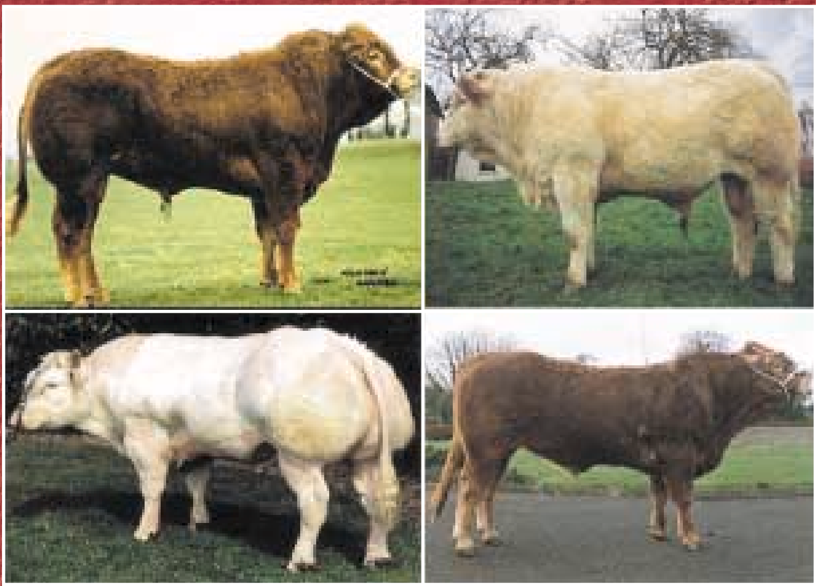
End of Project Report

EVALUATION OF THE PROGENY OF BEEF SIRES DIFFERING IN GENETIC MERIT



GRANGE RESEARCH CENTRE

Project No. 4687

Beef Production Series No.71

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End of Project Report – Project 4687

Evaluation of the Progeny of Beef Sires Differing in Genetic Merit

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SUMMARY/CONCLUSIONS

- The Irish Cattle Breeding Federation (ICBF) publishes breeding values (BVs) for beef bulls. Historically, BVs were expressed in index form relative to the base population. Sometime ago this changed to expression in units of measurement of trait. This change occurred in the course of this project and was accompanied by some re-ranking of bulls.
- BVs are published for growth, carcass grades and calving traits. Growth BV is expressed as carcass weight but there is no indication if this results from higher live weight gain or from a higher kill-out proportion and there is no indication of any consequences for feed intake or efficiency.
- The objectives of the project were (i) to compare progeny of bulls of high and low growth genetic index, for growth, feed intake, slaughter traits and carcass traits, (ii) to partition the extra live weight of progeny of high growth index bulls into carcass and non-carcass parts, and (iii) to partition any extra carcass weight of progeny from high growth index bulls into its component fat, muscle and bone fractions.
- In Experiment 1, two artificial insemination (AI) Belgian Blue bulls (EWN and KIC) which differed for growth, conformation and leanness by 9, 9 and 42 units of index, respectively produced progeny of similar growth rate, slaughter weight and carcass weight. Carcass grades tended to reflect the sire BVs for carcass grades. Ribs joint muscle proportion tended to be higher, and ribs joint fat proportion tended to be lower, for the progeny of the sire (EWN) with the higher BVs for conformation and leanness.
- In Experiment 2, progeny from the same two Belgian Blue bulls used in Experiment 1 were compared with progeny from unknown Belgian Blue sires, one known AI Charolais sire (HKI) and unknown Charolais sires. The progeny from the unknown sires were purchased as calves at livestock marts. The growth BV

differences between EWN, KIC and HKI were not reflected in the growth rate of their progeny, which was similar for the three sires.

- Performance of the calves from the unknown sires was similar to that of the known sires.
- The progeny of the unknown Charolais sires had better conformation than all other progeny groups and the progeny of EWN, which had a high BV for leanness had a lower fat score than all other progeny groups.
- The progeny of EWN and HKI (which had high BVs for conformation and leanness) had a significantly higher proportion of muscle and a significantly lower proportion of fat in the ribs joint than the other progeny groups.
- Two groups of Limousin bulls, which differed by 29 units index in growth BV produced progeny which differed by 16 kg in carcass weight (the expected difference was about 19 kg). About two thirds of the extra carcass weight was due to higher live weight gain and one third was due to a higher kill-out proportion.
- The bulls of higher growth BV also had higher conformation and higher fat score BVs. Progeny conformation tended to be better for the sires of higher conformation BV but measures of fatness did not differ between the progeny groups.
- Scaled for carcass weight, the progeny of sires with the higher BVs for growth and conformation had lower carcass measurements indicating greater carcass compactness.
- There was no effect of sire BVs for growth and carcass traits on feed intake.
- While differences in carcass composition were not significant, the progeny of sires of higher BVs for growth and conformation tended to have more muscle and less fat than progeny of sires with lower BVs for growth and conformation.
- Regressions of traits measured on the progeny on the corresponding sire BVs generally explained less than 0.5 of the variance and the regression coefficient was generally not significant.

- For the Belgian Blue and Charolais bulls, sire growth BV was generally a poor indicator of progeny growth rate but sire carcass grade BVs were better indicators of progeny carcass grades. For the Limousin bulls, mean sire group BV for growth was paralleled by mean progeny group growth rate. However, the relationship between individual sire growth BV and the growth rate of his progeny was poor.

INTRODUCTION

The national beef breeding programme operated by the Irish Cattle Breeding Federation (ICBF) aims to upgrade the genetic merit of breeding bulls and ultimately the national herd. Breeding values (BVs) are published regularly for beef bulls for growth, carcass grades and calving traits. Historically, Irish beef bull BVs were expressed in index form. This avoided the confusion often associated with expression of BVs, or expected progeny differences (EPDs), in units of measurement of trait. The index showed the ranking of a bull relative to the base population. Sometime ago the system was changed from the index form to the units of measurement of trait form. This change took place during the course of this project and some re-ranking of bulls occurred as result. Thus, by the time the progeny were slaughtered the ranking or magnitude of genetic differences between bulls were not the same as when the bulls were originally selected for evaluation.

As breeding values and genetic indices of bulls can seem abstract concepts to producers it is desirable that the differences between the BVs of bulls for various commercial traits be demonstrated in practice. In addition, it is desirable that the "extra weight increment" of bulls with superior BVs for growth be quantified and described in terms of extra carcass and extra non carcass parts. Then the extra carcass weight needs to be partitioned into fat, muscle and bone. Similarly, the relationships between carcass conformation or leanness, and meat yield or muscle proportion, needs to be established. Ultimately, the feed requirements associated with extra weight gain or change in composition needs to be quantified so that a complete economic assessment of differences in BVs can be undertaken.

The objectives of this project were (1) to compare the progeny of beef bulls of high and low growth genetic index, for growth, feed intake, slaughter traits and carcass composition, (2) to partition the “extra” live weight gain of the progeny from high growth index bulls into carcass and non carcass parts, and (3) to partition any extra carcass into its component fat, muscle and bone tissues. Three separate experiments were carried out in the course of the project.

EXPERIMENT 1. PERFORMANCE OF PROGENY OF BELGIAN BLUE BULLS

Materials and Methods

Thirty two spring-born male progeny by artificial insemination (AI) from two Belgian Blue sires (KIC and EWN) and Holstein-Friesian cows were sourced on dairy farms and identified shortly after birth. After registration at about 4 weeks of age they were transported to Grange. They were reared according to standard procedures and were turned out to pasture together on May 6 where they 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 for the control of internal parasites.

On September 20, they were assigned to a 2 (sires) x 2 (production systems) factorial experiment to take account of possible interactions between sire merit and production system. The two production systems were young bulls and steers. The calves for steer production were castrated immediately. All animals were housed together on November 4. The bulls were offered grass silage *ad libitum* plus concentrates increasing gradually to 4 kg per head daily. Two months later the bulls were tied in individual stalls and silage intake was measured for one month. During this time concentrate feeding level was reduced to 2 kg per head daily. Afterwards, it was again increased to 4 kg/day and it remained at this level until two months before slaughter when it was increased to 6 kg/day. The steers were offered the same silage as the bulls plus 1 kg concentrates per head daily during the first winter until turnout to pasture 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 for finishing over the second winter and were offered grass silage plus 4 kg concentrates per head daily until two months before slaughter when concentrates were increased to 6 kg/day.

After slaughter, cold carcass weight, carcass grades and routine carcass measurements were recorded. The right side of each carcass was divided into a pistola hind quarter and fore quarter. The ribs joint (6 to 10) was removed and separated into fat, muscle and bone.

Data were analysed using the general linear model least squares procedure. Live weight data up to allocation to the experimental treatments were analysed for sire genetic index effects only. After allocation to treatment data were analysed as a 2 x 2 factorial with interactions included.

The relative (breed mean = 100) BVs for sire KIC at insemination were: growth 113, conformation 97, leanness 86, length 107 and kill-out 96. The corresponding values for EWN were 104, 106, 128, 103 and 90. Based on these values the progeny of KIC would be expected to have a higher growth rate, poorer carcass conformation, fatter and longer carcasses and a higher kill-out proportion than the EWN progeny.

Results

Mean birth date differed by only two days between the two sires (Table 1), so live weights were entirely a function of growth rates and corrections for differences in birth date were unnecessary. There was no significant difference in live weight between the progeny of the two sires at any time throughout life. Although lighter at arrival, the progeny of KIC tended to be heavier at first turnout and at first housing. Thereafter, the difference narrowed and the mean slaughter weights of the two progeny groups were identical. The calves reared as bulls were born 6 days later and were 7 kg lighter at arrival than those reared as steers. They were also lighter at first turnout but the difference had disappeared by the date of first housing. Thereafter, the bulls grew faster. They were 42 kg heavier at the time of second turnout of the steers (the bulls remained housed) and were 118 kg heavier at final weighing before any animals were slaughtered. As intended, slaughter weight was similar for the bulls and steers. Because slaughter weight was similar for the progeny of the two sires and for the bulls and steers any differences in slaughter traits and carcass traits could not be attributed to differences in slaughter weight, but were due entirely to the experimental factors.

Slaughter traits and carcass measurements are shown in Table 2. Other than carcass conformation, which was close to being significantly higher ($P < 0.08$) for EWN, there were no significant differences between the two progeny groups. Carcass fat score tended to be higher for the KIC progeny. Kill-out proportion was significantly higher for bulls than steers but the difference in carcass weight (11 kg in favour of bulls) was not significant. Carcass conformation was significantly better and carcass fat score and kidney plus channel fat weight were significantly lower for bulls. There were no significant differences between bulls and steers in carcass length, leg length or leg width, but carcass depth was significantly greater for steers. Life time daily gains, *m. longissimus* area and silage dry matter (DM) intake of the bulls are shown in Table 3. As expected, life time daily gain was significantly higher for bulls than steers but life time gains for the progeny of KIC and EWN were identical. Slaughter weight and carcass weight per day of age were also higher for bulls than steers but there was no difference between the two sire progeny groups. *M. longissimus* area was also greater for bulls than steers but was identical for the two sire progeny groups. There was no difference in intake between the two sire progeny groups.

Ribs joint composition is shown in Table 4. There was no significant difference in ribs joint weight or composition between the two sire progeny groups although fat proportions tended to be higher and muscle proportions tended to be lower for the

KIC progeny. The weight of the ribs joint was significantly greater for steers than bulls. (This was probably due to different meat plant operatives removing of the joint from the side as the bulls and steers were slaughtered on different dates). The proportions of all fat and muscle tissues in the ribs joint differed significantly between bulls and steers. Bulls had lower fat and higher muscle proportions but the proportions of bone were similar for the two genders.

Discussion

The rationale for including the comparison of bulls and steers was to provide a perspective for the relative magnitude for any differences between the sire progeny groups. The normally expected differences between bulls and steers were evident from shortly after castration of the steers and these differences were generally statistically significant. There was no difference in slaughter weight between bulls and steers because both had the same target slaughter weight. The bulls had a higher kill-out proportion (as would be expected) but the consequential difference in carcass weight failed to reach significance. Carcass grades, kidney plus channel fat weight and all ribs joint tissue proportions except bone differed significantly between bulls and steers. The only interaction was for kidney plus channel fat weight which was higher for KIC progeny as bulls but was higher for EWN progeny as steers. Taken together, the data for the comparison of the genders show that the experiment was capable of detecting normal production factor differences and interactions.

Because the bull BVs were in index form, it is not possible to estimate accurately the expected progeny differences in units of trait but approximations can be made. The growth BVs suggest that the progeny of KIC should be 25-30 kg live weight and 13-17 kg carcass weight heavier than the EWN progeny. The present experiment would have identified significant differences of about 21 kg live weight or 11 kg carcass weight.

Carcass conformation should have been better for EWN progeny and it was ($P < 0.08$). Carcass fat score should have been lower for EWN progeny and it was, although the difference failed to reach significance. Carcass length should have been marginally greater for KIC progeny and it was, but kill-out proportion, which should also have been greater for KIC progeny, was actually greater for EWN progeny although the difference was not significant. Because there was little difference between the progeny groups in carcass weight, little difference would be expected in ribs joint composition. In line with their somewhat higher fat score, the KIC progeny tended to have higher ribs joint fat proportions and lower muscle proportions.

It is concluded that there was no difference between the sire progeny groups in growth rate, slaughter weight or carcass weight, but carcass grades did tend to reflect sire BVs. Bulls had a higher growth rate and at the same slaughter weight had a higher kill-out proportion, better carcass conformation, a lower fat score, less kidney plus channel fat, less carcass fat and more carcass muscle than steers

Table 1: Live weights of progeny of two Belgian Blue sires reared as bulls or steers

	BULL (B)		GENDER (G)			Significance	
	KIC	EWN	BULLS	STEERS	s.e.[1]	B	G
Birth date	**Feb 13**	**Feb 15**	**Feb 17**	**Feb 11**			
Live weights (kg) at:							
Arrival	61	68	61	68	2.2	NS	NS
1st Turnout	103	98	91	111	2.8	NS	**
1st Housing	226	205	218	214	5.8	NS	NS
2nd Turnout	340	336	358	316	7.3	NS	**
Final weighing[2]	499	489	553	435	8.6	NS	***
Slaughter	609	609	606	612	8.5	NS	NS

[1]For n = 16; [2]Before any animals were slaughtered. There were no significant B x G interactions.

Table 2. Slaughter traits and carcass measurements of progeny of two Belgian Blue sires reared as bulls or steers

	BULL (B)		GENDER (G)			Significance		
	KIC	EWN	BULLS	STEERS	s.e.[1]	B	G	BxG
Carcass weight (kg)	335	341	344	333	4.5	NS	NS	NS
Kill-out (g/kg)	551	560	567	544	4.2	NS	**	NS
Conformation[2]	3.0	3.3	3.5	2.9	0.08	P<0.08	***	NS
Fat score[3]	3.3	3.0	2.8	3.4	0.08	NS	**	NS
Kidney+channel fat (kg)	7.8	8.5	5.4	10.8	0.31	NS	***	*[4]
Carcass length (cm)	136.0	135.2	135.0	136.2	0.71	NS	NS	NS
Carcass depth (cm)	48.4	47.6	46.7	49.3	0.28	NS	***	NS
Leg length (cm)	71.2	71.4	70.5	72.1	0.51	NS	NS	NS
Leg width (cm)	45.7	44.9	44.8	45.8	0.37	NS	NS	NS

[1]For n = 16; [2]Scale 1 (poorest = P) to 5 (best = E); [3]Scale 1 (leannest) to 5 (fattest).
[4]Values of 5.9 and 5.0 for KIC and EWN as bulls and 9.7 and 12.0 as steers.

Table 3. Life time live weight gains, *m. longissimus* area and feed intake of progeny of two Belgian Blue sires reared as bulls or steers

	BULL (B)		GENDER (G)			Significance	
	KIC	EWN	BULLS	STEERS	s.e.[1]	B	G
Life time gain (g/day)[2]	848	848	949	747	12.3	NS	***
Per day of age (g)							
Slaughter weight	942	954	1056	840	13.7	NS	***
Carcass weight	519	536	598	457	7.1	NS	***
M.longissimus area (cm^2)[3]	0.246	0.246	0.254	0.238	0.005	NS	*
Silage intake (kg/day)[4]	3.65	3.75	3.70	-	0.069[5]	-	NS

[1]For n = 16; [2]From arrival to slaughter; [3]cm^2 per kg carcass; [4]After housing while being offered 2 kg/day supplementary concentrates; [5] For n = 8. There were no significant B x G interactions.

Table 4. Ribs joint composition of progeny of two Belgian Blue sires reared as bulls or steers

	BULL (B)		GENDER (G)			Significance	
	KIC	EWN	BULLS	STEERS	s.e.[1]	B	G
Ribs joint weight (g)	8248	8540	8085	8704	192.0	NS	*
Composition (g/kg)							
Subcutaneous fat	36	29	23	41	3.1	NS	***
Intermuscular fat	108	98	80	125	6.4	NS	***
M.longissimus	229	238	247	221	5.2	NS	***
Other muscle	435	447	460	423	7.5	NS	***
Total fat	144	127	103	166	7.8	NS	***
Total muscle	664	685	707	644	8.3	NS	***
Total bone[2]	192	188	189	190	3.9	NS	NS

[1]For n = 16; [2]Includes other tissue. There were no significant B x G interactions.

EXPERIMENT 2. PERFORMANCE OF PROGENY OF BELGIAN BLUE AND CHAROLAIS BULLS

Materials and Methods

A total of 84 spring-born male calves sired by Belgian Blue and Charolais bulls out of Holstein-Friesian cows were reared to slaughter within the framework of a two year-old steer beef production system. There were 49 Belgian Blue sired calves (18 progeny of EWN, 19 progeny of KIC and 12 from unknown sires (BBM)) and 35 Charolais sired calves (13 progeny of HKI and 22 from unknown sires (CHM)). The calves from unknown sires were purchased in small numbers at livestock marts. All the animals were managed together throughout their life time and when used in other experiments, the progeny groups were blocked and balanced across treatments. Calf rearing was by standard procedures and all calves were turned out to pasture together on May 31 where they grazed ahead of yearling steers in a leader/follower system of rotational grazing. They remained at pasture until November 29 when they were housed for the first winter and offered silage *ad libitum* plus a mean level of 1kg/day concentrates until turnout for the second grazing season on March 29. During the second grazing season they grazed behind calves in a leader/follower rotational grazing system. They were housed for finishing on November 7 and over the finishing winter they were offered silage *ad libitum* plus a mean concentrate level of 5 kg/day until slaughter on March 13.

After slaughter, cold carcass weight, carcass grades and routine carcass measurements were recorded. The right carcass side was divided into a pistola hind quarter and fore quarter. The ribs joint (6 to 10) was removed and separated into its component tissues of fat, muscle and bone.

The data were analysed by analysis of variance with unequal numbers per group. The significance of differences between means were determined by the least significant difference procedure.

The relative (breed mean = 100) BVs of sires KIC and EWN were as given in Experiment 1. The values for HKI were: growth 136, conformation 120 and leanness 113. As the sires of the mart purchased calves were unknown, it is assumed their BVs approximated to the breed mean. Thus, the comparison should demonstrate the differences between breed mean progeny and the progeny of sires with known BVs.

Results

Live weights of the 5 progeny groups are shown in Table 5. There were differences between the groups in birth date, arrival date and arrival weight which had knock-on effects on subsequent live weights to slaughter. The mart purchased calves were born earlier, were heavier at arrival and remained heavier to slaughter. Other than at arrival, there was no significant difference in live weight at any time between the KIC, EWN and HKI progeny groups. Because of the differences in birth dates and arrival weights, it is necessary to compare daily gains.

Live weight gains together with slaughter and carcass weights per day of age are shown in Table 6. Other than in the first grazing season when the mart purchased calves gained faster (probably a consequence of their earlier birth date and greater arrival weight), there were no significant differences in live weight gains between the progeny groups. Slaughter weight per day of age differed by less than 4% between the groups and carcass weight per day of age differed by less than 3%.

Slaughter traits and carcass measurements scaled for carcass weight are shown in Table 7. There was no significant difference between the progeny groups in carcass weight, kill-out proportion or carcass measurements scaled for carcass weight. The mart purchased Charolais group had significantly better conformation than the three Belgian Blue progeny groups. The progeny of EWN had a significantly lower fat score than all other groups. Kidney plus channel fat proportion was significantly lower for the HKI progeny than for the three Belgian Blue progeny groups. EWN progeny had a significantly larger *m. longissimus* area per kg carcass weight than the mart purchased Belgian Blue group.

Pistola proportion and ribs joint composition are shown in Table 8. Pistola proportion and ribs joint weight did not differ between progeny groups. Ribs joint composition was generally similar for KIC progeny and both mart purchased groups. EWN progeny had significantly lower fat and higher muscle proportions than KIC progeny and both mart purchased groups. HKI progeny ribs joint composition was intermediate between that of EWN progeny and the other groups.

Discussion

Progeny of KIC and EWN were included in the present comparison to ascertain if the previous results would be confirmed. The HKI progeny were included because at the time HKI had the highest growth BV and estimated highest progeny monetary value of all AI bulls. It was possible to obtain only a limited number of HKI progeny because the bull was not popular with dairy farmers due to above average incidence of calving difficulty.

The outcome of the comparison between KIC and EWN progeny was generally consistent with the findings in Experiment 1. In Experiment 1, slaughter weight was similar and carcass weight was less than 2% greater for EWN, while in Experiment 2, slaughter weight per day was less than 3%, and carcass weight per day was less than 2%, greater for KIC. None of these differences were close to being significant. The lower fat score of EWN progeny was consistent between experiments, as was the absence of any differences in carcass measurements. Although the differences were not significant in Experiment 1, in both experiments EWN progeny had lower proportions of fat, higher proportions of muscle and similar proportions of bone. Overall, it is concluded that despite the difference in growth BV, KIC and EWN progeny had similar live and carcass growth rates but at the same carcass weight EWN progeny were less fat and had more muscle in line with the higher BVs for conformation and leanness.

The mart purchased Belgian Blue calves were similar to the EWN and KIC progeny. They tended to grow faster initially, probably reflecting their earlier birth date and heavier arrival weight but later the others compensated with the result that both groups had similar slaughter and carcass weights for age. Slaughter traits and ribs joint composition were also similar. Because they were computed on a within breed basis, the BVs for HKI are not directly comparable with those for KIC and EWN. However, as the breed means for the main production traits are similar for Belgian Blue and Charolais (Keane, unpublished), it would be expected from his higher BVs that HKI progeny would have superior growth and conformation to KIC and EWN progeny. In ribs joint composition, the HKI progeny were intermediate between KIC and EWN progeny. The performance of the mart purchased Charolais calves was equal in every respect to that of the HKI progeny, and similar to that for the mart purchased Belgian Blues calves. While all reasonable precautions were taken to ensure that the calves were from the sires indicated, sire identify was not confirmed by genotyping. Calves from the known sires were sourced from farmers who had used them in their dairy herds and generally these farmers did not use any other beef bull. Calves were inspected shortly after birth to confirm that dam breed and birth date were in agreement with the service records. In view of these precautions it is unlikely that calves were wrongly attributed to progeny groups.

It is concluded that the growth BV differences between KIC, EWN and HKI were not reflected in differences in the growth rate of their progeny. Carcass grade BV differences were reflected in the progeny carcass grades and there were corresponding differences in ribs joint composition. Mart purchased calves had similar growth rates and slaughter traits to the progeny of the AI bulls.

Table 5. Live weights of progeny of Belgian Blue and Charolais bulls

	KIC	EWN	BBM	HKI	CHM	s.e.[1]	Significance
No. animals	**19**	**18**	**12**	**13**	**22**		
Birth date	Mar. 3	Mar. 7	Feb. 11	Feb. 26	Feb. 9	3.7	***
Arrival date	Mar. 23	Apr. 3	Mar. 10	Mar. 21	Mar. 5	3.8	***
Live weights (kg) at:							
Arrival	56[a]	64[b]	71[c]	62[b]	71[c]	2.2	***
1st Turnout (May 31)	105[a]	106[a]	130[b]	107[a]	136[b]	4.9	***
1st Housing (Nov 29)	245[a]	234[a]	294[b]	245[a]	297[b]	8.2	***
2nd Turnout (Mar 29)	335[a]	326[a]	361[b]	327[a]	365[b]	14.3	**
2nd Housing (Nov 7)	520[a]	506[a]	526[ab]	518[a]	556[b]	12.8	**
Final weighing (Mar 13)	637	620	650	629	665	17.1	NS
Slaughter	643[ab]	621[a]	653[ab]	634[ab]	669[b]	17.4	*
Days from							
Birth to slaughter	749	743	769	751	769	3.7	***
Arrival to slaughter	728	716	740	729	746	3.8	***

[1]For n= 12. Values within a row with a common superscript are not significantly different. BBM = mart purchased Belgian Blue; CHM = mart purchased Charolais.

Table 6. Live weight gains of progeny of Belgian Blue and Charolais bulls

	KIC	EWN	BBM	HKI	CHM	s.e.[1]	Significance
Live weight gains (g/day) for:							
First turnout to first housing	774[a]	703[b]	899[c]	759[ab]	885[c]	30.6	***
First housing to second turnout	751	765	558	685	567	98.0	NS
Second turnout to second housing	826	804	737	853	853	70.6	NS
Second housing to final weighing	928	906	991	879	866	90.5	NS
First turnout to final weighing	817	788	798	801	812	24.6	NS
Per day of age (g)							
Slaughter weight	859	835	851	844	870	23.4	NS
Carcass weight	461	454	457	457	467	14.2	NS

[1]For n = 12. Values within a row with a common superscript are not significantly different. BBM = mart purchased Belgian Blue; CHM = mart purchased Charolais.

Table 7. Slaughter traits and carcass measurements of progeny of Belgian Blue and Charolais bulls

	KIC	EWN	BBM	HKI	CHM	s.e.[1]	Significance
Carcass weight (kg)	345	337	351	344	359	10.6	NS
Kill-out (g/kg)	537	542	536	541	537	3.9	NS
Conformation[2]	2.4[a]	2.4[a]	2.4[a]	2.5[ab]	2.8[b]	0.16	*
Fat score[3]	3.4[bc]	2.6[a]	3.3[bc]	3.1[bc]	3.7[c]	0.23	**
Kidney + channel fat (g/kg)	39.2[a]	37.8[a]	40.0[a]	27.9[b]	34.9[ab]	1.74	*
M.longissimus (cm^2/kg carcass)	0.25[ab]	0.27[a]	0.24[b]	0.26[ab]	0.25[ab]	0.009	*
Carcass measurements (cm/kg)							
Side length	0.41	0.41	0.40	0.41	0.39	0.012	NS
Carcass depth	0.15	0.15	0.14	0.14	0.14	0.004	NS
Leg length	0.22	0.22	0.22	0.22	0.21	0.006	NS
Leg width	0.13	0.14	0.13	0.13	0.13	0.004	NS

[1]For n = 12. [2]Scale 1 (poorest = P) to 5 (best = E); [3]Scale 1 (leannest) to 5 (fattest). Values within a row with a common superscript are not significantly different. BBM = mart purchased Belgian Blue; CHM = mart purchased Charolais.

Table 8. Pistola proportion and ribs joint composition of progeny of Belgian Blue and Charolais bulls

	KIC	EWN	BBM	HKI	CHM	s.e.[1]	Significance
Pistola (g/kg side)	463	470	465	470	463	4.7	NS
Ribs joint weight (g)	9492	8798	9476	8877	9376	356.8	NS
Ribs composition (g/kg)							
Subcutaneous fat	60[c]	39[a]	54[b]	44[ab]	61[c]	4.9	***
Intermuscular fat	159[b]	112[a]	161[b]	130[ab]	159[b]	8.8	***
M. longissimus	208[a]	231[b]	208[a]	217[ab]	213[a]	7.1	*
Other muscle	387[a]	425[b]	398[a]	414[ab]	398[a]	8.4	***
Total fat	219[b]	151[a]	215[b]	174[a]	220[b]	12.0	***
Total muscle	595[a]	656[b]	606[a]	632[ab]	602[a]	10.5	***
Total bone	186	193	179	194	178	5.8	NS

[1]For n = 12. [2]Values within a row with a common superscript are not significantly different. BBM = mart purchased Belgian Blue; CHM = mart purchased Charolais.

EXPERIMENT 3. PERFORMANCE OF PROGENY OF LIMOUSIN BULLS OF HIGH AND LOW GENETIC INDEX

Materials and Methods

A total of 70 Spring-born progeny (42 males and 28 females) out of Holstein-Friesian dairy cows (54) and beef x heifers (16), and 7 Limousin sires were reared together from shortly after birth to slaughter. The 7 sires were classed as Low (L) genetic index (n=3) or High (H) genetic index (n=4) for growth. There were 16 male and 14 female progeny of L sires and 26 male and 14 female progeny of H sires. The males were reared entire. The number of progeny per individual bull ranged from 4 to 16. All of the females and 26 of the males were the result of planned matings in Teagasc herds. The remaining 16 males were sourced from commercial dairy farms where the sires of interest had been used. The 16 calves from beef x heifers were born at Grange. All calves were tagged shortly after birth and those born outside Grange were transferred to Grange within 4 weeks.

Calf rearing was according to standard procedures. On May 31, all calves were turned out to pasture, which they rotationally grazed until November 8. At 3, 8 and 13 weeks after turnout, they were treated with ivermectin for the control of gastrointestinal parasites. In early October, the male and female calves were separated. The mean duration of the first grazing season was 161 days.

During the first winter the animals were accommodated in a slatted shed and offered grass silage *ad libitum* plus 1.5 kg concentrates per head daily. At 2 weeks after housing they were treated with oxfendazole to control gastrointestinal parasites. The mean duration of the winter was 140 days and the animals were turned out to pasture at the start of the second grazing season on March 28.

Following 49 days at pasture the animals were again housed and offered grass silage *ad libitum* for 42 days. Concentrates were than introduced and gradually increased to *ad libitum* intake. From then until slaughter on November 20 (females) and November 27 (males), concentrates continued to be available *ad libitum*. During the final finishing period, all the animals were housed in a shed fitted with Calan-Broadbent doors for 42 days and individual feed intakes were measured. One week before slaughter of the females, body measurements (height at withers, height at pelvis, back length, chest width and depth, pelvic width and circumference of round) were recorded for all animals. The mean interval from birth to slaughter was 607 days for females and 615 days for males. The corresponding intervals from arrival at Grange to slaughter were 584 and 590 days.

After slaughter cold carcass weight and weight of kidney plus channel fat were recorded. Carcasses were graded and measured and the ribs joint was separated into its component tissues of fat, muscle and bone.

The statistical analysis was for a 2 x 2 factorial with terms for genetic index (Low or High), gender (male or female) and their interactions. The data are presented as main effects and where interactions occurred the individual values are shown in the table footnotes. Relevant growth and carcass variables were linearly regressed on bull BV. Generally, the model of best fit had a common slope and separate intercepts for each gender.

Results

The number of progeny per sire and BVs both in the index form and in units of trait are shown in Table 9. Weighted for the number of progeny per sire, the high index sires had BVs of 29 units higher for growth, 11 units higher for carcass conformation and 6 units lower for carcass leanness. The corresponding EPD units of trait were 19.4 kg carcass, 0.1 units for carcass conformation and -0.06 units for carcass leanness.

The sires were selected for use on the basis of the index form of their BVs but during the course of the experiment BVs in the form of units of trait were published. Live weights of the progeny by genetic index group and gender are shown in Table 10. At no time was there a significant effect of genetic index on live weight, but the high index progeny tended to be heavier at all times with the difference increasing over time. At the final weighing before the females were slaughtered, the weight difference in favour of the high index animals was 19 kg which was close to statistical significance ($P<0.08$). This was also the weight difference at slaughter. The males were significantly heavier than the females at all times throughout life except at turn out as calves when the 7 kg advantage to the males did not reach significance.

Live weight gains are shown in Table 11. They reflect the live weights. At no time was there a significant effect of sire group index on live weight gains. However, carcass weight per day of age was significantly higher for the high index progeny. Except for the calf rearing period, live weight gain was always higher for males than females but the differences were not always significant. However, from first turn out to first housing, first housing to second turn out, during the finishing period, and from arrival to slaughter, the live weight gains of males were significantly higher than those of females. Slaughter weight per day of age was also significantly higher for males as was carcass weight per day of age.

Both kill-out proportion and carcass weight were significantly higher for the progeny of the high index sires (Table 12). There was no difference in carcass grades nor in kidney plus channel fat weight or proportion between the sire index groups. All carcass traits (conformation $P<0.08$) were significantly affected by gender. Males had a significantly greater carcass weight and kill out proportion, and their carcass conformation tended to be better. Females had a higher carcass fat score and a greater weight and proportion of kidney plus channel fat.

Body measurements scaled for live weight did not differ significantly between the sire index groups, but the tendency was for the low index progeny to have higher values (Table 13). Despite the absence of significant differences in body measurements, most carcass measurements scaled for carcass weight were significantly affected by sire index. Carcass length ($P<0.06$), carcass width, leg length and leg width were all significantly greater for the low index progeny. This indicates that these carcasses were less compact.

All carcass measurements scaled for carcass weight were significantly greater for females than for males indicating less compact carcasses for the females. This agrees with their poorer ($P<0.08$) conformation.

Side weight reflected carcass weight, being heavier ($P<0.05$) for the high index progeny (Table 14). The pistola as a proportion of the side weight was greater ($P<0.01$) for the low than for the high index progeny. Fat depth and *m. longissimus* area, both absolutely and scaled for carcass weight, did not differ between sire index groups. Side weight and ribs joint weight were greater for males than females, but females had a higher pistola proportion. *M. longissimus* area was greater for males, but when scaled for carcass weight there was no significant effect of gender.

With the exception of "other muscle" which was greater for the high index animals, ribs joint composition was not significantly affected by sire index group although the tendency was for the high index progeny to have less fat and bone and more muscle than the low index progeny. Except for *m. longissimus,* all tissue proportions in the ribs joint were affected by gender. Females had more subcutaneous, intermuscular and total fats, more bone, and less "other muscle" and total muscle than males.

The regressions of growth and carcass traits on sire BVs are shown in Table 15. The only significant regression coefficient was for ribs joint muscle proportion on conformation. The regressions of slaughter weight per day and carcass weight per day on bull BV for growth were not statistically significant, although in both instances the coefficients were positive indicating a trend towards greater slaughter and carcass weights with increasing sire BV for growth. Neither were slaughter and carcass weights per day significantly related to sire BV for conformation but again the coefficients were positive suggesting a tendency towards higher growth with increasing BV for conformation. There was no relationship between carcass conformation score and sire BV for conformation. Kill-out proportion was not significantly related to sire BV for conformation either, but the coefficient was positive indicating a tendency for kill-out proportion to increase with increasing BV for conformation. As indicated earlier, ribs muscle proportion increased significantly with increasing sire BV for conformation. The relationship between bone proportion and sire conformation BV was not significant but the coefficient was negative suggesting a decrease in bone proportion with increasing conformation BV. There was no relationship between *m. longissimus* area scaled for carcass weight and sire BV for conformation.

Carcass fat score was not significantly related to sire BV for leanness, but the coefficient was negative suggesting a trend in the expected direction.

Discussion

At the time of commencement of this experiment Irish BVs were expressed as an index on a within breed basis using best linear unbiased predication (BLUP) methodology. BLUP derived deviations were scaled to a standard deviation of 10 and were expressed relative to a breed mean of 100. During the experiment there was a change to expression of genetic index in units of the original measurement of the trait and reporting these values for the progeny (EPDs) on an across breed basis. Holstein-Friesian bulls were used as link sires in the beef progeny test programme, and as the base against which the beef bull EPDs were calculated. The mean weight of Holstein-Friesian carcasses at 26 months of age in the beef progeny test programme was 350 kg. The Holstein-Friesian steer progeny test base for carcasses grades was 2.02 for carcass conformation score and 3.39 for carcass fat score.

The mean difference between the low and high growth index sires was 29 units (96 v 125) or 19.4 kg carcass (9.8 kg v 29.2 kg). No account was taken of carcass conformation or fat scores when selecting the sires. The high index sires had 10 units BV or 0.1 of a class, better conformation, and 6 units BV or 0.06 of a class lower leanness than the low index sires.

Although the differences were never significant, daily live weight gains were generally higher for the high index progeny and amounted to 24 g from arrival to slaughter and

29 g for slaughter weight per day of age. However, carcass weight per day of age was significantly greater for the high index progeny. Growth BV of bulls is expressed as carcass weight rather than live weight, but there is no indication of whether the carcass weight differences are due to differences in live weight gain or differences in kill-out proportion or both. Strict interpretation of the present results, where live weight gains did not differ significantly, but where kill-out proportion, carcass weight per day of age and carcass weight all differed significantly, would imply that differences between sires in growth BV were due to differences in kill-out proportion rather than to differences in live weight growth, but both contributed. The 25 g/day significant difference in carcass weight per day of age was comprised of about 16 g/day difference in live weight growth and the equivalent of 9 g/day difference in kill-out proportion.

The differences in carcass measurements were large relative to the small differences in carcass conformation and in conformation genetic index. The compactness of the high index carcasses (as indicated by their carcass measurements scaled for carcass weight) was considerably better than indicated by their carcass conformation score or than would be predicted from sire conformation genetic index. For all body and carcass measurements, the significantly greater values for females than males, indicating poorer compactness of the former, is in line with general experience. Despite the big differences between the genders in carcass measurements, and by extension compactness, the difference in carcass conformation score was small and not significant. As with genetic index, the carcass conformation score difference between the genders did not reflect the difference in carcass compactness.

While there was no significant effect of genetic index on ribs joint composition, the high index carcasses were heavier, and as such would be expected to have had higher fat and lower muscle proportions. In contrast, they had somewhat lower fat and higher muscle proportions. The composition of the “extra” carcass weight of the high index progeny was estimated as 140 g/kg bone, 745 g/kg muscle and 115 g/kg fat. Thus, the 15.7 kg extra carcass weight yielded about 11.7 kg extra muscle.

Generally, the regression equations showed poor relationships between measured traits and the corresponding sire genetic indices. For growth, the equations indicated that slaughter and carcass weighs per day of age increased by 0.64 g and 0.57 g, respectively per unit increase in sire growth BV.

Carcass conformation score was not significantly related to sire conformation BV, but the high index animals had somewhat better carcass conformation and significantly better compactness as indicated by carcass measurements. As with carcass conformation, carcass fat score showed no significant association with sire fat score BV. In fact, the regression coefficient was negative. The only variable that had a significant relationship with fat score BV was kidney plus channel fat proportion.

It is concluded that the progeny from a group of Limousin sires of high growth genetic index grew faster than progeny from a group of sires of lower growth genetic index but the relationship between progeny growth rate and the growth BV of individual sires was poor. About two-thirds of the "extra" carcass weight from high growth index progeny came from higher live weight gain and one third came from a higher kill-out proportion. High index progeny had a lower proportion of pistola in the side weight, but there was no difference in ribs composition between the two genetic index groups. There was little difference between the progeny groups in carcass conformation but the high index progeny had more compact carcasses as indicated by carcass measurements scaled for carcass weight. Males grew faster, had a higher kill-out proportion and better carcass grades than females. They also had more compact carcasses, with less fat and bone and more muscle. There were no biologically important interactions between genetic index and gender.

Table 9. Genetic values for Limousin bulls of High or Low index for growth

Genetic Value	Bull Code	Index[1] Growth[3]	Index[1] Conf[4]	Index[1] Lean[5]	Units of Trait (EPD)[2] Growth[3]	Units of Trait (EPD)[2] Conf[4]	Units of Trait (EPD)[2] Lean[5]
Low	FL10	87	104	103	4.5	0.94	-0.20
	CEE	107	111	96	17.0	1.00	-0.07
	PAL	97	104	114	6.8	0.92	-0.30
	Mean[6]	96	107	102	9.8	0.96	-0.16
High	FL18	115	117	99	22.4	1.06	-0.12
	DAD	123	119	108	27.7	1.06	-0.24
	DWB	129	105	108	30.1	0.93	-0.20
	PYR	128	126	83	32.3	1.15	0.03
	Mean[6]	125	118	96	29.2	1.06	-0.10

[1]Relative to breed mean = 100 and s.d. = 10 (Source: Department of Agriculture and Food, 1998 Genetic Values for Growth, Carcase and Calving Ease Traits for Beef AI Bulls). [2]Expected progeny difference relative to 26 month old Friesian steers of 350 kg carcass weight (Source: Irish Cattle Breeding Federation, 2000 Genetic Evaluation Results of all Beef Bulls Tested to Date. http://www.icbf.com/documents/all progeny-beef.htm; data for bull PAL taken from update by Grogan, March 2001). [3]Expressed as carcass weight; [4]Carcass conformation score; [5]Carcass fat score (inverse); [6]Weighted by no. progeny per bull.

Table 10. Live weights and feed intakes of male and female progeny of Low and High genetic index Limousin bulls

	Index (M) Low	Index (M) High	Gender (G) Male	Gender (G) Female	s.e.d.[1]	Significance M	Significance G
Live weights (kg) at:							
Arrival[2]	45.4	46.6	49.2	42.8	0.92	NS	***
1st Turnout (May 31)	70.5	76.3	76.8	70.0	3.45	NS	NS
1st Housing (Nov. 8)	170	177	185	161	5.2	NS	***
2nd Turnout (March 28)	252	263	274	241	6.3	NS	***
2nd Housing (May 16)[3]	276	285	299	261	6.5	NS	***
Start finishing (June 27th)[4]	304	315	331	287	6.4	NS	***
Concentrates *ad libitum* (Aug 1)[5]	343	354	373	324	7.4	NS	***
Last weigh day (Oct. 31)[6]	486	505	540	451	8.4	P<0.08	***
Slaughter[7]	507	526	567	466	9.1	NS	***
Concentrate intake[8] (kg)	8.5	8.6	9.2	7.8	0.13	NS	***

[1]For n = 30 (Low Index) in this and subsequent tables; [2]Including those born at Grange; [3]On silage only; [4]Concentrates introduced; [5]Start of ad libitum concentrate feeding; [6]On which all animals were present; [7]Nov. 20 (females) and Nov. 27 (males); [8]During the finishing period. There was no significant Index x Gender interaction.

Table 11. Live weight and carcass gains of male and female progeny of Low and High genetic index Limousin bulls

		Index (M)		Gender (G)			Significance	
		Low	High	Male	Female	s.e.d.	M	G
Live weight gains (g/day) for:	**Days**							
Arrival to 1st turnout	46	579	695	608	665	67.5	NS	NS
1st Turnout to 1st housing	161	617	623	673	566	24.9	NS	**
1st Housing to 2nd turnout	140	584	615	632	567	21.6	NS	*
2nd Turnout to 2nd housing	49	496	452	518	430	49.2	NS	NS
2nd Housing to start finishing	42	665	711	764	612	69.5	NS	NS
Start finishing to *ad libitum*[1]	35	1127	1124	1197	1054	96.1	NS	NS
Ad libitum[1] to slaughter	111 (118)[2]	1425	1497	1643	1279	41.2	NS	***
Arrival to slaughter	584 (590)[2]	790	814	878	726	14.5	NS	***
Slaughter weight for age	607 (615)[2]	831	860	922	769	14.2	NS	***
Carcass weight for age	607 (615)[2]	453	478	512	419	8.9	*	***

[1]Feeding of concentrates; [2]Values in brackets for males; There was no significant Index x Gender interaction.

Table 12. Slaughter traits of male and female progeny of Low and High genetic index Limousin bulls

	Index (M)		Gender (G)			Significance	
	Low	High	Male	Female	s.e.d.	M	G
Kill-out proportion (g/kg)	544	555	555	544	2.7	**	**
Carcass weight (kg)	276.6	292.3	314.9	253.9	5.51	*	***
Carcass conformation[1]	2.93	3.06	3.10	2.89	0.097	NS	P<0.08
Carcass fat score[2]	4.00	4.06	3.92	4.14	0.072	NS	*
Perirenal + retroperitoneal fat weight (kg)	7.8	7.8	6.4	9.2	0.31	NS	***
Perirenal + retroperitoneal fat weight (g/kg)[3]	28.9	27.3	20.2	36.0	0.88	NS	***

[1]EU Beef Carcass Classification Scheme: scale 1 (poorest) to 5 (best); [2]EU Beef Carcass Classification Scheme: scale 1 (leannest) to 5 (fattest). M x G interaction, values for Male Low, Male High, Female Low and Female High of 3.99, 3.85, 4.00 and 4.27, respectively; [3]Of carcass.

Table 13. Live animal and carcass measurements of male and female progeny of Low and High genetic index Limousin bulls

	Index (M)		Gender (G)			Significance	
	Low	High	Male	Female	s.e.d.	M	G
Body measurements (cm/kg live weight)							
Height at withers	0.249	0.244	0.228	0.263	0.0035	NS	***
Height at pelvis	0.263	0.258	0.242	0.280	0.0036	NS	***
Back length	0.244	0.237	0.229	0.252	0.0035	NS	***
Chest width	0.094	0.095	0.086	0.102	0.0016	NS	***
Chest depth	0.131	0.127	0.121	0.137	0.0012	NS	***
Pelvic width	0.099	0.099	0.093	0.105	0.0020	NS	***
Round circumference	0.383	0.375	0.352	0.406	0.0045	NS	***
Carcass measurements (cm/kg)							
Carcass length	0.460	0.442	0.415	0.488	0.0067	P<0.06	***
Carcass width	0.175	0.164	0.155	0.184	0.0025	*	***
Leg length	0.254	0.241	0.228	0.267	0.0167	*	***
Leg width	0.145	0.139	0.135	0.149	0.0021	*	***
Leg thickness	0.093	0.090	0.084	0.099	0.0179	P<0.07	***
Round circumference	0.420	0.404	0.378	0.445	0.0050	*	***

There were no significant Index x Gender interactions.

Table 14. Carcass traits and ribs joint composition of male and female progeny of Low and High genetic index Limousin bulls

	Index (M)		Gender (G)			Significance	
	Low	High	Male	Female	s.e.d.	M	G
Side weight (kg)	139.0	148.2	159.5	127.7	2.62	*	***
Pistola (g/kg side)	475	467	467	475	2.00	**	**
Ribs weight (g)	7824	8306	8539	7591	166.6	*	***
Fat depth (mm)	11.4	12.2	12.0	11.7	0.50	NS	NS
M. longissimus area (cm^2)	95.6	99.7	105.9	89.3	1.95	NS	***
M. longissimus area (cm^2/kg carcass)	0.348	0.343	0.339	0.352	0.0071	NS	NS
Ribs composition (g/kg)							
Subcutaneous fat[1]	74.5	78.2	72.3	80.4	2.36	NS	*
Intermuscular fat	165.1	154.9	145.4	174.6	4.76	NS	***
M. longissimus et thoracis	222.4	216.6	221.1	217.9	3.52	NS	NS
Other muscle	371.3	387.0	401.3	357.0	4.94	*	***
Total fat	239.5	233.2	217.7	255.0	5.48	NS	***
Total muscle	593.7	603.6	622.4	574.9	5.09	NS	***
Total bone	166.8	163.3	160.0	170.1	2.64	NS	***

[1]M x G interaction P<0.05, values for Male Low, Male High, Female Low and Female High of 73.9, 70.6, 75.0 and 85.8, respectively.

Table 15. Regressions of growth and carcass traits on the original genetic index values of Limousin bulls

	Intercept (a)		s.e.[1]	Slope	s.e.	Variance[2]
	Male	Female	(a)	(b)	(b)	proportion
Original Growth Index						
Slaughter weight per day[3]	854	698	68.0	0.64	0.588	0.496
Carcass weight per day[3]	451	356	41.1	0.57	0.356	0.508
Original Conformation Index						
Slaughter weight per day[3]	861	703	139.0	0.58	1.210	0.489
Carcass weight per day[3]	439	342	84.4	0.67	0.733	0.496
Carcass conformation score	2.80	2.58	0.940	0.003	0.0082	0.016
Kill-out proportion	505	494	26.8	0.45	0.233	0.139
Pistola proportion[4]	251	256	13.2	-0.15	0.114	0.105
Ribs muscle proportion	479	431	47.1	1.26	0.409	0.489
Ribs bone proportion	171	181	25.9	-0.10	0.225	0.084
M. longissimus area[5]	0.354	0.367	0.069	-0.0001	0.0006	Negative
Original Fat Class Index						
Carcass fat score	4.65	4.88	0.524	-0.008	0.0053	0.077
Kidney + channel fat[6]	14.4	30.2	6.42	0.059	0.0648	0.718
Ribs fat proportion	157	196	39.7	0.61	0.401	0.295

[1]For male; [2]Proportion of total variance accounted for by model; [3]From birth; [4]Of the carcass; [5]cm^2/kg carcass weight; [6]g/kg carcass weight.

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