End of Project Report

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A COMPARISON OF CHAROLAIS AND BEEF X FRIESIAN SUCKLER COWS

Authors

Michael J. Drennan and Richard J. Fallon
Teagasc, Grange Research Centre, Dunsany, Co.Meath

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Teagasc
Agriculture and Food Development Authority

GRANGE RESEARCH CENTRE,
Dunsany,
Co. Meath
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CONTENTS

SUMMARY

The following findings were obtained in a comparison of Charolais and Hereford x Friesian (used in production study while Limousin x Friesians were also used in other studies) suckler cows and their progeny:

- Charolais cows were 100 kg heavier than Hereford x Friesians.
- Voluntary silage intake of Charolais cows was similar to that of Beef (Hereford and Limousin) x Friesians on an absolute basis but was about 15% higher for the Beef x Friesians when expressed relative to liveweight.
- Estimated that the energy requirements of a 660 kg Charolais cow were equivalent to those of a 600 kg Beef x Friesian cow during late pregnancy.
- Unlike Beef x Friesian cows, Charolais cows did not transfer the immunoglobulin subclass IgG1 from their blood to colostrum during late pregnancy.
- Colostrum yield was lower for Charolais cows than for Beef x Friesians but yields were highly variable for both breed types.
- Colostrum Ig concentrations tended to be lower in Charolais than in Beef x Friesian cows, but there was large variation in both breed types.
- Overall, the total quantity of immunoglobulin produced in first milking colostrum was 1.6 to 1.9 times greater for Beef x Friesian than for Charolais cows.
- Second milking colostrum had less than half the Ig concentra tion of first milking colostrum.
- The immune status of calves from Charolais cows was lower than that of calves from Beef x Friesian cows.
- The milk yield of Charolais cows was lower than that of Beef x Friesian cows (7.1 v. 11.1 kg per day when at pasture)

- Milk yield was an important determinant of calf daily gain to weaning.
- The response in calf daily gain to a 1 kg increase in milk yield was greater at lower yields and in calves from Charolais cows than calves from Beef x Friesian cows.
- Incidence of calving difficulties (scale 1 to 5) was low (1.36 and 1.62 for Charolais and Hereford x Friesian cows, respectivly).
- Calf birth weights were similar for the two cow breed types.
- Calves from Charolais cows had lower liveweight gains from birth to weaning than those from Hereford x Friesian cows (1.10 v. 1.19 kg/day).
- Liveweights of steer progeny of Charolais and Hereford x Friesian cows taken to slaughter were 301 and 329 kg at weaning and 697 and 719 kg, respectively at slaughter.
- The weight difference of 28 kg at weaning (mainly due to increased milk production as the Hereford x Friesian progeny were only 4 days older than the Charolais progeny) thus largely remained until slaughter.
- Carcass weights of the Hereford x Friesian progeny were 11.4 kg heavier than those of Charolais progeny.
- However, the Hereford x Friesian progeny has heavier kidney plus channel fat weights, higher fat scores and a higher pro portion of fat in the pistola than the Charolais progeny.
- As a proportion of carcass weight the pistola (higher value cuts)of the Charolais progeny was 1.2 percentage units high er than that of the Hereford x Friesian progeny.
- Despite the lower carcass weight the yield of pistola meat was 5.8 kg greater for the Charolais progeny than for the Hereford x Friesian progeny.

INTRODUCTION

There are now 1.22 million suckler cows in Ireland having increased from 0.44 million in 1984 when milk quotas were introduced by the EU. Suckler cows presently account for 48% of the total cow herd compared with only 20% in 1984. Thus, the suckler herd is now an important source of calves for beef production. Traditionally, the replacements for the suckler herd were obtained mainly from the dairy herd as Beef x Friesians. However, with the increasing proportion of suckler cows and the increasing proportion of Holsteins in the dairy herd which are considered unsuitable from a beef viewpoint there is increased retention of replacements from within the suckler herd. With about 80% of mature suckler cows bred to the late maturing continental sire breeds, half of which are to Charolais, it is likely that an increasing proportion of replacements will be Charolais crosses. The continuance of such a policy would eventually lead to a suckler cow herd with a high proportion of Charolais genes, thus losing the advantages of heterosis or cross breeding.

Experimental programme

The studies carried out included comparisons of Charolais and Beef x Friesian suckler cows in terms of voluntary silage intake, colostrum yield and immunoglobulin level, calf immunoglobulin level and cow milk yield in addition to animal production experiments. In all experiments the Charolais animals used were a minimum of 7/8 Charolais and were the result of an upgrading programme at Grange commencing with Charolais x Friesians. In the production experiments, only Hereford x Friesian cows (and their progeny) were compared with the Charolais while in all other experiments the Beef x Friesians included both Hereford x Friesians and Limousin x Friesians.

Cow voluntary silage intake

In winter cows generally received moderate quality grass silage during late pregnancy. During early lactation cows received good quality grass silage to appetite. In 4 experiments in which cows were individually offered silage to appetite during winter pregnancy the quantity offered and refusals were recorded. Likewise, during early lactation individual records of silage offered and refusals were obtained in 3 experiments.

Colostrum yield and immunoglobulin level

In two experiments, the yield of first milking colostrum and the immunoglobulin (Ig) concentrations in first and second milking colostrum were obtained.

Calf immunoglobulin levels

In three experiments calf serum immunoglobulin levels were recorded 48 hours after birth using both total Ig values and the zinc sulphate turbidity (ZST) test.

Cow milk yields

Cow milk yields were estimated in three studies indoors prior to going to grass in spring and during two grazing seasons. The "weigh-suckle-weigh" technique was used to estimate yield which involves preventing the calf from suckling and subsequently allowing the calf access to the cow to remove all milk. The calf is again prevented from suckling for a defined time period and is subsequently weighed before and after suckling. The difference in weight is an estimate of the milk produced in that period.

Animal production experiments

The animal production experiments included (a) cow and calf performance to weaning over 4 consecutive years in which calving dates, calving performance, cow and calf liveweights and cow body condition scores were recorded, and (b) steer performance to slaughter in three experiments followed by dissection of the pistola into meat, fat and bone in two experiments.

Source of animals and management

As the Charolais replacements were from within the herd their rearing programme involved suckling on their dams until about 8 months of age. The Beef x Friesians were purchased as calves and were artificially reared. Previous studies have shown that Limousin x Friesian cows were about 15 kg heavier than Hereford x Frieisans, that voluntary feed intakes are similar and there was no difference in growth rate of their suckled progeny to weaning at approximately 8 months of age. Thus, use of either Limousin x Friesians or Hereford x Friesians for comparison with the Charolais was suitable for the feed intake, immunoglobulin and milk yield experiments.

All animals used in the present experiments were first bred to calve at two years of age using an easy calving Limousin bull (AI). Charolais bulls were used for subsequent calvings. Each year calving was in the period February to April. In the four production experiments the cows and calves were grazed together from April until weaning (and housing) in October/November. Cows were fed grass silage (restricted in some years pre calving) in winter and a mineral/vitamin supplement. In the three finishing experiments, weaned steer calves received good quality grass silage in winter plus about 1 kg of concentrates per head daily. The steers then spent a second grazing season at pasture and were finished on silage/concentrate or all concentrate diets.

Hereford x Friesian and Charolais cows and their calves

RESULTS AND DISCUSSION

Cow voluntary feed intakes

Silage dry matter (DM) intakes during pregnancy were 8.4 kg per day for both the Charolais and Beef x Friesian cows (Table 1). However, because liveweights of the Beef x Friesians averaged 96 kg less than the Charolais their intakes were 15% greater than the Charolais when expressed as a proportion of liveweight (Table 1). When compared during early lactation, there was again no difference in silage intake between the cow breed types but when expressed as a proportion of liveweight intakes of the Beef x Friesian cows were 17% greater than the Charolais (Table 2). Based on feed intakes, and liveweight changes it was estimated that the energy requirements of a 600 kg Beef x Friesian cow during pregnancy is equivalent to that of a 660 kg Charolais cow.

Table 1. Voluntary silage intakes by cows in pregnancy.

	Charolais	Beef x Friesian	Significance	Silage DMD (g/kg)
Intakes (kg DM/day)				
Experiment 1	9.0	8.5	NS	[1]650&605
Experiment 2	8.5	8.6	NS	633
Experiment 3	9.3	9.4	NS	685
Experiment 4	6.7	7.0	NS	713
Mean	8.4	8.4		
Intake (g/kg liveweight)	11.9	13.7		

[1]A 2 x 2 factorial experiment using 2 cow breed types and 2 silages.

Table 2. Voluntary silage intakes by cows in early lactation.

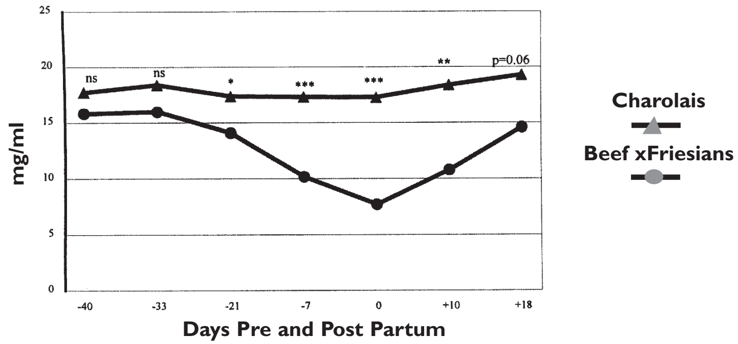
	Charolais	Beef x Friesian	Significance	Silage DMD (g/kg)
Intakes (kg DM/day)				
Experiment 1	9.4	8.8	NS	740
Experiment 2	9.6	9.8	NS	751
Experiment 3	9.3	9.2	NS	767
Mean	9.4	9.3		
Intake (g/kg liveweight)	14.4	16.8		

Colostrum yield and immunoglobulin level

In each comparison both the yield and Ig concentration of colostrum were numerically higher for the crossbreds than for the Charolais (Table 3). In the first experiment there was no significant difference in colostrum yield but colostrum from the Beef x Friesians had a higher Ig concentration. In the second experiment the colostrum yield was significantly higher (2.7 v. 4.5 litres) for the crossbreds than for the Charolais but there was no significant difference in Ig concentration. Averaged over the two studies the total Ig mass produced from first milking colostrum was 419 and 735 g for the Charolais and Beef x Friesian, respectively. The Ig concentration in second milking colostrum was less than half that in first milking indicating the importance of first milking colostrum as a source of immunity to disease.

These differences in yield of immunoglobulins in favour of the crossbred cows would be expected from the IgG1 values obtained in cow serum during late pregnancy. IgG1 accounts for approximately 90% of total Ig in colostrum and the level of IgG1 in the blood serum of the Beef X Friesian cows showed a significant reduction during late pregnancy indicating transfer from the dams blood to colostrum while no major change was evident in the Charolais cows (Figure 1).

Figure 1. **Cow Serum 1gG. concentration pre and post natal**



Charolais cow and her calf at pasture

Table 3. **Colostrum yield, immunoglobulin concentration and total Ig mass from 1st milking.**

	Charolais	Beef x Friesian	Significance
Colostrum yield (litres)			
Experiment 1	2.62	3.26	NS
Experiment 2	2.71	4.49	**
Total Ig concentration (mg/ml)			
Experiment 1: 1st milking	162	205	*
: 2nd milking	75	99	NS
Experiment 2 1st milking	168	187	NS
: 2nd milking	87	95	NS
Total Ig mass (g) from 1st milking			
Experiment 1	405	653	**
Experiment 2	432	817	***

Calf immunoglobulin levels

Calves have no immunoglobulins at birth and are dependent on colostrum as a source of immunoglobulin for protection against disease in early life. Thus, immunoglobulin levels in calf serum recorded 48 hours after birth provide an accurate measurement of intakes from colostrum. In all three comparisons calf serum total Ig values and ZST units for the progeny of Beef x Friesian cows were significantly greater than for the progeny of Charolais cows (Table 4). Thus, in an adverse environment the calves from Charolais may not be able to withstand disease as readily as the progeny of the crossbreds due to the lower immune status of the former.

Table 4. Calf serum total Ig levels (mg/ml) and ZST units recorded 48 hours after birth.

Experiment	Charolais Progeny	Beef x Friesian Progeny	Significance
1. Total Ig	52	69	*
ZST	19.9	26.7	**
2 Total Ig	36	62	***
ZST	20.7	28.8	**
3. Total Ig	46	62	**
ZST	14.2	20.9	**

Limousine x Friesian cows and their calves

Cow milk yield

In all comparisons milk yields of the Charolais cows were significantly lower than the Beef x Friesians (Table 5). In general, during the grazing season the expected yield of the Charolais would be only about two-thirds that of the Beef x Friesians. Milk yield of suckler cows normally increases when they are let to pasture in spring which reflects improved cow nutrition. The lower yield at pasture in Experiment 2 was due to reduced grass supplies later in that season as a result of drought.

Table 5. Cow milk yield (kg per day).

		Charolais	Beef x Friesian	Significance
Indoor	Experiment 1	7.1	9.3	***
	Experiment 2	7.6	9.5	***
	Experiment 3	6.6	9.1	***
At pasture	Experiment 1	7.6	12.1	***
	Experiment 2	7.0	10.1	***

The relationship between calf growth rate and cow milk yield was examined using regression analyses. The results were in agreement with other studies showing that milk yield of the cow was an important determinant of calf pre-weaning gain. Using the data obtained at pasture a 1 kg increase in daily milk yield was shown to increase daily gain of the progeny of Charolais and Beef x Friesians by 69 g by 30 g, respectively (Table 6). The better response to increasing yield with the Charolais was due to their lower yields as these studies showed that the calf weight response to increasing yield decreased as overall milk yield increased.

Table 6. Regression of liveweight gain at pasture (Y, g/day) on milk yield (X, kg/day).

	Experiment	
Charolais	1	Y = 695 + 60 (se 13.7) X
	2	Y = 660 + 77 (se 19.5) X
Beef x Friesian	1	Y = 911 + 26 (se 9.2) X
	2	Y = 972 + 33 (se 13.2) X

<u>Animal Performance:</u>
Cow and calf to weaning

Averaged over four consecutive years, performance data for the cows and their calves to weaning are presented in Tables 7, 8 and 9. The total number of Charolais and Hereford cross Friesian cows involved over the four years was 102 and 86, respectively.

Cow calving dates and calving interval

The mean calving dates for the Charolais and Hereford x Friesian cows were March 21 and March 9, respectively (Table 7). One factor contributing to the difference in calving date was that the Charolais replacements were younger when breeding commenced than the Hereford x Friesians. This was due to purchasing the latter replacements about mid March at 2 to 3 weeks of age while calving only commenced in mid February in the Charolais herd with some calves born in April. In this regard, there is also a breed type effect as cyclic activity commences at an older age in the late maturing beef breeds such as the Charolais than in Beef cross Friesians. In France, where purebred Charolais account for approximately half of the suckler herd of 4.2 million cows age at first calving is usually three years. The somewhat shorter calving interval in the Charolais is expected as the two cow breed types were let to pasture at the same time and therefore, the later calving Charolais were placed on a high plane of nutrition (pasture) sooner after calving than the Hereford x Friesians.

Steers Progeny at Pasture in Autumn

Cow liveweights and weight changes

At all times, Charolais cows were heavier than the Hereford x Friesians with the greatest weight difference (109 kg) at housing in autumn (Table 7). From calving to the start of grazing the Hereford x Friesian cows lost more liveweight than the Charolais due to a combination of the longer period indoors and the higher milk production of the former. During the first 54 days at pasture liveweight gains of the Charolais and Hereford x Friesians were 72 and 59 kg, respectively. The high weight gains during the early part of the grazing season (re-breeding period) in cows that lost about 100 kg in winter probably contributed to good reproductive performance. Both groups of cows gained over 100 kg at pasture and the yearly gains (calving to calving) of Charolais and Hereford x Friesian cows were 22 and 18 kg, respectively.

Table 7. Calving dates, cow liveweights (kg) and liveweight changes (kg).

	Charolais	Hereford x Friesian	SED
Number of animals	86	102	3.0
Calving: day of year	80	68	0.9
To grass: day of year	110	109	4.2
Calving interval (days)	363	370	
Liveweights			
Post calving	625	544	9.5
To grass	605	509	8.8
June	677	568	9.4
Housing	721	612	8.8
Post calving	649	552	10.0
Liveweight changes			
Calving to grazing	-23	-34	3.6
First 54 days at pasture	72	59	4.1
Total grazing season	117	105	4.9
Calving to calving	22	18	6.6

Cow body condition scores

In general, changes in body condition scores throughout the year closely reflect changes in liveweight. Mean body condition scores for both groups of cows were 2.4 at the start of the grazing season (Table 8). Substantial condition score gains were recorded during the early part of the grazing season with gains during the total grazing season of 0.92 and 1.05 for the Charolais and Hereford x Friesian cows, respectively. For the total year Charolais cows showed a small gain in body condition while there was a slight loss for the Hereford x Friesians.

Table 8. Cow body condition scores and condition score changes.

	Charolais	Beef x Friesian	SED
Condition scores			
Post-calving	2.4	2.6	0.10
To grass	2.4	2.4	0.09
June	3.1	3.1	0.10
Housing	3.3	3.5	0.08
Post-calving	2.5	2.5	0.10
Condition score changes			
Calving to grazing	0.01	-0.13	0.076
At grass to June (54 days)	0.66	0.71	0.073
Total grazing season	0.92	1.05	0.082
Calving to calving	0.11	-0.07	0.096

Calf performance

The overall incidence of calving problems was low and birth weights of calves from the two cow breed types were similar (Table 9). The higher weaning weight for the progeny of Hereford x Friesian cows was due to a higher daily gain from birth to weaning and being 12 days older at weaning. Daily gains from birth to weaning were 1.10 and 1.19 kg per day for the progeny of Charolais and Hereford x Friesian cows, respectively. Thus, adjusted to a 240 day age at weaning the difference in weaning weight between the progeny of the two cow breed types would be approximately 22 in favour of the Hereford x Friesian progeny.

Table 9. Calving difficulty score, calf liveweights and weight gains.

	Charolais	Beef x Friesian	SED
[1]Calving score	1.36	1.62	0.13
Birth weight (kg)	46.9	46.2	0.90
Weight (kg) to grass	68	82	2.4
Weaning weight (kg)	285	317	5.6
Daily gain (g) at grass	1172	1258	19
Daily gain (g) birth to weaning	1100	1190	19

[1]Scale 1 (no problem) to 5 (caesarean)

Charolais Head Replacements

Weaning to slaughter

The number of steer progeny of Charolais and Hereford x Friesian cows taken to slaughter were 9 and 12 in Experiment 1, 11 and 15 in Experiment 2 and 12 and 14 in Experiment 3, respectively. The pistola from one side of the carcass of 18 carcasses (8 from Charolais and 10 from Hereford progeny) in Experiment 1 and all carcasses in Experiment 2 was dissected into meat, fat and bone. The average age of Charolais and Hereford x progeny at weaning was 216 and 220 days, respectively (Table 10). Corresponding weaning weights were 301 and 329 kg. Thus, allowing for the small age difference at weaning about 23 kg of the 28 kg weight difference in favour of the Hereford x Friesian progeny was due to increased preweaning growth resulting from higher milk intake. When fed similarly from weaning to slaughter at about 2 years the final liveweights of the Charolais and Hereford x Friesian steer progeny were 697 and 719 kg, respectively. Corresponding carcass weights were 382.8 and 394.2 kg. Thus, the weight difference between the progeny of the two breed types present at weaning was still evident at slaughter. Carcass produced per day of age was 531 and 543 g for the progeny of the Charolais and Hereford x Friesians, respectively. However, kidney plus channel fat weights and carcass fat scores were lower for the progeny of the Charolais cows while carcass conformation was better than for the Hereford x Friesian progeny.

Table 10. Performance from weaning to slaughter of the steer progeny of Charolais and Hereford x Friesian cows in Experiments 1, 2 and 3.

	Charolais progeny				Hereford x Friesian progeny			
Experiment	1	2	3	Mean	1	2	3	Mean
Age at weaning (days)	225	204	218	216	226	212	223	220
Weaning weight (kg)	299	299	304	301	332	328	326	329
Slaughter weight (kg)	660	686	745	697	698	727	733	719
Carcass weight (kg)	363.8	376.2	408.5	382.8	381.0	391.9	409.7	394.2
Age at slaughter (days)	720	735	716	724	721	743	721	728
Carcass per day of age (g)	510	512	571	531	529	528	570	543
Kidney + channel fat	10.9	9.4	13.9	11.4	15.5	14.1	16.9	15.5
[1]Carcass conformation score	3.7	3.3	4.0	3.7	3.4	3.3	3.5	3.4
[2]Carcass fat score	3.6	3.7	4.2	3.8	4.0	4.1	4.4	4.2

[1]Scale 1 to 5 (best conformation) [2]Scale 1 to 5 (fattest)

When expressed as a proportion of carcass weight, the pistola of the Charolais progeny was greater than that of the Hereford x progeny (Table 11). In addition, although carcass weight of the Charolais progeny dissected was 12.4 kg less than that of the Hereford x progeny the meat yield in the pistola was 5.8 kg greater. The proportions of meat in the pistola of the Charolais and Hereford x progeny were 674 and 641 g per kg, respectively. The corresponding fat proportions were 154 and 184 g/kg. There was only minimal difference in bone content.

Table 11. Weight and composition of pistola in the half carcass from the steer progeny of Charolais and Hereford x Friesian cows in Experiments 1 and 2.

	Charolais progeny			Hereford x Friesian progeny		
	Experiment			Experiment		
	1	2	Mean	1	2	Mean
Pistola weight (kg)	85.9	88.1	87.0	85.7	89.4	87.6
Proportion of carcass (g/kg)	46.7	46.9	46.8	45.4	45.7	45.6
Meat (kg)	57.5	59.0	58.3	54.5	56.3	55.4
Fat (kg)	13.4	13.4	13.4	15.0	17.0	16.0
Bone (kg)	14.5	15.2	14.9	15.3	14.8	15.1
Meat (g per kg)	674	674	674	643	639	641
Fat (g per kg)	156	152	154	176	193	184
Bone (g per kg)	170	174	172	181	169	175

CONCLUSIONS

Although the Charolais cows were about 100 kg heavier than the Beef x Friesians voluntary silage intakes were similar. It was estimated that the energy requirement of a 600 kg Beef x Friesian cow were equivalent to those of a 660 kg Charolais cow during late pregnancy. The results of the present study clearly showed that the pre-weaning growth rate of the progeny of Charolais cows was lower than the progeny of Hereford x Friesian cows due to lower milk yield of the former. However, while this weight difference at weaning was largely retained until slaughter the weight of pistola meat was greater for the progeny of Charolais cows. The increased meat yield in the pistola indicates the carcass benefit of using continental cow breeds such as the Charolais as opposed to Hereford x Friesian dams. However, the desirability of increased yield of colostrum and milk by the Charolais is evident and attention must be given to potential milk yield when selecting continental breed crosses as suckler herd replacements. Due to heterosis it is also desirable that the replacement is a cross of two breeds rather than a purebred.

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