European Association for Animal Production, Dublin 2007, Session 11, paper 7.

Comparison of Friesian, Aberdeen Angus x Friesian and Belgian Blue x Friesian steers for beef production

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Introduction

About 50% of Irish dairy cows are bred to Holstein-Friesian bulls and the remainder are crossed with beef bulls in an approximate ratio of 50:50 early maturing:late maturing breed types. All male dairy calves are used for beef production with approximate proportions nationally of 0.50, 0.25 and 0.25 for pure Friesians, early maturing beef x Friesians and late maturing beef x Friesians, respectively. These breed types differ in body and carcass tissue growth patterns and consequently in body composition at a constant age or weight. The objective of this study was (i) to compare the productivity of Friesian (FR), Aberdeen Angus x Friesian (AA) and Belgian Blue x Friesian (BB) steers for beef production, and (ii) to compare these breed types finished off pasture in their second grazing season or finished indoors in their second winter.

Materials and Methods

Fifty-four (18 each of FR, AA and BB) spring-born calves were individually purchased on dairy farms. They were representative of at least five sires per breed and remained on their farms of origin for 3-4 weeks before being transferred to Grange Beef Research Centre. Calf rearing was by standard procedures. Animals were penned individually and offered a total of 25 kg milk replacer (196 g/kg fat) over the 56-day period following arrival. Calf concentrates (750 g/kg coarsely rolled barley, 170 g/kg soya bean meal, 55 g/kg molasses and 25 g/kg mineral/vitamin premix) were offered up to a maximum of 2 kg per head daily. Hay was available *ad libitum*. On June 11, the calves were turned out to pasture where they grazed together ahead of yearling steers in a leader/follower system of rotational grazing.

On September 26, they were castrated and from then until housing on November 5, they were offered a concentrate allowance of 1 kg per head daily. During the first winter they were accommodated in a slatted floor shed and were offered grass silage [197 g/kg dry matter (DM), 138 g/kg crude protein (CP) in the DM, 696 g/kg *in vitro* DM digestibility (DMD), pH 3.9] *ad libitum* plus 1 kg concentrates (875 g/kg rolled barley, 65 g/kg soya bean meal, 45 g/kg molasses and 15 g/kg mineral/vitamin premix) per head daily until mid January when the concentrates were withdrawn. Animals were turned out to pasture for a second grazing season on March 24 and later followed calves in a rotational grazing system. On July 27, they were blocked on weight to two finishing strategies in a 3 (breed types) x 2 (finishing strategies) factorial design. The two finishing strategies were (i) concentrate supplementation (mean of 3.65 kg/day) at pasture for 105 days to slaughter (Pasture), and (ii) pasture only for 105 days followed by indoor finishing on silage plus 5 kg/day concentrates for 141 days (Indoors). The pasture area was laid out in 9 pairs of paddocks and the two treatment groups rotated between paddock pairs daily. This was to ensure there was no confounding of treatment effects with pasture quantity or quality. The analysis of the silage offered during finishing was 198 g/kg DM, 144 g/kg CP, 736 g/kg *in vitro* DMD and pH 3.97.

After slaughter, perinephric plus retroperitoneal fat was weighed, and cold carcass weight (hot weight x 0.98), carcass conformation class and carcass fat class were recorded. After a chill period of 48 hours, the right sides of the carcasses from the indoor finished animals were quartered at the 5th rib into a pistola hind quarter (i.e the hind quarter to the 5th rib but without the flank) and a fore quarter that included the flank. *M. longissimus* area was measured at the 10th rib. The quarters were weighed and de-boned to commercial meat joints from which visible fat was removed.

Results

Live weights and gains to start of finishing

Birth and arrival dates were similar for FR and AA but were about one and two weeks, respectively earlier for BB (Table 1). There was no significant difference between breed types in calf arrival or turn out weights. At calf housing and yearling turn-out, BB were significantly heavier than FR and AA which did not differ. However, by late summer FR were similar to BB and both were heavier than AA.

During the first grazing season, live weight gains were similar for FR and AA but were significantly higher for BB (Table 2). There was no difference between the breed types in live weight gain during the first winter. From calf-turn out to yearling turn-out, BB gained significantly faster than AA, with FR intermediate and not significantly different from the two beef crosses. During the second grazing season FR gained significantly faster than the two beef crosses which had identical gains.

Live weights, gains, intakes and slaughter traits

Live weights from start of finishing to slaughter and initial carcass weights at the start of finishing are shown in Table 3. FR were significantly heavier than AA at

all times, and BB were significantly heavier up to the time of slaughter of the pasture finished group. There was no difference in live weight between FR and BB at any time. The pasture finished group was significantly heavier at slaughter than the indoor finished group on the same date. Carcass weight at the start of both pasture and indoor finishing was significantly heavier for BB than for FR and AA between which there was no difference.
Breed type did not significantly affect live weight gain or carcass gain during finishing (Table 4). Average daily gain from calf arrival to slaughter was significantly higher for FR than AA with BB not differing significantly from these. Slaughter weight per day of age was significantly higher for FR and BB than for AA with no difference between FR and BB. Carcass weight per day of age was significantly higher for BB than for AA, with FR intermediate and not significantly different from the beef crosses. Live weight gain of the indoor finished group indoors was similar to that of the pasture finished group. Daily gain from calf arrival to slaughter, slaughter weight per day of age, carcass weight per day of age and carcass gain during finishing were all significantly higher for pasture finishing than for indoor finishing.

Concentrate intake at pasture was 329 kg DM with resultant live weight and carcass gain responses of 33.2 and 27.4 kg, respectively. Thus, the conversion rates of concentrate DM were 9:9:1 for live weight and 12:8:1 for carcass weight. From housing to slaughter, the indoor finished animals consumed 769 kg silage DM plus 588 kg concentrate DM. The live weight and carcass weight gains were 120.1 and 72.3 kg, respectively.

Slaughter traits are shown in Table 5. FR and BB had significantly greater slaughter weights than AA with no difference between FR and BB. All three breed types differed significantly in kill-out proportion - it was highest for BB and lowest for FR. Carcass weight was significantly greater for BB than for FR and AA which did not differ significantly. Carcass conformation class differed significantly for all three breed types being highest for BB and lowest for FR. Carcass fat class did not differ significantly between FR and AA but was significantly lower for BB. Weight of perinephric plus retroperitoneal fat did not differ between the breed types, but when scaled for carcass weight, it was significantly lower for BB. Compared with pasture finishing, indoor finishing increased slaughter and carcass weights by 87 and 44 kg, respectively. Kill-out proportion was identical for the two finishing strategies. Neither carcass conformation class nor carcass fat class was affected by finishing strategy but perinephric plus retroperitoneal fat, both absolutely and scaled for carcass weight, were significantly greater for indoor finishing.

Carcass composition of indoor finished animals

In line with the differences in carcass weight, pistola weight was significantly greater for BB than for FR and AA (Table 6). As a proportion of side weight, pistola weight was significantly greater for BB than for AA with FR intermediate and not significantly different from the two beef crosses. *M. longissimus* area, both absolutely and scaled for carcass weight, was significantly greater for BB than for FR and AA which did not differ. All lean tissues proportions of the side were significantly higher for BB than for FR and AA between which there were no significant differences. Pistola, fore quarter and total side fat proportions did not differ between FR and AA but were significantly lower for BB. Pistola, fore and total side bone proportions did not differ between AA and BB but were significantly greater for FR. As proportions of the pistola, BB had significantly higher values for all measures of lean (except trim), and a significantly lower proportion of fat than both FR and AA which did not differ. All three breed types differed in pistola bone proportion which was highest for FR and lowest for BB. As proportions of the fore quarter, total lean was significantly higher, and fat was significantly lower, for BB than for FR and AA which did not differ significantly. Bone was significantly higher for FR than for AA and BB which were similar.

The distribution of side tissues is shown in Table 7. As proportions of side lean, total pistola lean was significantly higher for BB than for AA with FR not significantly different from these. High value lean was significantly higher for BB than for FR and AA which were similar. Total fore lean proportion was significantly lower for BB than for AA with FR intermediate. There were no differences between the breed types in the distribution of side bone and fat been the pistola and fore quarter.

Breed type x finishing strategy effects

While there were no significant interactions between breed type and finishing strategy, the values for the individual breed type x finishing strategy groups are meaningful in the context of commercially acceptable carcass traits (Table 8). Although carcass fat class did not differ significantly between strategies, this was not consistent with weight and proportion of perinephric plus retroperitoneal fat which were significantly higher for indoor finishing. This may have been due to differences in grading methods between the slaughter dates.

Discussion

The breed types used in the present study were chosen because of their numerical importance in the Irish beef industry and because of their contrasting maturity characteristics. Live and carcass weight gains during pasture finishing were 65.2 kg and 32.5 kg, respectively in the absence of concentrates, and 98.4 kg and 59.9 kg with concentrates. The daily values for pasture only (0.62 kg/live weight and 0.31 kg carcass weight) represent the potential of pasture to support growth in autumn when herbage supply was adequate.

Live weight gain during indoor finishing was in the expected range for the silage quality and concentrate level offered and was similar to the value for the pasture finished animals given concentrates. As the estimated proportion of carcass in the live weight gain was similar for the pasture and indoor finished groups, it follows that carcass gain per day was more expensive indoors because of the higher concentrate allowance and the higher cost of silage than grazed grass. However, there are other considerations. The indoor finished animals had gained some carcass weight at pasture before housing and also had a longer finishing period. As a result, their mean carcass weight was 44 kg heavier and so was closer to the commercial norm than that of the pasture finished animals. Normally, such an increase in carcass weight would be accompanied by increases in carcass conformation and fat classes which would enhance salability and value. It is arguable that perinephric plus retroperitoneal fat scaled for carcass weight is a more objective indicator of fatness than carcass fat class and it was significantly higher for indoor finishing.

It is unclear if there is a threshold carcass weight below which the price of steers is discounted in Ireland or if it is a question of adequate finish. Adequately finished heifer carcasses are accepted for both the home and export trades at weights up to 40 kg lighter than the present steer carcasses from the pasture finishing strategy. Although light by commercial standards, the carcasses of the AA steers slaughtered off pasture had a fat class > 3 which is considered acceptable finish. Furthermore, all the pasture finished AA carcasses graded “O” or better for conformation. Therefore, it seems that AA steers that are over 400 kg live weight at the end of July can be finished off pasture over a 15-week period with a concentrate input of about 380 kg. Slaughter and carcass weights should exceed 500 kg and 255 kg, respectively, and the carcasses should have a minimum fat class of 3 and a minimum conformation class of “O”. For FR to reach the same carcass fatness off pasture as AA, they should be 450 kg live weight by the end of July, 550 kg at slaughter and 280 kg carcass weight. The carcass weight and conformation of the present BB animals finished off pasture were commercially acceptable but fatness was not. If all carcasses must reach a minimum fat score 3, then it is unlikely that BB animals can be finished off pasture in the second grazing season.

Conclusions

It is concluded that differences in growth between the breed types were not uniform throughout life. BB grew faster early in life whereas FR grew faster in the second grazing season. Lifetime daily live weight gains were similar for FR and BB but were lower for AA. Daily carcass gains were highest for BB and lowest for AA with FR intermediate. BB had a higher proportion of carcass lean and a lower proportion of fat than both FR and AA. FR had a higher proportion of bone than both AA and BB. The live weight and estimated carcass weight responses to concentrates at pasture were 316 and 261 g/day for a mean daily input of 3.13 kg DM. Daily live weight and carcass gains indoors on silage plus concentrates were similar to those on pasture plus concentrates. All the animals finished indoors reached an acceptable level of carcass finish. Of the pasture groups, only AA reached an acceptable level of fatness. The data suggest that for acceptable finish off pasture minimum carcass weights of 250, 280 and 340 kg are required for AA, FR, and BB, respectively.

Table 1. Birth and arrival dates and live weights for Friesian (FR), Aberdeen Angus x Friesian (AA) and Belgian Blue x Friesian (BB) steers

	FR	AA	BB	s.e.[1]	Sig
Birth date	March 16	March 14	March 06	3.93	NS
Arrival date	April 12	April 15	March 28	3.88	**
Live weights at (kg):					
Arrival	64	60	58	2.2	NS
Calf turnout (June 11)	93	94	100	2.8	NS
Calf housing (November 05)	201[a]	196[a]	224[b]	5.44	**
Yearling turnout (March 24)	281[a]	272[a]	302[b]	6.43	**
Late summer (July 27)	427[a]	399[b]	429[a]	6.30	**

[1]For n = 18; [a,b]Values without a common superscript differ significantly (P<0.05) in this and subsequent tables.

Table 2. Daily gains (g) of Friesian (FR), Aberdeen Angus x Friesian (AA) and Belgian Blue x Friesian (BB) steers

	Days	FR	AA	BB	s.e.[1]	Sig
Arrival to turnout	[2]	477	677	548	60.2	NS
Turnout to housing	147	733[a]	697[a]	844[b]	34.8	*
Housing to yearling turnout	139	577	548	567	31.4	NS
Calf turnout to yearling turnout	286	657[ab]	625[a]	709[b]	21.5	*
Yearling turnout to late summer	125	1167[a]	1016[b]	1016[b]	31.2	**

[1]For n = 18; [2]Varied with arrival date – 60, 57 and 75 days for FR, AA and BB, respectively

Table 3. Live weights and initial carcass weights of Friesian (FR), Aberdeen Angus x Friesian (AA) and Belgian Blue x Friesian (BB) steers finished at pasture or indoors

	Breed Type (B)			Finishing Strategy (F)			Sig.	
Live weights (kg) at:	FR	AA	BB	Pasture	Indoors	s.e.[1]	B	F
Start of finishing[2]	427[a]	399[b]	429[a]	418	419	6.3	**	NS
Mid pasture finishing	475[a]	448[b]	473[a]	475	456	6.7	***	NS
Pasture slaughter	510[a]	481[b]	510[a]	517	484	7.1	**	***
Late indoor finishing	554[a]	522[b]	542[ab]	-	539	9.9	*	-
Indoor slaughter	616[a]	589[b]	606[ab]	-	604	11.8	*	-
Initial carcass weights (kg)								
Start of finishing[2]	204.9[a]	197.7[a]	223.3[b]	208.5	208.6	4.48	**	NS
Start of indoor finishing	235.7[a]	232.0[a]	255.5[b]	-	241.1	4.97	**	-

[1]For n = 18; [2]Both pasture and indoors. There was no significant B x F interaction.

Table 4. Live weight and carcass weight gains of Friesian (FR), Aberdeen Angus x Blue x Friesian (BB) steers finished at pasture or indoors

		Pasture			Finishing Strategy (F)			Sig.	
Live weight gains (g/day)	Days	FR	AA	BB	Pasture	Indoors	s.e[1]	B	F
Start of finishing to pasture slaughter	105	788	779	771	937	621	29.7	NS	***
Pasture slaughter to indoor slaughter	141	888	850	816	-	852	50.8	NS	-
Calf arrival to slaughter	[2]	789[a]	749[b]	773[ab]	793	748	13.3	NS	**
Slaughter weight per day of age		852[a]	802[b]	834[ab]	854	805	13.1	*	**
Carcass gains (g/day)									
Start of finishing to pasture slaughter	105	427	433	460	571	310	29.1	NS	***
Pasture slaughter to indoor slaughter	141	526	497	516	-	513	28.5	NS	-
Carcass weight per day of age		427[ab]	412[a]	452[b]	444	417	7.3	**	**

[1]For n = 18; [2]Varied with arrival date – 647, 644 and 662 for FR, AA and BB, respectively. There was no significant B x F interaction.

Table 5. Slaughter traits for Friesian (FR), Aberdeen Angus x Friesian (AA) and Belgian Blue x Friesian (BB) steers finished at pasture or indoors

	Pasture			Indoors			Sig.	
	FR	AA	BB	Pasture	Indoors	s.e[1]	B	F
Slaughter weight (kg)	572[a]	541[b]	568[a]	517	604	8.6	*	***
Carcass weight (kg)	287[a]	278[a]	308[b]	269	313	4.6	***	***
Kill-out (g/kg)	501[a]	514[b]	542[c]	519	519	2.4	***	NS
Conformation class[2]	1.90[a]	2.15[b]	2.89[c]	2.35	2.27	0.073	***	NS
Carcass fat class [3]	3.09[a]	3.27[a]	2.59[b]	2.93	3.04	0.122	***	NS
Perinephric + retroperitoneal fat (kg)	8.77	8.10	7.59	6.25	10.06	0.477	NS	***
Perinephric + retroperitoneal fat (g/kg)	30.0[a]	28.8[a]	24.3[b]	23.4	32.0	1.47	*	***

[1]For n = 18; [2]EU Beef Carcass Classification Scheme: scale 1 (poorest = P) to 5 (best = E); [3]EU Beef Carcass Classification Scheme: scale 1 (leanest) to 5 (fattest). There was no significant B x F interaction.

Table 6. Composition of carcass side and quarters for Friesians (FR), Aberdeen Angus x Friesian (AA) and Belgian Blue x Friesian (BB) steers

	FR	AA	BB	s.e.[1]	Sig.
Pistola weight (kg)	70.5[a]	67.4[a]	75.9[b]	1.52	**
Pistola (g/kg side)	446[ab]	438[a]	456[b]	3.8	**
M.longissimus area (cm^2)	61.8[a]	66.1[a]	84.4[b]	2.23	***
M.longissimus area (cm^2/kg carcass)	0.201[a]	0.220[a]	0.260[b]	0.0075	***
g/kg side					
Pistola lean	298[a]	300[a]	341[b]	4.7	***
High value lean[2]	219[a]	220[a]	257[b]	3.9	***
Pistola other joints lean[3]	43[a]	42[a]	47[b]	0.9	**
Fore quarter lean	342[a]	353[a]	381[b]	4.9	***
Fore lean joints[4]	150[a]	151[a]	176[b]	3.9	***
Fore other joints[5]	161	165	166	3.4	NS
Total lean	641[a]	653[a]	722[b]	7.9	***
Pistola fat	49[a]	50[a]	29[b]	2.5	***
Fore fat	87[a]	99[a]	57[b]	6.7	***
Total fat	136[a]	149[a]	86[b]	4.8	***
Pistola bone	104[a]	93[b]	90[b]	2.0	***
Fore bone	120[a]	103[b]	105[b]	1.9	***
Total bone	224[a]	198[b]	193[b]	3.3	***
g/kg pistola					
Total lean	661[a]	676[a]	741[b]	7.0	***
High value lean[2]	486[a]	496[a]	559[b]	4.8	***
Other joints lean[3]	96[a]	96[a]	102[b]	1.8	*
Lean trim	80	84	80	4.1	NS
Bone	230[a]	211[b]	196[c]	3.6	***
Fat	108[a]	113[a]	63[b]	5.9	***
g/kg fore quarter					
Total lean	624[a]	634[a]	705[b]	10.0	***
Lean joints[4]	274	271	326	4.2	NS
Other joints[5]	294	296	308	5.9	NS
Lean trim	56[a]	67[ab]	72[b]	4.9	*
Bone	219[a]	188[b]	190[b]	3.8	***
Fat	158[a]	178[a]	105[b]	11.4	***

[1]For n = 9; [2]silverside + topside + knuckle + rump + fillet + loin + cube roll + *m. semitendinosus*; [3]Hind shin + heel + tail of rump + cap of cube roll; [4]brisket + chuck + *triceps brachii* + blade steak + braising muscle + chuck tender + clod; [5]Fore shin + neck + plate + fore rib (plate and fore rib only partially defatted).

Table 7. Distribution of joints and tissues for Friesian (FR), Aberdeen Angus x Friesian (AA) and Belgian Blue x Friesian (BB) steers

g/kg side lean	FR	AA	BB	s.e.[1]	Sig.
Total pistola lean	466[ab]	459[a]	472[b]	4.2	*
High value lean[2]	342[a]	337[a]	356[b]	3.7	**
Other joint lean[2]	68	65	65	1.2	NS
Total fore lean	534[ab]	541[a]	528[b]	4.2	*
Fore lean joints[2]	235[ab]	232[a]	244[b]	4.2	*
Other fore joints[2]	252[a]	253[a]	230[b]	5.6	*
Pistola bone[3]	464	472	468	4.6	NS
Pistola fat[4]	359	341	341	13.8	NS

[1]For n = 9; [2]See Table 6 footnotes; [3]g/kg side bone; [4]g/kg side fat.

Table 8. Slaughter and carcass traits for Friesian, Aberdeen Angus x Friesian and Belgian Blue x Friesian steers finished at pasture or indoors

Finishing strategy (F)	Pasture			Indoors			s.e[1]
Breed type (B)	FR	AA	BB	FR	AA	BB	
Slaughter weight (kg)	528	494	529	616	589	606	12.1
Carcass weight (kg)	264	254	288	310	302	328	6.5
Kill-out (g/kg)	499	515	543	503	514	541	3.4
Carcass conformation class[2]	1.87	2.19	3.00	1.93	2.11	2.78	0.103
Carcass fat class [3]	2.89	3.23	2.67	3.00	3.30	2.52	0.172
Perinephric + retroperitoneal fat (kg)	6.43	6.67	5.66	11.11	9.53	9.52	0.674
Perinephric + retroperitoneal fat (g/kg)[4]	24.3	26.2	19.6	35.7	31.5	28.9	2.08
Carcass length[5]	0.518	0.509	0.459	0.458	0.451	0.409	0.0092
Carcass depth[5]	0.181	0.174	0.154	0.165	0.160	0.145	0.0033
Leg length[5]	0.310	0.287	0.264	0.247	0.235	0.218	0.0067
Leg width[5]	0.160	0.157	0.145	0.163	0.159	0.154	0.0036
Leg thickness[5]	0.090	0.091	0.091	0.106	0.107	0.105	0.0021

[1]For n=9; [2]Scale 1 = P (poorest) to 5 = E (best); [3]Scale 1 (leanest) to 5 (fattest); [4]g/kg carcass; [5] cm/kg carcass;
[a,b]Values without a common superscripts differ significantly (P<0.05) within feeding strategy.