

HIGHLIGHTS FROM THE 2006 BEEF RESEARCH PROGRAMME

In the beef **genetics** programme a study was undertaken to validate the Irish beef production sub-index (BPSI). The preliminary data showed that energy intake, average daily gain, slaughter weight, carcass weight and conformation score increased with BPSI, although none of the effects were significantly different from zero. Liveweight at slaughter and carcass weight increased significantly with increased PTA_{CWT} . An increase in carcass weight of 1.31 kg per unit PTA_{CWT} was slightly greater than the expectation of 1 kg. Sire PTA_{CWT} was significantly associated with heavier animals at slaughter.

In a related study the effect of contrasting genetic merit for beef production on phenotypic differences in dystocia and stillbirths in Irish multiparous suckler cows was examined. The results are in general agreement with previous international analyses. Factors affecting dystocia were calf sex, dam parity, sire breed, dam breed, month of calving and history of dystocia. The odds of a difficult calving was almost double for a bull calf compared to a heifer calf. Furthermore, the odds of a difficult calving decreased with parity, while it was higher in the autumn and winter months. The lack of a significant effect of genotype of beef production sub-index on calving dystocia and stillbirths suggest that selection for high genetic merit for beef production will, on average, have no deleterious effect on calving performance in multiparous suckler cows. Nonetheless, individual sires are likely to deviate considerably within genotype, and, estimated breeding values for direct and maternal calving performance are available for individual sires.

The relationship of live animal body scores and measurements on carcass attributes was further studied and it was concluded that ultrasound scanned muscle and fat measurements and visual muscular scores showed good correlations with carcass traits and could be useful in predicting carcass meat yield and carcass value. However, correlations between visual skeletal scores and carcass traits were not significant. A one unit (scale 1 to 15) increase in carcass conformation increased carcass meat proportion by 11.9 g/kg and value by 5.9 c/kg. A one unit increase in carcass fat score decreased carcass meat proportion by 11.1 g/kg and decreased value by 5.2 c/kg. The study further concluded that carcass conformation and fat scores obtained with mechanical grading were good predictors of meat and bone yield and carcass value but were modest predictors of carcass fat. Although carcass conformation and fat scores were poor predictors of the proportion of high value cuts these showed a high significant positive relationship with live conformation score and were negatively associated with fat score. When these relationships were applied to carcasses of progeny from the suckler and Holstein/Friesian herds it was found that with almost similar carcass fat and conformation scores, difference in meat yield of almost 10% in favour of the former was observed.

The growth and carcass differentiation between progeny of sires with average (A) and high (H) expected progeny difference (EPD) for carcass conformation was studied. The average EPD for growth (kg carcass), conformation and fat score (scale 1-5) was 25.6, 1.48, -0.35, and 30.9, 1.95 and -0.73 for A and H sires, respectively. The results revealed there was no effect of sire EPD for carcass conformation on live or carcass weight or their gains but kill-out proportion was significantly higher for progeny of H sires. Muscular scores at weaning and slaughter were significantly higher for bulls from H than A sires but not in heifers, which did not differ. Compared to A sires, muscle depth was significantly greater for H sires in both bulls and heifers. Carcass conformation score was higher and fat score lower for H than A sires in bulls, but heifers did not differ. There was a higher proportion of hindquarter, meat and high-value cuts and, a lower proportion of fat and bone in bulls from H than A sires but there was no effect of sire on heifers for these variables. Overall it is concluded that bull progeny from sires with high EPDs for carcass conformation had a higher muscular score, kill-out proportion, carcass conformation score, proportion of meat and high-value cuts and a

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lower fat score, carcass fat and bone proportion. Sire differences were smaller or absent in heifer progeny.

A beef **systems** study examined the options of pasture or concentrate finishing of Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian(AA) and Belgian Blue x Holstein-Friesian(BB) steers for beef production and evaluated different finishing strategies at the end of the second grazing season, and compared the response to concentrates in autumn and winter. Animals were either grazed or supplemented at pasture before sale in the autumn or housed for a conventional winter for finishing. For the finishing period as a whole, live weight gains differed significantly for the three finishing strategies, being lowest for pasture finishing and highest for early concentrate finishing and estimated carcass gains differed significantly for the three finishing strategies also. They were lowest for pasture finishing and highest for early concentrate finishing. Carcass weight per day of age did not differ significantly for the two concentrate finishing strategies but was significantly lower for the pasture finishing strategy. Compared with the animals at pasture, the animals finished early on concentrates gained 63 kg more live weight and 45 kg more carcass weight, for a concentrate input of 867 kg DM. Thus, the conversion rates of concentrates DM to live and carcass gains above those obtained at pasture were 13.7 and 19.2 kg, respectively. Based on concentrate costs and live and carcass weight prices, the early concentrate finishing strategy was uneconomic unless other factors such as improved carcass grades were considered.

Live and carcass weight gains during late concentrate finishing were 130 and 85 kg for a concentrate input of 941 kg DM, giving conversion rates of concentrates to live and carcass weight gains of 7.2 and 11.1, respectively. Based on these values, the late concentrate finishing strategy would be economic at current concentrate costs and live animal and carcass prices. The reason for the large difference in estimated conversion rates between the two concentrate finishing strategies is that in the early finishing strategy only the increment of performance above that obtained at pasture is considered, whereas in late finishing that increment is assumed to be zero. This is because grass growth had ceased and all available herbage had been utilised at the time the late concentrate finished group was housed. While the late concentrate finishing strategy may be acceptable economically, it can not be considered as early finishing or finishing without housing. Overall there were few differences between the breed types in life time live weights and live weight gains.

Another systems study was undertaken to compare young bulls from Holstein-Friesian (HF), Norwegian Red (NR), Norwegian Red x Holstein-Friesian (NX) and Jersey (JX) for feed intake, growth and carcass traits. The relative slaughter weights for HF, NR, NX and JX were 100, 102, 101 and 95, respectively. Overall it is concluded that silage and concentrate intakes scaled for carcass weight were similar for HF, NR and NX, but JX had significantly higher values. Growth, slaughter and carcass traits were similar for HF, NR and NX, but JX grew more slowly although the difference, while significant, was relatively small. JX also had a lower kill-out proportion and a lower carcass weight. Carcass fat score was similar for all the breed types. JX had a higher proportion of perinephric plus retroperitoneal fat than the other breeds and their carcass fat was more yellow in colour. All measures of carcass compactness were poorer for JX than for the other breed types.

In **grassland** research a study was undertaken to examine the initial productivity of 4-species grass/legume mixtures compared with monocultures in terms of total dry matter (DM) yield and suppression of weeds in the first year after sowing. Preliminary analysis of the data indicates there was no effect of overall seeding rate on total yield (at three sites) throughout the country. However, the mean total yield of the mixtures was greater than the mean total yield of the monocultures by 2-3 t DM/ha/year, which was consistent across the three sites and two levels of nitrogen fertiliser. Although the species-specific effects on the total yields of the monocultures were different across the sites and N treatments, the magnitude of the difference in total yield was the same. Conversely, the mean yield of weeds from the

monocultures was consistently greater than that from the mixtures. Therefore, there were advantages of the 4-species grass/legume mixtures over the monocultures in terms of both total yield and suppression of weeds in the first year after sowing.

Another grassland study examined the early growth and development of seedlings of contrasting pasture species after autumn sowing. There were six cultivars of red clover, either more suited to cutting or grazing, and two cultivars each of Caucasian clover, white clover and perennial ryegrass. These results suggest that the growth and development of individual pasture species need to be considered when making decisions on time of sowing and composition of pasture seed mixtures. All the red clover cultivars had high rates of leaf area expansion and could, therefore, be sown in autumn with perennial ryegrass. In contrast, spring sowing of Caucasian clover in seed mixtures that do not include perennial ryegrass or red clover should be recommended, to minimise the interval in days to axillary leaf development and to reduce competition for light from other pastures species.

The vast majority of spring-born calves are housed for their first winter, returned to pasture in spring and in late autumn, housed for their second winter for finishing. This may not always be cost effective due to the high costs involved in spending two winters inside, even though feed costs have been kept low. A system in which young cattle graze pasture through their first winter or not spend a winter inside would eliminate bedding, feeding and possibly reduce costs. In addition, an ability to maintain a proportion of the herd exclusively on pasture may contribute to the development of a high value grass-fed beef brand. A grazing study has commenced to measure growth and intake of weanling heifers managed on pasture or indoors on grass silage during winter is being undertaken.

A further grassland study examined the growth of steers grazing perennial ryegrass cultivars bred for normal or elevated concentrations of water soluble carbohydrates. There were no differences in mean liveweight gain and carcass weight between steers grazing either perennial ryegrass. There was a non-significant increase in plant WSC across the season. Similar values were also found between the two cultivars for herbage mass, herbage allowance, apparent intake, crude protein, digestibility and sward height post grazing. It is concluded that with the grasses used in this study there was no advantage by steers grazing elevated compared with normal water soluble carbohydrate perennial ryegrasses, which was associated with similar levels of herbage mass and nutritive value between the two cultivars.

It could be postulated that increasing the concentration of water soluble carbohydrates (WSC) in grass might better align the kinetics of carbohydrate and nitrogen metabolism in the rumen, leading to potentially improved growth rates and reduced excretion of urinary nitrogen by beef cattle. A further grassland experiment was carried out, where the sugar concentration of zero-grazed grass was incrementally increased by adding supplementary sucrose, to simulate such a WSC increase, and to quantify the resulting effects on the intake, digestion, N metabolism and growth of growing beef cattle. The data showed that increasing the sucrose content of ingested grass improves synchrony between carbohydrate and nitrogen compounds in the rumen, as evidenced by increased microbial protein production. The mean difference in intake between the unfortified and sucrose-fortified grass was equal to the mean intake of added sucrose, indicating that the mean intake of grass dry matter, *per se*, was unchanged. The mean numerical response in growth rate was higher than predicted solely from the incremental intake of energy from added sucrose, suggesting that increasing the sugar content of grass can improve the growth of grazing beef cattle if the increase is sufficiently large to adequately ameliorate asynchrony in the rumen. Also, increasing grass sugar content partitions nitrogen excretion from urine to faeces, which is an environmentally beneficial change.

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However, in a **forage conservation** study it is concluded that unwilted grass silage offered to growing steers fortifying with sucrose did not alter any of the intake, digestion, growth or feed efficiency variables examined, nor did it interact with concentrate supplementation.

As silages are inherently unstable once exposed to air, the mixing of concentrates with silage increases exposure to air and may increase the supply of fungal inoculum and/or respirable substrate, an experiment was carried out to determine the aerobic stability of grass silages and quantified the impacts of mixing with concentrates at time of feeding. It is concluded that mixing dry concentrates with silage at feed-out did not make silage aerobically less stable. However, once aerobic deterioration commenced, having mixed silage with dry concentrates increased the overall extent of deterioration.

Although the content and stage of development of grain in forage maize has a major impact on the nutritive value of the harvested whole crop, stover yield and quality also make an important contribution. Stover chemical composition at sequential harvest times could be influenced by factors modulating the physiological stage of crop development. Thus an experiment was conducted to evaluate the effects of cultivar, plastic mulch and harvest date on stover composition and contribution to crop yield. In general, delaying harvest date from early September to November reduced the proportion of stover in the crop and its digestibility (DMD) but increased dry matter (DM) content and neutral detergent fibre (NDF) contents. Stover DM content increased sharply in early November after air frost damage increased senescence. In general, delaying harvesting increased the proportion of cob in the crop and cob DM and starch contents but reduced NDF, ADF (acid detergent fibre), ash and crude protein contents. In general, forage maize cobs continued to mature from early September through to early November, with the rate of change declining as time progressed. By early September both the earlier cultivar and the use of plastic mulch had additively progressed crop maturity. However, between early September and November both the late cultivar and maize grown with no plastic mulch underwent the most extensive physiological development. Nevertheless, the earlier cultivar and the use of plastic mulch still resulted in cobs of more advanced maturity in early November.

In a survey to establish the incidence of fungal growth on baled grass silage in Ireland, 90% of bales examined had visible fungal growth present. *Penicillium roqueforti* and *Penicillium paneum*, two fungi known to be mycotoxin producers, represented 52% and 45%, respectively, of all fungal isolates detected. The study characterised the secondary metabolite profiles of *P. roqueforti* and *P. paneum* isolated from silage baled and concluded that *Penicillium* spp. commonly found in baled silage produce a variety of toxic compounds that may pose a risk to livestock and human health.

In a **nutrition** study the effects of method (total mixed rations (TMR) or ingredients offered separately) and level of feeding on muscle chemical composition in steers was measured (animal production data presented in previous years). It is concluded that as there was no effect of concentrate feeding method on carcass weight, no effect would be expected on measures of carcass fatness or muscle chemical composition. The increase in carcass weight with increasing concentrate level was associated with increases in measures of carcass fatness but the highly significant quadratic component of the response was unexpected. There is no obvious explanation for why all measures of carcass fatness increased up to the medium concentrate feeding level but not beyond. There were no significant method of feeding effect or method of feeding x concentrate level interaction for carcass traits or muscle chemical composition. Carcass weight and measures of carcass fatness increased quadratically with increasing concentrate level. Muscle moisture concentration decreased and lipid concentration increased with increasing concentrate feeding level. Carcass weight and measures of carcass fatness were poorly related to muscle chemical composition.

A further nutrition experiment quantified the response of finishing steers to supplementation of grass silage with concentrate feedstuffs offered as a TMR constituted at ensiling or at feeding. Previous work indicated that similar animal productivity occurred when finishing beef cattle were offered grass silage and concentrates separately or as a TMR produced at feeding time. An alternative option to the established TMR system is to co-ensile the concentrates with the grass and subsequently feed this TMR directly from the silo. This could reduce mechanisation costs, reduce labour input at feeding, reduce effluent production and potentially enhance silage fermentation. Potential risks include losses due to unsatisfactory silage fermentation, excess effluent flow or severe aerobic deterioration. In addition to *ad libitum* diets of grass silage or concentrates, total mixed rations constituted at ensiling or at feeding time in approximate dry matter ratios of grass silage: concentrates of 75:25, 50:50 and 25:75, respectively, were fed. Increasing concentrate content in the diet resulted in both linear and quadratic increases in total DM intake, and live weight and carcass gains. There was a significant effect of method of feeding for total DM intake, live weight gain and carcass gain in favour of the feeding time mixing. Fat score increased linearly and quadratically with increasing concentrate level. Method of feeding had no significant effect on fat score. It is concluded that increasing concentrate proportion in the ration improved animal performance and carcass traits and that offering steers a TMR constituted at feeding resulted in greater intakes and better animal performance than when the diet was constituted at ensiling.

A further nutrition study was conducted to examine the effects of increasing grass regrowth interval (RI) on intake, rumen fermentation, *in situ* degradability, rumen digesta kinetics and nutrient flow to the omasum in beef cattle. The results indicate that increasing the RI of a perennial ryegrass-based sward by 10 days (28 vs. 38) had no adverse effect on feed intake, rumen fermentation or digestion, but reduced ammonia N levels in the rumen, potentially reducing nitrogen excretion to the environment.

In a further nutrition study rumen fermentation and plasma metabolites in steers offered concentrates differing in energy source either as a supplement to grass silage or *ad libitum* concluded that concentrate energy source had no effect on rumen pH or fermentation parameters when offered as a supplement to grass silage but significantly altered the end products of rumen fermentation when offered *ad libitum*. A further study was conducted to determine, the intake, rumen fermentation pattern, microbial protein synthesis and nutrient flows to the omasum in beef cattle offered grass silage, maize silage, fermented whole-crop wheat and urea-treated unprocessed whole crop wheat, each supplemented with 3 kg of concentrate. Relative to grass silage, it is concluded that, non-grass conserved forages can significantly increase feed dry matter intake, alter the site of digestion and the capture of N in the rumen in beef cattle.

In nutrition of the suckler cow studies the performance of beef cows selected as low or high residual feed intake (RFI) capacity on grass-based systems was measured and the data showed that cows of low RFI had a lower grass silage intakes, but there was no effect on cow liveweight, body condition score or changes, calving difficulty, calf birth or weaning weights. These results indicate that beef suckler cows with lower RFI are more energy efficient.

In **meat quality** research some studies have focused on the differentiation of beef according to the pre-slaughter diet using the stable isotope ratios of carbon and nitrogen. The $\delta^{13}\text{C}$ value distinguished between beef from concentrate/wheat silage, grass silage, grazed grass and grazed grass/clover-fed cattle, but not between beef from alkalage and wheat silage-fed cattle or between beef from alkalage and concentrate-fed cattle. It is concluded that differences in the carbon and nitrogen stable isotope composition of the feeds examined were reflected in the muscle of cattle, thereby, allowing this approach to be used as a component, at least, of a scheme to authenticate the dietary history of beef cattle consuming these feeds. A further component of this work is examining whether the isotopic composition of light elements ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$, δD , $\delta^{18}\text{O}$ and $\delta^{34}\text{S}$) can be used as an intrinsic, biochemical marker for tracing

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and authenticating beef. The specific objectives are to determine the temporal variability in the stable isotope composition of C ($\delta^{13}\text{C}$) in feed materials over one growing season, and to determine the speed at which changes in the isotopic composition of beef muscle tissue occur following a change in diet. The data to date concludes that while $\delta^{13}\text{C}$ showed little temporal variation in concentrate and silage feed materials, it was more variable in fresh grass over one growing season, and that bulk muscle tissue reflected small isotopic differences between dietary components after about 100 days.

This programme is also examining new approaches to tracking dietary change in animals. Stable isotope analysis of incremental tissues such as hair and teeth are powerful tools used to track dietary changes and movement in animals. Spatially separated samples record the isotopic composition of the tissue at the time it was deposited. A study is underway to determine whether sequential analysis of tissues such as hooves or hair can be used to reconstruct the dietary history of cattle. The initial experimental results have demonstrate for the first time that hooves are a suitable incremental tissue for high-resolution isotopic reconstruction of the dietary and life history of bovine animals. Thus, stable isotopes measured in continually growing keratinised tissues like hair or hoof are proving to be a useful tool for reconstructing the individual history even at a weekly to daily basis with precision for 1 to 2 years prior to sampling date.

In other meat quality studies the effects of supplementation beef animal with a source of long chain ω -3 rumen protected-PUFA on the colour stability of minced beef was carried out and it could be hypothesised that such supplementation would decrease the colour stability of beef under simulated retail display conditions. However, it is concluded that supplementing did not have a deleterious effect on colour stability of minced beef stored for 1 week in high O_2 packs relative to control animals. A related study was conducted to investigate the effect of high c9,t11-CLA beef (produced by supplementing grazing cattle with sunflower oil and fishoil) on risk factors associated with the metabolic syndrome and to determine its efficacy relative to the synthetic form of the fatty acid. The preliminary results suggest that beef enriched with CLA may have beneficial effects on glucose metabolism, insulin sensitivity and mediators of inflammation, all of which are important health factors.

In **animal welfare** and health research a study was conducted to examine the expression of candidate neutrophil genes of young cattle subjected to transportation stress. The genes selected for profiling were sensitive to glucocorticoids. Given the prominence of neutrophils as a target of stress and in innate immune responses during bacterial infections, it is conceivable that measurements of altered neutrophil gene expression during stress may be effective indicators of altered immune status and thus susceptibility to infectious diseases. Thus, a broader investigation of the neutrophil transcriptome during transportation stress was performed in order to elucidate possible functional themes and a signature of changes that may illuminate future biomarkers of disease susceptibility. As expected, transportation elicited a classic stress response as evidenced by an acute and pronounced increase in plasma cortisol and in circulating neutrophil counts. Genes involved in immune response, apoptosis, and wound healing were confirmed as differentially expressed in this study, and mRNA abundance changes occurred at the same times that elevated plasma cortisol and circulating neutrophil counts were observed. The expression of 88 genes was significantly changed by transportation stress, as highlighted by differences in mRNA abundance. Seventeen of these genes were differentially expressed at more than one time point. The ontological clusters and number of genes (in brackets) included in each are were, signal transduction (16), immune response (15), protein trafficking (7), apoptosis (6), transcriptional regulation (6), ribosomal (6), wound healing (5), mitochondrial (3), metabolic enzymes (2), translational regulation (2), ubiquitin pathways (2), protein activation (1), RNA processing (1), steroid (1), and cell structure (1). The identification and/or function of 14 affected genes was not available in the databases searched and were thus grouped in a cluster called “unknown.”

A further study addressed concerns about long distance transport of animals by sea and its effects on animal welfare. The study involved a sea journey of approximately 12 days from Ireland to the Lebanon. Fifteen hundred Holstein-Friesian bulls accommodated on 5 decks of a shipping vessel were transported from Ireland to the Lebanon in October 2005. Physiological and haematological measurements showed that the blood parameters of transported animals returned to pre-transport levels by day 3 of sailing while the physiological variables (neutrophil and lymphocyte numbers, non-esterified fatty acid concentrations) remained altered compared with baseline. Transport of bulls for 12 days by sea did not impact negatively on animal welfare.

In a finishing beef cattle housing study where the effects of placing mats or wood-chips on concrete slatted floors on production, behavioural, physiological and immunological responses were measured, it is concluded that under the conditions of the study, there was no evidence to suggest that housing animals on slats alone was detrimental to their performance or welfare, based on the performance measurements and welfare indices that were evaluated. Placing mats or wood-chips over the concrete slats did not alter either animal production or welfare.

In **cattle reproduction** research, tissue concentrations of ω -3 PUFA can be manipulated through dietary supplementation and blood plasma concentration may be a useful predictor of concentrations of PUFA in some key reproductive tissues. Dietary ω -3 PUFA supplementation alters uterine expression to promote the production of prostaglandin E which is known to be embryotrophic. Dietary ω -3 PUFA supplementation inhibits gene expression of Δ -9 desaturase in the muscle of beef cattle. Fifty days of supplementation was sufficient to down regulate Δ -9 desaturase gene expression. These findings have important implications for the development of dietary strategies to augment the concentrations of both CLA and ω -3 PUFA in beef.

Other studies in reproduction found that cows in severe negative energy balance in early lactation show elevated expression of key genes involved in the inflammatory response and reduced expression of genes involved in cellular proliferation which is likely to compromise adaptation and recovery from negative energy balance.

Blood concentrations of insulin-like growth factor-I during early oestrus cycle are strongly associated with subsequent conception rate and may potentially be a good marker for cow fertility.

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HIGHLIGHTS FROM THE 2006 SHEEP RESEARCH PROGRAMME

In **sheep systems** studies it was found that relative to the housed unshorn ewes, shearing and extended grazing increased lamb birth weight and weaning weight and tended to increase lamb growth rate from birth to weaning. Unshorn ewes indoors had a higher body condition score at lambing than extended-grazed ewes. Winter grazed herbage allowance or silage feed value (indoors) in mid pregnancy had no effect on lambing assistance score and did not alter ewe or subsequent lamb performance. As determined by lamb weaning weight, a dry matter allowance of 0.8 kg per day of either the low- or medium-feed-value grass-silage had the same feed value as 1.8 kg DM of extended grazed herbage allowance offered in mid and late pregnancy. It is concluded that shearing housed ewes resulted in the same lamb birth weight and subsequent performance as out-wintering unshorn ewes and lambing outdoors.

In **grassland** research a study on autumn management concluded that a one day delay in grazing autumn pasture and subsequent harvest date reduced and increased herbage DM yield by approximately 54 and 147 kg, respectively. In a winter grazing study it was concluded that in a flock of single- and twin-bearing ewes, allocating herbage either daily or grazing in a leader-follower system (singles following twins) in late pregnancy did not alter lamb birth weight or subsequent growth rate. However single bearing ewes in the leader follower system had a lower condition score at lambing relative to ewes grazing separately. It is concluded that increasing herbage allowance during extended grazing increased herbage intake and animal performance, and decreased herbage utilisation. Supplementing with 0.5 kg concentrate replaced 1 kg herbage DM of extended grazing herbage allowance. Compensatory growth during the grazing season did not remove the effect of extended grazing treatments on animal live weight.

In **hill sheep** research where concentrates were offered to lambs on the hill or lowland, feed conversion ratios were 13:1 and 28:1 for Lowland and Hill, respectively. It is evident that the gain achieved would not cover the cost in the use of the Hill lambs but may be close to cost recovery in the case of the Lowland lambs. Based on all of the evidence from impact of creep feed in 2006 it is clear that returns in terms of extra animal performances do not justify the costs involved. This evidence is consistent with estimated obtained previously for hill lambs.

In a grazing hill sheep study it was observed that uneven sheep distribution and habitat use indicate that monitoring grazing impact on upland and peatland habitats is essential. Knowledge of hill sheep behaviour obtained from the study, combined with grazing impact assessments, would enable more-informed management decisions. Findings suggest that grazing-related damage is less likely to occur on blanket bog and most likely to occur on wet heath when both habitats are available to grazers. Where necessary, measures to redistribute grazing pressure, such as seasonal grazing, temporary fencing or the use of supplementary feed blocks, should be considered

In the sheep **genetics and breeding** programme the differences between Lean Meat Index (LMI) and non-LMI Suffolk and Charollais sires were estimated and were not statistically significant for any growth trait in either breed. The estimated difference for 14 week adjusted weights were very and are consistent with the results from 2005. The results suggest an effect of LMI status on birth weight in that positive differences were obtained for both breeds in 2005 and 2006, and this is consistent with the changes observed in Suffolk and Texel lines at Athenry that have been selected for pre-weaning growth rate.

In a ewe longevity/survival study, the survival probability for Suffolk and Belclare type ewes found significant differences in average longevity and estimates of 5.1 and 5.7 years for Belclare-X and Suffolk-X ewes, respectively, were observed. These values are considerably greater than those reported previously (1969) but this is at least partly due to differences

between the studies in culling policy. The breed effect was also significant when survival was based on time to death or culling for udder defects with censoring. This is not unexpected given the higher litter size and number of lambs reared for Belclare-X ewes. The breed-specific survival probabilities translate into annual replacement rates of 23% and 21% for Belclare-X and Suffolk-X, respectively. The annual replacement rate for Belclare-X ewes is 1.09 times that for Suffolk-X ewes and a difference of this order would add about €1.2 to annual ewe replacement cost.

In a sheep artificial insemination study the effect of sperm dose was highly significant and the effect on pregnancy rate was linear. There was also a significant effect of ewe breed with estimated values of 0.57, 0.71, 0.57 and 0.40 for Belclare, Scottish Blackface, Belclare x Scottish Blackface and Texel/Texel cross ewes, respectively. There was no evidence for any breed by dose interaction. The results indicate that lowering the dose of spermatozoa adversely affects pregnancy outcome when ewes are cervically inseminated with fresh semen. This remains a limiting factor affecting the rapid dissemination of identified superior genotype for this method of insemination. Previous studies have shown a highly significant effect of ewe breed on pregnancy rate when frozen-thawed semen is used. However, the effect of ewe breed on pregnancy rate following insemination with fresh semen is somewhat surprising as this has not been noted in previous experiments.

The breed composition (%) of the national ewe flock was determined according to the 'breed of sire of the ewe' as part of the National Farm Survey. The contribution of Scottish Blackface breed to the national ewe flock has halved since the last (1992) study of breed composition, when it accounted for 26%. The results show that there is now about 0.4 M Scottish Blackface ewes based on the total of 2.9 M ewes in the December 2006 data from CSO. The breed composition of ewe lambs kept for breeding was also evaluated and showed the proportion of flock replacements sired by Suffolk declined to 52% while that sired by Belclare increased to over 10%. This suggests that there is an increasing emphasis on genetic potential for prolificacy when choosing flock replacements. Information on the breed of stock rams used on Lowland farms showed the Suffolk breed accounted for 54%, followed by Texel (18%) and Charollais (14%). On farms classified as Hill type, Suffolk rams accounted for 36% followed by Scottish Blackface (34%), Cheviot (10%) and Texel (10%). This pattern indicates that a large proportion of hill breed ewes are crossed with terminal sire breeds and that the scope for selection within the purebred hill populations is very limited. The source of stock rams was dominated by private sales and mart sales whereas pedigree sales generally accounted for less than 25% of stock rams in any breed.

In **parasitology** the work on biological control of internal parasites has led to the development of a species specific PCR diagnostic test for the rapid detection of *D. flagrans*. Species specific primers were found to be highly specific when tested against 15 different fungal species. A single PCR product was exclusively amplified from *D. flagrans* demonstrating the specificity of the PCR assay. Soil samples containing the equivalent of 10 chlamydospores were sufficient for reliable amplification of the *D. flagrans* specific PCR product. However when the DNA extraction and PCR amplifications were performed on soil samples spiked with known quantities of chlamydospores the detection level was found to be 100 chlamydospores per gram of soil. The sensitivity achieved in this second method was lower but takes into account DNA losses that occur during the DNA extraction and clean up procedures and it is suggested that this is a more accurate measurement of assay sensitivity for field samples than a method which determines sensitivity based on serial dilution of DNA which overestimate the true sensitivity of PCR assays. The PCR diagnostic test developed in this study provides a rapid (< 8 h), accurate and sensitive test for *D. flagrans* which will enhance the evaluation of this fungus as a nematode biocontrol agent in the field.

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The studies on anthelmintic drug resistance has continued and measurements in Teagasc flocks indicate benzimidazole resistance in the trichostrongyle nematode populations in both the Leenane and Athenry flocks. In Leenane, the level of resistance is greater. Whereas in the Athenry flock there was no indication of a reduction in treatment efficacy against *Nematodirus*. The efficacy of benzimidazole was not improved by fasting the lambs prior to administration. The results also demonstrate a reduced efficacy of levamisole against 'other trichostrongyle' nematode populations. While the numbers of lambs with suitable *Nematodirus* egg counts are low, the results do suggest that both products are highly efficacious against *Nematodirus*. On commercial farms in Kilkenny (N=7) the results show evidence for significant resistance to benzimidazole and levamisole in the worm population on 7 and 3 farms, respectively. The present finding corroborate with the results from earlier studies on lowland flocks (Research Report 2002, 2005) and confirms the unsustainable nature of a chemotherapeutic dominated approach to nematode control.

GENETICS AND BEEF SYSTEMS

Performance of beef suckler cows with low and high residual feed intake on grass-based systems

The effect of residual feed intake (RFI), an alternative measure of feed efficiency, was determined using 36 spring-calving, primiparous, beef × Holstein-Friesian cows comprising 2 genotypes (G) and their progeny to weaning. Cows were offered grass silage *ad libitum* pre-partum and an additional 2 kg concentrate post-partum until turnout to pasture. Expected grass silage intake (GSI) was calculated for each G, separately, by regressing average daily GSI, recorded over a 53-day period in late pregnancy, on average daily liveweight gain (ADG) and mid-test liveweight^{0.75}. The RFI for each animal was then calculated as actual GSI minus the GSI predicted from the regression analysis. Within each G the cows were ranked on RFI and 0.5 were classified as having low or high RFI. At pasture, the low and high RFI cows and their calves were rotationally grazed, together. Cows of low RFI had a lower ($P < 0.001$) GSI but there was no effect ($P > 0.05$) of RFI on cow liveweight, body condition score or changes, calving difficulty, calf birth or weaning weights. These results indicate that beef suckler cows with lower RFI are more energy efficient.

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Effect of residual feed intake on immune function of beef suckler cows at weaning and housing

The effect of residual feed intake (RFI), an alternative measure of feed efficiency, on immune function at weaning and housing was determined using 36 spring-calving, beef × Holstein-Friesian cows, comprising 2 genotypes (G). Expected grass silage intake (GSI) was calculated for each G separately by regressing average daily GSI, recorded over a 53-day period in late pregnancy, on average daily liveweight gain (ADG) and mid-test liveweight^{0.75}. The RFI for each animal was then calculated as actual GSI minus the GSI predicted from the regression analysis. Within each G, the cows were ranked on RFI and 0.5 were classified as having low or high RFI. At pasture, the low and high RFI cows and their calves were rotationally grazed, together. Following abrupt weaning of calves, cows remained at pasture for a further 35 days (d) until housing in a slatted floor shed with *ad libitum* access to grass silage. Blood samples were obtained from the cows at weaning (d 0) and d 2, 7, 14, 21, 28, 35 (housing), 37, 42, 48 and 56. Cow RFI had no effect ($P > 0.05$) on white blood cell number. Neutrophil and lymphocyte % did not differ ($P > 0.05$) pre-weaning or housing but neutrophil % was higher 2 d post-weaning ($P = 0.08$) and housing ($P < 0.05$) but not subsequently, and lymphocyte % was lower ($P < 0.05$) at those times but not subsequently, in high than low RFI cows. In conclusion, the results indicate that high RFI cows are more susceptible to stress at weaning and housing than low RFI cows.

McGee, M., Earley, B. and Drennan, M.J.

RMIS No. 5522

Effect of weaning strategy on immune function of beef suckler cows and their calves

The effect of weaning strategy on immune function was determined using 36 previously grazed, spring-calving, beef × Holstein-Friesian cows and their calves. Following abrupt weaning, calves (276, s.d. 37.0 kg) were either 1) housed (WH) immediately in a slatted floor shed and offered grass silage *ad libitum* and concentrates or 2) remained at pasture (WP). Post-weaning, all cows remained at pasture (separate from the calves). Calves from WP and cows were housed 35 days later. Blood samples were obtained from the cows and calves at weaning (day 0) and days (d) 2, 7, 14, 21, 28, 35, 37, 42, 48 and 56. At d2 post-weaning, there was no change ($P > 0.05$) in white blood cell (WBC) number in WH calves while WBC number increased ($P \leq 0.05$) in WP calves. Neutrophil percentage (%) was unchanged

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($P>0.05$) in WH and WP calves between weaning and d 2. By d 7, WBC number and neutrophil % increased ($P\leq 0.05$) in WP whereas in WH calves neutrophil % remained unchanged ($P>0.05$) and WBC number decreased ($P<0.01$). By 2 days post-housing (d 37), neutrophil % increased ($P<0.05$) and subsequently decreased by d 42 ($P=0.06$) in WP calves while WBC number decreased ($P<0.01$) by d 42. In cows, WBC number ($P=0.06$) and neutrophil ($P<0.001$) % increased by d 2 and decreased ($P<0.05$ and $P<0.001$, respectively) by d 7. Post-housing, neutrophil % decreased ($P<0.001$) by d 7 (d 42) with no change ($P>0.05$) in WBC number. In conclusion, weaning and housing altered immune function in cows and calves.

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RMIS No. 5475

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Relationship between beef suckler cow colostrum production and immunoglobulin G₁ absorption in their calves

The importance of colostrum, because of its provision of immunoglobulins, to the survival and health of a newborn calf is well recognised. The overall objective of the study was to examine the relationship between beef suckler cow colostrum production and immunoglobulin G₁ (IgG₁) absorption in their calves.

Data were obtained using a total of 84 multiparous and 36 primiparous, spring-calving, beef × Friesian cows over three years. Cows were offered grass silage plus minerals and vitamins pre-partum. Colostrum yield, IgG₁ and crude protein concentrations were measured following administration of oxytocin and hand-milking of half (years 1 and 2) or the complete (year 3) udder. It was intended to give each calf 50 ml per kg birth weight of colostrum via stomach tube within 1-h of birth. Following an 8-h period after birth, during which suckling was prevented, a blood sample was obtained from the calf and it was then assisted to suckle (years 1 and 2) and/or fed excess colostrum, if any, (year 3) and subsequently left with the dam, as normal. A final blood sample was obtained from the calf at 48-h after birth. Concentrations of IgG₁ were determined in serum samples. Efficiency of IgG₁ absorption at 8-h post feeding was calculated as follows: $\text{IgG}_1 \text{ concentration in the calf serum} \times \text{plasma volume} (0.07 \times \text{calf birth weight}) \div \text{by the colostrum Ig mass (colostrum volume} \times \text{IgG}_1 \text{ concentration) consumed}$. The relationship between colostrum parameters and calf serum IgG₁ absorption was determined using PROC GLM with a model containing fixed effects for calf gender and year. Mean calf serum IgG₁ concentrations (mg/ml) at 8- and 48-h and IgG₁ absorption efficiency were 45.9, 56.7 and 0.39 and, 39.4, 43.9 and 0.40 for multi- and primiparous cows, respectively. Under the feeding conditions of this study, the most important variables affecting calf immune status were colostrum IgG₁ concentration, IgG₁ mass produced at birth, IgG₁ mass fed at birth, IgG₁ mass per kg birth weight fed at birth (Table 1). There was a negative linear relationship (not presented) between the efficiency of absorption of IgG₁ to serum and colostrum IgG₁ concentration ($R^2=-0.28$, $P<0.001$), IgG₁ mass produced at birth ($R^2=-0.19$, $P<0.01$), IgG₁ mass fed at birth ($R^2=-0.28$, $P<0.001$) and IgG₁ mass / kg birth weight fed at birth ($R^2=-0.31$, $P<0.001$) in calves from multiparous cows but not ($P>0.05$) in calves from primiparous cows. Despite the controlled colostrum feeding conditions, the variation in absorption explained was relatively low but the R^2 values are broadly in accord with previous results obtained with sheep.

In conclusion, mass of colostrum IgG₁ per kg birth weight fed at birth was the most important variable in determining the immune status in calves from beef × Friesian cows under the fixed time feeding protocol of this study.

Table 1: Linear regression coefficients between colostrum parameters and calf serum immunoglobulin concentrations (mg/ml) in multi- and primiparous beef suckler cows

Colostrum	Calf serum IgG ₁ concentration (mg/ml)					
	8-h			48-h		
	β_1 (s.e.m.)	R ²	Sig.	β_1 (s.e.m.)	R ²	Sig.
<u>Multiparous cows:</u>						
Yield (ml)	-0.002 (0.0009)	0.14	*	0.001 (0.0012)	0.05	NS
Volume fed at birth (ml)	0.013 (0.0051)	0.16	*	0.005 (0.0065)	0.05	NS
Volume fed / kg birth weight (ml)	0.62 (0.290)	0.15	*	0.63 (0.356)	0.08	P=0.08
Crude protein concentration (g/kg)	0.18 (0.040)	0.28	***	0.13 (0.053)	0.11	*
IgG ₁ concentration (mg/ml)	0.15 (0.021)	0.44	***	0.12 (0.030)	0.20	***
IgG ₁ mass produced at birth (g)	0.12 (0.005)	0.12	NS	0.02 (0.005)	0.18	***
IgG ₁ mass fed at birth (g)	0.07 (0.009)	0.47	***	0.05 (0.013)	0.19	***
IgG ₁ mass / kg birth weight fed at birth (g)	3.56 (0.437)	0.51	***	2.99 (0.639)	0.25	***
<u>Primiparous cows:</u>						
Yield (ml)	-0.002 (0.0019)	0.21	NS	0.002 (0.0025)	0.07	NS
Volume fed at birth (ml)	0.002 (0.0071)	0.18	NS	0.006 (0.0090)	0.06	NS
Volume fed / kg birth weight (ml)	0.48 (0.326)	0.23	NS	0.81 (0.406)	0.15	P=0.06
Crude protein concentration (g/kg)	0.27 (0.089)	0.37	**	0.22 (0.123)	0.13	P=0.08
IgG ₁ concentration (mg/ml)	0.19 (0.046)	0.48	***	0.18 (0.067)	0.21	*
IgG ₁ mass produced at birth (g)	0.02 (0.016)	0.21	NS	0.06 (0.018)	0.27	**
IgG ₁ mass fed at birth (g)	0.11 (0.027)	0.45	***	0.11(0.037)	0.25	**
IgG ₁ mass / kg birth weight fed at birth (g)	4.70 (0.870)	0.58	***	5.10 (1.247)	0.38	***

NS = non-significant; *, ** and *** = significant at 0.05, 0.01 and 0.001, respectively.

McGee, M. and Drennan, M.J.

RMIS No. 5522

Growth, muscular scores and carcass traits of progeny from sires differing in breeding value for carcass conformation

Carcasses of higher conformation score have a higher proportion of lean meat and a higher market value. An increasing proportion of beef from Ireland is exported to the EU where considerable premiums are paid for lean carcasses of good conformation.

The objective of this study was to quantify the growth and carcass differentiation between the progeny of sires with average and high expected progeny difference (EPD) for carcass conformation.

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A total of 8 Charolais sires, with average (A) and high (H) EPD for carcass conformation, were mated with Limousin × Friesian (LF), Limousin × LF, Simmental × LF, Limousin or Charolais cows over four years. The average EPD for growth (kg carcass), conformation and fat score (scale 1-5) was 25.6, 1.48, -0.35, and 30.9, 1.95 and -0.73 for A and H sires, respectively. The progeny were spring-born, single suckled and weaned and housed in autumn at about 8 months of age. The bull progeny received grass silage and concentrates (C) until slaughter at 15 months of age (4 years data, n=135). The heifer progeny were turned out to pasture for a second grazing season at the end of which, they received supplementary C either at pasture or indoors with a grass silage-based diet and were slaughtered at 20 months of age (3 years data, n=96). Live weight was recorded regularly. Live animal muscularity scores (Signet procedure) were obtained at weaning and slaughter, and, additionally at slaughter, ultrasonic back fat and muscle measurements were obtained. Post-slaughter carcass weight, grades, weight of perinephric + retroperitoneal fat and the proportion of meat, fat and bone in the hindquarter was determined. Analysis of variance was carried out on the data using PROC GLM with terms for sire, year and dam in the model. Calving day was included as a covariate.

There was no effect ($P>0.05$) of sire EPD for carcass conformation on live or carcass weight or their gains, but kill-out proportion was significantly higher for progeny of H sires (Table 2). Muscular scores at weaning and slaughter were significantly higher for bulls from H than A sires, but not in heifers, which did not differ. Compared to A sires, muscle depth was significantly greater for H sires in both bulls and heifers. Carcass conformation score was higher ($P<0.001$) and fat score lower ($P<0.01$) for H than A sires in bulls, but heifers did not differ ($P>0.05$). There was a higher proportion of hindquarter ($P=0.05$), meat ($P<0.001$) and high-value cuts ($P<0.001$) and, a lower ($P<0.01$) proportion of fat and bone in bulls from H than A sires but there was no effect ($P>0.05$) of sire on heifers for these variables.

In conclusion, bull progeny from sires with high EPDs for carcass conformation had a higher muscular score, kill-out proportion, carcass conformation score, proportion of meat and high-value cuts and a lower fat score, carcass fat and bone proportion. Sire differences were smaller or absent in heifer progeny.

Drennan, M.J. and McGee, M.

RMIS No. 4936

Table 2: Effect of sire breeding value for conformation on growth and carcass traits (s.e.m.) of bull and heifer progeny

Progeny gender	Bulls		Sig.	Heifers		Sig.
	Average	High		Average	High	
Birth weight (kg)	52.6 (0.80)	53.5 (0.79)		46.6 (0.82)	46.7 (0.87)	
Gain: birth – weaning (g/day)	1147 (21.4)	1168 (21.4)		1004 (20.2)	1003 (21.6)	
Gain: weaning – slaughter (g/day)	1261 (17.5)	1243 (17.5)		721 (11.0)	723 (11.6)	
Gain: birth – slaughter (g/day)	1208 (12.7)	1208 (12.9)		816 (9.7)	817 (10.2)	
Carcass weight (kg)	345 (4.8)	350 (4.7)		291 (4.4)	296 (4.2)	
Kill-out proportion (g/kg)	571 (2.5)	582 (2.4)	***	540 (2.4)	547 (2.6)	*
Carcass gain (g/day)	761 (7.6)	773 (7.5)		482 (5.8)	489 (6.2)	
Muscular score – weaning	6.9 (0.20)	7.7 (0.20)	**	6.7 (0.16)	6.4 (0.17)	
Muscular score – slaughter	8.2 (0.22)	9.3 (0.22)	***	8.0 (0.16)	7.9 (0.17)	
Fat depth (cm)	0.4 (0.02)	0.4 (0.02)		0.7 (0.09)	0.5 (0.10)	P=0.06
Muscle depth (cm)	8.0 (0.094)	8.5 (0.093)	***	8.2 (0.08)	8.4 (0.08)	*
Conformation score (1 poor - 15 best)	9.7 (0.19)	10.7 (0.19)	***	9.3 (0.17)	9.1 (0.18)	
Fat score (1 leanest - 15 fattest)	8.4 (0.19)	7.6 (0.19)	**	8.7 (0.20)	8.4 (0.22)	
Perinephric + retroperitoneal fat (kg)	6.5 (0.27)	6.0 (0.27)		6.4 (0.24)	5.8 (0.27)	
Hindquarter proportion (g/kg)	478 (2.9)	485 (2.8)	*	501 (1.5)	502 (1.7)	
Meat proportion (g/kg)	741 (3.0)	756 (2.9)	***	742 (3.8)	752 (4.1)	P=0.08
Fat proportion (g/kg)	69 (2.0)	61 (2.0)	**	74 (3.2)	66 (3.4)	P=0.07
Bone proportion (g/kg)	190 (1.8)	183 (1.8)	**	183 (1.7)	182 (1.8)	
High-value cuts (g/kg)	79 (0.6)	83 (0.6)	***	78 (0.6)	77 (0.6)	

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Effect of sire genotype for the beef production sub index and carcass weight on progeny performance

Carcass weight is one of the main drivers of profitability in beef production. Animals may be ranked for profitability through the use of the beef production sub-index which is based on carcass weight, weaning weight, carcass conformation score, carcass fat score and feed intake. The objective of this study was to quantify the effects of ranking sires for profitability, according to the beef production sub index (BPSI), on performance of their progeny.

In order to obtain an acceptable range, 11 sires of high and 11 sires of low genetic merit, based on the BPSI, were identified. Average reliability of the sires chosen was 90%. Sire breed was balanced across genotype and consisted of 10 Charolais, 2 Belgian Blue, 6 Limousin and 4 Simmental. The aim was to purchase 6 progeny from each of the 22 sires, half of which would be reared as bulls and slaughtered at 15 months of age (reported here), and, the remainder kept as steers for slaughter at 24 months of age. Progeny were sourced from 28 suckled beef herds as weanlings. Following purchase all animals were vaccinated for the control of respiratory disease and treated for hoose and stomach worms with an anthelmintic effective against *Ostertagia* Type II. They were offered grass silage to appetite and the daily concentrate allowance increased gradually to 3 kg per head daily. From January 2006 the bulls were accommodated indoors and the daily concentrate allowance was gradually increased and silage decreased. In early February they were fed an *ad libitum* concentrate diet and 1 kg of grass silage dry matter as roughage until slaughter on 26th June 2006 at, on average, 470 days of age. Records taken on the live animal included liveweight every 28 days and individual daily feed offered and refused for the final 132 days prior to slaughter. Energy values (UFV) for concentrates and silage were calculated using feed tables of O'Mara (1996). Average daily gain (ADG) was calculated using monthly liveweight by linear regression. At slaughter, carcass weight and carcass grades were recorded and the right side of each carcass was dissected into meat, fat and bone. Conformation score was on a continuous scale of 1 (poor) to 15 (excellent). Fat score was also on a scale of 1 (lean) to 15 (fat). Following parentage verification, using DNA, 50 bull progeny remained for analysis. The data was analysed using PROC MIXED (SAS, 2006) to determine the effect of BPSI and Predicted Transmitting Ability for carcass weight (PTA_{CWT}) on energy intake (UFV g/day), ADG, slaughter and carcass weight, conformation and fat scores, killout (KO), and carcass proportions of meat, and fat. BPSI and PTA_{CWT} were treated as continuous variables. In the analysis sire was included as a random effect and the fixed effects of parity of dam, week of birth, dam breed and dam age were tested for significance in the model. For repeated measures (weekly average energy intake and monthly liveweight) age was included as a repeated effect with a first order autoregressive correlation structure assumed among records within animal.

Table 3 shows the effect of a unit increase in sire BPSI (€) and PTA_{CWT} (kg) on a range of progeny performance traits. Energy intake, ADG, slaughter weight, carcass weight and conformation score increased with BPSI although none of the effects were significantly different from zero. Conformation scores increased as BPSI and PTA_{CWT} increased, but again these were not significant. Liveweight at slaughter and carcass weight increased significantly ($P < 0.05$) with increased PTA_{CWT} . The increase in carcass weight of 1.31 kg per unit PTA_{CWT} is slightly greater than the expectation of 1 kg. The similarity in regression coefficients between BPSI and PTA_{CWT} is due to the relatively large emphasis (55%) of carcass weight in the BPSI. Energy intake and daily gain were positively (NS) associated with increased PTA_{CWT} .

**Table 3: Mean values and regression co-efficient for (standard errors in parenthesis)
BPSI and PTA_{cwt}**

Trait	Mean	BPSI	PTA _{cwt}
Intake (UFV/day)	9642	6.3(5.66)	28.7(18.47)
ADG (g/day)	1459	1.4(1.39)	5.2(4.43)
Slaughter (kg)	602	0.5(0.28)	2.38(0.663)*
Carcass Wt (kg)	351	0.3(0.17)	1.31(0.521)*
KO (g/kg)	590	-0.04(0.145)	-0.24(0.473)
Conformation	11.11	0.004(0.006)	0.012(0.0180)
Fat	7.78	-0.007(0.006)	-0.011(0.012)
Meat (g/kg)	732	-0.48(0.163)	-0.48(0.521)
Fat (g/kg)	89	0.02(0.117)	0.23(0.377)

† Scale 1 – 15; *(P<0.05).

Sire PTA_{cwt} was significantly associated with heavier animals at slaughter, while the respective associations with BPSI approached significance (P<0.10). Although not significant bulls of greater genetic merit for BPSI had lower kill-out % and lower meat content which does cause concern as the opposite would be expected.

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RMIS No. 5503

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Effect of contrasting genetic merit for beef production on calving performance in beef herds

Prior to recommendation for genetic selection, on greater beef production potential, genetic antagonisms with auxiliary traits such as calving dystocia and stillbirths should be evaluated. The objective of this study was to assess the effect of contrasting genetic merit for beef production on phenotypic differences in dystocia and stillbirths in Irish multiparous suckler cows.

Data on calf, sire and dam identification number, as well as calving date, sex of the calf, calving dystocia, incidence of stillbirth, parity of the dam and breed of the service sire and dam were extracted from the Irish Cattle Breeding Federation database for the year 2005. In total, 996,851 records were available for inclusion in the analysis. In Ireland dystocia is scored on a scale of 1 to 5 as follows: 1=no assistance/unobserved; 2=slight assistance; 3=severe assistance; 4=veterinary assistance 5=caesarean. For the present study, dystocia was dichotomised as 0 (no assistance required) or 1 (assistance required). Records with no information on sire or information on dam parity, as well as primiparous cows or cows greater than 10 parities were removed. Twin calvings were also removed. Median age at calving was determined within parity and cows calving ± 2 years from the median were removed.

Calvings from stock bulls were removed as were calvings from herds with less than 10 calving records or less than 10 calvings from AI sires. Sires and dams were assigned to one of the following 6 breeds based on their main breed component as follows: Limousin, Simmental, Charolais, Hereford, Belgian Blue and Aberdeen Angus. Parity was recoded into four classes; 2, 3, 4 to 6 and 7 to 10. The study was mainly concerned with calvings of 22 sires of either high (n=11) or low (n=11) genetic merit based on the beef production sub index as progeny from these sires were involved in a detailed production study which included

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carcass evaluation. For the purpose of this study, progeny from other AI sires were also included in the analysis to facilitate greater connectiveness and, thus, more accurate estimation of fixed effects in the multiple regression model. However, only herds with calvings of at least one of the sires of interest were retained. Following all edits 5,400 calving records from 803 herds remained. However, information on stillbirths was only available on 733 lactations.

The logit of the probability of a difficult calving or stillbirth was modeled using generalised estimating equations in PROC GENMOD (SAS, 2006). Herd was included as a repeated effect in the model. Factors tested for significance in the multiple regression model were calf sex, dam parity, genotype of sire, sire breed, dam breed, month of the year at calving, age of the dam at calving nested within parity and history of calving difficulty in the immediately previous calving.

The overall mean incidence of dystocia in the edited dataset was 24%. This varied from a mean of 23% in the low genotype to a mean level of 26% in the high genotype group. The average incidence of stillbirths in the edited dataset was 8% varying from 4% (n=9) in the high genotype to 8% (n=4) in the low genotype group.

Factors significantly ($P<0.05$) affecting dystocia were calf sex, dam parity, sire breed, dam breed, month of calving and history of dystocia. The odds of a difficult calving in the progeny from a low genotype sire was 0.99 times (95% CI: 0.76 to 1.28) that of the progeny from a high genotype sire and did not differ between the two groups ($P>0.05$). The odds of a difficult calving was almost double (OR=1.9; 95% CI 1.69 to 2.18) for a bull calf compared to a heifer calf. Furthermore, the odds of a difficult calving decreased with parity while it was higher in the autumn and winter months. These results are in general agreement with previous international analyses of phenotypic data on calving dystocia.

Factors that significantly ($P<0.05$) affected the likelihood of a stillborn calf were calf sex and dam parity. Although the odds of a stillborn calf was numerically greater (OR=2.34; 95% CI: 0.70 to 7.78) in calvings from low genotype sires it was not significantly different to calvings from high genotype sires. The odds of a stillborn calf was 1.73 times higher (95% CI: 1.00 to 3.02) for males than for females and decreased with dam parity.

The lack of a significant effect of genotype of beef production sub index on calving dystocia and stillbirths suggest that selection for high genetic merit for beef production will, on average, have no deleterious effect on calving performance in multiparous suckler cows. Nonetheless, individual sires are likely to deviate considerably within genotype, and, estimated breeding values for direct and maternal calving performance are available for individual sires.

RMIS No. 5503

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The relationship of scores and measurements on the live animal and carcass grades with carcass traits

The objectives of the study were to examine the relationship of (1) live animal scores and ultrasonically measured eye muscle and fat depths, (2) carcass conformation and fat grades and (3) breed type, with killing-out rate, carcass meat, fat and bone proportions, proportion of high value cuts and carcass value.

Seventy-four bulls were used of which 53 were suckled late maturing breed crosses purchased as weanlings and 21 were Holstein/Friesians purchased as calves and reared at Grange. Animals were offered an *ad-lib* barley based diet, with 5 kg per day of silage offered as roughage, for six months prior to slaughter. At weaning (8-10 mths) and pre-slaughter all animals were ultrasonically scanned for eye muscle depth (MD) at the 3rd lumbar vertebra and fat depth (FD) at the 3rd lumbar vertebra (3 sites) and the 13th thoracic rib (4 sites) using a Dynamic Imaging Real Time Scanner, (model – Concept MLV, with a 3.5 MHz linear probe). Hair was clipped from areas to be scanned and vegetable oil was used to obtain adequate acoustic contact. Locations were found by physical palpation and when a satisfactory image was achieved it was captured on the monitor. Eye muscle depth and fat depths were then measured using an internal caliper built into software to give instant results. At weaning and pre-slaughter all animals were also scored using linear and Signet procedures. Linear scoring was carried out by two certified assessors from the Irish Cattle Breeding Federation (ICBF) which involved assigning muscularity scores on a scale of 1 (poor muscularity) to 15 (good muscularity) at six locations and skeletal scores (scale 1-10) at three locations. The Signet scoring system was carried out by two members from Grange Research Centre and involved assigning muscular scores at three locations based on a scale of 1 (poor muscularity) to 15 (good muscularity). Carcass data collected included cold carcass weights (taken as 0.98 of hot carcass weight) and EU carcass grades for conformation and fatness using mechanical grading on a 15 point continuous scale. The right side of each carcass was split into an 8 rib pistola and forequarter, which were further split into 13 and 9 retail cuts, respectively. Where appropriate the bones from each cut were removed and scraped clean. All dissectible fat was removed from each cut. Each meat cut, lean trim, fat and bone were weighed separately with lean trim subsequently included with the meat cuts to give meat yield. Carcass value (cents/kg) was calculated, as the sum of the commercial values of each fat trimmed boneless cut with a small deduction for bone, expressed as a proportion of the half carcass weight. Data were analysed using PROC CORR and PROC REGG procedures in SAS (2006).

Relationship of live animal scores/measurements with carcass traits

Animals were slaughtered at a mean age of 458 days having an average liveweight of 575 kg and a cold carcass weight of 322 kg (Table 4). Carcass conformation and fat scores were 9.6 and 7.9, respectively. Carcass meat, fat and bone proportions were 712, 96 and 192 g/kg respectively. At weaning and at slaughter the ICBF linear scoring system for muscular scores (at 6 locations), Signet scores and scanned muscle depth were highly positively correlated with killing-out rate (KO), proportion of meat and high value cuts in the carcass and carcass value while a high negative correlation was obtained for carcass bone and a low negative correlation for carcass fat (Tables 5 and 6). The ICBF linear scoring system for skeletal scores showed no significant relationship at weaning or at slaughter with any traits. Scanning for fat depth at slaughter showed a significant positive correlation with carcass fat score. In conclusion ultrasound scanned muscle and fat measurements and visual muscular scores showed good correlations with carcass traits and could be useful in predicting carcass meat yield and carcass value. Correlations between visual skeletal scores and carcass traits were not significant.

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Table 4: Mean, standard deviation and range for live animal and carcass data of bulls

<u>Weaning</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Minimum</u>	<u>Maximum</u>
¹ Muscular scores	6.0	2.04	1.5	10.2
Signet scores	6.3	2.9	1.0	13.0
Eye muscle depth (mm)	57.6	9.6	38.9	87.5
Fat depth (mm)	0.95	0.37	0.40	2.5
<u>Pre slaughter</u>				
Age at slaughter (days)	458	41.1	386	569
Pre slaughter wt.(kg)	575	84.6	408	857
Muscular scores	8.5	2.5	3.0	13.0
Signet scores	7.2	2.8	2.3	14.7
Eye muscle depth (mm)	67.7	9.71	46.2	87.5
Fat depth (mm)	1.82	1.073	0.30	6.0
<u>Post slaughter</u>				
Cold carcass wt(kg)	322.1	57.56	207	475
Killing-out rate (g/kg)	569	36.9	494	680
² Conformation score	9.6	2.60	4.0	14.0
² Fat score	7.9	1.42	3.0	12.0
Meat (g/kg)	712	39.67	627	840
Fat (g/kg)	96	25.22	31	163
Bone(g/kg)	192	22.79	129	251
High priced cuts (g/kg)	72	5.60	56	85
High priced cuts in meat(g/kg)	102	6.2	87	112
Value(cents)	305	20.10	261	352

¹At 5 locations; ²Scale 1 to 15.

Table 5: Correlation coefficients (r) between live animal scores at weaning and carcass traits

	<u>Weaning</u>					
	<u>KO</u>	<u>Meat %</u>	<u>Fat %</u>	<u>Bone %</u>	<u>% HVC¹</u>	<u>Carcass value (c/kg)</u>
SIGNET MS	0.78***	0.70***	-0.35**	-0.82***	0.45***	0.67***
ICBF MS	0.78***	0.66***	-0.31**	-0.80***	0.47***	0.65***
ICBF SS	0.15	0.024	0.17	-0.22	0.045	0.042
Scanned FD	0.64***	0.53***	-0.22	-0.67***	0.37**	0.56***
Scanned EMD	0.69***	0.61***	-0.32**	-0.71***	0.40***	0.58***

MS = Muscular Score, SS = Skeletal Score, FD = Fat Depth, EMD = Eye Muscle Depth, KO = Killing-out rate.

Table 6: Correlation coefficients (r) between live animal scores at slaughter and carcass traits

	<u>Slaughter</u>					
	<u>KO</u>	<u>Meat %</u>	<u>Fat %</u>	<u>Bone %</u>	<u>% HVC¹</u>	<u>Carcass value (c/kg)</u>
SIGNET MS	0.83***	0.77***	-0.42***	-0.87***	0.56***	0.79***
ICBF MS	0.82***	0.72***	-0.32**	-0.89***	0.50***	0.71***
ICBF SS	0.074	0.015	0.058	-0.09	-0.12	-0.02
Scanned FD	-0.01	-0.30**	0.56***	-0.09	-0.31**	-0.31**
Scanned EMD	0.71***	0.68***	-0.34**	-0.81***	0.52***	0.69***

MS = Muscular Score, SS = Skeletal Score, FD = Fat Depth, EMD = Eye Muscle Depth, KO = Killing-out rate.

Relationship of carcass grades with carcass traits

Correlations for carcass conformation score were positive ($r = 0.52$ to 0.84) with KO, carcass meat proportion, proportion of high value cuts and carcass value, negative with carcass bone proportion ($r = -0.89$) and fat proportion ($r = -0.40$) (Table 7). Correlations for carcass fat score were positive with fat proportion ($r=0.61$) but correlations with all other traits were low and negative. Regression analysis (Table 8) showed that carcass grades explained 0.69 to 0.80 of total variation in KO, carcass meat and bone proportion and carcass value. The corresponding figures were 0.55 for carcass fat proportion and 0.28 for the proportion of high value cuts. Increasing conformation score increased KO, the proportion of carcass meat and high value cuts and carcass value but decreased fat and bone proportions in the carcass. Increasing fat score increased carcass fat but decreased all other traits. A one unit (scale 1 to 15) increase in carcass conformation increased carcass meat proportion by 11.9 g/kg and carcass value by 5.9 c/kg. A one unit increase in carcass fat score decreased carcass meat proportion by 11.1 g/kg and decreased carcass value by 5.2 c/kg.

Table 7: Correlation coefficients (r) between carcass grades and carcass traits

	Carcass conformation	Carcass fat
KO%	0.84***	-0.08
Meat%	0.77***	-0.35**
Fat%	-0.40***	0.61***
Bone%	-0.89***	-0.06
%HVC	0.52***	-0.21
Carcass value(cents/kg)	0.76***	-0.32**

*** P< 0.001, ** P<0.01, * P<0.05.

Table 8: Regression between carcass grades and KO, carcass composition and value

	Intercept	Conformation score	Fat score	R ²
KO (g/kg)	477	+12.0 (0.90)***	-2.9 (1.7)	0.71
Meat (g/kg)	685	+11.9 (0.91)***	-11.1 (1.8)***	0.74
Fat (g/kg)	42	-4.0 (.76)***	+11.8 (1.48)***	0.55
Bone (g/kg)	273	-7.9 (0.46)***	-0.70 (0.89)	0.80
High value cuts (g/kg)	68.6	+1.1 (.21)***	-0.86 (0.42)*	0.28
Value (c/kg)	289.7	+5.9 (0.51)***	-5.2 (.98)***	0.69

** P< 0.001, * P<0.05.

In conclusion carcass conformation and fat scores obtained with mechanical grading were good predictors of meat and bone yield and carcass value but were modest predictors of carcass fat. Although carcass conformation and fat scores were poor predictors of the proportion of high value cuts these showed a high significant positive relationship with conformation score and were negatively associated with fat score.

Carcass traits of sucklers and Holstein/Friesian bulls

The 53 sucklers were at least 0.5 continental breeds and averaged 469 days of age at slaughter. The average age of the Holstein/Friesians at slaughter was 429 days. The carcass weights of the sucklers and Holstein/Friesians were 351 and 249 kg, respectively (Table 9). Corresponding conformation scores were U and O+ while both had similar fat scores of 3. The sucklers had 60 (729 v 669) g/kg more meat 18 (91 v 109) g/kg less fat, 42 (180 v 222) g/kg less bone, 7 (74 v 67) g/kg more high-value cuts and were valued at 31 c/kg more than the Holstein/Friesians. In conclusion the results show that with almost similar carcass fat

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scores and conformation scores of U and O+ for the sucklers and Holstein/Friesians respectively, the substantial difference in meat yield of almost 10% in favour of the former is in agreement with the results of previous studies.

Table 9: Carcass and production traits for suckler v Holstein/Friesian steers

	<u>Sucklers</u>	<u>Holstein/Friesian</u>
Age of slaughter (day)	469	429
Carcass weight (kg)	351	249
¹ Carcass conformation score	11 (U)	6 (O+)
Carcass fat score	8 (3)	7.7 (score 3)
Meat (g/kg)	729	669
Fat (g/kg)	91	109
Bone (g/kg)	180	222
High value cuts (g/kg)	74	67
Value (c/kg)	314	283

¹Scale 1 to 15.

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Pasture or concentrate finishing of Holstein-Friesian, Aberdeen Angus x Holstein-Friesian and Belgian Blue x Holstein-Friesian steers for beef production

Ensuring that there are adequate replacement heifers for the Holstein-Friesian dairy herd is a high priority for dairy farmers. This necessitates breeding about 0.5 of the herd to Holstein-Friesian bulls. The remaining cows are crossed with beef bulls. In 2005, proportionally 0.51 of calves born to Holstein-Friesian dairy cows were beef crosses. Aberdeen Angus comprised a large proportion of these and Belgian Blues were the second most numerous late maturing sire breed calves. In terms of body composition or maturity at a fixed age or weight, Aberdeen Angus and Belgian Blue provide the greatest contrast amongst the breeds commonly used for crossing on dairy cows in Ireland.

Prior to the decoupling of premia payments from animals, two-year-old steer beef production was popular and profitable largely because of the payment of the second Special Beef Premium (SBP) at about 22 months of age shortly before slaughter. Where calves are spring-born, two-year-old production systems involve an expensive winter finishing period. Following the removal of the SBP winter finishing will not be economically sustainable in future unless there is a substantial autumn to spring price increase. Thus, shorter and lower cost cattle finishing options must be explored.

The objectives of the present study were (i) to compare the productivity of spring-born Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers for beef production, (ii) to evaluate different finishing strategies at the end of the second grazing season, and (iii) to compare the response to concentrates in autumn and winter.

Animals and management: Spring-born calves of HF, AA and BB breed types were individually purchased on dairy farms following identification from artificial insemination records. The calves were the progeny of at least five sires per breed. At 3-4 weeks of age the calves were transferred from their farms of origin to Grange Beef Research Centre and reared according to standard methods. They were penned individually and offered a total of 25 kg

milk replacer (196 g/kg fat) over an 8-week rearing period. Hay was available *ad libitum* and calf concentrates (750 g/kg coarsely rolled barley, 170 g/kg soya bean meal, 55 g/kg molasses and 25 g/kg mineral/vitamin premix) were offered up to a maximum of 2 kg per head daily. On May 17, any calves in excess of 18 per breed type were culled on the basis of extremes of birth date or live weight. No data from these animals were used. The calves were turned out to pasture and grazed ahead of yearling steers in a leader/follower system of rotational grazing. They were injected with ivermectin (Qualimec, Janssen Animal Health) for the control of internal parasites at 3, 8 and 13 weeks following turn out.

The animals were castrated on September 20 and from then until housing for the first winter on October 7, they were offered 1 kg of cattle concentrates (875 g/kg rolled barley, 65 g/kg soya bean meal, 45 g/kg molasses and 15 g/kg mineral/vitamin premix) per head daily. During the first winter, accommodation was in a slatted floor shed where the diet comprised of grass silage (206 g/kg dry matter (DM), 132 g/kg crude protein (CP) in the DM, 708 g/kg *in vitro* DM digestibility (DMD) and pH 3.9) *ad libitum* plus 1 kg cattle concentrates per head daily until January 19 when the concentrates were withdrawn. Animals were turned out to pasture for a second grazing season on March 23 and later they followed calves in a leader/follower system of rotational grazing until the end of July.

On August 1 and 2, the animals were weighed, and on the mean of these two live weights were blocked within breed type and assigned to three finishing strategies in a 3 x 3 factorial arrangement of treatments. The finishing strategies were (i) pasture only for 94 days to slaughter (PS), (ii) housed and adapted to *ad libitum* concentrates for 94 days to slaughter (CE), and (iii) pasture only for 94 days, then housed and adapted to *ad libitum* concentrates for 98 days to slaughter (CL). Housing was in a slatted floor shed in pens of 2 giving 9 replicates (3 per breed type) for feed intake. After housing, the animals were initially offered grass silage *ad libitum* and concentrates were increased gradually to *ad libitum* intake over a three week period. Thereafter, the animals continued to receive 5 kg (1 kg DM) grass silage per head daily to aid normal rumination. Fresh concentrates were weighed in daily and refusals were weighed back and discarded twice weekly. The concentrate composition was: rolled barley 585 g/kg, extruded full fat soya bean meal 390 g/kg, mineral/vitamin premix 25 g/kg. (The full fat soya bean meal was used to produce muscle of high fatty acid concentration for a related study). Samples of silage and concentrates were retained for chemical analysis.

The animals that remained at pasture were managed as a single group. They rotationally grazed a 6 paddock farmlet and were offered a target daily herbage allowance of 14 kg per head, estimated from sward height. The objective was to ensure no restriction of herbage intake. Herbage heights were measured on entry to, and exit from, paddocks. Samples of the pre grazed herbage were retained for chemical analysis. There were two complete rotations of the grazing area with a target mean residency time per paddock of one week. This varied, as did paddock area, with herbage availability and weather conditions but the target herbage allowance was generally maintained. After these animals were housed, feeding and management were as for those housed earlier.

Carcass assessment: The animals were slaughtered in a commercial beef plant. After slaughter, perinephric plus retroperitoneal fat was weighed, and cold carcass weights (hot weights x 0.98), carcass conformation and fat scores and carcass measurements were recorded. After chilling, the right side of each carcass was divided at the 5th rib into a pistola hind quarter (i.e. the hind quarter to the 5th rib but without the flank) and a fore quarter that included the flank. The 5th to 10th ribs joint was removed and separated into fat, muscle and bone (including *ligamentum nuchae*). Muscle *longissimus* area was measured at the 10th rib.

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Initial carcass weights were estimated for all animals using the kill-out proportions (0.474, 0.483 and 0.517 for HF, AA and BB, respectively) of the pasture only finished group. These kill-out values were used because previous data had shown that the kill-out proportion of cattle on autumn pasture gaining about 0.75 kg/day is relatively constant. Similar, but slightly modified, values (0.475, 0.486 and 0.512 for HF, AA and BB, respectively) were used to estimate the carcass weights of the CL group at housing. The minor modifications were the equalise random differences between the breeds in the change in kill-out proportion during finishing.

Statistical analysis: Data were statistically analysed using the general linear model least squares procedures of SAS. Live weights and live weight gains up to the start of finishing were analysed for breed effects only. The finishing and slaughter data were analysed as a 3 x 3 factorial with terms for block, breed type, finishing strategy and their interactions. Feed intakes were similarly analysed but with half the number of blocks. As there were no significant interactions of biological or economic importance, the finishing, slaughter and feed intake data were reanalysed for main effects only. Because of the interest in the response of the different breeds to the various finishing strategies, a table of slaughter data is included showing the finishing strategy x breed type means.

Performance to start of finishing: Mean birth and arrival dates were in February and March, respectively, for the three breed types with the BB dates about two weeks later than for HF and AA (Table 10). Mean arrival weights were similar for HF and AA, but were greater ($P < 0.001$) for BB. Thereafter, there were no significant differences in live weight between the breed types to late summer of their second grazing season. Live weight gains from calf arrival to turn out, during the first winter or during the second grazing season did not differ significantly between the breed types (Table 11), but in the early part of the first grazing season AA grew more slowly, and in the later part grew more rapidly, than the other two breed types.

Performance during finishing: Live weights and estimated initial carcass weights are shown in Table 12. There was no significant effect of breed type on live weight at any time although by the late slaughter date, AA and BB were 11 and 26 kg, respectively, heavier than HF. As intended, live weights were similar for the two groups on pasture only at the time of early slaughter. The response to concentrates up to the time of early slaughter was 59 kg. While live weights at the start of finishing were similar for the three breed types there were significant differences in estimated initial carcass weights. BB carcasses were 18.2 kg and 14.8 kg heavier than HF and AA carcasses, respectively. Initial carcass weights, were similar for the three finishing strategies. At the time of early slaughter, the estimated mean carcass weights of those retained for late slaughter was 244 kg. It differed significantly between the breed types with BB being 21.3 and 18.0 kg heavier than HF and AA, respectively.

Live weight gains and estimated carcass weight gains during finishing are shown in Table 13. There was no significant effect of breed type on live weight gains at any time although they were numerically higher during finishing for the beef crosses. Carcass weight per day of age was significantly higher for BB than for the other two breed types which did not differ significantly.

Live weight gain during pasture finishing exceeded 0.8 kg/day but this was 0.6 kg/day below potential gain, as the animals on *ad libitum* concentrates gained over 1.4 kg /day in the same period. Live weight gains during *ad libitum* concentrate feeding were similar for the early and late concentrate finished groups. For the finishing period as a whole, live weight gains differed significantly for the three finishing strategies, being lowest for pasture finishing and highest for early concentrate finishing. Slaughter weight per day of age was significantly lower for pasture finishing compared with the two concentrate finishing strategies which were

similar. Carcass gains reflected live weight gains. They were similar for the two groups at pasture up to the date of early slaughter and significantly higher for the early concentrate finished group. Estimated carcass gains were similar for the early and late concentrate finished groups during the period of concentrate feeding. For the finishing period as a whole, estimated carcass gains differed significantly for the three finishing strategies. They were lowest for pasture finishing and highest for early concentrate finishing. Carcass weight per day of age did not differ significantly for the two concentrate finishing strategies but was significantly lower for the pasture finishing strategy.

Pasture measurements and feed intake: Mean pre-grazing sward heights for the first and second grazing rotations were 12.5 and 11.6 (s.e. 0.36) cm, respectively. Corresponding post grazing values were 6.0 and 5.1 (s.e. 0.19) cm. Estimated pre-grazing yields were 1495 and 1355 (s.e. 58.3) kg/ha DM. Corresponding post grazing yields were 497 and 349 (s.e. 31.4) kg/ha DM for first and second rotations, respectively. Mean herbage DM content was 194 and 174 (s.e. 8.2) g/kg for the first and second grazing rotations, respectively.

Concentrate DM intakes during finishing are shown in Table 14. During the first 3 weeks, adaptation period when all animals were fed the same concentrate allowance, the mean daily intake was 5.37 kg DM. There was no effect of breed type on concentrate intake other than in the final 4 weeks when the AA values were significantly higher than for the other two breed types which were similar. For the period overall, mean daily intake was 9.40 kg concentrate DM, representing 18.0 g/kg mean live weight. Mean total concentrates DM intake per animal of 903 kg. During the adaptation period, mean daily concentrate intakes were similar for the two concentrate finishing groups. Thereafter, concentrate DM intake was significantly higher, by about 0.4 kg/day, for the late finished group. However, as the difference in mean live weight during the period was proportionately greater than the difference in concentrate DM intake, intake per kg mean live weight was significantly lower for the late finished group.

Slaughter and carcass traits: Slaughter weight was not significantly affected by breed type (Table 15) but kill-out proportion was significantly higher for BB, and significantly lower for HF, than for AA. This led to a significant effect on carcass weight which was heavier for BB than for HF and AA. Carcass conformation was significantly better for BB and poorer for HF than AA. Carcass fat score was significantly higher for AA than for the other two breed types which did not differ significantly. Weight of perinephric plus retroperitoneal fat did not differ significantly between the breed types but when scaled for carcass weight it was significantly higher for HF than for BB with AA intermediate and not significantly different from the other two.

Slaughter weight, kill-out proportion and carcass weight were significantly greater for the early concentrate finished group than for the pasture finished group, and for the late concentrate finished group than the early concentrate finished group. Carcass conformation score did not differ significantly between the two concentrate finishing strategies but was significantly poorer for pasture finishing. All measures of fatness were higher for late concentrate finishing than for early concentrate finishing, and for early concentrate finishing than for pasture finishing.

With an exception of leg thickness which did not differ between breed types, all carcass measurements scaled for carcass weight were significantly lower for AA than for HF, and carcass length and depth were significantly lower for BB than for AA. All carcass measurements scaled for carcass weight were significantly lower for early concentrate finishing than for pasture finishing, and were significantly lower for late than for early concentrate finishing.

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As a proportion of side weight, pistola weight did not differ significantly between HF and BB but was not significantly lower for AA (Table 16). Ribs joint weight was significantly greater for BB than for HF with AA intermediate. *M. longissimus* area, both absolutely and scaled for carcass weight, did not differ significantly between HF and AA, but was significantly greater for BB. Pistola weight as a proportion of carcass weight was significantly greater for pasture finishing, and significantly less for late concentrate finishing, than for early concentrate finishing. Ribs joint weight was significantly greater for late than for early concentrate finishing, and for early concentrate finishing than for pasture finishing. *M. longissimus* area, both in absolute value and scaled for carcass weight, differed significantly between pasture finishing and late concentrate finishing. It was higher for the latter in absolute terms, but lower when scaled for carcass weight. The values for early concentrate finishing were intermediate between these for pasture finishing and late concentrate finishing and did not differ significantly from them.

As proportions of the ribs joint, neither *m. longissimus* nor total muscle differed between HF and AA, but BB had significantly higher proportions of both than the other two breed types. AA had significantly more total fat and less bone than HF, while BB had a similar bone proportion to AA but had a significantly lower fat proportion. *M. longissimus* proportion did not differ significantly between the three finishing strategies but other muscle proportion was significantly lower for late concentrate finishing than for pasture finishing. Total muscle proportion was significantly lower for early concentrate finishing than for pasture finishing, and for late than for early concentrate finishing. Fat proportion increased significantly from pasture finishing to early concentrate finishing, and from early to late concentrate finishing. Bone proportion was similar for the two concentrate finishing strategies and significantly higher for pasture finishing.

Breed type x finishing strategy: While there were no significant interactions between breed type and finishing strategy it is important to evaluate the effects of the finishing strategies separately for the breed types (Tables 17 and 18) as there are threshold market values for carcass weight and grades below which price is discounted. These are carcass weight, conformation and fat scores of about 270 kg, O and 3, respectively. Except for the pasture finished groups, all of the others essentially met the minimum carcass weight and conformation requirements. While only the late concentrate finished AA group actually exceeded fat score 3, all the concentrate finished groups except the early finished BB had acceptable carcass fat scores. All the groups finished on pasture and the BB group finished early on concentrates had unacceptably low carcass fat scores.

Carcass fat score is not a very precise measure of carcass fatness, as relatively small number of classes cover all commercial carcasses. Perinephric plus retroperitoneal fat weight scaled for carcass weight, or ribs joint fat proportion, should be more accurate measures of fatness. Perinephric plus retroperitoneal fat proportion has a different relationship with carcass fatness for different breed categories and so is not very useful for across breed comparisons. Regression of carcass fat score or carcass weight separately for the breed types showed that HF, AA and BB would achieve carcass fat class 3 at carcass weights of approximately 310, 295 and 360 kg, respectively. Similarly, regression of ribs joint fat proportion on carcass weight showed that 150 g/kg ribs joint fat would be achieved at carcass weights of 305, 275 and 355 kg for HF, AA and BB, respectively. Clearly, relative to HF, carcass fat score over estimated ribs joint fat proportion for AA and under estimated it for BB. Using 150 g/kg ribs joint fat as an indicator of acceptable finish, all concentrate finished groups, except BB on early concentrates, were acceptably finished, and this group was close (140 g/kg ribs joint fat) to acceptable finish. None of the breed types were acceptably finished off pasture.

With early concentrate finishing, and assuming a starting weight of 420 kg for all breed types, acceptable carcass weights of 300, 280 and 350 kg would be achieved after 122, 83 and 151

days for HF, AA and BB, respectively (based on carcass gains of 833, 942 and 886 g/day for HF, AA and BB, respectively). Corresponding periods for late concentrate finishing are 82, 47 and 99 days, respectively (based on carcass gains of 784, 868 and 943 g/day for HF, AA and BB, respectively). Clearly, if the concentrate finishing period is not to exceed 100 days or require more than about 1.0 t concentrates per animal, then only AA is suited to the early concentrate finishing strategy, while HF and BB require the late finishing strategy.

Live weight gain on autumn pasture alone exceeded 0.8 kg/day which is at the upper end of the range reported in the literature. Therefore, this can be taken as the maximum likely gain for non compensating steers grazing an adequate supply of autumn herbage. The potential gain of these steers, as represented by performance indoors on *ad libitum* concentrates, was in excess of 1.4 kg/day. The relative potential of pasture to concentrates for carcass gain was even lower than for live weight gain due to the higher kill-out proportion of the concentrate fed animals.

It is somewhat surprising that there was no difference in performance between the two concentrate finished groups during the period of concentrate finishing. It might be expected that the late concentrate finished group would have expressed compensatory growth having spent the previous period gaining below their potential at pasture. However, because the two concentrate finishing periods were not simultaneous there may have been some treatment related confounding factors such as weather/season (early concentrate finishing occurred in autumn whereas late concentrate finishing occurred in winter) or sub clinical respiratory disease (early concentrate finishing occurred when few other cattle were housed whereas sheds were fully occupied during late concentrate finishing).

Since for the early concentrate finished group concentrates replaced pasture the response to concentrates as a supplement to pasture cannot be estimated but the conversion of concentrates to weight gains can. The early concentrate finished animals gained 140 kg live weight and 83 kg carcass weight, for a concentrate input of 867 kg DM, giving conversion ratios of 6.2 and 10.5 for live and carcass weight gains, respectively. However, while these gains were being achieved indoors, the animals at pasture were also gaining live weight and carcass weight. Compared with the animals at pasture, the animals finished early on concentrates gained 63 kg more live weight and 45 kg more carcass weight. Thus, the conversion rates of concentrates DM to live and carcass gains above those obtained at pasture were 13.7 and 19.2 kg, respectively. Based on current concentrate costs and live and carcass weight prices, the early concentrate finishing strategy was uneconomic unless other factors such as improved carcass grades are considered.

Live and carcass weight gains during late concentrate finishing were 130 and 85 kg for a concentrate input of 941 kg DM, giving conversion rates of concentrates to live and carcass weight gains of 7.2 and 11.1, respectively. Based on these values, the late concentrate finishing strategy would be economic at current concentrate costs and live animal and carcass prices. The reason for the large difference in estimated conversion rates between the two concentrate finishing strategies is that in the early finishing strategy only the increment of performance above that obtained at pasture is considered, whereas in late finishing that increment is assumed to be zero. This is because grass growth had ceased and all available herbage had been utilized at the time the late concentrate finished group was housed. While the late concentrate finishing strategy may be acceptable economically, it cannot be considered as early finishing or finishing without housing.

In 2005, proportionately 0.49 of calves born to Irish Holstein-Friesian dairy cows were pure bred, proportionately 0.15 were Aberdeen Angus sired, and proportionately 0.04 were Belgian Blue sired. Thus, the breed types used in the present study represent proportionately 0.68 of Irish dairy bred calves. Furthermore, they represent the extremes of breed type in terms of

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fatness, conformation and muscling. The differences in these traits imply differences in suitability of the breed types to various finishing systems. The Aberdeen Angus crosses are more suited to earlier and less intensive finishing than the Belgian Blue crosses. The relatively high usage of Aberdeen Angus bulls in dairy herds reflects their suitability for use on heifers and young cows because of their shorter gestation length, lower calf birth weight and lower incidence of calving difficulty than other beef breeds. The Belgian Blue breed is becoming increasingly popular for crossing on dairy cows because, amongst the late maturing breeds, it has the shortest gestation length, the lowest incidence of calving difficulty and the lowest calf mortality.

Conclusions: There were few differences between the breed types in life time live weights and live weight gains. Kill-out proportion was higher for AA than HF but the difference was not sufficient to yield significant differences in carcass weight or life time carcass gain. The superior kill-out proportion of BB over the other two breed types did yield a significantly greater carcass weight and life time carcass gain. Carcass conformation was best for BB and poorest for HF while indicators of fatness were highest for AA and lowest for BB. Concentrate intake did not differ significantly between breed types. Ribs joint muscle proportion and *m. longissimus* area were similar for HF and AA but were higher for BB. Ribs joint fat proportion were similar for HF and BB and higher for AA, while ribs joint bone proportions were similar for AA and BB and higher for HF. Pasture alone supported live and carcass weight gains of about 800 g/day and 400 g/day, respectively. Corresponding values for concentrates *ad libitum* were 1400 and 870 g/day with no difference between the early and late finishing strategies. While concentrate intake was higher for late finishing in absolute terms, it was lower per kg live weight. Concentrate finishing increased all measures of fatness with higher values for the late finishing strategy. Concentrate finishing also increased kill-out proportion and carcass conformation score with no difference between the two concentrate strategies for these traits.

Table 10: Birth and arrival dates, and live weights for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers

	<u>HF</u>	<u>AA</u>	<u>BB</u>	<u>s.e.</u> ¹	<u>Sig</u>
Date of birth	Feb 10	Feb 13	Feb 27	2.63	***
Date of arrival	March 06	March 10	March 28	2.74	***
<u>Live weight at (kg):</u>					
Arrival	51.8 ^a	56.7 ^a	69.7 ^b	2.01	***
Calf turn-out (May 17)	98.3	102.3	95.5	2.37	NS
Mid season (July 20)	142	136	141	3.51	NS
Calf housing (October 7)	209	213	205	4.27	NS
Mid winter (January 19)	267	265	260	6.49	NS
Yearling turn-out (March 23)	294	299	295	6.13	NS
Post yearling turn-out (April 14)	300	300	299	5.83	NS
Early summer (May 12)	340	341	343	6.34	NS
Late summer	427	422	419	10.31	NS

¹For n = 18.

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Table 11: Daily live weight gains (g/hd) for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers

	<u>Days</u>	<u>HF</u>	<u>AA</u>	<u>BB</u>	<u>s.e.</u> ¹	<u>Sig</u>
Arrival to calf turn-out	²	646	671	516	68.0	NS
Calf turn-out to mid season	64	680 ^a	523 ^b	707 ^a	40.1	**
Mid season to housing	79	855 ^a	973 ^b	817 ^a	33.7	**
Calf turn-out to housing	143	777	771	768	27.5	NS
Housing to mid winter	104	559	506	530	42.2	NS
Mid winter to yearling turn-out	63	420	534	541	53.3	NS
Housing to yearling turn-out	167	506	517	534	28.0	NS
Post yearling turn-out	22	290	33	189	130.8	NS
Post yearling turn-out to late summer	126	1056	974	991	55.8	NS
Yearling turn-out to late summer	148	899	831	838	47.5	NS
Calf turn-out to yearling turn-out	310	631	635	644	29.8	NS
Calf turn-out to late summer	436	754	732	743	21.2	NS

¹For n = 18; ²Varied with breed type -72, 68 and 50 days for HF, AA and BB, respectively.

Table 12: Live weights and initial carcass weights for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers slaughtered off pasture or following indoor finishing

	<u>Breed type (B)</u>			<u>Finishing strategy (F)</u>			<u>s.e.</u> ¹	<u>Sig</u>	
	<u>HF</u>	<u>AA</u>	<u>BB</u>	<u>PS</u>	<u>CE</u>	<u>CL</u>		<u>B</u>	<u>F</u>
<u>Live weights at (kg):</u>									
Start of finishing	418	418	419	419	415	420	7.6	NS	NS
Early slaughter	514	520	514	496	555	497	8.4	NS	***
Late slaughter	615	626	641	-	-	627	17.8	NS	-
<u>Initial carcass weights</u>									
Start of finishing	198.2 ^a	201.6 ^a	216.4 ^b	205.9	203.9	206.4	3.37	**	NS
Early slaughter	235.8 ^a	239.1 ^a	257.1 ^b	-	-	243.9	4.63	*	-

¹For n = 18. There was no significant Breed type x Finishing strategy interaction.

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Table 13: Live weight and carcass gains for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian steers slaughtered off pasture or following indoor finishing

Live weight gains for (g/day):	Breed type (B)			Finishing strategy (F)			s.e. ¹	Sig		
	HF	AA	BB	PS	CE	CL		B	F	B x F ²
Start to early slaughter	1022	1086	1014	818 ^a	1489 ^b	814 ^a	36.9	NS	***	* ³
Early to late slaughter	1208	1361	1415	-	-	1328	146.7	-	-	-
Start to slaughter	1086	1190	1108	819 ^a	1489 ^b	1076 ^a	40.8	NS	***	NS
Slaughter weight per day (g)	833	852	864	797 ^a	886 ^b	866 ^b	13.5	NS	***	NS
Carcass gains for (g/day):										
Start to early slaughter	539	577	575	403 ^a	887 ^b	400 ^a	21.9	NS	***	NS
Early to late slaughter	-	-	-	-	-	865	25.3	-	-	-
Start to slaughter	604	660	663	403 ^a	887 ^b	637 ^a	23.5	NS	***	NS
Carcass weight per day (g)	412 ^a	429 ^a	464 ^b	392 ^a	459 ^b	454 ^b	7.4	***	***	NS

¹For n = 18; ²Breed type x Finishing strategy interaction; ³Values for HF, AA and BB for PS, CE and CL of 805, 849, 801; 1431, 1660, 1367; and 830, 748 and 865 (s.e. 63.9), respectively (Table 9).

Table 14: Concentrate dry matter intakes for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers finished indoors

kg/day for weeks	Breed type (B)			Finishing strategy (F)			s.e. ¹	Sig	
	HF	AA	BB	CE	CL	B		F	
1 to 3	5.37	5.37	5.37	5.30	5.43	-	-	-	-
4 – 10	10.58	10.74	10.45	10.40	10.78	0.160	NS	0.057	
11-14	10.28 ^a	10.77 ^b	10.27 ^a	10.24	10.64	0.118	*	*	
1 to 14	9.36	9.56	9.29	9.22	9.60	0.078	NS	**	
Total intake (kg)	899	918	892	867	941	9.7	NS	**	
g/kg LW for weeks									
1 to 3	11.24	11.24	11.16	11.86	10.56	0.105	NS	***	
4 to 10	20.07	20.06	19.49	20.50	19.24	0.374	NS	***	
11 to 14	18.12	18.51	17.79	18.80	17.49	0.240	NS	***	
1 to 14	18.02	18.20	17.69	19.00	17.08	0.198	NS	***	

¹For n = 18; LW = Live weight. There was no significant Breed type x Finishing strategy interaction.

Table 15: Slaughter traits and carcass measurements for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers slaughtered off pasture or following indoor finishing

	Breed type (B)			Finishing strategy (F)			s.e. ²	Sig	
	HF	AA	BB	PS	CE	CL		B	F
Slaughter weight (kg)	554	564	561	496 ^a	551 ^b	627 ^c	9.31	NS	***
Carcass weight (kg)	275 ^a	284 ^a	301 ^b	244 ^a	287 ^b	329 ^c	5.13	**	***
Kill-out (g/kg) ²	494 ^a	502 ^b	536 ^c	491 ^a	518 ^b	524 ^b	3.66	***	***
Carcass conformation ³	1.75 ^a	2.42 ^b	2.89 ^c	1.81 ^a	2.56 ^b	2.69 ^b	0.109	***	***
Carcass fat score ⁴	2.48 ^a	2.89 ^b	2.17 ^a	1.83 ^a	2.71 ^b	3.01 ^c	0.112	***	***
Perinephric + retroperitoneal fat (kg)	7.0	6.5	6.3	3.2 ^a	6.7 ^b	9.3 ^c	0.32	NS	***
Perinephric + retroperitoneal fat (g/kg) ⁵	24.7 ^a	22.2 ^{ab}	20.5 ^b	13.4 ^a	23.5 ^b	30.4 ^c	1.11	*	***
<u>Carcass measurements (cm/kg)⁶</u>									
Carcass length	0.508 ^a	0.483 ^b	0.445 ^c	0.547 ^a	0.463 ^b	0.426 ^c	0.0074	***	***
Carcass depth	0.181 ^a	0.167 ^b	0.157 ^c	0.194 ^a	0.160 ^b	0.151 ^c	0.0028	***	***
Leg length	0.292 ^a	0.251 ^b	0.234 ^b	0.287 ^a	0.260 ^b	0.230 ^c	0.0107	**	**
Leg width	0.163 ^a	0.151 ^b	0.147 ^b	0.176 ^a	0.153 ^b	0.132 ^c	0.0026	***	***
Leg thickness	0.096	0.096	0.093	0.109 ^a	0.096 ^b	0.080 ^c	0.0014	NS	***

¹For n = 18; ²g cold carcass per kg slaughter weight; ³EU Beef Carcass Classification Scheme-scale 1 = P (poorest) to 5 = E (best); ⁴EU Beef Carcass Classification Scheme-scale 1 (leanest) to 5 (fattest); ⁵g per kg cold carcass; ⁶cm per kg cold carcass. There was no significant Breed type x Finishing strategy interaction.

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Table 16: Carcass traits and ribs joint composition for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers slaughtered off pasture or following indoor finishing

	Breed type (B)			Finishing strategy (F)			s.e. ¹	Sig	
	HF	AA	BB	PS	CE	CL		B	F
Pistola weight (g/kg) ²	468 ^a	459 ^b	472 ^a	483 ^a	464 ^b	453 ^c	2.44	**	***
Ribs joint weight (kg)	6.91 ^a	7.31 ^{ab}	7.52 ^b	5.98 ^a	7.32 ^b	8.45 ^c	0.174	*	***
<i>M. longissimus</i> area (cm ²)	62.2 ^a	67.4 ^a	78.8 ^b	62.3 ^a	70.8 ^{ab}	75.3 ^b	1.91	***	***
<i>M. longissimus</i> area (cm ² /kg) ³	0.228 ^a	0.239 ^a	0.264 ^b	0.255 ^a	0.247 ^a	0.229 ^b	0.0063	***	**
<u>Ribs joint composition (g/kg)</u>									
<i>Longissimus thoracis</i>	188 ^a	194 ^a	224 ^b	203	201	203	4.24	***	NS
Other muscle	440 ^a	418 ^b	440 ^a	453 ^a	437 ^a	407 ^b	6.20	*	***
Total muscle	627 ^a	613 ^a	663 ^b	655 ^a	639 ^b	610 ^c	5.83	***	***
Total fat	144 ^a	183 ^b	133 ^a	103 ^a	162 ^b	195 ^c	6.51	***	***
Total bone ⁴	229 ^a	204 ^b	204 ^b	242 ^a	199 ^b	195 ^b	3.91	***	***

¹For n = 18; ²g/kg right side; ³cm²/kg cold carcass; ⁴Includes *ligamentum nuche*. There was no significant Breed type x Finishing strategy interaction.

Table 17: Slaughter and carcass traits of Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian steers following three finishing strategies

Finishing strategy (F)	PS			CE			CL			s.e. ¹
	HF	AA	BB	HF	AA	BB	HF	AA	BB	
Breed type (B)										
Slaughter weight (kg)	496	496	497	551	571	544	615	626	641	16.1
Carcass weight (kg)	235	240	257	276	289	298	313	324	350	8.9
Kill-out (g/kg)	474	483	517	501	506	547	509	519	546	6.3
Carcass conformation score	1.17	1.92	2.33	2.00	2.67	3.00	2.08	2.67	3.33	0.188
Carcass fat score	1.67	2.50	1.33	2.95	2.83	2.33	2.83	3.35	2.83	0.195
Perinephric + retroperitoneal fat (g/kg carcass)	13.4	14.5	12.2	27.1	20.9	22.6	35.5	31.1	26.6	1.93
<i>M. longissimus</i> area (cm ²)	56.0	59.8	71.1	64.2	69.3	79.0	66.4	73.0	86.4	3.31
<i>M. longissimus</i> area (cm ² /kg)	0.238	0.249	0.279	0.233	0.241	0.266	0.212	0.227	0.247	0.0109
Ribs joint fat (g/kg)	96	123	88	163	184	140	173	241	171	11.3

¹For n = 6; See Tables 6 and 7 for footnotes and significance effects.

Table 18: Live weights, live weight gains, initial carcass weights and carcass gains for Holstein-Friesian (HF), Aberdeen Angus x Holstein-Friesian (AA) and Belgian Blue x Holstein-Friesian (BB) steers following three finishing strategies

Finishing strategy	PS			CE			CL			s.e. ¹
	HF	AA	BB	HF	AA	BB	HF	AA	BB	
<u>Breed type</u>										
<u>Live weights at (kg):</u>										
Start of finishing	420	417	422	417	415	415	418	422	421	13.2
Early slaughter	496	496	497	551	571	544	496	492	502	14.5
Late slaughter	-	-	-	-	-	-	615	626	641	17.9
<u>Live weight gains for (g/day):</u>										
Start to early slaughter	805	849	801	1431	1660	1376	830	748	865	63.9
Early to late slaughter	-	-	-	-	-	-	1208	1361	1415	146.7
Start to slaughter	805	849	801	1431	1660	1376	1023	1061	1146	70.7
<u>Carcass weights at (kg):</u>										
Start of finishing	199.4	201.0	217.8	197.4	200.1	214.2	198.3	203.6	217.3	6.46
<u>Carcass gains for (g/day):</u>										
Start to early slaughter	384	411	414	833	942	886	399	377	423	37.9
Early to late slaughter	-	-	-	-	-	-	784	868	943	43.8
Start to slaughter	384	411	414	833	942	886	596	628	689	40.6
Carcass of LWG (g/kg) ²	484	497	518	586	568	645	588	600	603	32.2

¹For n = 6; ²Carcass gain as g/kg live weight gain (LWG). See Tables 3 and 4 for significance effects.

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Comparison of Holstein-Friesian, Norwegian Red and Jersey young bulls for beef production

Norwegian Red and Jersey dairy cattle have been evaluated for milk production at Moorepark Dairy Production Research Centre and some of the male calves became available for beef production. The objective of this study was to compare Holstein-Friesian (HF), Norwegian Red (NR), Norwegian Red x Holstein-Friesian (NX) and Jersey (JX) young bulls for feed intake, growth and carcass traits.

A total of 40 (10 each of HF, NR, NX and JX) young bulls were reared together from shortly after birth to slaughter at about 17 months of age. They were the progeny of 3 to 5 bulls per breed type. Due to the small numbers available, the JX animals were a 50:50 mix of pure Jerseys and Jersey x Holstein-Friesians. The calves were born at Moorepark Dairy Production Research Centre and were transferred to Grange at 2-4 weeks of age. They were reared indoors for about 3 months when any animals in excess of 10 per breed type were culled on the basis of late birth dates or low live weights. No data from these animals were used.

The calves were turned out to pasture together on June 6 and grazed ahead of yearling steers in a leader/follower rotational grazing system. From September 14 until housing, they were offered 1 kg concentrates per head daily at pasture. On November 9, they were housed in a slatted floor shed in pens of 5 (2 pens per breed type), and they were offered grass silage (mean analysis : 210 g/kg dry matter (DM), 134 g/kg DM of crude protein (CP), 713 g/kg DM *in vitro* digestibility (DMD), pH 3.9) plus 2.0 kg concentrates (870 g/kg rolled barley, 67.5 g/kg soya bean meal, 47.5 g/kg molasses and 15g/kg mineral/vitamin premix) per head daily. The DM content of the concentrates was 876 g/kg. After one week of housing, 8 animals per breed type picked at random, were tied in stalls and individual silage intake was measured twice weekly for 6 weeks. During this period the supplementary concentrates allowance was reduced to 1 kg per head daily. After this intake measurement the animals were returned to their original pens and diet until April 21. Concentrate allowance was then gradually increased over the following 4 weeks to *ad libitum* intake and continued at this level until slaughter on August 15. During the *ad libitum* concentrate finishing period the animals were offered 1 kg silage DM per head daily to maintain normal rumen function. Concentrate intakes were measured on a pen basis (2 pens for breed type).

The animals were slaughtered together in a commercial meat plant. After slaughter, perinephric plus retroperitoneal fat weight, cold carcass weight (hot weight x 0.98), carcass grades, carcass measurements and carcass fat colour, visually assessed on a scale of 1 (white) to 3 (yellow), were recorded.

The data were statistically analysed using the general linear model least squares procedures of the SAS.

Silage intake during the period of individual feeding was lower for HF than for the other three breed types (Table 19), but mean live weight during the measurement period was also lower. Consequently, when silage intake was expressed as a function of live weight there was no significant difference between HF, NR and NX, but JX had a significantly higher value than NR and NX. Concentrate intake during finishing did not differ significantly between the breed types but as JX had a lower mean live weight at this time, they had a significantly higher intake per kg live weight.

Mean birth dates ranged from February 8 to February 19 for the four breed types and mean arrival dates ranged from March 4 to March 8 (Table 20). Arrival weight was significantly greater for NR than for the other three breed types, which did not differ significantly. At turnout, both NR and NX were significantly heavier than JX with HF intermediate. Differences between the breed types in live weight at housing or in mid winter were not statistically significant but by the start of finishing NR and NX were significantly heavier

than HF and JX which did not differ. At slaughter, NR and NX were 26 and 20 kg, respectively, heavier than HF, while JX were 9 kg lighter than HF. The differences between JX and the Norwegian breed types were statistically significant but HF did not differ significantly from any of the others.

From arrival to turnout, live weight gains were significantly greater for HF and NX than for JX, but there were no differences in live weight gains at pasture (Table 21). In early winter, NX gained significantly faster than JX, with HF and NR not significantly different from NX and JX. Thereafter to slaughter, there were no significant difference in live weight gain between the breed types. From calf arrival to slaughter, daily live weight gains were similar for HF, NR and NX, but tended to be lower for JX. Slaughter weight and carcass weight per day of age were similar for HF, NR and NX and significantly lower for JX.

Slaughter data are shown in Table 22. There was no significant difference in carcass weight between HF, NR and NX, but JX carcasses were significantly lighter. Neither was there any significant difference in kill-out proportion between HF, NR and NX, but JX had a significantly lower value. Carcass conformation was significantly poorer for JX than for NR, with HF and NX intermediate and not significantly different from either NR or JX. Scaled for carcass weight, perinephric plus retroperitoneal fat was similar for HF, NR and NX and significantly greater for JX. Carcass fat colour score was also similar for HF, NR and NX and significantly higher for JX.

Carcass length, carcass depth and leg length did not differ significantly between the breed types (Table 23). Leg width was significantly greater for HF and NX than for JX, and leg thickness was significantly greater for HF, NR and NX than for JX. Scaled for carcass weight, carcass length and depth did not differ significantly between HF, NR and NX, but JX had higher values. Leg length per kg carcass was significantly greater for JX, and significantly less for NR than HF. Leg width and thickness per kg carcass were significantly greater for JX than for NR and NX with HF intermediate and not significantly different from the others.

There is no obvious explanation for the greater arrival weight of NR other than their somewhat earlier birth date compared with HF and NX. As JX had the earliest birth date, it appears they had the lowest birth weight. While live weights and live weight gains varied between the breed types throughout life, there were no consistent differences between HF, NR and NX, but JX generally had lower values. Neither was there any difference in kill-out proportion between HF, NR and NX but again JX had a lower value. Relative slaughter weights per day for HF, NR, NX and JX were 100, 102, 101 and 95, respectively.

The absence of any differences in fatness indicators between HF and NR agrees with previous findings and accordingly no differences would be expected between these and NX. While JX did not have a significantly higher carcass fat score than the other breed types, it tended to be higher. Perinephric plus retroperitoneal fat weight was significantly higher for JX than for NR and scaled for carcass weight, it was significantly higher than for the other three breed types. Accordingly, it can reasonably be concluded that JX were fatter than the other breed types. As JX had significantly lighter carcasses it follows that if carcass weight was increased to that of the other breed types then fatness measures would be even higher as fatness increases with increasing carcass weight.

In conclusion, silage and concentrate intakes scaled for carcass weight were similar for HF, NR and NX, but JX had significantly higher values. Growth, slaughter and carcass traits were similar for HF, NR and NX, but JX grew more slowly although the difference while significant was relatively small. JX also had a lower kill-out proportion and a lower carcass weight. Carcass fat score was similar for all the breed types. JX had a higher proportion of perinephric plus retroperitoneal fat than the other breeds and their carcass fat was more

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yellow in colour. All measures of carcass compactness were poorer for JX than for the other breed types.

Table 19: Silage and concentrate dry matter intakes of dairy bulls of four breed types

	HF	NR	NX	JX	s.e.	Sig
Silage intake (kg/day) ¹	3.54 ^a	3.73 ^b	3.69 ^b	3.72 ^b	0.053	*
Silage intake (g/kg LW) ¹	14.9 ^{ab}	14.8 ^a	14.8 ^a	15.7 ^b	0.29	*
Concentrate intake (kg/day) ²	10.50	10.57	10.40	10.60	0.29	NS
Concentrate intake (g/kg LW) ²	19.2 ^a	19.0 ^a	19.0 ^a	20.4 ^b	0.31	*

¹During individual intake measurement in early winter with 1 kg/day supplementary concentrates;

²During *ad libitum* concentrate finishing with 1 kg/day silage DM; LW = Live weight.

Table 20: Birth dates, arrival dates and live weights of dairy bulls of four breed types

	HF	NR	NX	JX	s.e.	Sig
Birth date	Feb 19	Feb 12	Feb 16	Feb 8		
Arrival date	March 8	March 6	March 5	March 4		
<u>Live weights (kg) at:</u>						
Arrival	44.3 ^a	59.0 ^b	49.0 ^a	47.3 ^a	1.96	***
Turn-out (June 6)	90 ^{ac}	104 ^b	100 ^{ab}	85 ^c	4.1	**
Housing (Nov 9)	213	225	221	214	7.5	NS
Mid winter (Jan 12)	257	274	274	256	7.8	NS
Start finishing (April 21)	349 ^a	380 ^b	378 ^b	351 ^a	9.6	*
Slaughter (August 15)	544 ^{ab}	570 ^b	564 ^b	535 ^a	12.2	*

Table 21: Live weight gains of dairy bulls of four breed types

	No. Days	HF	NR	NX	JX	s.e.	Sig
<u>Live weight gains for (g/day)</u>							
Arrival to turnout	¹	506 ^a	482 ^{ab}	556 ^a	405 ^b	36.3	*
Turnout to housing	156	788	773	774	826	33.8	NS
Housing to mid winter	64	688 ^{ab}	767 ^{ab}	840 ^a	650 ^b	64.7	*
Mid winter to start finishing	99	925	1070	1043	965	60.3	NS
Start finishing to slaughter	116	1772	1645	1509	1581	83.1	NS
Arrival to start finishing	¹	743	781	799	737	27.8	NS
Arrival to slaughter	¹	971	971	977	922	23.8	NS
Slaughter weight per day (g)		1022 ^a	1040 ^a	1036 ^a	967 ^b	20.6	*
Carcass weight per day (g)		505 ^a	510 ^a	508 ^a	481 ^b	14.0	*

¹Varies with arrival date.

Table 22: Slaughter data for dairy bulls of four breed types

	HF	NR	NX	JX	s.e.	Sig
Carcass weight (kg)	280 ^a	291 ^a	287 ^a	258 ^b	7.6	*
Kill-out (g/kg)	505 ^a	510 ^a	508 ^a	481 ^b	4.9	***
Conformation score	2.42 ^a	2.50 ^a	2.58 ^a	1.98	0.130	**
Fat score	2.33	2.52	2.42	2.58	0.134	NS
Perinephric + retroperitoneal fat (kg)	8.84 ^{ab}	8.39 ^a	8.94 ^{ab}	10.06 ^b	0.568	*
Perinephric + retroperitoneal fat (g/kg carcass)	31.8 ^a	28.7 ^a	31.3 ^a	39.1 ^b	1.98	**
Carcass fat colour ³	1.25 ^a	1.50 ^a	1.67 ^a	2.25 ^b	0.205	**

¹EU Beef Carcass Classification Scheme: scale 1 = P (poorest) to 5 = E (best); ²Scale 1 (leanest) to 5 (fattest); ³Higher number = yellower fat.

Table 23: Carcass measurements for dairy bulls of four breed types

	HF	NR	NX	JX	s.e.	Sig
<u>Carcass measurements (cm)</u>						
Carcass length	131.8	132.8	131.3	133.8	1.31	NS
Carcass depth	45.3	45.4	44.5	44.7	0.59	NS
Leg length	68.8	66.9	68.0	68.4	0.71	NS
Leg width	50.0 ^a	49.7 ^{ab}	50.1 ^a	48.3 ^b	0.56	*
Leg thickness	31.7 ^a	31.9 ^a	32.1 ^a	30.3 ^b	0.35	**
<u>Carcass measurements (cm/kg carcass)</u>						
Carcass length	0.475 ^a	0.459 ^a	0.461 ^a	0.526 ^b	0.0125	**
Carcass depth	0.164 ^a	0.157 ^a	0.157 ^a	0.176 ^b	0.0055	*
Leg length	0.248 ^a	0.231 ^b	0.239 ^{ab}	0.269 ^c	0.0065	**
Leg width	0.181 ^{ab}	0.172 ^a	0.176 ^a	0.189 ^b	0.0047	*
Leg thickness	0.114 ^{ab}	0.111 ^a	0.112 ^a	0.119 ^b	0.0028	*

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Effects of level and method of feeding on muscle chemical composition in steers

The level and method (separate feeds or as total mixed ration (TMR)) of offering supplementary concentrates with grass silage may affect muscle chemical composition in steers. Measures of carcass fatness may be indicative of muscle lipid concentration. The objectives of this study were to determine the effects of (i) level of supplementary concentrates with grass silage, and (ii) separate or TMR feeding of the silage and concentrates, on muscle chemical composition.

There were 6 feeding treatments with 14 steers per treatment as follows: (i) grass silage offered *ad libitum* (SO), (ii) SO plus a low level of concentrates offered separately (LS), (iii) SO plus a low level of concentrates offered as a TMR (LM), (iv) SO plus a medium level of concentrates offered separately (MS), (v) SO plus a medium level of concentrates offered as a TMR (MM), (vi) concentrates offered *ad libitum* with a restricted silage allowance (AL). Low and medium target concentrate levels were 3 and 6 kg dry matter (DM) per head daily, respectively. The mean duration of the feeding period was 132 days. After slaughter the 6th – 10th ribs joint was removed and dissected. A sample of *m. longissimus et thoracis* was chemically analysed for moisture, protein and lipid. In the statistical analysis, the 5 degrees of freedom for treatment were partitioned to 5 *a priori* contrasts, one for the effect of mixing, one for the concentrate level x mixing interaction, and one each for the linear, quadratic and cubic effects of concentrate level. Measures of carcass fatness and muscle lipid concentration were regressed on carcass weight and on carcass fatness variables.

Carcass weights, measures of fatness and muscle chemical composition are shown in Table 24. There was no significant effect of feeding method and no significant concentrate level x feeding method interaction for any variable. There were significant linear and quadratic effects of concentrate level for carcass weight, carcass fat score, perirenal plus retroperitoneal fat weight and perirenal plus retroperitoneal fat weight as a proportion of carcass weight. Muscle moisture concentration decreased (linear and quadratic terms significant) and lipid concentration increased (linear term significant) with increasing concentrate level, while muscle protein concentration was unaffected. Linear regressions ($y = a + bx$) of carcass fat score and perirenal plus retroperitoneal fat (kg) on carcass weight were $y = -1.2$ (s.e. 0.78) + 0.013 (s.e. 0.002) x , $R^2 = 0.27$, and -5.7 (s.e. 3.51) + 0.05 (s.e. 0.001) x , $R^2 = 0.23$. Similarly, regressions of perirenal plus retroperitoneal fat (kg), perirenal plus retroperitoneal fat as a proportion of carcass weight (g/kg), and muscle lipid concentration (g/kg) on carcass fat score were $y = 4.9$ (s.e. 1.37) + 2.3 (s.e. 0.14) x , ($R^2 = 0.26$); $y = 19.2$ (s.e. 3.73) + 4.8 (s.e. 1.12) x , ($R^2 = 0.17$); and $y = 7.2$ (s.e. 5.83) + 7.2 (s.e. 1.76) x , ($R^2 = 0.16$), respectively. There was no

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relationship between muscle lipid concentration and perirenal plus retroperitoneal fat weight or proportion.

It is concluded that as there was no effect of concentrate feeding method on carcass weight, no effect would be expected on measures of carcass fatness or muscle chemical composition. The increase in carcass weight with increasing concentrate level was associated with increases in measures of carcass fatness but the highly significant quadratic component of the response was unexpected. There is no obvious explanation for why all measures of carcass fatness increased up to the medium concentrate feeding level but not beyond. Carcass fat score and perirenal plus retroperitoneal fat weight could reasonably be estimated from carcass weight but muscle chemical composition could not be accurately estimated from any of the carcass variables. There were no significant method of feeding effect or method of feeding x concentrate level interaction for carcass traits or muscle chemical composition. Carcass weight and measures of carcass fatness increased quadratically with increasing concentrate level. Muscle moisture concentration decreased and lipid concentration increased with increasing concentrate feeding level. Carcass weight and measures of carcass fatness were poorly related to muscle chemical composition.

Table 24: Effects of concentrate level and feeding method on carcass traits and muscle chemical composition

	Feeding treatment						s.e.	Significance ¹	
	SO	LS	LM	MS	MM	AL		L	Q
Carcass weight (kg)	305	350	348	367	360	374	7.4	***	*
Carcass fat score ²	2.02	3.44	3.33	3.51	3.62	3.51	0.175	***	***
Perirenal + retroperitoneal fat (kg)	7.5	12.2	12.1	13.2	13.9	13.2	0.76	***	***
Perirenal + retroperitoneal fat (g/kg) ³	29.7	34.9	34.8	35.9	38.6	35.3	1.98	**	**
<u>Muscle composition (g/kg)</u>									
Moisture	749	739	737	729	732	733	3.2	**	*
Lipid	21	28	32	36	34	34	3.1	*	
Protein	227	228	228	228	226	226	8.3		

¹Linear and Quadratic effects of concentrate level; ²Scale 1 = leanest to 5 = fattest; ³Of carcass weight.

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Performance of finishing beef steers offered total mixed rations constituted at feeding or ensiling

Previous work indicated that similar animal productivity occurred when finishing beef cattle were offered grass silage and concentrates separately or as a total mixed ration (TMR) produced at feeding time. However, the TMR system can be more labour efficient. An alternative option to the established TMR system is to co-ensile the concentrates with the grass and subsequently feed this TMR directly from the silo. This could reduce mechanisation costs, reduce labour input at feeding, reduce effluent production and potentially enhance silage fermentation. Potential risks include losses due to unsatisfactory silage fermentation, excess effluent flow or severe aerobic deterioration. This experiment quantified the response of finishing steers to supplementation of grass silage with concentrate feedstuffs as a TMR constituted at ensiling or at feeding.

One hundred and nineteen continental crossbred steers of mean initial live weight 505 (s.d. 41.5) kg were divided into blocks of 17 based on weight and type and assigned from within blocks to a pre-experimental slaughter group or to one of 16 treatments in an 8 (feeding treatments) x 2 (finishing periods) factorial arrangement. The feeding treatments were: 1)

grass silage only *ad libitum*; 2), 3) and 4) TMR constituted at feeding (FED) in approximate dry matter (DM) ratios of grass silage: concentrates of 75:25, 50:50 and 25:75, respectively; 5), 6) and 7) TMR diets of the same approximate ratios as 2), 3) and 4), but constituted at ensiling (CEM), and 8) concentrates *ad libitum*. Concentrate composition was 830 g rolled barley, 100 g soyabean meal, 50 g molasses and 20 g minerals and vitamins/kg. The two finishing periods were 112 (Short) and 168 (Long) days. Individual intakes were recorded daily through Calan gates. Live weights were recorded at three-week intervals. The treatment effects were evaluated using *a priori* contrasts for the linear, quadratic, cubic and quartic effects of silage: concentrate ratio and their interactions with finishing period, the effect of feeding method (FED vs. CEM) and its linear and quadratic interactions with silage: concentrate ratio, the effect of finishing period and its interaction with feeding method, together with the linear and quadratic silage: concentrate ratio x feeding method x finishing period interactions.

Table 25: Intake, performance and carcass traits of steers

	TDMI ¹ (kg/day)	LWG ² (g/day)	Carcass gain (g/day)	Fat score ³
Feeding treatments:				
Silage <i>ad libitum</i>	6.0	158	146	1.9
FED 75:25	8.5	742	479	2.5
FED 50:50	8.7	867	623	3.1
FED 25:75	9.8	994	687	3.6
CEM 75:25	6.6	565	417	2.7
CEM 50:50	7.8	732	513	2.9
CEM 25:75	8.7	779	589	3.3
Conc. <i>ad libitum</i>	9.2	938	695	3.6
s.e.	0.22	64.0	32.9	0.15
Finishing period⁴:				
Short	8.2	703	535	2.7
Long	8.1	741	502	3.2
s.e.	0.11	32.1	16.5	0.07
Significance of contrasts:				
Linear	***	***	***	***
Quadratic	***	***	***	*
Feeding method	***	**	**	NS
Finishing period	NS	NS	NS	***

¹Total dry matter intake; ²Live-weight gain; ³Scale 1 (leanest) to 5 (fattest); ⁴Short = 112 Days, Long = 168 days. There were no interactions between silage: concentrate ratio, feeding method and finishing period.

The mean (s.d.) DM (g/kg) (uncorrected for volatiles), *in vitro* DM digestibility (g/kg) and pH of the silage only, FED 75:25, FED 50:50, FED 25:75, CEM 75:25, CEM 50:50 and CEM 25:75 were 215 (11.3), 266 (5.5), 331 (16.2), 451 (20.8), 249 (26.0), 318 (28.5) and 423 (89.0), 721 (11.8), 761 (12.6) 786 (16.2), 795 (28.2), 775 (15.2), 796 (9.2) and 820 (13.0) and 3.9 (0.15), 3.9 (0.01), 4.0 (0.04), 4.1 (0.08), 3.9 (0.08), 4.0 (0.07) and 4.1 (0.04), respectively. Increasing concentrate content in the diet resulted in both linear and quadratic increases (P<0.001) in total DM intake, and live weight and carcass gains (Table 25). There was a significant effect of method of feeding for total DM intake (9.0 vs. 7.7 kg/day, s.e. 0.13); live weight gain (868 vs. 692 g/day, s.e. 36.9) and carcass gain (596 vs. 506 g/day, s.e. 19.0) in favour of FED. Fat score increased linearly (P<0.001) and quadratically (P<0.05) with increasing concentrate level. Method of feeding had no significant effect on fat score. Finishing period had no significant effect on daily DM intake, live weight gain or carcass gain per day. Animals slaughtered on Day 168 had a significantly higher fat score than those slaughtered on Day 112.

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It is concluded that increasing concentrate proportion in the ration improved animal performance and carcass traits. Offering the steers a TMR constituted at feeding resulted in greater intakes and better animal performance than when the diet was constituted at ensiling.

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Heterogeneity of genetic parameters for calving difficulty in Holstein heifers in Ireland

For specific situations, genetic parameters for calving difficulty, across parity, may be influenced by the maturity of the dam. In Ireland large differences exist in the ages at which heifers first give birth. The objective of this study was to estimate genetic parameters for calving difficulty in first parity Holsteins and to determine if the estimates differed with age of dam at first parturition.

Field data, collected in Ireland by Irish Cattle Breeding Federation (ICBF), between 2002 and 2006, on 18,798 calving performances of first parity Holstein heifers, which were between 600 and 1100 days of age at parturition, were analysed. Edits ensured that each record had pedigree information, as well as having a sire and dam which were $\geq 87.5\%$ Holstein. Records from herds where all calvings were scored as the same value were removed. Calving difficulty was recorded as four categories according to the amount of assistance applied. The data were transformed to a linear scale assuming an underlying normal distribution with a mean of zero and a standard deviation of one. The transformed scores were 0, 1.86 and 3.14 for none, some and serious assistance, respectively. Univariate (UN), multitrait (MT) and random regression (RR) sire maternal-grandsire models were fitted in ASReml (Gilmour *et al.*, 2006) with the direct (sire of calf + $\frac{1}{2}$ maternal-grandsire of calf) and maternal (maternal-grandsire of calf + $\frac{1}{2}$ maternal-grandsire of dam) genetic components accounted for. Fixed effects were contemporary group of birth of calf, type of birth (single or twin/triplet birth) and gender. One MT model divided the direct component into four traits depending on the age of the dam at first parturition while a second partitioned both the direct and maternal components. These models only converged when fixing the genetic correlations between the direct and maternal components to zero and within the direct and maternal components to 0.99. The RR models were fitted with random regressions on the dam age fitting either a single or four residual variance classes for dam age. Models were compared using likelihood ratio tests, Aikake and Bayesian information criterion.

Large differences were not observed in the incidence of serious calving difficulty in different dam age groups. Population average estimates of the heritability were low for both the direct (0.12) and maternal (0.04) components. The direct-maternal genetic correlation was -0.47.

The MT model which divided the maternal component into four traits was less optimal than assuming a single trait. Models which fitted random regressions for the maternal component failed to converge. Overall, the model with a second order random regression for the direct component, a single maternal genetic component and a single residual component, was best, suggesting that significant heterogeneity of variance existed for the direct component but not for the maternal and residual components. Heritability estimated from the most optimal RR model (Figure 1) reduced initially followed by a steady increase in slope along the dam age trajectory. At youngest dam age, the direct heritability was 0.20. This decreased to a low of 0.11 before increasing to 0.37 at oldest dam age. The genetic correlations between the direct effects had a smooth surface along the dam age trajectory. The correlations declined from unity with increasing interval between dam ages. Re-ranking and re-scaling of sires along the dam age trajectory occurred. Possible reasons for such re-ranking could be age exacerbated feto-pelvic incompatibility or an interaction between a propensity for bulls to produce malpresented offspring at birth and dam age. Secretion of oestrogenic hormones by the foetal

membranes might be related to dystocia. Maternal preparation for parturition might come under the influence of foetal genotype. It could be speculated that foetal hormone production interacts with hormone levels in the dam. Hormone levels in the dam could be affected by her age.

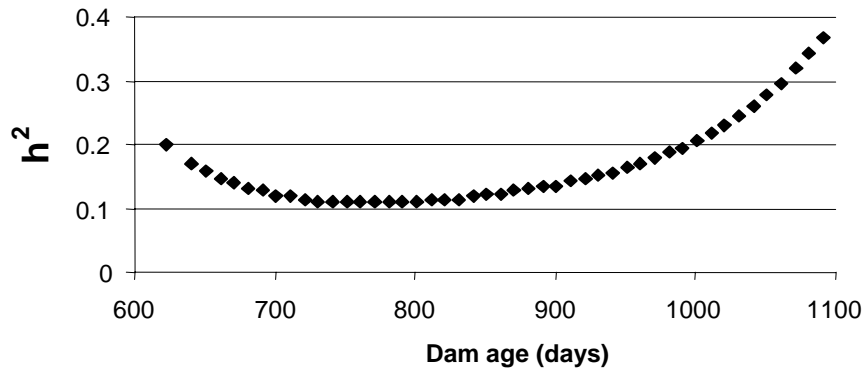


Figure 1. Estimated direct heritability (h^2) for transformed calving difficulty estimated across different dam ages at parturition.

It is concluded that data on calving difficulty recorded by farmers in Ireland allows the estimation of genetic parameters. The direct and maternal heritabilities were low, but considerable genetic variation exists. There was heterogeneity of direct genetic variance depending on the age of the dam at parturition.

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The effect of breed on growth rate and body measurements in beef × dairy and dairy male cattle

Profitability in beef production can be influenced by the growth rate of the animal. Body dimensions or linear measurements are used to supplement body weight as a measure of productivity (Gilbert et al., 1993) or as indicators of growth rate and live-weight (LW; Brown et al., 1973). The objective of this study was to compare growth rate and body measurements of Aberdeen Angus × Holstein-Friesian, Belgian Blue × Holstein-Friesian, Holstein and Friesian male cattle in their first year of life.

In 2006, 174 calves from 61 commercial dairy herds were purchased and transferred to Grange Research Centre at 2 to 8 weeks of age. The calves were Aberdeen Angus (AA; n=59) and Belgian Blue (BB; n=59) crossbreds from Holstein-Friesian dams and Holsteins (HO; n=28) and Friesians (FR; n=28) from Holstein and Friesian dams, respectively. A total of 41 sires were represented in the dataset, comprising of 10 AA, 12 BB, 7 FR, and 12 HO. Calves were reared indoors on milk replacer, concentrates and hay before being turned out to pasture where they were offered up to 2 kg concentrate per head daily. They were treated with ivermectin (Qualimec, Janssen Animal Health) at 3, 8 and 13 weeks post turn-out for the control of gastrointestinal parasites. All calves were weighed monthly. Average daily gain (ADG) from arrival to housing (mean = 186 days) was calculated by fitting a linear regression of live weight (LW) on age. in PROC REG (SAS, 2006). Prior to first housing, body

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measurements, namely height at withers, chest girth, length of back (LB), chest depth (CD) and pelvic width (WP) were recorded.

Mixed model methodology in PROC MIXED (SAS, 2006) was used to determine the effects of breed on ADG, LW at housing and body measurements. Sire and herd were included as random effects. For the analysis of ADG and LW at first housing, week of birth was adjusted for in the model. Furthermore, in the analysis of LW an interaction between breed and fortnight of age was also included in the model to account for the different growth patterns of the different breeds; fortnight of age was included as a repeated effect with a first order autoregressive correlation structure assumed among records within animal. For analysis of the body measurements, age at measurement was included as a covariate and only the linear term was significant. Least squares means for the effect of breed were calculated and compared following the Tukey adjustment for multiple comparisons.

The effect of breed on LW prior to first housing and ADG from arrival to housing are shown in Table 26. The results show that BB were heavier ($P < 0.05$) than AA, but otherwise there were no significant differences between the breeds. There were differences in ADG with FR gaining faster ($P < 0.05$) than both AA and BB, while HO was intermediate, but not different ($P > 0.05$) from the other breeds. In terms of body measurements, FR and HO were taller than AA and BB and also had greater chest depth. There were no differences ($P > 0.05$) between AA and BB, or between FR and HO except for WP, where FR and BB had greater ($P < 0.05$) values than HO and AA, respectively. Friesians had numerically the greatest values for all measurements except CD where HO was greatest, but the differences were generally not significant.

It is concluded that when body measurements were expressed per 100 kg LW, AA were taller, longer and had greater chest girth and depth than BB ($P < 0.05$). The dairy strains were intermediate between, and not significantly different from AA and BB.

Table 26: Effect of breed type on LW (kg), ADG (kg/d) and body measurements (mm/100 kg)

Breed	AA	BB	FR	HO	s.e.	Sig
LW ¹	174 ^a	187 ^b	184 ^{ab}	181 ^{ab}	4.6	**
ADG	0.60 ^a	0.64 ^a	0.79 ^b	0.67 ^{ab}	0.03	***
Height	575 ^a	522 ^{bc}	535 ^{ac}	565 ^{ac}	13.6	*
Girth	763 ^a	705 ^{bc}	703 ^{ac}	743 ^{ac}	15.0	**
LB	505 ^a	458 ^{bc}	461 ^{ac}	472 ^{ac}	11.2	**
CD	282 ^a	253 ^{bc}	259 ^{ac}	276 ^{ac}	6.4	**
WP	190	180	182	176	4.0	NS

¹At housing; ^{abc}Means with a common superscript are not significantly ($P > 0.05$) different.

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