.1	0.33			***
Perinephric + Retroperitoneal fat (kg)	12.0[a]	9.9[b]	8.2[c]	7.9	12.1	7.8	12.2	0.41	***	***	***
Perinephric+ retroperitoneal Fat (g/kg carcass)	42.0[a]	32.3[b]	23.9[c]	25.5	39.9	27.9	37.5	1.24	***	***	***
M. longissimus area (cm^2)	65.3[a]	66.7[a]	82.3[b]	74.2	68.7	63.4	79.4	2.18	***	*	***
M. longissimus area (cm^2/kg carcass)	0.230[ab]	0.220[a]	0.243[b]	0.236	0.226	0.239	0.0067	*		*	

[1]EU Beef Carcass Classification Scheme: scale 1 (poorest = P) to 5 (best = E).
[2]EU Beef Carcass Classification Scheme: scale 1 (leanest) to 5 (fattest).

Table 2b. Slaughter carcass measurements for New Zealand (NZ) and European/American (EU) dairy, and Belgian Blue x Holstein-Friesian (BB) male cattle.

	Breed (B)			Sex (S)		Slaughter weight (W)			Significance		
	NZ	EU	BB	Bulls	Steers	Light	Heavy	s.e.d.	B	S	W
Carcass measurements (cm)											
Side length	138.4[a]	140.2[a]	135.8[b]	137.7	138.6	136.7	139.6	0.66	***		***
Carcass depth	49.8[a]	50.6[b]	48.1[c]	48.1	50.9	48.5	50.5	0.24	***	***	***
Pistola length	113.0[a]	114.6[b]	111.8[ac]	112.4	113.8	113.1	113.2	0.65	*		
Leg length	72.9[a]	74.0[b]	71.4[c]	72.2	73.3	71.7	73.8	0.46	***	*	***
Leg width	44.3[a]	46.7[b]	45.3[c]	45.5	45.4	44.1	46.7	0.49	**		***
Leg thickness	26.9[a]	26.8[a]	28.3[b]	27.1	27.5	26.2	28.4	0.41	*		***
Round circumference	118.7[a]	122.6[b]	126.4[c]	124.2	121.0	120.8	124.4	0.67	***	***	***
Carcass measurements (cm/kg)											
Side length	0.494[a]	0.469[b]	0.406[c]	0.449	0.463	0.489	0.432	0.0053	***	***	***
Carcass depth	0.178[a]	0.169[b]	0.144[c]	0.157	0.170	0.174	0.154	0.0021	***	***	***
Pistola length	0.398[a]	0.380[b]	0.330[c]	0.360	0.375	0.400	0.340	0.0050	***	*	***
Leg length	0.260[a]	0.247[b]	0.214[c]	0.235	0.245	0.257	0.224	0.0031	***	**	***
Leg width	0.158[a]	0.156[a]	0.135[b]	0.148	0.151	0.158	0.141	0.0019	***		***
Leg thickness	0.096[a]	0.089[b]	0.085[c]	0.088	0.092	0.094	0.086	0.0018	***		***
Round	0.418[a]	0.407[b]	0.373[c]	0.398	0.398	0.428	0.373	0.0049	***		***

Retaining animals to the Heavy slaughter weight increased carcass weight by 50 kg. This was accompanied by a significant increase in kill-out proportion. Carcass conformation score was not affected, but all measures of fatness increased significantly with increasing slaughter weight. Both absolutely and scaled for carcass weight LTL area was greater at the Heavy than at the Light slaughter weight. All carcass measurements increased significantly with increasing slaughter weight but when scaled for carcass weight all decreased significantly.

Joint proportions and ribs composition

Side weight, pistola proportion of side, ribs weight and ribs composition are shown in Table 3. Side weight reflected carcass weight and was greater for EU than NZ, and for BB than EU. Pistola proportion of side weight was similar for the two dairy strains and significantly greater for BB. Ribs weight did not differ significantly between the two dairy strains but was significantly greater for BB than NZ. There were differences between the genotypes in ribs composition. Subcutaneous fat proportion was lower for BB than for the two dairy strains which were similar. Otherwise, EU had lower proportions of intermuscular fat and total fat and higher proportions of muscle and bone than NZ, while BB had lower proportions of intermuscular fat, total fat, and bone and a higher proportion of muscle than EU.

Side weight and ribs weight did not differ significantly between bulls and steers but pistola weight as a proportion of side weight was greater for bulls. Except for bone proportion which was similar, bulls had significantly lower values for fat proportions and significantly higher values for muscle proportions than steers. Both side weight and ribs weight increased with increasing slaughter weight but pistola weight as a proportion of side weight decreased. The only effect of slaughter weight on ribs composition was on bone proportion which declined significantly with increasing slaughter weight.

Table 3. Side weight, pistola proportion, ribs weight and composition for New Zealand (NZ) and European/American (EU) dairy, and Belgian Blue x Holstein-Friesian (BB) male cattle

	Breed (B)			Sex (S)		Slaughter weights (W)			Significance		
	NZ	EU	BB	Bulls	Steers	Light	Heavy	s.e.d	B	S	W
Side weight (kg)	142.3[a]	151.2[b]	171.2[c]	156.4	153.4	142.4	167.4	1.57	***		***
Pistola (g/kg side)	445[a]	445[a]	453[b]	454	442	455	441	2.6	*	***	***
Ribs weight (g)	7413[a]	7549[a]	8055[b]	7512	7833	6827	8518	201.0			***

Ribs composition (g/kg)											
Subcutaneous fat	40[a]	40[a]	33[b]	27	48	38	36	2.2	*	***	
Intermuscular fat	175[a]	143[b]	104[c]	115	165	136	144	4.5	***	***	
M. longissimus											
thoracis et lumborum	183[a]	193[b]	233[c]	218	188	201	205	3.7	***	***	
Other muscle	396[a]	408[b]	439[c]	434	395	412	417	5.3	***	***	
Total fat	215[a]	182[b]	136[c]	142	213	175	181	5.5	***	***	
Total muscle	579[a]	601[b]	672[c]	652	582	613	622	5.9	***	***	
Total bone[1]	206[a]	217[b]	192[c]	206	204	212	198	2.8	***		***

[1]Includes *ligamentum nuchae.*

Discussion

Production context

This experiment was undertaken to complement the dairy evaluation of the two dairy strains and all decisions on factors such as genetic merit, source and season of calving were made from a dairy rather than a beef evaluation perspective. The dairy interest in the New Zealand animals was, that having been selected under grass-based production systems, they might be more suited to Ireland than European-North American animals selected under conditions of high concentrate feeding. Because of the similarity in dairy production systems between Ireland and New Zealand there was some expectation that the beef traits of the New Zealand animals would be more like those of Irish Friesians than high genetic merit Holstein-Friesians. The rationale for including Belgian Blue x Friesians in the comparison was to provide a perspective for the relative magnitude of the differences between the dairy strains. This rather than any other beef cross was chosen because there has been a big expansion in the use of Belgian Blue for crossing on dairy cows in recent years (16% of inseminations in 2001 compared with 4% in 1993), so up to date information on performance and carcass traits was required.

Animal performance

The NZ calves were born to heifers, whereas the EU calves were the progeny of mature cows. It is presumed that BB were also the progeny of mature cows as dairy farmers rarely use Belgian Blue bulls on heifers. The NZ calves were born earlier and had a lower birth weight than the EU calves but at the time of arrival in Grange both strains had similar liveweights. Liveweight gains and liveweights were similar for the two dairy strains until the second grazing season when EU started to gain faster and continued to do so until slaughter. Thus, both from arrival to slaughter and from birth to slaughter liveweight gain per day was significantly greater for EU than NZ. Accordingly, slaughter weight was significantly greater, and as kill-out was also higher, carcass weight was significantly heavier and carcass weight per day of age was significantly greater for EU. The proportional superiority of EU over NZ was 0.1 in carcass weight per day from birth, 0.08 in carcass weight per day from arrival (the difference is due to the lower birth weight but similar arrival weight for NZ), and 0.06 in carcass weight. Although the Belgian Blue crosses were heavier than the two dairy strains at arrival, probably due to a higher birth weight and a higher level of feeding, they grew more slowly during their first grazing season. Thereafter however, they grew faster and had significantly higher liveweight and carcass weights per day both from arrival and from birth. They also had a higher kill-out proportion than the dairy strains.

From shortly after castration of the steers, the bulls gained faster to slaughter. Their proportional superiority in liveweight and carcass weight per day from birth was 0.24 and 0.29, respectively. As intended, slaughter weight was similar for bulls and steers but as the bulls had a significantly higher kill-out proportion they had a greater carcass weight.

Slaughter and carcass traits

The absence of a difference in carcass grades between NZ and EU was surprising considering that the strains differed in most measures of fatness and in ribs composition.

Differences between the dairy strains in carcass measurements were small especially when scaled for carcass weight and in all cases the EU values were between those for NZ and BB. This indicates that shape and compactness were better (i.e. more like BB) for EU than NZ. This finding was unexpected as it was believed that NZ were of less extreme dairy type and so should have better carcass shape/conformation and compactness than EU.

In all respects BB carcasses were superior to those of both dairy strains. They had better conformation, less fat, larger LTL area and smaller carcass measurements both absolutely and scaled for carcass weight indicating better shape and greater compactness.

In absolute terms, carcass measurements did not differ greatly between bulls and steers but when scaled for carcass weight all values for bulls were lower except circumference of round which was the same. Carcass measurements increased with increasing weight, but when scaled for carcass weight, values generally decreased indicating increased carcass compactness. It was somewhat surprising therefore that carcass conformation score was not affected by increasing weight eventhough LTL area, both absolutely and scaled for carcass weight, did increase with increasing weight. This suggests that muscle size increased more than proportionately with increasing carcass weight and as fatness also increased it is difficult to explain why this was not reflected in improved carcass conformation.

Side weight as a proportion of carcass weight did not differ with genotype, sex or slaughter weight and the mean value was 504 g/kg. As a proportion of side weight the pistola was similar for the two dairy strains but significantly greater for BB. Ribs weight generally paralleled side and pistola weights although it tended to be a smaller proportion at heavier weights.

The NZ animals resembled modern high genetic merit dairy strains in carcass conformation and compactness but resembled Friesians in body composition. This may have particular relevance to dairying, when in times of negative energy balance, mobilised body tissue which is higher in fat yields more energy with consequent potential benefits for milk production and fertility.

Pistola proportion decreased with increasing slaughter weight but ribs composition with the exception of bone proportion which declined, was unaffected by slaughter weight. With increasing weight, bone proportion generally declines and fat proportion increases.   In the present study however, the 14 g/kg decrease in ribs joint bone proportion was offset by a 9 g/kg increase in muscle proportion and a 5 g/kg increase in fat proportion (neither were statistically significant) suggesting that the animals were relatively immature at slaughter and were still growing muscle at proportionately about the same rate as fat up to the Heavy slaughter weight.

Conclusions

All the genotypes were suited to the production systems in which they were used. No unusual health or management problems were encountered and all carcasses were acceptable commercially. There was no advantage or disadvantage for any one breed type in rearing as bulls rather than steers.

Contrary to expectations, the NZ animals had no advantage over EU for beef production. In fact, even though they were 22 days older at slaughter, their slaughter weight was 22 kg less and their carcass weight was 18 kg less. However, it should be remembered that they were born to heifers rather than to mature cows and their birth weight was 9 kg lower.

In addition to the lower growth rate, kill-out proportion was also lower for NZ with the result that the difference in carcass weight was almost as great as the difference in liveweight. There was no difference in carcass grades between NZ and EU but carcass measurements scaled for carcass weight (measures of carcass compactness) tended to be lower for EU. With the exception of carcass fat score and ribs subcutaneous fat proportion, all measures of fatness were higher for NZ. This is of no advantage for beef production but it may be advantageous to dairy cows in times of negative energy balance. Bone proportion was significantly less for NZ than EU resulting in a higher soft tissue to bone ratio for NZ (3.85 v. 3.61).

Compared with EU, BB carcasses were 37 kg heavier and 1.5 units better in conformation. The carcasses were also more compact, had 8 g/kg more of the carcass weight in the pistola and had 71 g/kg more muscle in the ribs joint. Using this as an indicator of muscle production, BB produced proportionately about 0.25 more muscle than EU which in turn produced proportionately about 0.10 more than NZ.

While bulls and steers had the same target slaughter weight the bulls produced 8 kg more carcass weight and had 0.5 units better conformation. They had more compact carcasses and had 70 g/kg more muscle in the ribs joint. Generally, an increase in slaughter weight increases all measures of fatness and reduces muscle proportion. An increase in fatness with increasing slaughter weight was also observed here but it was offset by a decrease in bone proportion leaving muscle proportion unaffected.

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