Producing high quality carcasses from grass-based suckler beef systems

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GENERAL INTRODUCTION

Suckler cow numbers in Ireland have almost trebled over the last twenty-five years reaching 1.18 million in 2008 or 52% of the total cow population (Department of Agriculture Fisheries and Food (DAFF), 2004 and 2008). Total cattle disposals in 2007 were 1.98 million of which, 1.77 million were slaughtered in Ireland and 0.21 million were exported live (Bord Bia, 2008). Thus, most cattle are slaughtered in Ireland with the number exported as live animals varying in recent years from a high of 0.40 million in 2000 to a low of 0.10 million in 2001. Total beef output was 578,000 tonne of carcass weight equivalent in 2007 of which, 85% was exported.

The destination of beef exports has changed substantially in recent years with the proportion going to international markets declining and to EU markets increasing. Between 1997 and 2007 the proportion of carcass beef exports to international markets has declined from 59 to 2%, that to continental EU countries has increased from 19 to 45%, while the proportion to the UK has increased from 22 to 53% (Bord Bia, 2008). The importance of Irish beef production to the EU is shown by the fact that it accounts for over 7% of total EU production. In the EU the level of self sufficiency is now only 94% and is continuing to decline further (European Commission, 2008).

A breakdown of beef meat exports from Ireland show that only 15% is exported as bone-in with 72% in boneless form and 14% processed (Bord Bia, 2008). Therefore, with boneless sales predominating, meat yield and distribution in the carcass (proportion in higher-value cuts) are important determinants of carcass value. While meat yield is one determinant of value, the prices paid in the different markets vary considerably. The highest priced markets available are in continental EU where top prices are paid for carcasses of good conformation that are lean. Breed is the main factor determining conformation with the late-maturing continental breeds being superior and also having the leanest carcasses. Thus, the main source of high quality carcasses is the suckler herd, where some 70% of cows are continental breed crosses and 88% are bred to late-maturing continental sire breeds.

Not all producers with suckler herds take the progeny to slaughter. A large proportion of progeny are sold as weanlings at about 9 months of age in autumn. Although the emphasis in this publication is on the final product (carcass), because there is a very close relationship between the quality (muscularity) of the weanling and the final carcass, the principles outlined apply to all stages of suckler beef production.

The following four important determinants of efficient suckler beef production are discussed using data obtained from the suckler beef research programme at Grange Beef Research Centre:

1. *Carcass quality and markets:* In addition to carcass weight, of vital importance in all production systems is carcass meat proportion, which can vary from 60% to over 75% of carcass weight, and meeting market specification because of the large variation in price between markets.
2. *Breeds and breeding programme:* In suckler beef production the cow breed or breed cross and the sire breed selected is under the control of the producer. In addition, within a breed there is scope to select animals with particular attributes such as good muscularity or easy calving.
3. *Reproductive performance:* The two most important components are percent pregnant with a target figure of about 94%, and calving interval with a target of 365 days.
4. *Production system:* The system practised should result in good reproductive performance, low mortality and high live weight gain in the progeny, resulting in a high carcass weight for age. It is important that this is achieved at minimum cost and as feed is a large proportion of total costs, maximum use should be made of grazed grass, which is the cheapest source of feed available.

A list of publications is provided for those requiring further information on any of the studies carried out at Grange Beef Research Centre. External sources of data are referenced throughout and a separate reference list is provided.

GENERAL SUMMARY AND CONCLUSIONS

1. Carcass quality and markets

- A carcass dissection study showed that on a scale of 1 to 5, a 1 unit increase in carcass conformation score (e.g. O to R) increased meat yield by 3.5 percentage units and carcass value by 5.8%, whereas a 1 unit increase in carcass fat score (e.g. 4 to 5) decreased meat yield by 2.9 percentage units and carcass value by 5.2%.

- As beef carcasses in Ireland mainly fall into 2 categories for both conformation (O and R) and fatness (4 and 3) using the 5-point EU beef carcass classification scheme, a better differentiation is achieved by using a 15-point (e.g. R^-, R and R^+) continuous scale. This is readily achieved with mechanical classification.

- Live animal muscular scoring and ultrasonic measurement of the eye muscle for fat and muscle depths are useful indicators of potential meat yield and are of particular relevance for pedigree breeding animals where carcass data is not available.

- The importance of improved carcass conformation (muscularity) is shown by the fact that on a 5 point scale a 1 unit increase would also increase kill-out rate by 3.0 percentage units.

- The need for carcass price to reflect carcass value cannot be over-emphasised.

2. Breeds and Breeding programmes

- The 3 most important factors in the efficient production of cattle with high growth rates and lean carcasses of good conformation are (i) using a high proportion of late maturing breeds, (ii) availing of hybrid vigour (most relevant in relation to fertility) and (iii) milk production of the dam.

- As a result of hybrid vigour (heterosis), the weight of calf weaned per cow put to the bull is 13% greater. Using a sire from a third breed would be expected to increase the weight of calf weaned by a further 8%.

- Possible breeding programmes with purchased replacements would include having 50% ($^{1}/_{2}$ Friesian from the dairy herd) or 75% ($^{1}/_{4}$ Friesian and 2 continental breeds) late-maturing continental crossbred cows.

- When producing replacements from within the herd, the simplest method of breeding high quality animals is by using a two breed rotational cross with Simmental (good milk production potential) and Limousin (good conformation) or Charolais and Limousin (the most widely used breeds). In the latter instance, potential milk production could be further improved by introducing Simmental and having a three breed rotational cross. Two and three breed rotational crossing results in retention of $^{2}/_{3}$ and $^{7}/_{8}$ of hybrid vigour, respectively

- In a comparison of Charolais, Limousin, Simmental and Belgian Blue sires, progeny from Limousin had about 20 kg lower carcass weights than the other three sire breeds, which were similar. Simmental had 2 percentage units lower carcass meat than Charolais and 3 percentage units less than Limousin and Belgian Blue progeny. However, factors such as ease of calving and suitability as replacements (where applicable) are further considerations. Thus, Belgian Blue crosses would not be generally recommended as suitable herd replacements because of the likelihood of a high incidence of calving difficulties.

- A comparison of progeny from Charolais sires of high or average expected progeny difference (EPD) for carcass conformation score showed that those from the high EPD sires had 1.0 percentage units higher kill-out percentage and 1.4 (75.5 v 74.1) percentage units more carcass meat than progeny of average EPD sires.

3. Reproductive performance in the Grange suckler herd

- Data obtained from 978 spring-calving cows at Grange showed a high pregnancy rate (94%) with a good calving interval (367 days).

- Calving intervals for cows calving before March 6 (early), between March 6 and April 1 (mid-season) and after April 1 (late) were 378, 364 and 353 days, respectively.

- There was no effect of cow body condition score at calving on either calving rate or calving interval in the mid-season or late calving cows but increased body condition score did reduce calving interval in the early calvers.

- Although there was no effect of cow age on calving interval, first calvers (calving at 2 years of age) despite receiving a higher feeding level from calving to grazing (concentrate supplement in addition to grass silage) showed only a small increase in live weight gain from calving to June, while older cows made more substantial gains.

- The short calving interval in cows calving close to turnout to grass shows that the calving date can be brought forward by increasing the feeding level after calving.

- It must be emphasised that the results obtained are dependent on good recovery of live weight and body condition resulting from the provision of a high plane of nutrition following turnout to pasture combined with good stockmanship and minimal disease.

4. Grass-based production systems

- Grass-based systems of suckler beef production were developed and evaluated using spring-calving late-maturing crossbred cows bred to late-maturing sire breeds. A semi-intensive system (0.83 ha per cow, progeny and replacements, 201 kg nitrogenous fertiliser per ha and 2 silage harvests) was operated with the production of heifers at 20 months of age (309 kg carcass weight) and steers at 2 years (396 kg carcass weight). The annual feed budget for the calf-to-beef system was 61% grazed grass, 31% grass silage and 8% supplementary concentrate. Corresponding figures for a calf to weaning system are 73%, 26% and 1%.
  Subsequently, this semi-intensive system was compared with a more extensive system (25% lower stocking rate, 97 kg of fertiliser nitrogen per ha and 1 staggered silage harvest). Individual animal performance was the same for both production systems.

- An examination of the effect of using a leader/follower grazing system showed a loss in overall live weight gain and that this grazing system has only application where the followers have low feed requirements (e.g. dry cows) or the leaders only consume a small proportion of total available grass (e.g. suckler calves).

- Creep grazing calves ahead of cows showed no benefit when grass supplies are high and of good quality.

- Extending the grazing season by letting yearling cattle out to grass three weeks earlier in spring and grazing the silage area resulted in 20 kg extra live weight gain per head at grass but only 5 kg of additional carcass. Grazing the silage area had no effect on silage digestibility but reduced silage yield by 29% when harvested on May 19 and by 9% when harvested on June 6.

- Due to compensatory growth moderate live weight gains of 0.5 to 0.6 kg per day during the first winter is adequate for steers/heifers that attained good pre-weaning live weight gain and subsequently receive an adequate supply of high quality pasture. This rate of gain during winter can readily be attained from feeding 1 to 2 kg of concentrates per head daily with moderate to high quality grass silage.

CHAPTER 1.

CARCASS QUALITY AND MARKETS

1.1 Introduction

Beef carcass prices should take account of meat yield and market price. In addition to almost a 3-fold increase in suckler cow numbers over the last 25 years there was also a substantial increase in the use of late-maturing continental breeds in the herd. Late-maturing continental breeds and crossbreds now account for over 70% of suckler cows, of which, 88% are bred to continental sire breeds (DAFF, 2008). Such a breeding policy has led to an increased proportion of animals suitable for the higher-priced continental EU market where prices are highest for animals of good conformation that are lean. As 85% of Irish carcass beef is exported, of which, 45% is destined for continental EU markets, it is important that the animals produced meet the requirements of those markets (Bord Bia 2008). An examination of steer and bull beef prices for 2007 shows that, when compared to Ireland the average prices in France and Italy were only 9 c/kg greater for conformation and fat score O3 carcasses (264 v 273 c/kg ex VAT) but were 63 c/kg (282 v 345 c/kg) greater for U3 carcasses (Bord Bia, 2007). Thus, the beef price difference in Ireland and the average for those two countries was 7 times greater for U conformation score than for O conformation score showing the extent to which carcasses of good conformation are under-priced in Ireland. Therefore, market outlet, in addition to carcass meat yield and distribution is important in determining carcass value. Having a beef price structure, which reflects the value of the animal, is in the long term interest of the beef industry. Price is the mechanism whereby the processor can indicate both to the farmer and to those involved in beef improvement programmes, such as breed societies and the Irish Cattle Breeding Federation (ICBF), the requirements of the market. As payment for beef carcasses within the EU is based on conformation and fat classification the relationship of these with meat yield and distribution, and carcass value is important. The results of a comprehensive study are presented, the objective of which, was to determine the effect of carcass conformation and fat scores on meat yield and value.

Summary and Conclusions

A large carcass dissection study was carried out to determine the effect of conformation and fat scores on meat yield and value.

- The results showed that on a scale of 1 to 5, a 1 unit increase in carcass conformation score (e.g. O to R) at constant fat score increased meat yield by 3.5 percentage units and carcass value by 18 c/kg (5.8%), which is double that paid by meat processors in Ireland in 2007. In the high-priced continental EU markets where requirements are for carcasses of good conformation that are lean, a 1 unit increase in carcass conformation score can increase value by up to 80 c/kg.
- In the present study, a 1 unit increase in carcass fat score on a scale of 1 to 5 decreased meat yield by 2.9 percentage units and carcass value by 17 c/kg (5.2%).
- Results obtained with young bulls and heifers were similar to those obtained for steers.
- The original EU carcass classification scheme involved a visual appraisal on a 5-point scale for conformation (E, U, R, O, P with E best) and fatness (1 to 5 with 5 fattest). Better differentiation of carcasses is required as 87% of steers and 91% of heifers are confined to just two conformation classes namely, R and O. Likewise, 87% of steers and 85% of heifers are confined to fat classes 3 and 4. Therefore, a 15-point scale was deemed essential for payment to be based on conformation and fatness, which is readily achieved using mechanical classification. Using a 15-point scale, a 1 unit increase in carcass conformation score should result in a price increase of at least 6 c/kg (i.e. 18 c/kg on the 5-point scale).
- This suggested difference in price is solely based on meat yield and distribution and does not take into account additional factors such as the higher processing costs associated with poorer meat yield or the increased value of better quality carcasses in certain continental EU markets. This would result in further price differentiation.
- In addition to using carcass data to predict meat yield, live animal data is also required. This is particularly relevant for breeding animals in pedigree herds where carcass data would not be available. The Irish Cattle Breeding Federation presently operate a linear scoring system involving both muscular and skeletal scoring. Ultrasonic scanning of the eye muscle for fat cover and

muscle measurements can also be used as indicators of carcass composition on the live animal.

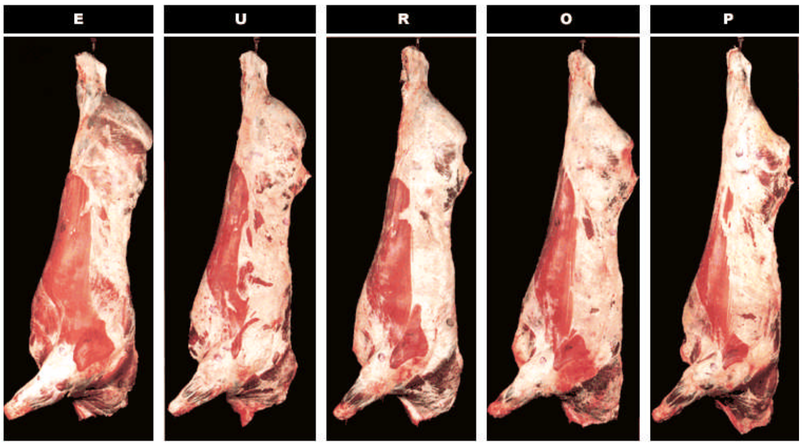
- The results of the studies using live animal data showed that muscular scores are closely related to carcass conformation scores and are thus, a useful indicator of meat yield. It is, however, apparent that muscular scores are most accurate when recorded close to slaughter on animals in relatively good body condition. This has implications for interpreting records obtained at weaning of suckled animals, where in the absence of a reasonable level of supplementary meals, body condition is mainly a reflection of the dam's milk production potential.
- On a scale of 1 to 15, a 1 unit increase in muscular score at slaughter was shown to increase meat yield by 1.2 percentage units.
- Skeletal scores were found to be poor indicators of carcass meat percentage but ultrasonically scanned measurements were shown to be useful indicators. Eye muscle area or depth measurements were closely associated with muscular score and conformation, while fat depth reflected carcass fat content.
- The importance of carcass price structure as an indicator of carcass value cannot be over-emphasised. Adequate premiums for better quality carcasses would result in an overall improvement in carcass conformation. The importance of improved conformation (muscularity) is shown by the fact that on a 15 point scale a 1 unit improvement in conformation score would increase kill-out rate by 1.0 percentage units and carcass meat yield by 1.1 percentage units resulting in an overall increase equivalent to about 12 kg of carcass weight. With total disposals of about 2 million animals yearly, this amounts to 25 million kg of carcass beef, which is equivalent to about 72,000 average carcasses.

Carcass dissection study

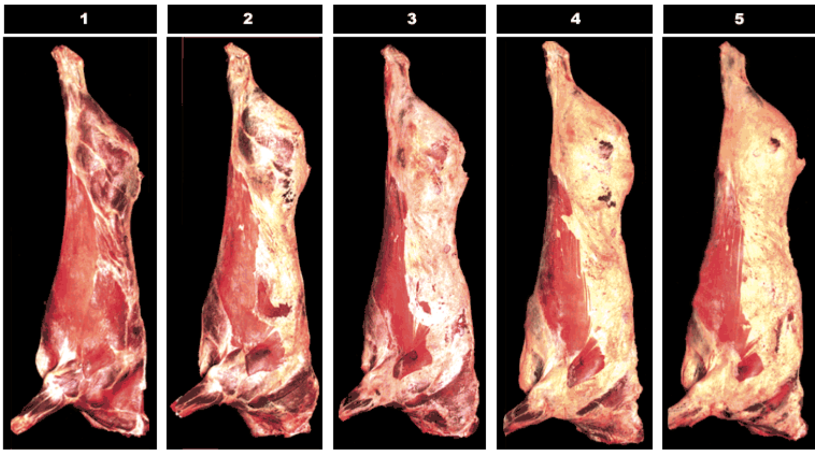
The objective of the study was to examine the relationship of carcass conformation and fat scores with carcass meat, fat and bone proportions and carcass value.

A total of 507 steers, were used representing the various sections of the carcass classification grid for conformation and fatness. In addition, 115 young bulls and 40 heifers were dissected. Carcasses were mechanically graded according to the EU Beef Carcass Classification Scheme. Carcass meat, fat and bone proportions were obtained by dissection of the right side of each carcass, which was quartered into an 8 rib pistola hind-quarter and the remainder as fore-quarter.

Mechanical classification of beef carcasses for conformation and fatness was used in Ireland from 2004



Visual guidelines of Conformation class (E best score) for cattle



Visual guidelines of Fat class (1 lowest fat score) for cattle

Source : EU Commission - Brussels

The pistola was dissected into 12 meat cuts (silverside, topside, knuckle, rump, tail of rump, fillet, striploin, cube roll, cap of ribs, leg, heel and eye of round). The bones were removed and scraped clean. All dissectable fat was removed from each cut. The weight of each cut and total weight of fat trim, lean trim and bone were recorded for the pistola. The fore-quarter was dissected into 11 cuts (front shin, brisket, chuck, neck, flat ribs (1 to 5), plate, leg of mutton cut, bladesteak, braising muscle, chuck tender and clod) and a similar dissection procedure was undertaken as outlined for the pistola. For both quarters, lean trim was added to the meat cuts to give meat yield. Total carcass yields of meat, fat and bone were the combined values for the pistola and fore-quarter. Carcass value was taken as the sum of the wholesale values of the individual meat cuts and meat trim in the half carcass with a deduction for bone expressed as a proportion of the half carcass weight. Thus, when estimating carcass value the weight of carcass fat was not considered.

The slaughter and carcass weight of the steers were 625 and 333 kg, respectively. Regression analyses were used to quantify the relationship between carcass conformation and fat scores with carcass meat, fat and bone proportions, meat distribution and carcass value (Tables 1 and 2). A 1 unit increase in carcass conformation score (e.g. O3 to R3) increased meat yield by 3.5 percentage units and decreased fat and bone yield by 1.3 and 2.2 percentage units, respectively. A 1 unit increase in carcass conformation score also increased carcass value by 18 c/kg (or 5.8 %). The effect of a 1 unit increase in carcass fat score was an increase of 3.6 percentage units in fat and decreases of 2.9 and 0.7 percentage units in meat and bone, respectively. This unit increase in carcass fat score also decreased carcass value by 17 c/kg. There is, however, a minimum fat requirement which varies with the actual market (greater in the UK than in continental EU) and thus, unlike conformation, changes in fat score do not apply across the entire carcass classification grid. An increase in carcass meat proportion of 1 percentage unit was shown to increase carcass value by 5.3 cent per kg. This amounts to an increase in value of €19 for a 360 kg carcass.

In order to obtain a wide range in carcass conformation scores the steers used in the study consisted of the main breeds and breed crosses available in the country. The data showed that the equations developed were applicable to all breed types and traits were predicted with a high degree of accuracy, which for carcass meat proportion was 78 percent. The data showed that there was no bias in estimation of carcass composition across gender. Therefore, the results obtained with steers also apply to bulls and heifers.

Table 1. The effect of a 1 unit increase in carcass conformation score in steers.

	O3	R3	Difference
Meat (%)	66.3	69.8	+3.5
Fat (%)	12.6	11.3	-1.3
Bone (%)	21.2	19.0	-2.2
[1]Value (c/kg carcass)	312	330	+18

[1]Assumes a base price of 312 c/kg for an O3. The price increase for an R3 over O3 is 5.8%.

Table 2. Effect of a 1 unit increase in carcass fat score in steers.

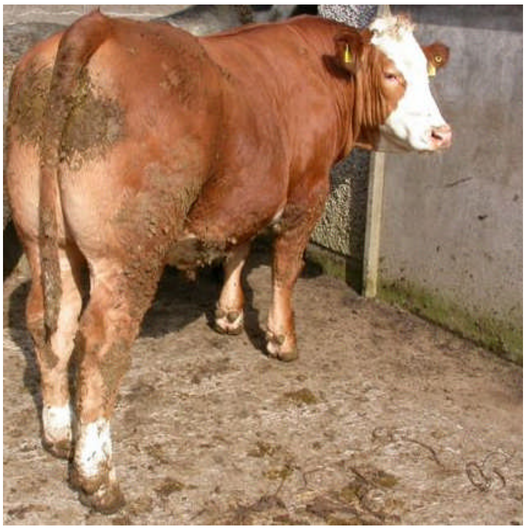
	R3	R4	Difference
Meat (%)	69.8	66.9	-2.9
Fat (%)	11.3	14.9	+3.6
Bone (%)	19.0	18.3	-0.7
Value (c/kg carcass)	330	313	-17

Included in the 507 steers were 94 progeny, of known parentage, from the suckler herd (about ⅞ continental breeds) and 76 Holstein-Friesian. The carcass weights of the suckler herd progeny and Holstein-Friesian were 404 and 316 kg, respectively (Table 3). Corresponding conformation scores were U^- and O^-, while both had similar fat scores of 3^+. Progeny from the suckler herd had 6.2 (71.2 v 65.0) percentage units more meat, 1.7 (11.5 v 13.2) percentage units less fat, 4.5 (17.3 v 21.8) percentage units less bone, 0.5 (7.1 v. 6.6) percentage units more high-value cuts and were valued at 36 c/kg carcass more than the Holstein-Friesian.

Young bull E2+ , Kill-out = 68.2%,
Meat = 84.8%, Carcass wt = 398kg

Young bull U+3 , Kill-out = 62.0%
Meat = 76.7%, Carcass wt = 363kg

Holstein bull O+3 Kill out = 52.9%,
Meat = 63.2%, Carcass wt = 267kg



Two-year-old steer U3+, Kill out = 57.0%
Meat = 69.1%, Carcass wt = 501kg

Two-year-old Friesian steer O3+ , Kill out = 51.8%
Meat = 65.9%, Carcass wt = 348kg

Conformation score

Fat score	E^+	E	E^-	U^+	U	U^-	R^+	R	R^-	O^+	O	O^-	P^+	P	P^-
1^-															
1															
1^+															
2^-															
2															
2^+															
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5^+															

About 90% of steer and heifer carcasses in Ireland are in conformation classes R and O and use of a 15-point scale (e.g. R^-, R, R^+) gives a better description of carcasses

Table 3. Data for Suckler herd progeny v. Holstein-Friesian steers.

	Sucklers	Holstein-Fr	Difference
Carcass wt. (kg)	404	316	
Carcass class	U^-3^+	O^-3^+	
Meat (%)	71.2	65.0	+6.2
Fat (%)	11.5	13.2	-1.7
Bone (%)	17.3	21.8	-4.5
High value cuts (%)	7.1	6.6	+0.5
Value (c/kg)	336	300	+36

Comparison of dissection study results with market prices

The price difference between carcass classes U3 and O3 (a 2 unit change in conformation) steer or bull carcasses in 2007 varied from 18 c/kg in Ireland to 64 c/kg in France and 80 c/kg in Italy (Table 4). With the exception of Ireland and Great Britain (GB), the advantage in EU countries was considerably greater than the 37 c/kg calculated for steers in the present study based on meat yield and distribution. While there were no Irish or GB quotations for heifers grading U for conformation, it was noticeable that in continental EU markets the effect of carcass conformation score on heifer prices was even greater than for steers/bulls. It was therefore evident that the carcass pricing structure in Ireland had to be reviewed so that emphasis in breeding goals could be placed on improving carcass meat yield and distribution, in addition to, meeting the higher priced export market specifications.

Table 4. Price difference (c/kg) between steer (or bull) carcass classes R3 or U3 over O3 in the present study and for various EU countries in 2007.

	Present study	Ireland	GB	France	Italy	Spain	Netherlands
R3 v O3	*18*	12	16	35	(59)	(21)	(24)
U3 v O3	*37*	18	23	64	(80)	(45)	(59)

Source: Bord Bia 2007

Beef carcass classification

Beef carcass classification data in Ireland for 2007 shows that 87% of steers and 91% of heifers fall into the combined conformation classes of O and R (Table 5). Therefore, a better differentiation would be achieved by classifying carcasses on a 15-point scale (eg R^-, R, R^+) rather than on a 5-point scale. For the same reason it would be more informative to have carcass fat class also classified on a 15-point scale as 87% of steers and 85% of heifers were in fat classes 3 and 4 in 2007 (Table 6). The mechanical carcass classification system currently in operation at Irish meat processing plants facilitates this expanded system. It is noticeable that the proportion of animals in fat class 5 is very low with the exception of cows at 10% and to a lesser extent heifers at 5%. The fact that 85% of young bulls had carcass conformation scores of U and R shows that they are mainly late-maturing breed crosses. The fact that 40% of these young bulls have fat scores of 2 indicates the potential to carry them to heavier carcass weights.

Table 5. Percentage of beef carcasses in the different conformation classes in Ireland in 2007.

	E	U	R	O	P	Carcass wt (kg)
Steers	-	7	45	42	7	358
Young bulls	1	43	42	13	1	368
Heifers	-	6	55	36	3	291
Cows	-	1	11	44	44	305

Source: DAFF 2007

Table 6. Percentage of beef carcasses in the different fat classes in Ireland in 2007.

	1	2	3	4	5
Steers	1	11	53	34	1
Young bulls	4	40	51	5	-
Heifers	2	9	41	44	5
Cows	9	13	33	36	10

Source: DAFF 2007

Using this expanded beef carcass classification system for conformation score a premium of 6 c/kg on a 15-point scale (= 18 c/kg on a 5-point scale) is merited based on meat yield alone, while a greater premium would be due if savings in processing overheads were also considered. In addition the premium would be substantially higher if higher-priced market outlets were also considered. Similarly, a deduction of 6 c/kg per unit increase in fatness on a 15-point scale for overfatness (i.e. above that required by the specific market) is also justified based on the results of the present study.

Implications

A carcass pricing system based on meat yield and market outlet would result in a price improvement for animals of good conformation that are lean. This would, in turn, lead to an overall improvement in the quality of carcasses produced and provide more animals suitable for the high-priced continental EU market. As the suckler herd is the source of the higher quality carcasses the improved income from suckling would help to maintain suckler cow numbers and thus, beef output. This is important as figures for 2007 (European Commission 2008) show that the EU was only 94% self-sufficient in beef and 85% of Irish beef output goes to other EU markets. Predictions indicate that EU beef production will continue to be considerably less than requirements thus, ensuring a market for the foreseeable future.

As carcass conformation and fat scores are recorded on beef carcasses in the EU, their relationship with commercially important traits such as meat yield and distribution in the carcass is important. The results of the study discussed show that carcass conformation and fat scores are good indicators of carcass meat yield and as a result, carcass value. However, other technology, which involves recording an image of a section of the eye muscle at the 10th rib would allow calculation of the meat, fat and bone content at that point, which when related to composition of the entire carcass, may offer a more accurate assessment of carcass composition. Such images have been recorded on a proportion of the carcasses dissected. This procedure may be used as a relatively precise estimation of meat yield and carcass value in the future.

Live animal scores and measurements as indicators of meat yield

Live animal records include visual muscular and skeletal scores (presently recorded by the Irish Cattle Breeding Federation (ICBF)), ultrasonic scanning of the eye muscle to estimate size and fat cover, and body condition scoring. The most important use of live animal scores and measurements is with pedigree animals which are retained for breeding and thus, do not have any carcass data. Of less importance is their use in commercial animals in that information will be available at an earlier stage but at greater costs than the carcass data, which is freely available. Information collected at Teagasc Grange in recent years show that both muscularity scores and ultrasonic scans on the eye muscle are useful indicators of carcass meat yield. Initially an Aloka scanner was used, which recorded eye muscle area, but more recently a Dynamic Imaging Scanner was used to record eye muscle depth. Muscle depth was found to be as good an indicator of meat yield as muscle area and the Dynamic Imaging Scanner is more suited to on-farm recording.

Very good relationships (high correlation coefficients of 0.85) were obtained between live animal muscularity scores recorded before slaughter and carcass conformation score. This is not surprising as the two scores are quite similar with the live animal muscularity scores defined as thickness of the muscle, while carcass conformation is thickness of muscle and fat. However, the relationship with carcass conformation was not as good when the muscular score was recorded at weaning (8 to 9 months of age). It is considered that in order to obtain satisfactory scores the animals should be in good body condition to allow expression of muscular development and in commercial herds a major factor influencing condition at weaning is milk yield of the dam. This was clearly shown in studies comparing the progeny of Limousin × Friesian cows (high milk production) with purebred Charolais and Limousin cows (low milk production) whereby, there was no difference in muscularity score at weaning but at slaughter muscularity score of the progeny of the purebreds was superior and they also had a better carcass conformation score. Thus, muscular scoring should be recorded following a period on a high level of feeding, which is more likely to arise in pedigree herds using moderate to high levels of supplementary meal feeding. Because of the good relationship between muscularity score and carcass conformation score it is not surprising that muscular score was also useful in predicting carcass meat percent. Muscular score, recorded at slaughter was shown to explain 36% of the total variation in carcass meat yield of steers. On a scale of 1 to 15, a 1 unit increase in muscular score increased carcass meat yield by 1.2 percentage units.

However, combining skeletal scores (length of back, length of pelvis and height at withers) with the muscular score did not result in any improvement in predicting meat yield indicating that skeletal scores were not an important contributing factor as a predictor of meat yield. As previously discussed, meat yield is also influenced by the level of fatness, which is not taken into account when using just muscular score to predict meat yield. Thus, it is not surprising that when scanned muscle and fat measurements were used the amount of total variation in meat yield explained was higher (value of 51%). Scanned eye muscle depth, like muscular score also showed a good relationship with carcass conformation and is also an indicator of muscularity. In a publication dealing with a terminal sire selection index for UK beef cattle Amer, Crump and Simm (1998) pointed out that carcass conformation and live animal muscling have emerged as more important determinants of the value of finished animals than was implied in the original index of 1985.

In addition to the good relationship shown between both muscular scores and conformation scores and meat yield they are also positively associated with kill-out percentage. As a guide-line, on a scale of 1 to 15, a 1 unit increase in muscular score or conformation score can be expected to increase kill-out by about 1.0 percentage unit. Thus, at 660 kg live weight an animal with a conformation score U would be expected to have a kill-out of 58% and a carcass weight of 383 kg. The corresponding figures for an animal with a conformation score O would be 52% and 343 kg.

In conclusion, the importance of the carcass price structure as an indicator of carcass value cannot be over-emphasised. Carcass price is the best mechanism whereby a clear guideline of market requirements can be provided for producers and those involved in breed improvement programmes. The importance of a price structure, which emphasises carcass conformation score, is shown by the fact that based on the data from the present studies a 1 unit increase in carcass conformation score on a scale of 1 to 15 increased kill-out rate by 1.0 percentage units and carcass meat yield by 1.1 percentage units. This would result in an overall increase equivalent to 12 kg of carcass weight. With total annual disposals of about 2 million animals this amounts to 24 million kg of carcass beef, which is equivalent to some 72,000 average carcasses.

CHAPTER 2.

BREEDS AND BREEDING PROGRAMME

Introduction

The objective of suckler beef production is to produce animals or carcasses of good conformation suitable for the higher priced EU markets. Thus, the breeding programme should be based on late-maturing breeds and crossbreds. It is also essential to obtain good reproductive performance, have a low incidence of calving problems and low mortality rates and obtain high pre-weaning weight gains. Although the ideal carcass for the EU markets would be similar to that produced from purebred Charolais, Limousin and Blonde d'Aquitaine herds in France, the breeding programme practised should avail of the benefits of hybrid vigour resulting from cross-breeding. The fact that cow milk yield is the most important determinant of calf pre-weaning gain this must also be an important consideration. It should also be kept in mind that within all breeds there is large variation for both growth and carcass traits and so efforts to improve the genetics associated with carcass quality must be based on selection according to individual animal performance, within the breed chosen.

Summary and Conclusions

- There is increased interest by producers in providing replacements from within the suckler herd. One advantage of keeping purchased animals to a minimum is that it avoids the introduction of disease. However, a certain level of purchasing would be required as most suckler cows are bred using natural mating thus, necessitating purchase of bulls. In addition, breeding suitable replacements from within the suckler herd may not always be possible necessitating the purchase of breeding females.
- In providing suitable replacements important considerations include availing of hybrid vigour by crossbreeding, ensuring satisfactory milk production potential and having at least 50% and preferably 75% of a late-maturing continental breed in the cow in order to produce progeny suitable for the highest priced markets. As a result of hybrid vigour (heterosis), which is the superiority of the crossbred over the average of the two parent breeds, a crossbred cow will result in an increase in the weight of calf weaned per cow to the bull of 13 percent. Using a sire from a third breed would be expected to increase the weight of calf weaned by a further 8 percent.

- When producing replacements from within the herd, the simplest method of producing high quality animals is achieved by using a two breed rotation crossing with e.g Simmental (good milk production) and Limousin (good conformation) or Charolais and Limousin, which are the most widely used breeds. However, in the latter instance potential milk production could be further improved by introducing the Simmental and having a three breed rotation crossing. Two and three breed rotation crossing results in retention of $^{2}/_{3}$ and $^{7}/_{8}$ of hybrid vigour, respectively, and leads to a substantial improvement in fertility compared to purebreds.
- When replacements are purchased this should ideally be at the calf stage (from dairy herds) or as weanlings (from suckler herds), thus avoiding the purchase of pregnant animals which could result in a high incidence of disease in newborn calves.
- Possible breeding programmes with purchased replacements would include either having 50% (½ Holstein-Friesian) or 75% (¼ Holstein-Friesian and 2 continental breeds) late maturing continental crossbred cows. Approximately 40% of the cow herd can be bred to provide suitable replacements using purebred Limousin and Simmental sires with the remainder bred to a terminal sire breed e.g. Charolais.
- Upgrading to a purebred cow would result in the absence of hybrid vigour resulting in lower fertility and reduced milk production potential. While composites, which involves creating a new breed but would have similar advantages to crossbreds a composite (crossbred) bull would be needed for breeding replacements which would not be feasible at present. Although the quality of the cow is important, it should be noted that as the majority of suckler cows are bred using natural mating therefore, major emphasis must be placed on improving the overall genetic merit of the bulls used.
- In a comparison of Charolais, Limousin, Simmental and Belgian Blue sires, Limousin progeny had about 20 kg lower carcass weight than the progeny from the other three breeds, which were quite similar. Simmental had 2 percentage units lower carcass meat content than Charolais and 3 percentage units less than Limousin progeny and Belgian Blue progeny. However, factors such as ease of calving and suitability as replacements (where applicable) are further considerations. Thus, Belgian Blue crosses would not be generally recommended as suitable herd replacements because of the likelihood of a

high incidence of calving difficulties. Again, it should be noted that there is substantial variation within breeds for all important production traits.

- A comparison of progeny from Charolais sires of high or average expected progeny difference (EPD) for carcass conformation showed that those from the high sires had 1.0 percentage units higher kill-out rate and 1.4 (75.5 v 74.1) percentage units more carcass meat than progeny of average sires. This additional meat yield from the progeny of high conformation sires would increase carcass value (if based on meat yield) by 7.4 c/kg or almost €27 for a 360 kg carcass.

Breed composition of the suckler herd in Ireland

A desirable feature of cattle breeding in Ireland over the last 25 years has been the substantial increase in the proportion of the calf crop, which are the progeny of late-maturing breeds and their crosses. The proportion of continental crossbred suckler cows was 29% in 1992, 52% in 1998 and 73% in 2007 (Table 7). The proportion of suckler cows bred to late-maturing sire breeds has increased from 78% in 1992 to 83% in 1998 and 87% in 2007 (Table 8).

Table 7. Cow breed types (%) in suckler herds.

	1992	1998	2007
Friesian	20	2	-
Hereford ×	35	31	12
Aberdeen Angus ×	9	12	12
Shorthorn	7	3	3
Charolais ×	7	17	25
Simmental ×	9	16	14
Limousin ×	8	15	26
Other	5	4	7
Total	**100**	**100**	**100**

Table 8. Breed of sire used on suckler cows and heifer replacements (%).

	1992	1998	2007
Hereford	14	9	4
Aberdeen Angus	6	8	8
Belgian Blue	-	-	5
Charolais	41	43	41
Simmental	16	15	7
Limousin	21	18	31
Other	2[a]	6	4
Total	**100**	**100**	**100**

[a]Shorthorn.

Suckler cow breed comparisons at Grange

Hereford ×Friesian and Limousin × Friesian cows

A comparison of the performance of Hereford × Friesian and Limousin × Friesian spring-calving cows and their progeny was carried out over 4 calf crops. A Limousin sire, selected for ease of calving, was used for first calving with Charolais sires used subsequently. The progeny were taken to slaughter as bulls at 16 months of age and heifers at 20 months of age. Cows were offered grass silage (plus a mineral/vitamin supplement) in winter except after first calving when 1 kg of a barley–based concentrate was offered from calving until turnout to pasture. Cows and their calves spent from April to October/November at pasture. Following housing, the bull progeny were offered grass silage to appetite and the daily concentrate allowance was increased gradually to 5 kg per head daily until slaughter. Heifers were offered 1 kg of concentrate daily with silage during the winter following which, they were let to pasture. During the final 2 to 3 months before slaughter heifers were offered approximately 3 kg of concentrates per head daily with grazed grass or silage.

There was no effect of cow breed type on silage dry matter intake of cows, live weight or reproductive performance but body condition score gain was higher for Hereford × than for Limousin × cows. Calf birth, weaning and slaughter weights were not different but bull progeny of Limousin × cows had a higher kill-out percentage, a heavier carcass weight and a lower carcass fat score than those from Hereford × cows. The breed difference for heifer progeny were in the same directions but were not as great. Overall, when averaged for bulls and heifers, Limousin × progeny had 10.4 kg heavier carcasses and a 1.2 unit lower fat score on a scale of 1 to 15 than Hereford × progeny (Table 9). Carcass weight of bull progeny of Limousin × and Hereford × cows were 363 and 347 kg, respectively. The corresponding figures for heifers were 300 and 295 kg.

Table 9. Live weights and intakes of Hereford × Friesian and Limousin × Friesian cows and performance of their progeny (average bulls and heifers).

	Hereford × Fr	Limousin × Fr
Cow		
Live wt (kg)	525	538
Dry matter intake (kg/day)	7.1	7.4
Dry matter intake (% of live weight)	1.24	1.26
Progeny		
Daily gain (kg) birth to slaughter	1.00	1.02
Kill-out %	55.4	56.3
Carcass weight (kg)	321.1	331.5
[1]Carcass conformation (scale 1 to 15)	9.5	9.5
[2]Carcass fat (scale 1 to 15)	10.5	9.3

[1]Scale 1 to 15 (best) [2]Scale 1 to 15 (fattest).

Charolais and Beef × Friesian cows

The performance of spring-calving Charolais and Beef (Hereford and Limousin) × Friesian cows and their progeny to weaning were compared over 4 calf crops. The steer progeny of the Charolais and Hereford × Friesian cows by Charolais sires were taken to slaughter at two years of age and carcass data was obtained. The Charolais cows were $^{7}/_{8}$ Charolais and were the result of an up-grading programme commencing with Charolais × Friesian. All cows used in the study were first bred to calve at two years of age using an easy-calving Limousin bull. Charolais bulls were used for all subsequent calvings. Each year calving was in the period February to April. Cows and calves were grazed together from April until weaning (and housing) in October/November. During the indoor winter period mature cows were fed grass silage and a mineral/vitamin supplement and weaned steer calves received high digestability grass silage plus about 1 kg of concentrates per head daily. At the end of the winter the steers then spent a second grazing season at pasture and were finished indoors on silage/concentrate diets.

Voluntary intake of silage during pregnancy was the same (8.4 kg of dry matter per day) for Charolais and beef × Friesian cows but because of their greater live weight (96 kg heavier), intake as a percentage of live weight was lower for Charolais (1.2%) than beef × Friesian (1.4%). Similar findings were obtained when intake was measured in early lactation (Table 10). Based on feed intake and live weight changes it was estimated that the energy requirements of a 600 kg beef × Friesian cow during pregnancy is equivalent to that of a 660 kg Charolais cow.

Table 10. Voluntary silage intakes by upgraded Charolais and Beef × Friesian cows.

	Charolais	Beef × Friesian
Pregnancy		
kg dry matter/day	8.4	8.4
% of live weight	1.2	1.4
Lactation		
kg dry matter/day	9.4	9.3
% of live weight	1.4	1.7

Calves have no immunogloblins (Ig) at birth and are dependent on colostrum as a source of Ig for protection against disease in early life. The beef × Friesian cows produced a greater quantity of Ig from first-milking colostrum than Charolais cows due mainly to a greater yield of colostrum. Colostrum yield of beef × Friesian cows was almost 1.5 times greater (3.9 v 2.7 litres) than Charolais cows (Table 11). 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. Thus, Ig concentration in calf serum recorded 48 hours after birth provide an accurate assessment of intakes from colostrum. Calf serum Ig concentration for progeny of Beef x Friesian cows were significantly greater than for progeny of Charolais cows (Table 11). Thus, in an adverse environment calves from upgraded Charolais may not be able to withstand disease as readily as the progeny of the cross-breds due to a lower immune status.

At pasture, milk yield of Charolais cows (7.3 kg/day) was only about two-thirds that of beef × Friesian (11.1 kg per day). Milk yield of spring-calving suckler cows normally increases when they are turned out to pasture in spring, which reflects improved cow nutrition. In agreement with other studies, the results showed that milk yield was an important determinant of calf pre-weaning gain. Calf daily gains to weaning were 1.10 and 1.19 kg/day for Charolais and beef × Friesian progeny, respectively. A 1 kg increase in daily milk yield was shown to increase daily live weight gain of the progeny of Charolais and beef × Friesians by 69 g and 30 g, respectively. The better response to increasing yield with the Charolais was due to lower yields as calf weight response to increasing yield decreases as milk yield increases.

Table 11. Colostrum yield, calf serum immunoglobulin (Ig) levels, milk yield and pre-weaning growth of progeny of upgraded Charolais and Beef × Friesian cows.

	Charolais	Beef × Friesian
Colostrum yield (L)	2.7	3.9
Calf Ig (mg/ml)	45	64
Cow milk yield (kg/day)	7.3	11.1
Daily live weight gain to weaning (kg)	1.10	1.19

At all times, Charolais cows were heavier than Hereford × Friesian with the greatest difference in live weight (109 kg) at housing in autumn (Table 12). From calving to the start of grazing Hereford × Friesian cows lost more live weight than Charolais due to the higher milk production of the former. During the first 54 days at pasture, live weight gains of the Charolais and Hereford × Friesian cows were 72 and 59 kg, respectively. The high live 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 their good reproductive performance. Both cow breed types gained over 100 kg live weight at pasture and the yearly gains (calving to calving) of Charolais and Hereford × Friesian cows were 22 and 18 kg, respectively.

In general, changes in body condition score throughout the year closely reflected changes in live weight. Mean body condition score for both groups of cows was 2.4 (scale 0 to 5) at the start of the grazing season (Table 12). Substantial body 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 × Friesian cows, respectively. For the total year Charolais cows showed a small gain in body condition, while there was a slight loss for Hereford × Friesian.

Progeny of upgraded beef cows had lower pre-weaning live weight gains but superior carcasses

Table 12. Calving intervals, cow live weight and body condition score and changes (kg).

	Charolais	Hereford × Friesian
Number of animals	86	102
Calving interval (days)	363	370
Live weight (kg)		
Housing	721	612
Post-calving	649	552
Live weight changes (kg)		
Calving to grazing	-23	-34
First 54 days at pasture	72	59
Total grazing season	117	105
Calving to calving	22	18
Body condition score (scale 0 – 5)		
Post-calving	2.4	2.6
Body condition score changes		
Calving to grazing	0.01	-0.13
At grass to June (54 days)	0.66	0.71
Total grazing season	0.92	1.05
Calving to calving	0.11	-0.07

The overall incidence of calving problems was low and birth weight of calves from the two cow breed types were similar. For steer progeny taken to slaughter, the 28 kg difference in live weight of the Hereford × Friesian over the Charolais progeny at weaning (218 days of age) was due to increased pre-weaning growth resulting mainly from higher milk intake (Table 13). When fed similarly from weaning to slaughter at about 2 years the final live weight of Charolais and Hereford × Friesian steer progeny were 697 and 719 kg, respectively. Corresponding carcass weights were 383 and 394 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 × Friesian, respectively. However, weight of kidney plus channel fat and carcass fat score were lower and carcass conformation was better for progeny of Charolais cows than for Hereford × Friesian progeny.

Table 13. Performance from weaning to slaughter of the steer progeny of upgraded Charolais and Hereford × Friesian cows.

	Charolais progeny	Hereford × Friesian progeny
Weaning weight (kg)	301	329
Slaughter weight (kg)	697	719
Carcass weight (kg)	383	394
Age at slaughter (days)	724	728
Carcass per day of age (g)	531	543
Kidney + channel fat (kg)	11.4	15.5
[1]Carcass conformation score	11.1	10.2
[2]Carcass fat score	11.4	12.6

[1]Scale 1 to 15 (best conformation); [2]Scale 1 to 15 (fattest)

When expressed as a proportion of carcass weight, the pistola of Charolais progeny was greater than that of Hereford × Friesian progeny (Table 14). Furthermore, for the carcasses dissected, carcass weight of Charolais progeny was 12.4 kg less than Hereford × Friesian progeny while the meat yield in the pistola was 5.8 kg greater. The percentage meat in the pistola of Charolais and Hereford × Friesian progeny was 67.4 and 64.1, respectively. The corresponding fat percentages were 15.4 and 18.4. There was only a minimal difference in bone content.

Table 14. Weight and composition of pistola from the steer progeny of upgraded Charolais and Hereford × Friesian cows.

	Charolais progeny	Hereford × Friesian progeny
Weight of pistola (kg)	174.0	175.2
Proportion of carcass (%)	46.8	45.6
Meat (%)	67.4	64.1
Fat (%)	15.4	18.4
Bone (%)	17.2	17.5

Limousin × Holstein-Friesian and Simmental × (Limousin × Holstein-Friesian) cows

Intake and performance during pregnancy of spring-calving Limousin × Holstein-Friesian (LF) and Simmental × (Limousin × Holstein-Friesian) (SLF) cows was compared during the winter indoor period. A total of 33 and 24 first calving (calving at 2 years of age), and 33 and 18 mature spring-calving LF and SLF cows, respectively. First calving and mature cows were bred to Limousin and Charolais sires, respectively. During the indoor winter period, cows were offered grass silage *ad libitum* and a mineral plus vitamin supplement daily. Dry matter intake (kg/day) was proportionately 7% higher for SLF than LF cows (Table 15). Live weight of SLF cows was 60 kg greater than LF but live weight loss to post-calving did not differ between the cow breed types. There was no difference between the cow breed types in body condition score at the start of the winter, but post-calving, body condition score was lower for LF than SLF cows. Loss of body condition to post-calving did not differ between the breed types. Incidence of calving difficulty was lower for SLF than LF cows. Calf birth weight and concentration of IgG_1 in colostrum and calf serum were similar for both cow breed types.

Therefore, use of Simmental genetics to maintain milk production when selecting replacements from within the suckler herd, also results in preservation of calf humoral immune status, a lower calving difficulty score but this must be offset against a higher dry matter intake.

Table 15: Intake and performance during pregnancy of Limousin × Holstein-Friesian (LF) and Simmental × (Limousin × Holstein-Friesian) (SLF) cows.

	Breed type	
	LF	SLF
Dry matter intake		
kg /day	6.9	7.3
% of live weight	1.22	1.17
Live weight (kg)		
Initial (at housing)	536	596
Post-calving	494	553
Change to post-calving	-42	-43
Body condition score (0-5)		
Initial (at housing)	2.5	2.6
Post-partum	2.0	2.3
Change to post-calving	-0.5	-0.3
Calving difficulty (1-5)	2.3	1.3
Calf birth weight (kg)	42.4	44.3
Colostrum IgG_1 (mg/ml)	148	137
Calf serum IgG_1 (mg/ml)	55	53

Limousin × Holstein-Friesian and Simmental × Holstein-Friesian cows

Intake during pregnancy and annual performance of spring-calving Limousin × Holstein-Friesian (LF) with Simmental × Holstein-Friesian (SF) cows and pre-weaning growth of their calves was compared over two calf crops. The animals were first calving in Year 1. The LF and SF cows were mated to Simmental and Limousin sires, respectively, in Year 1 and to Simmental sires in Year 2. Cows were offered grass silage *ad libitum* plus a mineral/vitamin supplement during the winter indoor period and an additional 2 kg of concentrates post-calving until turnout to pasture in Year 1. At pasture, both cow breed types and their calves were rotationally grazed, together. Live weight and pre-calving intake of grass silage was greater for SF than LF cows, whereas incidence of calving difficulty, calf birth weight and calf pre-weaning growth was similar for both breed types (Table 16).


Charolais calf from Limousin × Friesian cow


Charolais calf from Simmental × (Limousin × Friesian cow)


Charolais calf from Simmental × (Limousin × Friesian cow)

Table 16: Intake, live weight, body condition score (BCS) and calving difficulty of Limousin × Holstein-Friesian (LF) and Simmental × Holstein-Friesian (SF) cows, and birth weight and growth of their calves pre-weaning.

	LF	SF
Dry matter intake pre-calving		
kg/day	7.7	8.9
% of live weight	1.46	1.58
Cow live weight (kg)		
Initial	515	547
Post-calving	493	533
Turnout to pasture (April)	468	507
June	510	538
Weaning (Oct)	547	568
Cow body condition score (0-5)		
Post-calving	2.2	2.3
Turnout to pasture (April)	2.3	2.2
June	2.2	2.2
Weaning (Oct)	2.3	2.1
Calving difficulty (1-5)	1.6	1.3
Calf weight (kg)		
Birth	41.1	41.9
Turnout to pasture (April)	72	69
Weaning (Oct)	288	292

Five suckler cow breed types : crossbreds and purebreds

This comparison involved spring-calving, Limousin × Holstein-Friesian (LF), Limousin × (Limousin × Holstein-Friesian (LLF), Limousin (L), Charolais (C) and Simmental × (Limousin × Holstein-Friesian) (SLF) and their progeny to slaughter as bulls at 15 months of age and heifers at 20 months of age. The objective of the four-year study was to quantify the effects of 1) stepped increase in the proportion of late maturing "continental" breeding in the dam (LF, LLF and L); 2) purebred v. crossbred (C, L v. LF, LLF, SLF) dams and 3) three-quarters continental bred dams of contrasting genetic potential for milk production (LLF v SLF). The animals were bred to Limousin sires as heifers to calf at 2 years of age and to Charolais sires subsequently. Thus, the proportion of continental breed genes in all the progeny was three-quarters or greater. The progeny were from first, second and third calving dams. There was no effect of cow breed type on grass intake but when expressed relative to live weight, intake was greater for LF and SLF than for L and C cows, whereas LLF were intermediate (Table 17). Silage DM intake before calving was greater for C and SLF than L and LLF cows, while LF were intermediate. However, when expressed relative to live weight there was no difference in silage intake between the cow breed types. It is noteworthy, that for both the grass and silage intake periods, intake decreased as the proportion of Limousin breeding increased. This occurred despite the fact that live weight was in the opposite direction, with purebred Limousin being the heaviest (Table 18).

Table 17. Dry matter intake and intake expressed relative to live weight of five beef cow breed types.

	Cow breed type				
	LF	LLF	L	C	SLF
Grass					
Kg/day	11.0	10.4	9.9	12.5	11.6
% of live weight	2.25	1.94	1.75	1.83	2.12
Silage					
Kg/day	8.3	7.8	7.0	8.7	9.2
% of live weight	1.46	1.32	1.10	1.13	1.56

Live weight of C cows was greater than all other breed types while L were also heavier than LF and LLF (Table 18). The decrease in live weight over the indoor winter period was greater for L and C cows than LLF and SLF, while LF were intermediate. The increase in live weight during the grazing season was greater for C cows than for all other breeds types except L. Annual live weight changes did not differ between the breed types. Body condition score was lower at housing for LF cows than LLF, L and SLF with C cows intermediate. There was no affect of cow breed type on body condition score changes for any of the periods examined throughout the year. Muscularity scores at housing were lower for LF cows than all other breed types. C and L had the highest scores, while LLF and SLF were intermediate. There was no effect of cow breed type on gestation length. Calving difficulty score was low but highest for C cows.

Table 18. Mean values for live weight, body condition score and changes, visual muscular scores, gestation length, calving difficulty score colostrum and calf immunoglobulin (Ig) concentration and milk yield of five cow breed types.

Variable	Cow breed type				
	LF	LLF	L	C	SLF
Live weight (kg)					
Housing	552	574	616	702	582
Post-calving	526	553	575	662	556
Live weight change (kg)					
Winter (Indoor)	-43	-26	-52	-52	-32
Grazing season	79	74	84	101	69
Annual	35	48	33	48	41
Body condition score (units, scale 0-5)					
Housing	2.26	2.73	2.71	2.46	2.66
Post-calving	2.17	2.65	2.54	2.62	2.63
Body condition score change					
Winter (Indoor)	-0.15	-0.25	-0.37	-0.04	-0.23
Grazing season	-0.03	0.12	0.26	0.13	0.21
Annual	-0.21	-0.11	-0.11	0.09	-0.04
Muscularity scores (1-15) at housing	5.5	6.8	8.0	7.8	6.2
Gestation length (days)	291	288	290	290	290
Calving difficulty score (1-5)	1.89	1.39	1.64	2.23	1.61
Colostrum IgG_1 (mg/ml)	80	76	76	96	89
Calf IgG_1 (mg/ml)	27	22	21	18	24
Milk yield (kg/day)	9.7	7.0	5.5	6.9	8.7

There was no effect of cow breed type on colostrum IgG_1 concentration but calves from LF had higher IgG_1 levels than all other progeny except those from SLF cows. Therefore, calves from the LF and to a lesser extent the SLF were better protected against disease in early life due to higher levels of Ig. Milk yield of LF and SLF cows was similar and greater than that of the two purebreds and LLF which did not differ. Birth weight of calves from C cows was greater than all other breed types except L (Table 19). Daily gain from birth to weaning was greater for progeny of LF cows than all other breed types except SLF, who in turn, were greater than progeny of L and C cows. A 1 kg increase in daily milk yield for LF, LLF, L, C and SLF cows was associated with an increase of 41, 52, 51, 59 and 45 g, respectively, in daily live weight gain from birth to weaning of their progeny. This showed that the response in calf live weight to milk yield is greater at lower yields. There was no effect of cow breed type on daily gain of the progeny from weaning to slaughter. Daily live weight gain from birth to slaughter was however, higher for progeny of LF and SLF cows than for L and LLF. The progeny of C dams had intermediate gains and differed only from LF progeny. There was no difference in muscularity score between the progeny of the 5 cow genotype at weaning but L and C progeny had higher scores than the others at slaughter.

Table 19. Relative values for birth weight, live weight gains and muscularity scores for progeny of five cow breed types.

	Cow breed type				
	LF	LLF	L	C	SLF
Calf live weight (kg)					
Birth	47.9	43.4	48.7	50.5	46.2
Calf live weight gains (kg/day)					
Pre-weaning	1.12	1.00	0.92	0.98	1.07
Post-weaning	0.96	0.95	0.96	0.99	0.98
Birth to slaughter	1.01	0.95	0.93	0.97	1.00
Muscularity scores (scale 1-15)					
Weaning	7.8	7.8	7.9	8.1	8.1
Pre-slaughter	9.1	9.1	9.7	9.9	9.5

Slaughter weight and carcass produced per day of age were greater for progeny of LF and SLF cows than for progeny of L and LLF dams, while C were intermediate (Table 20). Kill-out proportion was greater for progeny of L dams than all other breed types except LLF. There were no other differences in kill-out proportion.

Table 20. Mean values for slaughter weight, carcass weight, kill–out percent, growth and carcass traits for the progeny of five beef cow breed types.

	Cow breed type				
	LF	LLF	L	C	SLF
Slaughter weight (kg)	573	536	532	553	568
Cold carcass (kg)	318	302	304	310	317
Kill-out %	55.4	56.2	57.1	55.9	55.8
[1]Carcass conformation score	8.7	8.7	9.7	9.6	9.1
[2]Carcass fat score	7.6	7.6	6.6	6.4	7.5
Carcass produced per day of age (kg)	0.61	0.58	0.59	0.60	0.61

[1]Scale 1 to 15 (best) [2]Scale 1 to 15 (fattest)

Carcass conformation score was higher for progeny of L and C dams than for LF and LLF progeny, while SLF was intermediate. Carcass fat score was lowest for the progeny of L and C cows. The proportion of meat in the hind-quarter was highest for the progeny of L cows (Table 21). Progeny of L and C cows had a similar proportion of fat in the hind-quarter and were lower than the other three breed types which did not differ. Bone proportion in the hind-quarter was highest for progeny of C cows and lowest for L progeny. The meat to bone ratio was highest for progeny of L cows.

Table 21. Carcass composition for progeny of five beef cow breed types.

Variable	Cow breed type				
	LF	LLF	L	C	SLF
Hind-quarter (%)	49.0	49.7	50.0	50.1	48.8
Carcass meat (%)	74.3	74.4	76.5	74.6	74.2
Carcass fat (%)	8.1	8.8	6.4	7.6	9.1
Carcass bone (%)	18.5	18.5	17.2	19.1	18.2
Meat to bone ratio	4.0	4.1	4.4	3.9	4.1

Suckler Cow Replacement Policy

There is a need for effective suckler cow replacement programmes. The increase in suckler cow numbers and the decline in carcass quality of the dairy herd due to the influence of the Holstein breed (and more recently the Jersey breed), mean that both the availability and quality of beef × dairy replacement heifers are reduced. Providing replacements from within the herd in addition to ensuring suitable breeding animals (continental cross-breds of satisfactory milk production potential) reduces the danger of introducing disease (e.g. respiratory disease, Leptospirosis, Bovine viral diarrhoea, Johnes) and avoids the cost of assembling replacements. There are a wide range of options in selecting suckler herd replacements. In addition to satisfactory milk production potential, cross-breeding must be seriously considered in order to avail of hybrid vigour.

Hybrid vigour

Hybrid vigour (heterosis) is defined as the superiority of the crossbred over the average of the two parent breeds for a particular trait. There is widespread, organised use of crossing in both the pig and poultry industries (Simm, 1998). The aim of these programmes is to produce breeding females for commercial herds and flocks which, as well as having high additive genetic merit for reproduction and associated characteristics, show maternal heterosis. Mating these cross-bred females to males of a different breed or strain then maximises individual heterosis (resulting from the animals themselves being cross-bred) in the offspring. In cattle, a summary of the available data shows that the overall advantage expected from using a cross-bred suckler cow as opposed to a purebred in terms of kg of calf weaned per cow put to the bull is about 13% (Table 22). This advantage results from a combination of improved fertility, lower calf mortality and higher calf live weight gain to weaning. In addition, using a sire from a third breed increases the weight of calf weaned per cow put to the bull by approximately a further 8%. Not all crosses result in the same level of hybrid vigour and it is usually greater for crosses between genetically diverse breeds. Therefore, in crossbreeding it is important that the breeds selected are complimentary such as for example in producing a crossbred cow by crossing a breed with good milk production potential (e.g. Simmental) with one of good conformation (e.g. Limousin).

Table 22. Improvements from heterosis in suckler cows.

Cow	Calving rate	Live calves	Weaning weight	Overall calf weaned (kg) per cow to bull
Purebred	100	100	100	100
Crossbred	105	104	104	113

Gregory and Cundiff (1980) estimated the advantage in terms of weight of calf weaned per cow put to the bull of various crossbreeding systems compared to purebreeding . The simplest type of cross is that between two purebreds (a two-way cross) and the resulting progeny are called F1 or first cross animal. When compared to the average of the two purebreds the advantage of this crossing programme is 8% due to hybrid vigour (Table 23). Maximum hybrid vigour of 23% is obtained by crossing this first cross female with a bull from a third breed. The advantages of various other crossbreeding programmes are presented in Table 23. If animals from the F1 or first cross are mated back to one of the parent breeds, this is termed a back-cross and individual heterosis is halved compared to that in the F1 generation. This is also true in all subsequent generations of backcrossing to the same parent breed in that individual heterosis is halved on each occasion. The four main types of suckler cow replacement based on continental breeds that can be considered are:

1. Half and three-quarter bred beef cows
2. Two-or three-breed rotational crossing
3. Composite breeding
4. Pure breeding

The half breds for option 1 are Friesian-Holstein crosses from the dairy herd, while all other replacements are sourced from within the suckler herd. The merits of the different breeding strategies will be discussed and optimum breeding programmes suggested.

Table 23. Fractions of heterosis retained and improvements in different crossing systems.

			Fraction of heterosis relative to that in the F1		Calf weaned (kg)/cow
	Cow	Bull	Individual	Maternal	to bull
Purebred × Purebred	A	A	0	0	100
Purebred cow × sire from 2^{nd} breed	A	B	1	0	108
Half bred cow × sire from one of these 2 breeds	AB	A	½	1	116
Half bred cow × terminal sire	AB	C	1	1	123
Two breed rotation	⅓A ⅔B	A	⅔	⅔	116
Three breed rotation	$^1/_7$A $^2/_7$B $^4/_7$C	A	$^6/_7$	$^6/_7$	120
Four breed composite	ABCD	ABCD	¾	¾	118

A, B, C and D represent 4 breeds Source: Gregory and Cundiff (1980)

Half and three-quarters bred beef cows

One method of ensuring satisfactory milk production is by sourcing some replacements from the dairy Holstein-Friesian herd. However, with emphasis on the production of progeny of good muscularity, it is desirable to minimise the proportion of Friesian-Holstein in the cow. Assuming that the basis of the suckler cow herd is Limousin × Friesian and Simmental × Friesian then crossing the Limousin × with Simmental sires and the Simmental × with Limousin sires results in a cow herd which are ½ and ¾ late-maturing continental breeds. For a 50 cow herd requiring 10 replacements yearly, 3 could be purchased as Limousin or Simmental crosses from the dairy herd. These would be bred throughout life to Limousin or Simmental sires as indicated above to provide the remaining 7 replacements resulting in a herd consisting of 15 cows which are ½ continental breeding and 35 cows which are ¾ continental breeding. Apart from the 10 replacements, which are bred to easy calving sires, the 12 mature ½ continental cross cows are used to provide replacements, and the remaining 28 (56% of total) mature ¾ continental cross cows would be bred to a terminal sire such as the Charolais (Table 24).

Table 24. Breeding programme for a 50-cow herd consisting of half- and three-quarter continental breed crosses.

	Number	Cow breed	Sire breed
Heifer replacements			
From dairy herd	3	L F (or S F)	Easy calving
From suckler herd	7	SLF (or LSF)	Limousin (or Simmental)
Mature cows			
Bred for herd replacements	12	L F (or S F)	S (or L)
Bred for beef (Terminal sire used)	28	S L F or L S F	Charolais
Total	50		

F = Friesian-Holstein; L = Limousin; S = Simmental

As the replacements are all crossbreds containing not more than 50% of any one breed, maternal heterosis would be 100%. Using a terminal sire from a further breed such as the Charolais on the ¾ continental cows would result in maximum individual heterosis. In practice, such a breeding programme would be most readily achieved by having some herds specialised for producing replacements. Thus, herds with Limousin × Friesian cows would use a Simmental bull, while those with Simmental × Friesian cows would use a Limousin sire and in each instance the heifer progeny would be marketed as suitable suckler herd replacements.

Two-or three-breed rotational crossing

Replacements are entirely sourced from within the suckler herd. The Grange studies with purebred Charolais and Limousin cows resulted in progeny of good conformation with high meat yields. However, due to the absence of hybrid vigour, reproductive performance was reduced. Milk yield was also low and as a result pre-weaning calf live weight gain was low. Crossing those two widely used breeds in a two-breed rotation would be a simple breeding programme and would result in improved fertility and some increase in milk production. This process continues until the proportions of genes from the two breeds stabilises in one herd at an average of $^1/_3$ Limousin and $^2/_3$ Charolais or $^2/_3$ Limousin and $^1/_3$ Charolais in successive generations. Potential milk production could be further improved by including Simmental (a higher milk production potential) resulting in a three-breed rotational cross or simply a two-breed rotation using Simmental as one of the breeds. Two- and three-breed rotational crossing maintains about $^{2}/_{3}$, and $^{6}/_{7}$, respectively, of the level of heterosis in the F1 (first cross) generation (Table 23).

Composite breeding

Composite breeding really involves the development of a new breed and requires three generations to develop. A varying number of breeds may be used in the development of a composite but in a typical situation four pure breeds (A B C and D) which are complimentary to each other are used. Breeds A and B are crossed as are breeds C and D. The males from one cross are then bred to the females of the other to produce a composite consisting of ¼ A, ¼ B, ¼ C and ¼ D. Unrelated males and females from the composite generation are inter-bred so that subsequent generations all contain ¼ of each breed. The breeding strategy can then be the same as for purebreds. Again only 40% of the herd need to be bred to composite sires to produce herd replacements with the remainder bred to a terminal sire. As the programme really involves the development of a new breed with crossbred sires required for breeding replacements, it is considered that greater progress is likely from using existing sire breeds where improvements are continuously being made. The proportion of maternal hybrid vigour obtained using a four breed composite is ¾ that seen in the F1 generation.

Pure-breeding

Pure breeding while apparently simple involving only one breed, involves emphasis on both maternal traits (milk production, fertility, calving ease, calf survival and cow longevity) in addition to terminal sire traits such as growth and carcass quality. Because continental breeds have generally been imported for use as terminal sires in Ireland, selection was primarily for growth rates and carcass traits rather than maternal traits. In a pure-breeding scheme, maternal traits would need to be given major consideration necessitating the use of more than one sire. Although not available at present, except in pedigree herds, purebreds could be readily achieved by upgrading within the suckler herd. Thus, while the system produces high quality animals it is not as simple as first apparent and there is obviously no hybrid vigour as in all of the other systems.

Purebred cows have no maternal heterosis but progeny of late maturing beef breeds have excellent carcass traits.

Sire breed comparison

The effect of beef sire breed on performance of progeny from the suckler herd was examined using the male progeny of 10 Charolais, 6 Limousin, 4 Simmental and 2 Belgian Blue sires. The progeny were purchased at weaning and were taken to slaughter as either bulls at 16 months of age or steers at 24 months of age. The total number of progeny were 106 of which, 56, 23, 18 and 9 were from Charolais, Limousin, Simmental and Belgian Blue sires, respectively. Averaged over the bull and steer production systems, dry matter intake was lowest for Limousin but when expressed relative to live weight there were no differences between the progeny of the four sire breeds (Table 25). Although Limousin progeny had the lowest final live weight, their kill-out percentage was greater than Simmental. Kill-out percentage of progeny was greatest for Belgian Blue, lowest for Simmental, while values for the progeny of Charolais and Limousin sires were intermediate. Carcass weight was similar for the progeny of Charolais, Simmental and Belgian Blue sires with Limousin about 20 kg lighter. Carcass produced per day of age followed a similar trend with a figure of 0.65 kg for Charolais, Simmental and Belgian Blue, and 0.61 for Limousin progeny. Progeny of Simmental sires had the lowest carcass conformation score, whereas Belgian Blue had the highest. The percentage meat in the carcass was 69.3% for Simmental progeny compared with 71.5% for Charolais, 72.4% for Limousin and 72.8% for Belgian Blue. The lower meat yield of Simmental progeny was reflected in higher fat and bone proportions. While these differences are in general agreement with the results of other comparisons it must be pointed out that there is considerable variation within all breeds not just for growth and carcass traits but also for incidence of calving difficulty and potential maternal traits such as milk production of their progeny when retained for replacements. Because of the high incidence of difficult calving, Belgian Blue progeny would not be considered as suitable heifer replacements in most circumstances.

Table 25. Performance of the progeny of Charolais (CH), Limousin (LM), Simmental (SM) and Belgian Blue (BB) sires from suckler cows.

	CH	LM	SM	BB
Final live weight (kg)	682	630	697	657
Kill-out (%)	57.3	58.2	56.2	59.4
Carcass weight (kg)	387	367	385	388
Carcass gain/day of age (kg)	0.65	0.61	0.65	0.65
Muscularity score (scale 1 to 15)	9.7	9.5	9.5	10.2
Conformation score (scale 1 to 15)	10.4	10.3	9.7	11.1
Carcass meat %	71.5	72.4	69.3	72.8
Carcass fat %	10.8	10.3	12.4	10.2
Carcass bone %	17.6	17.3	18.1	17.0

Effect of sire EPD for carcass conformation score on performance and carcass traits of their progeny

In selecting terminal sires where the aim is to produce progeny with carcasses of high carcass conformation score and high lean yield, emphasis is placed on muscularity of the sire. Thus, the effect of sire Expected Progeny Difference (EPD) for carcass conformation score as an indicator of muscularity of the sire on live animal and carcass traits of their progeny was examined over 4 years with bulls and 3 years with heifers. The bull and heifer progeny of Charolais sires of high or average EPD for carcass conformation mated to spring-calving, suckler cows were taken to slaughter at 455 and 607 days, respectively. The differences in EPD between the four sires of high and the four sires of average conformation for carcass conformation and fat scores (scale 1 to 15) and carcass weight were 0.49 units, -0.41 units and 5 kg, respectively. Bull progeny of sires of high EPD for conformation had a higher kill-out percentage (58.4 v 57.2 %), better muscularity scores at weaning and at slaughter, and greater scanned eye muscle depth than progeny of sires with average EPD for conformation (Table 26). The actual differences between bull progeny of high and average EPD sires was 1.1 units (expected 0.49) in carcass conformation units and -0.8 (expected -0.41) in carcass fat score (Table 27). The progeny of sires of high EPD for conformation had more meat (75.9 v 74.3%), less fat and less bone in the hind-quarter than progeny of average EPD sires. The heifer progeny were taken to slaughter only in the last three years and the figures for the differences in EPD between the three sires of high and the three of average EPD for conformation were 0.35 units for conformation score, -0.41 units for fat score and 8 kg for carcass weight. There was no difference in carcass conformation score or fat score between the heifer progeny of the high and average EPD sires but progeny of sires of high EPD for conformation had a greater kill-out percentage (55.3 v 54.4%) greater scanned muscle depth, more meat (74.6 v 72.9%) and less fat in the carcasses than the progeny of the average EPD sires. Both bull and heifer progeny of sires of high EPD for conformation had a greater proportion of hind-quarter (which is the most valuable part of the carcass) than progeny of average EPD sires. In conclusion, the results of this study show that use of sires with better EPD for carcass conformation will result in an improvement in kill-out percentage and meat yield of their progeny.

Progeny from sires of better conformation (greater muscularity) have better kill-out percentages and higher meat yields than progeny of sires of poorer conformation

Table 26. Performance of bull and heifer progeny of sires of high or average Expected Progeny Difference (EPD) for carcass conformation score.

	Bull Progeny		Heifer Progeny	
Sire EPD for conformation	High	Average	High	Average
Birth weight (kg)	53.2	52.2	47.6	47.2
Slaughter weight (kg)	598	597	540	541
Carcass weight (kg)	350	344	299	296
Kill-out (%)	58.4	57.2	55.3	54.4
Muscularity scores (scale 1 to 5)				
Weaning	8.1	7.6	7.2	7.0
Slaughter	9.6	8.9	9.7	9.3
Scanned fat depth (mm)	3.4	3.2	3.9	6.2
Scanned muscle depth (mm)	85	80	82	80

Table 27. Carcass traits for bull and heifer progeny of sires differing in Expected Progeny Difference (EPD) for carcass conformation scores.

	Bull Progeny		Heifer Progeny	
Sire EPD for conformation	High	Average	High	Average
Kidney and channel fat (kg)	5.8	6.3	6.2	6.7
Carcass fat score[1]	7.5	8.3	9.0	9.3
Carcass conformation score[2]	10.8	9.7	9.4	9.2
Hind-quarter (% of carcass)	48.6	47.8	50.2	49.6
Hind-quarter composition (%)				
Meat	75.9	74.3	74.6	72.9
Fat	5.8	6.6	7.1	8.4
Bone	18.2	19.0	18.3	18.7
High-value cuts (%)	8.3	7.9	7.7	7.8
Carcass value (c/kg)	336	329	342	340

[1]Scale 1 to 15 (fattest); [2]Scale 1 to 15 (best conformation).

CHAPTER 3.

REPRODUCTIVE PERFORMANCE IN THE GRANGE SPRING-CALVING SUCKLER HERD

Introduction

Good cow fertility is essential for successful suckler beef production. As three-quarters of cows calve in the February to May period re-breeding is mainly at grass from April onwards. To reduce costs of production, cows are generally provided with moderate feeding levels in winter and are in moderate body condition score when turned out to grass at the end of winter. However, it is essential that such a practice does not reduce subsequent reproductive performance. It is therefore important to provide adequate grass supplies following turnout in order to allow recovery of weight and body condition. Previous studies clearly show that the effects of cow body condition at calving on reproductive performance fall into two main categories of animals.

Category 1 relates to spring- calving cows grazing lowland pastures during the breeding season which provides a high plane of nutrition, thus, permitting rapid recovery in live weight and body condition in cows rearing one calf. The influence of body condition score at calving is shown to be relatively unimportant in such a situation. A study carried out on winter/spring calving Charolais and Limousin herds in France (Agabriel *et al.*, 1992) showed that body condition score at the end of winter had no effect on subsequent reproductive performance in cows calving at the start of the grazing season but did have an influence where cows calved about two months prior to grazing. A study in New Zealand showed no effect of restricted grass supplies pre-calving on reproductive performance but a similar level of restriction after calving led to a large reduction in fertility (Nicoll, 1979). Likewise, studies with spring-calving dairy cows in Teagasc, Moorepark showed no effect of body condition score at calving on reproductive performance (Buckley *et al.*, 2003).

Category 2 relates to cows offered at best, moderate feeding levels after calving and where body condition score at calving does affect subsequent reproductive performance. In general, studies in the US (Wiltbank *et al.*, 1962; Selk *et al.*, 1985) where feeding levels of beef suckler cows after calving are generally moderate to low show that body condition score at calving is an important factor influencing reproductive performance. In that situation cows calving in spring would generally graze unimproved pasture where the nutritional level would be substantially lower than that obtained by cows grazing lowland pasture in Ireland. Similarly, cows calving in autumn/early winter in Ireland and bred indoors would also fall into this category. In this instance the feeding level provided post-calving would usually consist of grass silage with possibly up to 2 kg of supplementary concentrates daily, which would result in far lower live weight and body condition score gains than that obtained on grass. Although moderate quality grass silage is adequate for spring-calving cows bred when at pasture, it is necessary to provide high quality silage for animals bred indoors.

Good breeding management is also essential. This involves recording breeding dates when using natural mating as bull fertility problems do arise, which are not confined just to young bulls. With AI, aids to heat detection include frequent observation, steers running with the herd, tail-painting and a vasectomised bull with a chin-ball marking device. Studies in the USA (Custer *et al.*, 1990; Stumpf *et al.*, 1992) have shown that the presence of a bull with the herd reduced the time from calving to first oestrous by 6 to over 16 days. Likewise, Diskin (1997) has shown that calf removal from the cow and twice-daily access for suckling also reduces the period from calving to first oestrous. To provide information on factors influencing fertility the reproductive performance of the spring-calving suckler herd at Teagasc, Grange was examined over the years 1987 to 1999.

Summary and Conclusions

In the present study using data from 978 cows, a pregnancy rate of 93.7% and a calving interval of 367 days shows that reproductive performance was good as these are the two most important indicators of herd fertility. However, calving interval was longer for cows calving earlier in the season than for those calving later. Calving intervals for cows calving before March 6 (early), between March 6 and April 1 (mid-season) and after April 1 (late) were 378, 364 and 353 days, respectively.

There was no effect of cow body condition score at calving on either calving rate or calving interval in the mid-season or late calving cows but increased body condition score did reduce calving interval in the early calvers. These results are consistent with previous studies involving spring-calving cows grazing low land pastures.

Overall, the three most important findings from this study were as follows:

- Calving date was the most important factor affecting calving interval. Early calvers (calving in February/early March) had the longest calving interval and the greatest weight and body condition score losses in winter thus, indicating the need for higher feeding levels after calving if moving to earlier calving resulting in a longer period indoors after calving.

- Although there was no effect of cow age on calving interval, first calvers (calving at two-years of age) despite a higher feeding level from calving to grazing (concentrate supplement in addition to silage) showed only a small increase in live weight or body condition from calving to mid-June, while older animals made more substantial gains. This indicates the need for a higher winter feeding level for first-calvers, particularly after calving.
- Cows calving after April 1 (close to turnout to grass) had a calving interval of 353 days thus, showing the influence of the high plane of nutrition provided at grass and the ability to bring forward the calving date, thus, avoiding the need to cull late calvers at considerable cost to the system.

It must be emphasised that the results obtained are dependent on good recovery of live weight and body condition resulting from the provision of a high plane of nutrition following turnout to pasture combined with good stockmanship and minimal disease. Animals bred indoors such as autumn calving cows and others receiving a lower plane of nutrition after calving must be in better body condition at calving in order to achieve a similar high level of fertility. The results support the breeding programme practised at Grange whereby heifers are bred at the same time as the main herd rather than earlier. This practice, in addition to having a more compact calving season, means that heifers are calving up to 3 weeks older which is desirable with 2-year-old calving. Furthermore, it reduces the post-calving indoor period when weight and body condition losses can be substantial.

Suckler cow reproduction study

A total of 978 spring calving suckler cows were presented for breeding at the research centre between 1987 and 1999. The cows were mainly crossbreds the majority of which were Limousin × Friesian. An easy-calving Limousin bull was used on heifers while cows were bred to Charolais (or Simmental to provide replacements) bulls. Breeding commenced each year in early May with AI generally used initially and a bull introduced towards the end of the breeding season. First calving was at 2 years of age and cows were only retained if they reared a calf in the previous year. The average calving date was March 15 and cows were generally weaned in November. They were offered grass silage plus a mineral/vitamin supplement in winter and spent from April to November at pasture. In addition to silage, first calvers received 1.5 kg (varied from 1 to 2 kg) of concentrates daily from calving until grazing commenced.

Breeding performance

The pregnancy rate was high (93.7%) resulting in a small number of cows that were not pregnant, thereby limiting the amount of information that could be expected on factors affecting pregnancy. The main factor affecting calving interval (averaged 367 days) was calving date but cow age must also be considered as it was shown to be important in other studies where first calvers were not provided with a higher feeding level in winter.

Effect of calving date on calving interval

The calving interval for cows calving before March 6 (early) was 378 days, from March 6 to April 1 (mid-season) was 364 days and after April 1 (late) was 353 days (Table 28). The initial live weight of the cows was 580 kg and the initial body condition score was 2.9 units. The early-calvers lost 77 kg live weight and 0.82 condition score units in winter and gained 98 kg live weight and 0.71 body condition score unit during the following grazing season. At the other extreme the late-calvers lost only 40 kg live weight and 0.68 body condition score unit in winter and gained 82 kg and 0.59 condition score unit at grass. The mid-season group were intermediate.

Table 28. Effect of calving date on calving interval, live weight (580 kg initially) and body condition score (2.9 initially on scale of 0 - 5) changes.

	Calving date		
	Before March 6	March 6 to April 1	After April 1
Calving rate (%)	94.8	93.8	91.5
Calving interval (days)	378	364	353
Live weight change (kg)			
Winter	-77	-59	-40
Start to calving	-36	-33	-27
At grass	98	88	82
Yearly	22	29	39
Body condition score changes			
Winter	-0.82	-0.74	-0.68
Start to calving	-0.51	-0.56	-0.59
At grass	0.71	0.64	0.59
Yearly	-0.12	-0.10	-0.08

The results show the very good cow performance obtained at pasture resulting in a build-up of body reserves. When provided with a moderate feeding level in winter there were substantial live weight and body condition score losses. This was particularly evident with the early-calvers indicating the higher energy requirements in lactation than in pregnancy. In fact both the live weight and body condition score losses from housing to calving were the same for all 3 groups despite the longer period for those calving after April 1 compared to the early calvers. This emphasises again the sizeable increase in energy requirements after calving. The fact that calving date was almost 2 weeks earlier the following year for cows calving after April 1 shows the influence of the high plane of nutrition provided by adequate supplies of high quality grass on reproductive performance.

Effect of cow lactation number on calving interval

There was no effect of cow lactation number on calving interval. However, first-calvers despite receiving a higher feeding level from calving until the grazing season started (and generally receiving higher quality silage in winter) showed only a small improvement in live weight and body condition score from calving to mid-June, while mature cows gained 22 kg live weight and 0.40 body condition score units in this period (Table 29). The important contribution of the grazing period is indicated by the fact that the mature cows lost about 30 kg live weight from calving to turnout but gained 52 kg from turnout to mid-June (about 2 months). In contrast, first-calvers lost 24 kg live weight from calving to turnout but gained only 31 kg from turnout to mid-June. Although first-calvers gained live weight (still growing) over the year they actually lost 0.78 condition score units. In autumn, at 20 months of age in-calf heifers were 523 kg and had a body condition score of 3.3.

Table 29. Effect of lactation number on calving interval, live weight, body condition score (scale 0 – 5) and changes.

	Lactation number			
	1	2	3 to 7	>7
Pregnant (%)	93	94	94	92
Calving interval (days)	370	366	365	369
Live weight (kg) at housing	523	549	614	623
Live weight change (kg)				
Winter	-61	-52	-65	-67
Calving to turnout	-24	-26	-30	-34
Turnout to June	31	50	57	49
Calving to June	7	24	27	15
At grass	81	99	94	75
Yearly	20	52	27	1
Body condition score				
Initially - housing	3.3	2.6	2.9	3.0
Body condition score change				
Calving to turnout	-0.23	-0.21	-0.20	-0.21
Turnout to June	0.32	0.83	0.72	0.57
Calving to June	0.07	0.30	0.46	0.44
At grass	0.35	0.87	0.77	0.61
Yearly	-0.78	0.09	0.07	-0.10

Animals one year older (having reared their first calf) were 549 kg and had a body condition score of only 2.6. Cows in lactations 3 to 7 were 614 kg live weight and had a condition score of 2.9. This again shows that the critical period is between 20 and 32 months of age indicating the need for a higher feeding level for first calvers particularly after calving. Animals calving at 2 years of age need preferential treatment because their intake capacity is about 20 percent lower than that of mature cows resulting in a lower recovery following turnout to grass in spring.

It must be emphasised that the results obtained are dependent on good recovery of live weight and body condition resulting from the provision of a high plane of nutrition following turnout to pasture combined with good stockmanship and minimal disease. Animals bred indoors such as autumn calving cows and others receiving a lower plane of nutrition after calving must be in better body condition at calving in order to achieve a similar high level of fertility. The results support the breeding programme practised at Grange whereby heifers are bred at the same time as the main herd rather than earlier. This practice, in addition to having a more compact calving season, means that heifers are calving up to 3 weeks older which is desirable with 2-year-old calving. Furthermore, it reduces the post-calving indoor period when weight and body condition losses can be substantial.

CHAPTER 4.

GRASS-BASED PRODUCTION SYSTEMS

Introduction

The suckler herd in Ireland is predominantly spring-calving with 42% of calvings in March/April, 65% in the four month period February to May and 87% in the first six months of the year (DAFF, 2007). Using spring-calving suckler herds established at Grange a series of studies were carried out to 1) outline production targets for a planned semi-intensive calf-to-beef system of suckler beef production, 2) compare the semi-intensive production system with a lower input system, 3) examine the effect of method of grazing management on animal performance, 4) determine the effect of turnout date to pasture in spring on output from the systems, and 5) examine the effect of increasing the rate of gain of steers and heifers during the first winter by altering the concentrate feeding level on live weight gain in winter and subsequently at pasture.

Summary and Conclusions

Spring-calving cows were used in the development and evaluation of grass-based systems of suckler beef production. The results of these studies were as follows:

1. In the first study, spring-calving Limousin × Friesian cows were used to outline production targets for a semi-intensive system of production. Breeding commenced in early May and Charolais (or Simmental) sires were used on mature cows. Replacement heifers were bred to calve at two years of age using an easy-calving (AI) Limousin bull. Heifers were slaughtered at 20 months of age in November having spent the final 2 to 2.5 months indoors on a silage/concentrate diet. Steers were slaughtered at 23/24 months of age in March. In the semi-intensive system the actual stocking rate was 0.83 ha per cow unit (cow plus progeny to slaughter plus replacements) and the actual nitrogenous fertiliser application rate was 201 kg per ha. Two grass harvests for silage (late May for progeny and late July for cows) were taken each year. A brief summary of the results show that

- Carcass weights of steers were 396 kg with a total concentrate intake of 725 kg per head. The corresponding figures for heifers were 309 kg carcass weight and 329 kg of concentrates.
- Carcass conformation scores were U's and R's with 60% of steers and 43% of heifers in class U.

- The annual feed budget consisted of approximately 61% grazed grass, 31% grass silage and 8% supplementary concentrates. Corresponding figures for a calf to weanling system are 73, 26 and 1%.

2. In the second study the semi-intensive (standard) system was compared with an extensive system. In both systems, steers slaughtered at 2-years of age were used for the first 2 years, while subsequently, the males were finished as young bulls at 15 months of age. In all years heifers were finished at 20 months of age. The two systems were 1) semi-intensive with a stocking rate of 0.65 (bull production) or 0.80 (steer production) ha per cow unit, 211 kg of fertilizer nitrogen per ha and two silage harvests and 2) extensive with a stocking rate of 0.82 (bull production) or 0.99 (steer production) ha per cow unit, 97 kg fertilizer nitrogen per ha. and one staggered silage harvest. A cow unit was again a cow plus progeny to slaughter plus replacements (25%). Central to the performance of the systems is maximizing the proportion of grass in the diet.

The results showed that similar individual animal performance levels can be expected in an extensive grassland-based suckler calf-to-beef system as that attained in a more intensive system using both a moderately high stocking rate (about 1.25 times higher) and fertiliser nitrogen application (about 2.1 times higher).

3. An examination of the effect of using a leader/follower system of grazing management using cows and calves in autumn showed that the extra live weight gained by the leaders was lower than that lost by the followers. It was apparent from this study that such a grazing procedure has greatest application where either pasture supply or quality is limiting and where animals used as followers have low requirements (e.g. dry cows) or the leaders only consume a small proportion of the total available grass supply (e.g. suckled calves). For leader/follower grazing to be useful in suckling systems, it is imperative that neither fertility of the cow nor the recovery of her body reserves is compromised.

4. Creep grazing calves ahead of cows showed no overall effect on either cow or calf performance, indicating that when grass supplies are high and of good quality with associated high calf performance there is no advantage from creep grazing.

5. In grass-based beef production systems, a high proportion of total weight gain is achieved at pasture and this pasture gain has a major influence on economic returns. Extending the grazing season by letting the animals to pasture early is one method of obtaining higher weight gains at pasture. Work at Grange with progeny of the suckler herd showed that extending the grazing season by 3 weeks in spring by grazing the silage area resulted in increased live weight gain per animal of 20 kg at pasture but the overall increase in carcass weight gain was only 5 kg. Grazing the silage area reduced silage yields but on the other hand the benefits of a shorter winter include less winter feed requirements and lower quantities of slurry for storage and spreading. The extent to which the season can be extended depends on soil type and location with greater scope on free draining soils in lower rainfall areas. Overall, the critical factor with growing/finishing animals is to ensure high weight gains during the period the animals are at pasture and the avoidance of pasture damage, which can influence subsequent grass growth.

6. Due to subsequent compensatory growth moderate live weight gains of 0.5 to 0.6 kg per day during the first winter period is generally adequate for spring-born steers/heifers that attained good pre-weaning gains and will be provided with adequate supplies of pasture subsequently. As a general guideline this can be achieved by feeding 1 to 2 kg of concentrates per animal daily with moderate to high digestibility grass silage.

Spring-born continental cross suckled bulls can be finished at 15 months of age on either high concentrate diets or high digestibility grass silage (74% DMD) plus 5kg of concentrates daily

Semi-intensive production system

In the first study, a semi-intensive (standard) grass-based single-suckling system was operated at Grange over a 7 year period. The system involved spring calving (February/April) Limousin × Friesian cows. The heifer progeny were taken to slaughter at 20 months of age in autumn while the steers were slaughtered at 23/24 months of age in spring. Replacement heifers (22 to 25% of the cow herd) were purchased yearly as calves and bred to calve at two years of age. Breeding commenced in early May each year and a Charolais (or Simmental) bull was used on mature cows. Artificial insemination (AI) was used in the early part of the breeding season with sires selected for high growth rate while a bull ran with the herd subsequently. An easy-calving Limousin AI bull was used on heifers.

Cattle grazing commenced each year in April. The total planned grassland area per cow unit (cow plus progeny to slaughter plus replacements) was 0.84 ha but higher rates were applied in later years resulting in an average of 0.83 ha per cow unit (Table 30). Two silage harvests were taken yearly, the first in late May and the second in late July. The objective was to provide high digestibility silage for the progeny and thus, grass was conserved at a leafy stage of growth in May and an effective additive used when necessary to ensure good preservation. The second silage harvest was taken in July/early August, and as this was intended for the cows, the same emphasis on digestibility was not necessary. To provide adequate grass silage for the cattle herd, it was planned to cut 0.45 and 0.28 ha per cow unit on the first and second occasions, respectively. However, due to inclement weather






Central to the Grange Systems is high live weight gain at pasture, which is achieved through supplying an adequate allowance of high digestibility, leafy grass throughout the grazing season.

conditions the commencement of grazing was delayed in some years resulting in higher than planned stocking rates initially and a greater acreage ensiled for the first harvest resulting in excess silage in some years. Thus, while a planned production system is essential, such flexibility in management is necessary to allow for variations in weather conditions. First silage harvests were taken between May 17 and May 27 and silage dry matter digestibility (DMD) values averaged 73.6% (Table 31). Second silage harvests taken in late July/early August resulted in DMD values of 65.9%. The entire area was grazed from August until the end of the grazing season and animals were housed as grass supplies declined.

Table 30. Planned and actual grass conservation and grazing areas (ha) per cow unit*.

	Silage		Grazing		
	First harvest	Second harvest	April to June	June to August	August to November (total area)
Planned	0.45	0.28	0.39	0.56	0.84
Actual	0.51	0.32	0.31	0.51	0.83

*Cow and progeny to slaughter plus replacements

Table 31. Mean silage cutting dates and dry matter digestibility (DMD) values.

	First harvest		Second harvest	
	Cutting date	DMD (%)	Cutting date	DMD (%)
Mean	May 23	73.6	July 29	65.9

Housing usually occurred in early September for finishing heifers, late September/mid October for finishing steers, mid-November for the cow herd and weanlings, and late November for replacements.

The planned nitrogen fertiliser programme and the actual quantity applied is shown in Table 32. The nitrogen fertiliser programme for silage and early grass was as planned but top dressings over the grazing area depended on grass supplies (if adequate grass was available then a particular top dressing was omitted). Urea was generally used as the nitrogen source except in dry weather conditions where calcium ammonium nitrate was applied. The average nitrogen application rate was 201 kg/ha per year varying from 182 to 222 kg/ha yearly. Phosphorus and potassium application rates were based on soil analyses. Slurry produced by the herd in winter was returned to the silage ground.

Table 32. Planned nitrogen fertiliser programme and annual application rate (kg/ha).

For first silage harvest	114
For second silage harvest	80
Early grass/after silage/after 1st grazing	57
Further top dressing (if needed)	34
Planned total application	225
Actual total application (average over 7 years)	201

The planned mean concentrate feeding levels per head daily in winter was 1 kg for weanlings, 3 to 4 kg for finishing heifers and 4 to 5 kg for finishing steers (Table 33). Lower levels were fed initially and the daily quantity was increased gradually during an introductory period. Mean concentrate feeding levels over the years were generally as planned. Concentrate inputs to replacement heifers (calf stage, first grazing season and first winter), cull cows, suckled calves (indoors as calves and prior to weaning in autumn) and first calvers post-calving (1.5 kg per day) represented a relatively small proportion of the total. Total concentrates fed per cow unit averaged 629 kg.

Table 33. Concentrate feeding programme (kg) per animal, per cow unit and per ha.

	Weanlings	Finishing heifers	Finishing steers	*Per cow unit	Per ha
Planned supplementation level (kg per day)	1	3	4		
Total	150	180	600		
Actual (averaged over 6 years)	152	177	573	629	761

*Assumes equal number of steers and heifers slaughtered yearly

The mean date of birth of the calves was March 16 (Table 34). Averaged over years, steer live weights were 46.6, 316, 404 and 700 kg at birth, 8 months, 13 months and at slaughter, respectively. Corresponding heifer live weights were 41.8, 288, 373 and 565 kg. Carcass weight of steers (at 725 days of age) and heifers (at 606 days of age) were 396 and 309 kg, respectively.

Table 34. Steer and heifer live weights (kg), kill-out rates (%) and slaughter ages (days).

	Steers	Heifers
Date of birth in March	16	16
Birth weight	46.6	41.8
Weaning weight (November)	316	288
Yearling weight (April)	404	373
$1^1/_2$ year old weight (October or September)	585	508
Slaughter weight (March or November)	700	565
Carcass weight	396.0	309.2
Kill-out rate	56.6	54.8
Age at slaughter	725	606

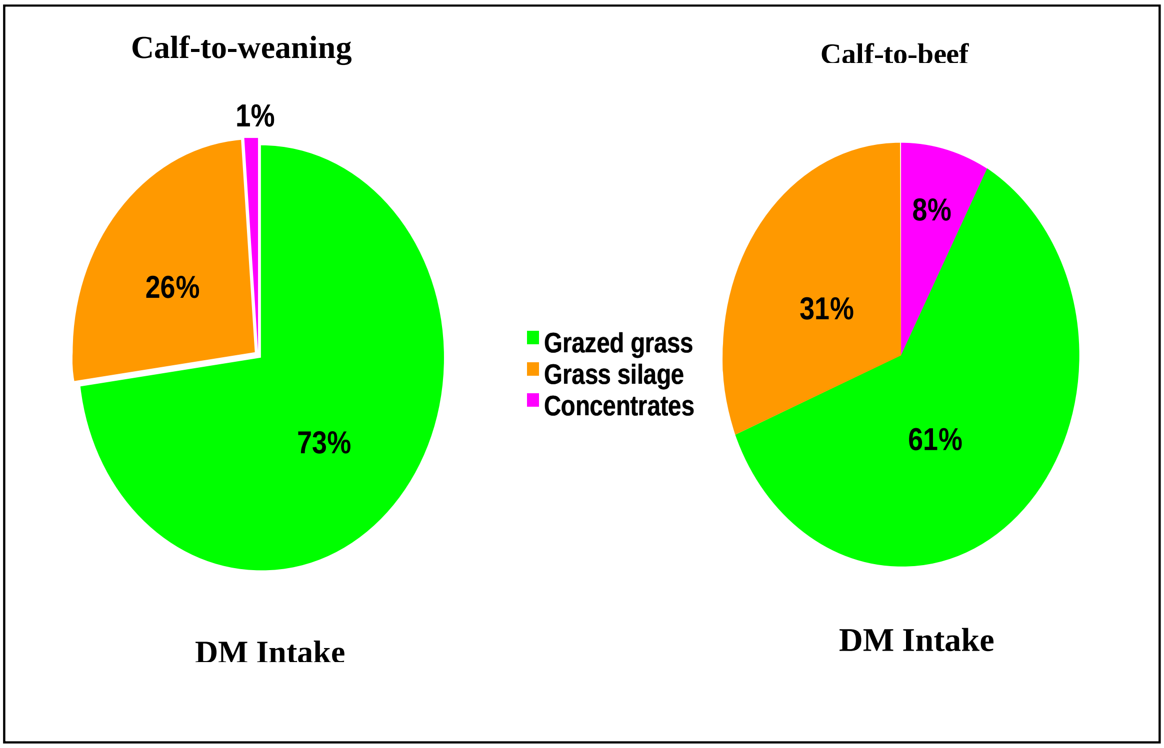
Inclusion of carcass weights of cull cows with those for steers and heifers gives total carcass output of 414 kg per cow unit and 508 kg per ha. Averaged for all steer progeny of Limousin × Friesian cows 60, 39 and 1% had carcass conformation scores of U, R and O, respectively (Table 35). Corresponding conformation scores for heifers were 43% U and 57% R. Carcass fat scores were predominantly 4L and 4H which accounted for 79% of both steer and heifer carcasses. Kidney plus channel fat weights averaged 13.5 and 9.6 kg for steers and heifers, respectively.

Table 35. Carcass classification scores and kidney plus channel fat weights of steer and heifer progeny of Limousin × Friesian cows and late-maturing continental breed sires.

	Steers	Heifers
No. of animals	125	111
Conformation score %		
U	60	43
R	39	57
O	1	-
Fat score %		
3	9	15
4L	42	47
4H	37	32
5	12	6
Kidney + channel fat (kg)	13.5	9.6

Central to the performance of the systems is maximizing the proportion of grazed grass in the diet. Annual feed budgets for the calf-to-beef systems are 61% grass, 31% grass silage and 8% concentrates (Figure 1). A large number of producers are involved in spring-calving calf-to-weaning systems, with only the cow herd retained over the winter period. Corresponding values for a calf-to-weanling system are 73, 26 and 1%.

Figure 1. Annual feed budgets for calf-to-weaning and calf-to-beef systems



High cow and calf live weight gains are obtained by providing adequate supplies of high quality pasture

Semi-intensive and Extensive suckler production systems

In a second study the semi-intensive (standard) system was compared with a more extensive system over an 8-year period. The cows were again spring-calving and consisted of Limousin × Holstein-Friesian (LF) and Simmental × (Limousin × Holstein-Friesian) (SLF) for the first four years. The herd was then replaced by first calving animals which, in addition to LF and SLF, included Limousin × (Limousin × Holstein-Friesian), purebred Limousin and purebred Charolais. Mature cows were mated to Charolais sires and replacement heifers were bred to calve at 2 years of age using a Limousin sire. Heifer progeny were again slaughtered at 20 months of age in November. For the first two years the male progeny were slaughtered as steers at about 24 months of age in March, while in subsequent years they were slaughtered as bulls at about 15 months of age.

The two systems compared were 1) semi-intensive with a stocking rate of 0.65 (bull production) or 0.80 (steer production) ha per cow unit, 211 kg of fertiliser nitrogen per ha and two silage harvests and 2) extensive with a stocking rate of 0.82 (bull production) or 0.99 (steer production) ha per cow unit, 97 kg fertiliser nitrogen per kg and one staggered silage harvest. A cow unit was defined on a cow plus progeny to slaughter plus replacements. The stocking rate of the intensive system was 25% higher than the extensive system. The extensive system was designed to be compatible with REPS 3 where maximum permissible levels of organic and total nitrogen were 170 and 260 kg/ha, respectively. Under the REPS 4 scheme operated in Ireland from 2008, the intensive system also qualifies, provided participants farming above 170 kg organic nitrogen per ha have a derogation from the Nitrates Directive. The planned grassland management programme for the two systems is outlined in Table 36.

Table 36. Grass conservation and grazing area (ha per cow unit) for the semi-intensive and extensive systems of suckler beef production.

System	Silage			Grazing		
	First harvest		Second harvest	April to June	June to August	August to November
Semi-intensive						
Steers	0.44		0.28	0.36	0.52	0.80
Bulls	0.37		0.23	0.28	0.42	0.65
Extensive	Early	Late				
Steers	0.28	0.28	-	0.43	0.99	0.99
Bulls	0.24	0.24	-	0.34	0.82	0.82

In the semi-intensive bull and steer production systems approximately 56% of the total area was harvested for silage in late May and a second harvest was taken from 35% of the total area in late July/early August. In the extensive bull and steer production systems where the grassland allowance/cow unit was 25% greater than in the semi-intensive system, all of the silage was taken in one harvest. Thus, 59% of the total area was used for silage, half of which was harvested as high quality material for the progeny in late May with the remainder harvested about 14 days later resulting in lower digestibility silage, which would be adequate for the cows.

Herbage availability and dry matter digestibility was similar for the two systems, whereas herbage crude protein content was lower for the extensive than the semi-intensive system (Table 37). Post-grazing sward height varied during the grazing season with lower values recorded early in the season when close grazing was practiced and higher values later in the season. Average values for post-grazing height were greater than generally recommended as on a number of occasions animals were moved to the next paddock early in order to avoid poaching due to poor ground conditions. As no second silage harvest was taken in the extensive system, herbage supply in the July period frequently exceeded requirements, which necessitated taking out some paddocks from the rotation in this period and conservation as baled silage. In this system it was possible to have a greater supply of grass built up into the autumn period than in the semi-intensive system. The lower crude protein content of the grass in the extensive system was expected due to the lower level of fertiliser nitrogen application in that system. Performance of the cows was similar in both systems (Table 38). Live weight of 588 kg for the cows in autumn was lower than would be expected in a more mature herd. Likewise, annual cow live weight gains of 40 kg was high and again reflected the fact that the average cow age was low with a relatively small proportion of mature cows. Likewise, there was no difference in calf performance between the two systems (Table 39).

It can be concluded that similar individual animal performance levels can be expected in an Extensive grassland-based calf-to-beef system as that attained in a more Intensive system involving both a moderately higher stocking rate (25% higher), over twice the fertiliser nitrogen application and 2 as opposed to 1 (staggered) silage harvest.

Table 37. Herbage availability, dry matter digestibility (DMD) and crude protein content for the semi-intensive and extensive grassland management systems.

	Semi-intensive system	Extensive system
Sward height (cm)		
Pre-grazing	11.9	11.8
Post-grazing	6.0	6.3
Herbage mass (kg DM/ha)		
Pre-grazing	2174	2455
Post-grazing	715	779
Herbage DMD (%)		
Pre-grazing	75.6	75.6
Post-grazing	65.7	64.8
Crude protein (%)		
Pre-grazing	20.9	17.6
Post-grazing	17.6	14.7

Table 38. Cow live weight, body condition score and their changes for the semi-intensive and extensive grassland management systems.

	Grassland Management System	
	Intensive	Extensive
Live weight (kg)		
Housing	588	587
Live weight change (kg)		
Winter	-44	-42
Grazing season	82	82
Annual	37	41
Body condition score (units)		
Housing	2.7	2.7
Body condition score change (units)		
Winter	-0.31	-0.32
Grazing season	0.22	0.16
Annual	-0.11	-0.16

Table 39. Relative growth, slaughter and carcass traits of all progeny from the semi-intensive and extensive grassland systems.

	Grassland Management System	
	Intensive	Extensive
First grazing season	100	99
Second grazing season	100	99
Finishing winter	100	101
Birth to slaughter	100	100
Carcass gain per day of age	100	101

Leader-Follower grazing management

The objective of this study using spring-calving suckler cows and calves was to examine the effects on performance in autumn of grazing as leaders, followers or independently as controls in a rotational grazing system. From September 12 to November 10, forty-four spring-calving cows and their calves were grazed either independently as controls (n=22), as leaders (n=11) or as followers (n=11). Paddocks were divided into equal sections and assigned to either the control or leader-follower treatments. Followers had less herbage available and it was of lower quality than leaders or controls (Table 40). This resulted in greater cow live weight and body condition score losses, lower milk yields and lower calf live weight gains. The combined cow and calf live weight gain advantage of leaders over controls in the autumn period was 5 kg, while the advantage of controls over followers was 35 kg. Corresponding values over the combined autumn and winter periods were 8 and 19 kg, respectively. This shows that, the live weight loss of the followers compared to the controls was greater than the live weight gain of leaders over the controls. Thus, where grass supplies and quality are not limiting the gain from additional herbage or an improvement in quality is relatively small. Leader-follower grazing systems have greatest application where either pasture supply and(or) quality is limiting and where animals used as followers have low requirements (e.g. dry cows) or the leaders only consume a small proportion of the total available grass supply (e.g. suckled calves). For leader-follower grazing to be useful in suckling systems, it is imperative that neither cow fertility nor the recovery of cow body reserves are compromised.

Table 40. Herbage availability and quality and animal performance in different grazing management systems.

	Grazing management group		
	Controls	Leaders	Followers
Pre-grazing			
Sward height	12.2	11.0	6.8
Herbage DM yield (kg/ha)	1554	1485	904
Herbage DMD (%)	76.0	75.9	69.0
Post-grazing			
Sward height	5.6	6.8	5.4
Herbage DM yield (kg/ha)	510	904	469
Herbage DMD (%)	63.2	69.0	62.1
Cow weight changes (kg)			
Autumn	-2	-4	-24
Autumn and winter	25	32	11
Cow body condition score change (scale 0 to 5) autumn	0	0.1	-0.4
Calf weight gain (kg)			
Autumn	57	65	44
Autumn and winter	109	110	104

Creep grazing of calves ahead of cows.

To further improve the performance of suckled calves during their first grazing season, without incurring any costs, a system of creep grazing was examined, to determine its effects on pre-weaning performance of suckled calves and their dams. With declining grass supplies and cow milk yields towards the end of the season, creep grazing the calves ahead of the cows gives them an opportunity to consume the taller, more leafy, portion of the grass sward. This would be expected to improve calf intakes and therefore, maintain calf performance up to the end of the grazing season.

The cows were divided into two equal groups, one of which was (1) conventionally grazed, i.e. the calves grazed with the cows while (2) creep grazing was made available to the calves of the other group. The creep grazed calves were given access to the paddock due to be grazed next by the cows. Movement of the cows to their next paddock took place at the same time for the two treatment groups. Creep grazing was made available to the calves from mid-July until weaning on October 20th.

There was no effect of grazing management on the overall live weight gained by the cows during the grazing season (Table 41). However, the cows on the creep grazing treatment gained less weight than the cows on the conventional grazing management treatment, during the latter part of the grazing season. There was no significant difference in the body condition score of the cows at the end of the season between the two grazing management treatments. Grazing management had no effect on the overall live weight gained by the calves over the grazing season. There was no effect of grazing management on the pre-grazing or post-grazing sward heights.

In conclusion, creep grazing showed no overall effect on either cow or calf performance, indicating that when grass supplies are high and of good quality with associated high calf performance there is no performance advantage from creep grazing.

Table 41. Cow and calf live weight gains (kg) and pre- and post-grazing sward heights (cm) for conventional and creep grazing management.

	Grazing management	
	Conventional	Creep
Cow live weight gain		
Turnout to June	51	52
June to post-housing	40	26
Turnout to post-housing	91	78
Calf live weight gain		
Turnout to July	110	113
July to post-housing	122	125
Turnout to post-housing	233	238
Grass height		
Pre-grazing July/August	11.5	11.6
Pre-grazing September/October	11.7	11.0
Post-grazing July/August	5.5	6.0
Post-grazing September/October	5.5	5.7

Turnout date to pasture in spring

As the aim is to obtain high animal performance at least cost, maximum use of grazed grass in the diet is an important consideration. However, that must be achieved without poaching which can affect future grass production. Thus, the duration of the grazing season will be influenced both by geographical location and soil type. In addition, the scope to remove animals off pasture during short periods of high rainfall when most pasture damage arises is important. This can be readily achieved where the grazed areas are in close proximity to suitable accommodation, which is not always the situation on beef farms. In grass-based beef production systems a high proportion of total live weight gain is achieved at pasture and this pasture gain has a major influence on economic returns.

Extending the grazing season by letting the animals out to pasture earlier is one method of obtaining higher live weight gains at pasture. However, at high stocking rates this can only be attained by grazing all or some of the silage area. In three studies, 50% of the yearling steers and heifers were let to pasture on March 21 (early turnout) and grazed half of their allocated silage area during the subsequent 21 days. The remaining 50% of animals (late turnout) remained indoors during this 21 day period and were offered silage only (1 year) or with 1 kg of concentrates per head daily (2 years). From April 11 the early- and late-turnout animals were treated similarly until slaughter both at pasture and during a finishing period on grass silage/concentrate diets. During the summer period the animals turned out early gained 20 kg more live weight than the late turnout group due to spending 21 days longer at pasture (Table 42).

Table 42. Effect of turnout date to pasture on live weight and carcass traits of steers and heifers.

	Turnout date to pasture	
	March 21 (Early)	April 11 (Late)
Live weight (kg)		
Initial: Nov 18	311	313
At turnout	375	385
Autumn	550	539
Slaughter	616	606
Live weight gain (kg)		
First winter	64	72
At pasture	175	155
Live weight gain (g/day)		
First winter	513	495
At pasture	883	873
Carcass weight (kg)	340	335
Kill-out rate (%)	54.9	55.1

There was no difference between the two groups in daily live weight gain during this period. Average slaughter date was November 11 (about 20 months of age) for heifers and March 7 of the following year (almost 2 years of age) for steers. Average carcass weights (kg) of the early and late turnout groups were 340 and 335 kg, respectively, resulting in a difference of 5 kg in favour of the early turnout group.

In two of the years, grass yields following early-grazing in spring were measured at silage harvesting as either early or late-cuts (Table 43).

Table 43. Grass yields (kg DM/ha), DMD (%) and crude protein (% DM) of grazed and ungrazed pastures harvested early or late.

Grazing	Grazed	Ungrazed	Grazed	Ungrazed
Cutting date	Early	Early	Late	Late
Exit yield	703	1593	734	1561
Silage yield[1]	4059	5713	6103	6708
Grass growth[2]	3356	4120	5369	5137
Herbage DMD	80.0	78.1	71.3	69.0
Herbage crude protein	17.7	16.7	12.5	12.9

[1]Grass yield at silage harvesting; [2]Represents grass growth (from yield differential) between date of closure of plot for conservation and harvesting

Grazing the intended silage area significantly reduced grass yields in early (May 19) harvested silage plots (4059 v 5713 kg DM/ha) but had no significant effect (6103 v 6708 kg DM/ha) when harvested later (June 6). Delaying the harvesting date significantly reduced the DMD of herbage but there was no effect of grazing on herbage DMD value.

Thus, although animals turned out to pasture early gained more live weight in summer than those turned-out late, overall extra carcass weight averaged only 5 kg. Where grass was harvested early for silage, grazing the silage area resulted in a 29% reduction in herbage yield, whereas when harvesting was delayed the reduction in herbage yield as a result of grazing in spring was only 9%. The yield increase of the ungrazed area between the two harvest dates was only 1027 kg/ha compared to 2013 kg/ha on the previously grazed area. This was due to lodging of the already heavy grass crops on the ungrazed area.

Compensatory growth and winter supplementary feeding level.

Winter feed costs are considerably greater than the cost of grazed grass. Thus, decreasing inputs when cattle are housed should decrease production costs leading to improved profits, provided the saving in costs is not offset by reduced animal performance.

Due to compensatory growth, animals which gain less weight than their counterparts in winter will gain more weight during the following grazing season. However, there is never complete recovery at pasture by animals restricted in winter and the extent of recovery varies and is greater for animals that are older and heavier. Thus, the degree of restriction and the extent of recovery will vary and for 8/9 month old steers and heifers of three-quarter or more late-maturing breeds that are still growing, a live weight gain of 0.5

kg per day in winter is needed in order to maintain these animals in reasonable body condition. In three experiments, suckled weanlings were offered either low or high levels of supplementary concentrates with high quality silage in winter in order to obtain different rates of live weight gain. The low concentrate level was 0.50 to 0.75 kg per head daily, while the high level was 1.5 to 2.0 kg/day. Total concentrate intakes in winter were 97 and 206 kg per animal for the low and high groups, respectively. The low and high animals were subsequently grazed together at pasture. The initial weights of the weanlings at housing was 303 kg and live weight gains of the low and high groups in winter was 85 and 102 kg, respectively (Table 44).

Corresponding weight gains at pasture were 186 and 175 kg. Thus, the difference of 17 kg in favour of the high group at the end of winter was reduced to 6 kg at the end of the following grazing season. Therefore, moderate live weight gains of approximately 0.5 to 0.6 kg per day during the indoor winter period is generally adequate for spring-born weanlings that attained good pre-weaning gains and will be provided with adequate supplies of high quality pasture during the subsequent grazing season.

Table 44. Effect of concentrate feeding level with high digestibility grass silage during the first winter on performance of suckled weanlings (steers and heifers).

	Concentrate feeding level	
	Low	High
Concentrates (kg)	97	206
Live weight (kg) at start	302	303
Live weight gain (kg)		
Winter	85	102
Summer	186	175
Total	271	277

As a general guideline suitable rates of gain can be achieved by feeding 1 to 2 kg of concentrates per animal daily where the silage digestibility is moderate to good. Animals that would benefit from higher concentrate feeding levels during the winter include those of high growth potential that had low pre-weaning gains. Additionally, higher levels of concentrate feeding are needed where the quality of the roughage available is poor.

Animal health

A critical factor in having a successful suckling system is good animal health. This involves attention to detail at all times as disease problems are not just confined to one animal type at one time of the year. With regard to all diseases and metabolic disorders the approach should be to adopt control measures which prevent disease rather than having to treat animals following an outbreak, which is more costly both in terms of veterinary treatment, reduced animal growth and possible animal death. In addition, the time spent in controlling disease outbreaks is considerable and interferes with other work programmes. A brief outline of the control measures and treatments practised in the Grange research herd are outlined. The aspects of herd health are dealt with from a husbandry viewpoint. A veterinary practitioner should always be consulted with regard to specific health problems.

Calf scours:

Control measures include

- Vaccination of cows for control of E.coli, rotavirus and coronavirus (and any other organism(s) known to be responsible for infection on the farm) in calves.
- Ensuring that each calf receives adequate colostrum (2 to 2.5 litres) immediately post-partum.
- Providing a clean, disease-free environment. This involves thorough cleaning and disinfection before and during the calving season of all areas used by calves.
- Providing a straw-bedded lying area with no draughts and good ventilation.
- Accommodating cows and calves in batches based on order of calving, by calving and retaining early-born calves in one area and moving to a different area for the next batch. Thus, young calves are never mixed with or accommodated in areas used by older calves.
- Avoiding introduction of disease from sources such as purchased calves (and cows). Isolate all purchased animals from young home-bred calves.
- Feeding a suitable mineral supplement pre-calving.

Joint-ill: Navels of all calves are disinfected using tincture of iodine immediately after birth.

Grass tetany (hypomagnesaemia): Mainly a problem in lactating cows in spring (and possibly in autumn and at weaning) and is prevented by providing magnesium. Control at Grange was achieved by dusting pasture with calcined magnesite. Other control measures include magnesium compounds in piped drinking water, a 50:50 mixture of calcined magnesite and molasses in containers and purchased magnesium licks in buckets. Magnesium bullets are not a reliable protection against tetany.

Trace element deficiency: A suitable mineral/vitamin mixture was provided for the cows in winter, which is the cheapest method of providing trace elements (copper and iodine are the most likely deficiencies at Grange).

Black leg: It is recommended that annual vaccination of all cattle under two years should be carried out at least two weeks before turnout to grass in spring.

Parasites: At Grange calves are generally treated twice during the grazing for the control of stomach and lung worms. At housing, they are always treated with an anthelmintic effective against Ostertagia Type II. Occasionally, animals are also treated during their second grazing season for the control of stomach worms and lung worms. Where fluke is a problem all animals should be treated after housing the timing dependent on the actual product. Treatment for the control of lice is given in winter, the exact detail depending on the control procedure adopted.

Respiratory disease: Bovine respiratory disease is an important cause of ill-health in calves and particularly in suckled animals following weaning. In general, problems are greatest where animals from different sources are mixed following weaning. Agents such as Pasturella, Respiratory Syncytial Virus (RSV), Infectious Bovine Rhinotracheitis (IBR) and Para-Influenza 3 (PI3) are responsible. Effective vaccination programmes are available and should be used where problems are likely to arise. Reducing stress at weaning is beneficial and procedures which are helpful include creep meal feeding, creep grazing, batch weaning (by removing cows at 5 (or more) day intervals, while leaving the weaned calves with the main herd), and avoiding practices such as castration shortly before or following weaning.

Leptospirosis and Bovine Viral Diarrhoea (BVD): In Grange, vaccination programmes are used for the control of both Leptospirosis and BVD.

Mastitis in cows: No control measures are used for spring-calving cows weaned in autumn but cows should be examined, particularly during the drying off period. With autumn-calving cows weaned in July, it is advisable to treat each quarter with a long-acting antibiotic preparation.

Johne's and BVD: Johne's and BVD are increasingly becoming major problems and where herds are free, the main source of infection is purchased animals. Both diseases can result in major economic losses and every attempt should be made to keep herds free of these diseases. Information on Johne's disease can be obtained in a booklet produced by the Department of Agriculture, Fisheries and Food.

Labour Use

An increasing problem on many suckler farms is meeting labour demands for specific tasks and at critical times. While such problems would be greater for part-time farmers they also apply to those in full-time farming. However, demands on labour are not just confined to the need for attention at calving and breeding (particularly where there is reliance on AI). They are also associated with the availability of suitable handling facilities, animal accommodation, land fragmentation and the need (in many instances) to provide transport when moving animals to a different part of the farm. Some suggestions which may be helpful in reducing the time spent at various tasks include:

Animal handling:

- provision of suitable handling pens with associated race and crush where separate locations exist.
- providing calving crush, calving jack etc. in calving area.

Animal accommodation:

- easily operated e.g. straw-bedded accommodation should be designed for easy access of machinery for bedding and manure removal.
- allow easy movement of animals from accommodation to crush one-man operations.
- allow for easy feeding of silage (or hay) and concentrates.

Land fragmentation:

- confine animals to a minimum number of locations with areas closed for silage in other locations to reduce travelling time when herding.

- plan easy assess from field to holding pen by having the width decreasing as the pen is approached and use of a visible tape attached to the electric fence to direct the animals forward towards the holding pen.

Animal health:

- the time and cost involved in controlling a disease outbreak can be substantial and thus, preventative measures must be a priority. The two most important preventative measures are avoiding introduction of the diseases such as Johnes and BVD by keeping stock purchases to a minimum and carrying out the necessary tests. Following the necessary tests, vaccination programmes for control of diseases such as calf scours, leptospirosis, BVD and respiratory disease must be considered.

Animal docility:

- time spent herding is not just useful in regard to early detection of health problems but improves herd docility which leads to easier handling of the animals. In extreme cases culling of individual cows should be considered where temperament is a problem.

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