

Teagasc

Research Report 2007

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BEEF AND SHEEP PRODUCTION RESEARCH

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INTRODUCTION

Teagasc – the Agriculture and Food Development Authority – is the national organisation providing integrated research, advisory and education services to the agriculture and food industry and rural communities. The organisation is overseen by an 11 member Board appointed by the Minister for Agriculture, Food and Fisheries (DAFF).

Teagasc Board Members

Dr. Tom O'Dwyer (Chairman)

Mr Martin Heraghty

Mr Jerry Henchy

Mr Derek Deane

Mr Patrick Kelly

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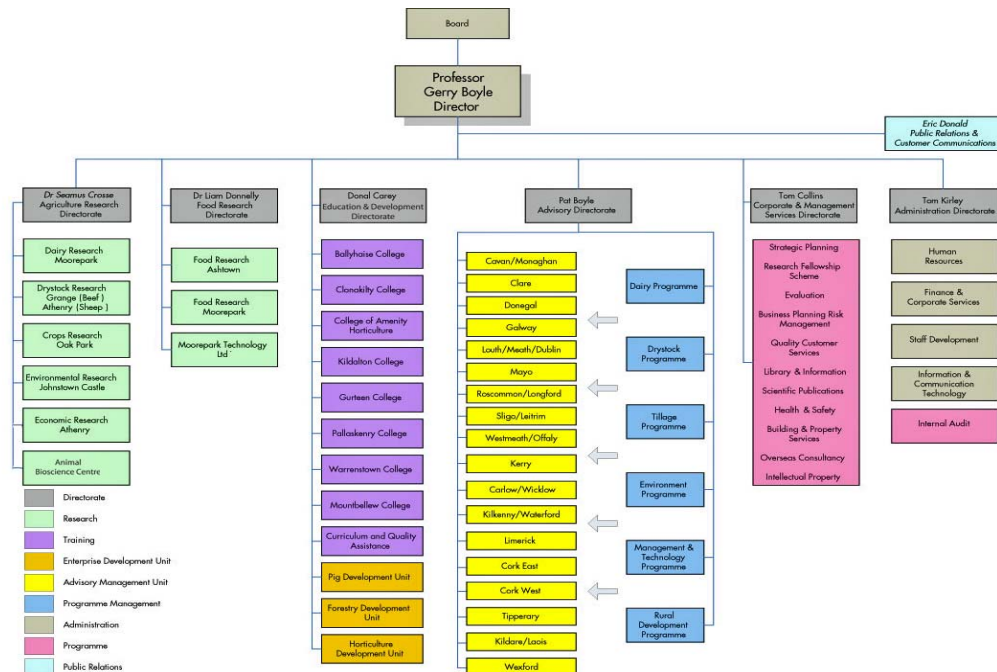
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Mr Michael O'Dwyer

Mr Stephen Flynn

Mr. Joe Fitzgerald

Teagasc employs over 1600 staff in 100 locations throughout Ireland. It has an annual operating budget in excess of €170 million. Teagasc operates in partnership with all sectors of the agriculture and food industry and with rural development agencies. The overall structure of the organisation is shown.



The organisational structure of Teagasc.

The Agriculture Research Directorate is one of the six Directorates and is a national leader in agriculture in Ireland. The annual research programme covering Animal, Crops, Environment and Economics and Rural Research comprises almost 200 research projects. The key objectives of the research programme are to:

- provide a strong scientific basis for competitive and sustainable primary production,
- underpin product innovation and ensure safety and nutritional attributes of food, and
- support the development and assessment of national and international policies in relation to the agri-food industry and rural communities.

The Teagasc research programme is conducted by 250 scientific and technical staff located at six Research Centres including Moorepark, Grange (2), Athenry, Oak Park and Johnstown Castle. There are four main programme areas including Livestock, Crop, Environment and Economics and Rural Development. Within each programme area there are a number of sub-programmes (*Table 1*).

Table 1. List of main programme and sub-programme areas.

Livestock Research	Crops Research
Genetic Improvement of Livestock.	Crop Agronomy.
Grassland/Forage	Genetic Improvement of Crops.
Animal Growth & Physiology.	Plant Genomics for Crop Sustainability.
Animal Well-Being and Reproduction.	Non Food use of Crops.
Sustainable Production Systems and Systems Analysis.	Sustainable Crop Production Systems.
Livestock Facilities / Labour and Automation.	Economics & Rural Research
Technology Evaluation & Transfer.	National & International Trends.
Animal Genomics / Proteomics to Improve Production Efficiency.	Farm Economics.
Animal Nutrition & Product Quality.	Food Industry Economics.
Environment Research	Quality of Life in Rural Areas.
Nutrient Efficiency	Land Use & Spatial Analysis.
Water Quality and Risk Assessment	Evaluation (Policy & Intervention).
Greenhouse Gases and Climate Change	Database-Collection & Management.
Soils and Environmental Protection	Economics of Scientific Innovation.
Biodiversity / Ecology	Statistical Analysis, Modelling & Forecasting.
Modelling and Integration	Environmental Economics.
Mini-catchments	

Beef and Sheep Production research, which contributes to the livestock research programme is conducted at Grange Research Centre and the Athenry Production Research Centre.

Grange Research Centre is located in County Meath. It is the national Beef Research Centre which provides research information on all aspects of beef production in Ireland. Staff numbers consist of 11 researchers, with a support staff of 60. In addition, 15-20 students undertake post graduate studies as part of the programme.

Athenry Production Research Centre is located in County Galway. It is the national sheep production research centre which provides research services in sheep production and animal reproduction. In addition to the facilities at Athenry the centre has a hill sheep farm at Leenane, County Mayo.

BEEF AND SHEEP RESEARCH
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HIGHLIGHTS FROM THE 2007 BEEF RESEARCH PROGRAMME

In **beef systems and animal genetics** studies, animals with differences in residual intakes (RFI) did not differ in live weight, average daily gains (ADG), body and ultrasound measurements, muscularity score or blood variables. Behaviour at pasture was similar between the RFI groups and pregnant beef heifers differing in phenotypic RFI as weanlings did not differ in haematological profiles around housing.

In a study using sires of high or low beef carcass index (BCI) the high BCI progeny were heavier at slaughter but there was no difference between the progeny of high or low BCI sires for feed intake, weight gain or feed efficiency during finishing. There was no difference in muscular score between the progeny of the high and low BCI sires, but progeny of the high BCI sires had greater skeletal scores, scanned muscle depth and carcass weight. There was no effect of BCI on carcass conformation score but the high BCI progeny had lower fat score. There was no effect of BCI on carcass meat and fat proportions. Mean expected predicted differences (EPD) observed between the respective progeny was 14 kg for carcass weight, 0.10 for conformation score and 0.60 for fat score. For each unit increase in sire EPD, weaning weight, DM intake, carcass weight, carcass conformation score and carcass fat score, progeny performance increased by 1.0 kg, 1.1 kg, 1.3 kg, 0.9 (scale 1 to 15) and 1.0 (scale 1 to 15), respectively, all of which did not differ from the theoretical expectation of unity. The expected difference between the progeny of the high and low BCI sires was €42, whereas, the observed mean differences in the progeny was €52.

In a study examining the relationships between linear scores and carcass output, it was found that at 8 to 12 months of age and at slaughter, the ICBF linear scoring system for muscular scores, Signet scores and scanned muscle depth, were positively correlated with the 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. The ICBF linear scoring system for average skeletal score showed only a low significant relationship with the proportion of high-value cuts in the carcass at 8 to 12 months. At slaughter, skeletal scores showed low negative relationships with carcass meat proportion, the proportion of high-value cuts in the carcass and carcass value and low positive relationships with carcass fat and bone proportions. Scanning for fat depth at slaughter showed a significant positive correlation with carcass fat score. It is 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. Correlations between visual average skeletal scores and carcass traits were generally poor.

In a study examining the relationships between carcass grade and meat yield, it was found that correlations for carcass conformation score were positive with carcass meat proportion, proportion of high-value cuts in the carcass and carcass value, and negative with carcass bone and fat proportions. Correlations for carcass fat score were positive with fat proportion but with all other traits were low and negative. Regression analysis showed that carcass scores explained 0.63, 0.76 and 0.60 of total variation in carcass meat and bone proportion and carcass value, respectively. A one unit (scale 1 to 15) increase in carcass conformation increased carcass meat proportion by 11.2 g/kg and carcass value by 5.6 c/kg. A one unit increase in carcass fat decreased carcass meat proportion by 8.2 g/kg and decreased carcass value by 5.1 c/kg.

A study using beef cross males from the dairy herd compared spring-born Friesian (HF), Aberdeen Angus × Friesian (AA) and Belgian Blue × Friesian (BB) steers reared extensively to the end of the second grazing season and slaughtered at about 28 months of age, determined the effects of feeding level during the second winter on performance and slaughter traits, and also compared finishing at pasture with finishing indoors on a high concentrate diet. There was no significant effect of breed type on live weight at any time. A higher winter

feeding level increased end of winter live weight by 38 kg and pre-slaughter live weight by 23 kg. Compared with pasture finishing, indoor finishing increased pre-slaughter live weight by 55 kg. The higher feeding level increased winter live weight gain by 341 g/day and reduced finishing live weight gain by 150 g/day due to the expression of compensatory growth by those on the lower winter feeding level. However, overall (winter plus finishing period) live weight gain was still 118 g/day higher for the higher winter feeding level. Compared with pasture finishing, indoor finishing increased finishing live weight gain by 666 g/day.

Throughout the winter period, intake was significantly higher for FR than for BB, with AA intermediate and generally not significantly different from the other two breed types for silage intake or from FR for total intake. When expressed per kg LW, there was no significant intake difference between AA and BB, but the FR values were always significantly higher than for the other two breed types.

Feeding a higher concentrate level in winter significantly depressed silage intake at all times, both absolutely and per kg LW. The overall depression in silage intake due to the higher winter concentrate level was 1.62 kg DM/day or 3.9 g/kg LW. The corresponding increase in total DM intake was 1.47 kg DM or 2.1 g/kg LW. Over the entire winter period mean daily concentrate DM intakes were 0.91 and 4.0 kg for the low and high concentrate feeding levels, respectively. Corresponding total intakes were 103 and 452 kg concentrate DM. The end of winter response to the higher concentrate input was 38 kg live weight or 109 g live weight per kg extra concentrate DM.

Slaughter weight did not differ significantly amongst the breed types but due to differences in kill-out proportion, carcass weight was significantly greater for AA than for FR, and for BB than AA. Carcass conformation class was significantly higher for AA than FR, and for BB than AA. Carcass fat class was significantly higher for AA, and significantly lower for BB, than for FR. The higher winter feeding level significantly increased slaughter weight and carcass weight but had no effect on kill-out proportion. It also tended to increase carcass conformation class but had no effect on carcass fat class. Finishing indoors rather than at pasture significantly increased all the measured slaughter variables except carcass fat class where the numerical increase did not reach significance.

In a study comparing feed intake and growth rate of steers differing in breed and genetic merit for growth, male progeny of 23 beef sires having either high (H; n=13) or low (L; n=10) genetic merit for growth were sourced in spring 2006. The beef sire breeds were Aberdeen Angus (AA; n=10) and Belgian Blue (BB; n=13). There were also progeny from Friesian sires (F; n=7) and Holstein sires (O; n=6) giving a total of 6 genetic groups. During the winter period, growth rate and DMI were influenced by genetic merit. H grew faster and had greater DMI than L on an absolute basis but when total DMI was adjusted for LW, L had the greater values. Consequently, feed efficiency was superior for H. Dairy breeds had greater DMI and LW than beef breeds. Intake trends were generally similar for the silage-based and grass diets.

In **systems modelling** a Grange Beef Model (GBM), using linear programming, has been designed to identify financially optimal beef production systems in Ireland given a range of resource and economic parameters. Likewise, an Integrated Farm System Model (IFSM) simulation model has been developed which can be used to evaluate the long term performance and environmental impact of beef production systems. A component-based comparison was undertaken to evaluate the capacity of the Grange Beef Model to accurately simulate suckler beef production systems. Relative to the growth curves assumed in the GBM, IFSM underestimated production in spring and overestimated production in autumn. However, the annual production across all fertilization strategies indicated a yield differential of only 2% between the two models. The different model specifications resulted in IFSM predicting annual average beef cow intakes 2% greater than the GBM. For weanling through finishing cattle, intake predictions were closer throughout the year with IFSM predictions

being a little greater than GBM during the finishing period. There was a modest difference between the two models with IFSM predicting 6% greater total feed consumed relative to GBM. In general, the production systems were similarly represented by the two models.

In **grassland** an animal intake study was undertaken to estimate the DMI of steers of high or low genetic merit for beef production compared with Holstein-Friesian (HF) steers, when grazing pasture during summer and when offered grass silage indoors during winter. Pasture and silage DMI did not differ between the genotypes. Relative to LW, DMI for both forages was higher for L than H beef genotypes, however, only relative silage DMI was higher for HF than beef genotypes. DMI of pasture and grass silage by individual steers was poorly correlated. There was no difference in mean DMI of pasture using the n-alkane and disappearance methods.

Another grassland study was undertaken to determine the effects of changes in the relative proportions of two grass and two clover species in a seed mixture at two sites: Co. Cork and Co. Galway. The results show that there are benefits to be gained by going beyond perennial ryegrass as the only grass species in the seed mix. Averaged across the two sites and seeding rates, timothy was consistently the highest yielding species after 2 years. Any of the seed mixtures which contained the two grasses and at least 10% of white clover were most productive. These mixtures also strongly reduced the ingress of weeds into the swards which meant that no herbicides were needed.

The objective of another grassland study was to compare the growth and feed intake of weanling heifers grazing pasture with that of heifers offered grass silage indoors during winter. The results showed that weanling heifers grazing pasture at a mean daily DM allowance of 11 kg DM/head gained more LW than heifers offered grass silage indoors during winter. This result was associated with a higher DM intake and similar FCE for the grazed heifers.

In **forage conservation** studies, as part of a national survey to determine the proportion of bales with visible mould growth on farms in Ireland, data were collected on current bale-making and storage practices. It concluded that bale wrapping, handling and storage were typical of the Irish on-farm practices observed in 1999, although there have been some noteworthy changes. For example, the use of plastic netting rather than twine to secure bales increased from 0.09 to 0.71 and the practice of wrapping bales close to the storage site and not in the field rose from 0.28 to 0.40.

The occurrence of particular fungi was analysed in relation to silage characteristics. The fungal species that colonised the largest surface area on bales, were namely *P. roqueforti*, *Schizophyllum commune*, *Pichia fermentans* and *Penicillium paneum*. Analysis showed that only region, lactic acid concentration, butyric acid concentration and weather at harvest contributed to the variance found in the species data. These four silage variables explained 0.63 of the variance. *P. roqueforti* and *P. paneum* were more common in bales that were harvested in dry weather and had higher concentrations of butyric and propionic acids. *P. fermentans* occurred in wetter silage, harvested later in the summer, and on bales that were surrounded by apparently undamaged polythene film; it was more common in the northern half of Ireland. *S. commune* was distinctly different from the previous fungi mentioned in that its occurrence was positively correlated with (i) bales stored more than one tier high, (ii) where visible damage to the polythene film was evident and (iii) in silage with a high pH and DM content and lower lactic acid, acetic acid and ammonia-N concentrations.

It is concluded that growth of spoilage fungi on baled silage is not a random occurrence but is facilitated where in-bale environments allow the fungi to survive, colonise and reproduce, depending on the nutritional and physical requirements and tolerances of particular species.

Previous research found no difference in intake or carcass gain when beef cattle were offered wheat or barley silage harvested at a normal or an elevated cutting height. As digestible energy is higher in cereal grain than straw, reducing the amount of straw, and thus increasing the proportion of grain in the mixture, should increase its feeding value when harvested as whole-crop cereal silage. Thus, a study was undertaken to quantify the intake and digestibility in cattle offered varying grain:straw (G:S) ratios of whole-crop wheat or barley silages. There was a positive linear (and quadratic for barley) effect on the digestibility of DM, organic matter and N as G:S increased, and a corresponding negative linear effect on NDF and starch digestibility for both cereal types. It is concluded that increasing the proportion of grain in whole-crop wheat or barley silage based diets from 0 to 0.9 increased the intake of digestible nutrients. These increases were linear for both wheat and barley. Increasing the G:S ratio increased the concentration of fermentation products (total VFA, ammonia, and the molar proportions of the VFA's, except acetic acid) in the rumen and altered the mean profile of fermentation products from acetic acid towards the C₃-C₅ fatty acids (propionic, butyric and valeric).

A further study examined the effects of harvesting maize silage at different stages of maturity on the intake, performance and methane (CH₄) emissions of finishing beef steers and concluded that delaying date of maize harvest beyond 13 September, reduced CH₄ emissions on a DMI basis, but did not result in a decrease when expressed per kg carcass gain. Cattle offered *ad libitum* concentrates were superior to those fed maize silage in terms of growth, reduced methane emissions when expressed relative to DMI and carcass gain, carcass weight and feed conversion ratio.

In an **animal nutrition** study the effects of replacing a proportion of the barley in a barely-based concentrate ration with maize meal plus sufficient soya bean meal to ensure an adequate protein content in the diet, was undertaken. Concentrate intake was higher for the ration with maize but when scaled for mean live weight, intake did not differ between the two rations. The higher intake occurred in the early weeks of finishing when live weight gain was also higher. However, the animals on the barley based ration tended to gain faster with the result that for the total finishing period there was no significant difference between the rations in overall growth rate. Neither were there any significant effects on slaughter weight, kill-out proportion or carcass traits. In summary, feed intake was about 3% higher for the maize ration and live weight gain was also about 3% higher.

In an earlier total mixed ration (TMR) study, offering varying silage:concentrate ratio constituted at ensiling (CEM) resulted in lower intakes and poorer performance and carcass traits than when similar TMRs constituted at feeding (FED) were offered. It was suggested that the lower intakes of the TMRs constituted at ensiling may have been due to their greater bulk as a result of effluent absorption by the concentrate component and that this resulted in a slower clearance from the rumen and passage through the gastrointestinal tract. Therefore, a further study was undertaken to investigate the effects on intake pattern, behaviour, rumen characteristics and blood metabolites in steers, due to different ratios of grass silage and concentrates, method of feed preparation (TMR constituted at feeding or at ensiling), and to ascertain if there were interactions between concentrate proportion in the TMR and method of feeding. Total DM intake over a 24 h measurement period increased with increasing concentrate proportion. There was an effect of method of feeding on total DM intake with animals on the FED diets having a higher total DM intake than those on the CEM diets.

It is concluded that increasing the concentrate proportion in the diet increased total DM intake despite the decreased proportion of time spent eating and ruminating. It also changed the rumen fermentation pattern from a cellulolytic to an amylolytic profile. TMRs constituted at feeding resulted in greater intakes, higher total VFA concentrations and higher plasma glucose and urea concentrations compared with feeding similar TMRs constituted at ensiling. While the data fail to provide a clear explanation for the lower intakes and hence lower

performance on the CEM diets in the earlier study, the most likely reason was a slower clearance rate of DM and its components from the rumen. For DM, OM and NDF, the fractional rumen clearance rates on CEM were proportionately only 0.76, 0.75 and 0.78, respectively, compared to FED.

In an **animal housing and welfare** study the effect of placing mats on concrete slatted floors on performance, hoof condition and dirt scores of finishing beef steers was undertaken, and compared with animals on out-wintering pads (OWP). Animals on the OWP's had a higher dry matter (DM) intake compared with those on the slats and three mat types. Animals on the OWP treatment had a greater liveweight gain than Mat 2 and Mat 3, with slats and Mat 1 being intermediate but not different. The carcass weight was greater for the OWP and Mat 1 treatments than the slats treatment, with Mat 2 and 3 being intermediate but not different. Kill out proportion was higher in all treatments compared with slats. Feed conversion efficiency was lower for Mat 1 treatment compared with slats and was not different from Mat 2, Mat 3 and OWP's. No incidence of laminitis was observed among treatments. The number of hoof lesions was higher on all mat types compared with slats and OWP treatments. Dirt scores did not differ between treatments.

In an **animal health and welfare** study, the effect of weaning strategy on leukocyte populations (neutrophil and lymphocyte sub-types) and acute phase proteins (APPs) (fibrinogen and haptoglobin) in beef suckler calves, was examined. Following abrupt weaning, leukocyte (Leu) counts were decreased in weaned/housed (WH) calves at d 7 and remained lower than the pre-weaning baseline (d 0) for the remainder of the experimental period. Weaned and remaining at pasture (WP) calves had increased Leu counts on d 2 to d 21 compared with the pre-weaning baseline. Following housing (d 35), WP calves had a lower Leu counts at d 42 and remained lower than pre-housing baseline (d 35) up to d 56. Neutrophil (Neu) counts for WH calves were decreased at d 14 and for the remainder of the experimental period, whereas it were increased at d 2 and d 7 for WP calves. Abrupt weaning altered leukocyte populations and acute phase protein profiles in WH and WP calves. The lower circulating leukocyte count observed for WH calves may suggest that abrupt weaning can be exacerbated by housing.

Another animal health and welfare study was undertaken to investigate changes in expression of candidate genes known to be important for neutrophil-mediated immunity with the aim of developing a profile of possible biomarkers associated with transportation stress. Pro-inflammatory neutrophil genes, namely, those involved in apoptosis (A1 and Fas), tissue remodelling (MMP-9), margination (L-selectin), bacterial killing (BPI), and wound healing (Betaglycan) were investigated. Identifying changes in the expression of the inflammatory neutrophil genes involved in regulation of apoptosis, tissue remodelling, margination, and bactericidal function could begin to reveal a possible signature of imbalanced immunocompetence genes in transportation-stressed cattle. Plasma cortisol concentrations were elevated at 4.5 and 9.75 h after transport by road compared to -24 h. Blood neutrophil counts were elevated between 4 and 14 fold when compared. MMP-9, BPI, and L-selectin were up-regulated while Fas expression was down-regulated by transportation. It is concluded that bovine neutrophils exhibit a hyperactive inflammatory response during transportation stress, indicating a potential risk for increased disease susceptibility following transport.

In the **molecular biology** programme a study was undertaken to investigate the influence of dietary n-3 PUFA on the gene expression of two putative regulators of Δ -9 desaturase, SREBP-1c and PPAR α , in bovine muscle. Dietary supplementation with a blend of oils rich in long chain omega-3 polyunsaturated fatty acids (n-3 PUFA) and linoleic acid, have a synergistic effect on the accumulation of ruminal and tissue concentrations of trans vaccenic acid (VA). VA is the main substrate for Δ -9 desaturase which is responsible for *de novo* tissue

synthesis of the *cis* 9, *trans* 11 isomer of CLA. n-3 PUFA supplementation appear to enhance ruminal synthesis of VA, but then inhibits its conversion to CLA using this dietary regime in beef cattle. Expression of mRNA for SREBP was decreased 2.1 fold in animals fed a fish oil (FO) diet compared to the control. Dietary supplementation with FO did not alter the expression of PPAR- α . A positive relationship existed between Δ -9 desaturase and SREBP-1c gene expression, however, no relationship was displayed between PPAR- α and both Δ -9 desaturase and SREBP-1c gene expression. A significant negative relationship existed between VA and SREBP-1c gene expression while no relationship was observed between PPAR- α mRNA expression and any fatty acid measured. Simultaneous enhancement of CLA and n-3 PUFA concentrations in bovine muscle may be hindered by negative effects of dietary n-3 PUFA supplementation on tissue Δ -9 desaturase gene expression, mediated through reduced mRNA transcription for SREBP-1c.

In a further study a 23K oligonucleotide bovine microarray (Affymetrix[®]) was used to examine the effects of dietary supplementation of n-3 PUFA on bovine uterine endometrial gene expression and to relate changes in gene expression to key biochemical pathways using novel bioinformatic tools. Human homologue Entrez Gene IDs could be assigned to 4926 of the 5787 differentially expressed bovine genes. These 4926 genes were mapped to the Ingenuity Pathway Analysis database. 3712 were found to be network eligible, from this 1350 were up-regulated and 2362 were down-regulated. Of the 3712 genes that were network eligible a total of 418 genes were significantly differentially expressed of which 256 were up-regulated and 162 were down-regulated. Fold changes ranged from a minimum of -13.53 to a maximum fold change of 13.17. There were significant changes in the expression of genes involved in a number of important functions, including embryonic development, reproduction, immune function, protein synthesis and cell death.

In **meat quality** research a study was undertaken to determine the effects of feeding level (supplementary concentrates with grass silage), feeding method (feeds offered separately or as a total mixed ration (TMR)), breed type (Friesian or Charolais x Friesian) and duration of finishing period on *m. longissimus* chemical composition of steers, and to describe the relationships between certain carcass traits and carcass and muscle composition. There were significant linear and quadratic effects of concentrate level on slaughter weight but there were no significant effects of breed type. There was a significant linear effect of concentrate level, and significant breed type and duration of finishing effects on kill-out proportion. Carcass fat class, perinephric plus retroperitoneal fat weight, and fat depth all increased linearly and quadratically with increasing concentrate level. There were significant linear and quadratic effects of concentrate level on ribs joint total fat and bone proportions, and a significant linear effect on total muscle proportion. For the overall data set, carcass weight was moderately predictive of kill-out proportion, carcass conformation class, carcass fat class, and perinephric plus retroperitoneal fat weight. Fatness traits were more closely related to carcass weight for Friesians than for Charolais crosses but the opposite was so for kill-out proportion. The close relationship between *m. longissimus* lipid and moisture concentrations both within breeds and overall, suggests that for practical purposes, measurement of one or other of these should be sufficient to estimate muscle chemical composition. As ash concentration is low and relatively stable, and protein concentration is also relatively stable, and as all constituents must sum to unity, measurement of either moisture or lipid alone would permit estimation of the others.

The reconstruction of animal feeding strategies is an important piece of the puzzle that links an animal to its environment. Stable isotope analysis has emerged as one of the most versatile tools available to animal ecologists to reconstruct animal dietary preferences. Recently, hair has received an increased interest as an archive of past diets. This is because hair grows continuously and becomes biologically inactive once formed. Therefore, measuring sections of hair facilitates the examination of feeding history at a fine scale. Although progress has

been made in understanding the kinetics of isotope turnover in hair, the influence of age and animal growth rate has not been investigated so far. It is important, however, to quantify this possible source of variability because there is usually no control on these parameters when sampling hair from animals. It could be hypothesised that young, growing mammals would record the isotope composition of their diet in keratin faster than older animals or animals fed at maintenance.

An animal growth study with sheep demonstrates, for the first time, that growth and age play a role in the record of dietary $\delta^{13}\text{C}$ value in sheep wool. The wool from fast-growing lambs approached equilibrium faster than the wool from slow-growing lambs and young ewes, with old ewes being the slowest. However, the differences between the four groups of animals were relatively small suggesting that a single equation can be used to reconstruct previous diets for animals of different age, provided the dietary make-up is not too different and that all individuals are fed at or above maintenance.

In a study to measure dietary history it is concluded that bovine liver and kidney had fast ^{13}C turnover rates while those of heart and brain were slower. Results demonstrated that in a period of 2-3 months of feeding, the $\delta^{13}\text{C}$ values of bovine liver and kidney would be >90% equilibrated with the diet. On the other hand, heart or brain need a period of approximately 6 months to reflect >90% of the $\delta^{13}\text{C}$ and value of the diet. Since the turnover rates were somewhat similar between liver and kidney and between heart and brain tissues, it is concluded that the combined isotope analysis of either liver or kidney and heart or brain could provide a similar level of temporal information about the timing of pre-slaughter diet shift in cattle.

In other meat quality work the change in the fatty acid composition of muscle from cattle that grazed perennial ryegrass subsequently offered concentrate-based rations was studied. Replacement of grazed grass with a concentrate-based ration resulted in a decrease in the CLA and n-3 PUFA proportion of muscle lipids that could be described by a quadratic function. Feeding cut grass, maintained the CLA and n-3PUFA proportion in muscle of previously grazing cattle.

In other meat quality studies examining the effects of Vitamin E on meat colour it is concluded that for concentrate feeding systems, the beneficial effects on redness and saturation of increasing the dietary supply of Vitamin E become more apparent as the display period progresses but that grazing is as effective as a targeted Vitamin E intake of 3,000 I.U/head/day on a concentrate-based diet in terms of colour stability.

A **cow reproduction** study was undertaken to examine the effect of cow genotype (North America Holstein Friesian and New Zealand Holstein Friesian) on the expression of genes in the growth hormone and insulin-like growth factor (GH-IGF) axis during early and mid-lactation and concluded that the decrease in IGFBP-1 and IGFBP-2 mRNA abundance from days 35 to 150 is consistent with improving energy balance status. Consistent with greater IGF-I mRNA abundance, the NZHF strain also exhibited greater circulating IGF-I concentrations, and increased abundance of ALS (critical to IGF-1 stability), which, may play a role in achieving superior reproductive performance. Cow genotype and stage of lactation have significant effects on the GH-IGF axis.

In a related study the objective was to determine the effects of NEB on immune function in the *post-partum* cow using a model of severe negative energy balance (SNEB). SNEB balance resulted in increased systemic concentrations of NEFA and BHB and in a reduction in circulating lymphocyte numbers. These effects were in turn associated with pleiotropic effects on splenic gene expression including signalling pathways and networks associated with

oxidative stress, mitochondrial dysfunction, endoplasmic reticulum stress and natural killer cells.

Another study examined the intrauterine protein changes that occur between metestrus (Day 3) and late dioestrus (Day 15) in the bovine uterus using spontaneously cycling, lactating Holstein-Friesian dairy cows at least 50 days *post-partum* were used. Uterine flushings were collected from the uterine horns, ipsilateral and contralateral to the *corpus luteum* on Days 3 and 15 of the oestrous cycle. Three proteins were found to be upregulated on Day 15 compared to Day 3 and were identified as, aldose reductase, plakoglobin and heat shock protein 27. Overall, while a number of proteins were found to be upregulated on Day 15 compared to Day 3, the exact nature of their function or regulation is not readily explained. This study indicates that the uterine environment of the cow is dynamic and that its composition is not only affected by stage of cycle but also by local environmental factors.

Another study examined the relationship between blood concentrations of insulin, IGF-I, β -hydroxybutyrate (BHB), glucose, non-esterified fatty acids (NEFA) and urea during the immediate *post-partum* period and subsequent conception rate in dairy cows. Conception rate to 1st service was 47% which contributed to a overall pregnancy rate of 87%. There was no association between insulin, in the 4 weeks *post-partum*, mean insulin or changes in insulin from weeks 1 to 4 and conception rate to 1st service and similarly for NEFA, BHB and urea. Both concentrations of IGF-1 and glucose showed positive relationships with 1st service conception rate.

Blood metabolites indicative of energy balance had low repeatability during the first 4 weeks of the *post-partum* period, whereas, IGF-I had a moderate repeatability and would indicate that it is well conserved with an individual animal and that fewer measurements are needed. There was no association with either body condition score at calving or total milk yield or composition and 1st service conception rate. Conception rate to 1st service was significantly associated with plasma concentrations of IGF-I and glucose over the 4 week period. This data would suggest that sampling for IGF-1 and glucose during the early *post-partum* period has the potential to provide markers of metabolic status and fertility.

A further study looked at the effects of peri-ovulatory changes in endocrine and follicular activity on *corpus luteum* (CL) size, function and subsequent embryo survival. There was a tendency for a negative relationship between ovulatory follicle diameter and embryo survival, this was a linear relationship with an increase in ovulatory follicle size leading to a reduced likelihood of embryo survival. Embryo survival was not related to CL diameter or corrected CL volume. Concentration of prostaglandin on d7 was positively associated with embryo survival, again confirming the positive influence of progesterone during the early luteal phase on embryo survival. However the steroidogenic capacity of the CL could not be explained either by its size or by any stimulating effects of circulating estradiol and IGF-1 around heat or on day 7. The tendency for heifers ovulating larger follicles to have reduced fertility may be due to the production of incompetent oocytes produced from these large dominant follicles.

HIGHLIGHTS FOR THE 2007 SHEEP PRODUCTION PROGRAMME

The **grassland** research a study was undertaken to evaluate the effects of grass silage harvest system, maturity of maize at harvest and protein supplementation of maize silage diets on the performance of ewes in mid and late pregnancy and subsequent lamb performance. Relative to ensiling in big bales, precision chopping did not alter forage intake but increased subsequent lamb growth rate, weaning weight and number of lambs reared. Increasing concentrate feed level in late pregnancy increased lamb birth weight. Increasing maturity of maize at harvest tended to decrease lamb birth weight. Ewes offered precision chopped silage tended to rear larger litters relative then ewes offered high dry matter maize silage. Supplementing maize silage with soyabean significantly increased forage intake but did not affect litter size, birth weight or subsequent lamb performance. Relative to maize silage (without supplementation), grass silage increased forage intake. There were no effects of forage type, grass silage harvest number or soyabean supplementation of maize silage on ewe or subsequent lamb performance. The potential concentrate sparing effect of a low dry matter and high dry matter maize silages, as determined by lamb weaning weight were approximately 3 and 16.5 kg and -11 and -2.5 kg relative to baled and precision chopped silages, respectively.

A further grassland study evaluated the effects of grazing date and management of extended grazed pastures on subsequent herbage yield. It concluded that delaying grazing had a significant negative impact on herbage yield up to early May. By mid May, the impact of extended grazing date between 5 Dec and 2 Jan had disappeared. However, herbage yield in mid May was reduced due to delaying grazing date to 23 Jan. Reducing herbage allowance at grazing increased the proportion of bare ground which may impact on subsequent sward composition. Differences in bare ground due to grazing date were associated with differences in rainfall during grazing.

A **grazing systems** study was undertaken to evaluate two contrasting grass-based systems (year round grazing (YRG) and standard system) for prime-lamb production. The systems involved stocking rates and fertilizer N inputs at levels similar to those used in the study reported in 1972. Ewes of improved genetic capacity were used and the flocks were either housed during the winter period or grass grazed all year-round. Two ewe genotypes were used to examine if there were any interactions between level of prolificacy and the grassland-based systems. There was no evidence for any ewe genotype x system interaction for ewe or progeny performance. Ewes on the year round grazing system had a higher condition score at lambing. Relative to Belclare, Belclare X Cheviot ewes had a higher condition score post mating and at weaning. Lambs from ewes on the YRG system were heavier at birth and weaning and slaughtered at a younger age. System had no effect on lamb carcass weight. Relative to the Belclare X Cheviot genotype, Belclare produced larger litters and reared more lambs per ewe mated. Lambs from Belclare ewes were lighter at birth but had similar growth rate and weaning weight to lambs from the crossed ewes. Lamb carcass outputs for the Belclare and the crossed genotypes on the standard and all grazing systems were 492, 448, 362 and 330 kg/ha, respectively. It is concluded that the year round grazing provides an alternative system of producing mid season prime lamb, but requires a reduction in stocking of about 25% relative to the standard system. Use of genotypes producing litters up to 2.34 lambs/ewe are suitable for both systems. The lamb carcass output of 492 kg/ha is an increase of 63%, in approximately 30 years, using similar stocking rate and N fertiliser input. Genetic changes in ewe prolificacy accounts for approximately 60% of the increased carcass output.

In a study evaluating the effect of the season of shearing on ewe fertility and on subsequent lamb birth and weaning weights, it is concluded (based on evidence to date) that season of shearing did not alter ewe fertility, litter size or number reared. Shearing at housing increased lamb birth weight. Shearing prior to mating provides an alternative to shearing at housing.

Another study examined the effects of plane of nutrition during the first winter and subsequent grazing season, and potential interactions, on body size and ovulation rate at ~18 months of age using two breed types with contrasting prolificacy potential. It is concluded that altering the plane of nutrition during the first winter and second grazing season altered body size and condition but did not alter ovulation rate at 18 months of age. Herbage allowance during winter grazing had the greater effects on body measurements.

In the sheep research **environmental** programme, Teagasc has established several projects on its Hill Sheep Farm near Leenane, Co. Mayo, to monitor the impact of grazing. The site consists of upland and peatland. The annual stocking rate was ~0.9 ewes per ha from 1993 to 1998, and ~0.8 ewes per ha in subsequent years. In a study examining fauna populations, a total of 390 captures of pygmy shrews were made throughout the trapping season of which 82 were first and the remainder repeat captures. While the vast majority of first captures (72%) were, as expected, in the woodland, their occurrence in what are perceived as inhospitable habitats was of interest. Furthermore, those in the wet heath habitats exhibited a behavioural difference, with those in the woodland habitat in having a much lower propensity to re-enter the traps.

The aim of an EPA-funded project is to quantify the physical impact of hill sheep at low, medium and high levels of grazing by quantifying changes in micro soil erosion, plant cover and soil nutrient content over time. Purple moor-grass (*Molinia caerulea*) is the dominant species in the low and high densities of sheep occupation on the Teagasc Hill Sheep Farm. Its frequency of occurrence, however, increased by over 8 percentage points in areas of low activity compared with almost 5 percentage points in areas of high activity in the period 1995-2004. Differences in grazing intensity, represented by location and sheep activity had a significant effect on changes in surface soil levels. Data from the reference marker pins clearly indicated active micro-erosion and deposition, but the net overall effect appears to have been minimal. In relation to soil and water nutrient data, grazing intensity had no significant effect on seasonal differences followed by sheep activity and slope.

In sheep **genetics** a study is evaluating the impact of the pedigree sheep breed improvement programme for terminal sire breeds. The pattern of results, to date, indicate that the differences in progeny performance between sire with high lean meat index values and those with none or low lean meat index values are very small and of the order of not more than 0.1 kg at 14 weeks of age. A summary of all sire effects for Suffolk and Charollais rams tested to date in this project shows that the estimated effects for 90% of the individual rams are within ± 0.5 kg. Results also show that the vast majority of rams used on lowland flocks are purchased without any reference to objective genetic evaluation. This will have to be addressed if reorganisation of genetic evaluation services for the sheep sector is to impact on the genetic merit of sheep on lowland farms.

In sheep **artificial insemination** a study was designed to determine the effects of storage diluent and temperature on sperm motility and viability of fresh ram semen after prolonged storage. Storage at 5°C gave the highest sperm viability and motility up to 72 h post collection. Diluent was not an important factor at 5°C, but was when the storage was at 15°C. The fertilising capacity of viable sperm after 48 to 72 h storage at 5 °C needs to be determined. In a related study the objective was to assess the ability of ram sperm to penetrate fresh cervical mucus collected from Belclare and Suffolk ewes during the peri-ovulatory period. Mucus volume was not affected by breed. However the penetrability (by sperm) of cervical mucus in the peri-ovulatory period varies with time and this variation is breed dependent.

In sheep **parasitology** a study was undertaken to evaluate the effect of diet during mid and late pregnancy on the peri-parturient rise in nematode egg output in ewes. Regardless of diet, total faecal egg count was elevated in late pregnancy and early lactation compared to the other

time points. None of these factors (forage type, harvest system, harvest number, concentrate level and protein supplementation) had a significant effect on total egg counts. The results indicate that differences in concentrate and protein supplementation had no effect on the peri-parturient rise in nematode egg output in ewes.

Another study examined the effect of season of shearing on the peri-parturient rise in nematode egg output of ewes and concluded that the timing of shearing had no effect on the peri-parturient rise in nematode egg count in ewes.

Previous work carried out at Athenry identified 6 fungal species with a clear ability to affect the development of *T. circumcincta* eggs and the objective a further study was to evaluate the ability of these fungi to pass through the gastrointestinal tract of lambs. Chlamydospores were observed in the faeces for all fungi tested, with the majority of chlamydospores observed at collection times 12 h and 24 h. No chlamydospores were observed on day 7 from any fungal treatment. There was no significant effect of GI passage time (12 h and 24 h) on the number of spores recovered. Fungal species had an effect on the number of spores recovered. Gastrointestinal passage had an adverse effect on the ability of the six fungi, namely, *F. coeruleum*, *F. incarnatum*, *H. sphaerosporum*, *H. anguillulae*, *P. lilacinus* and *V. chlamydosporium*, to reduce larval development in faecal cultures. *D. flagrans* was the only fungus that demonstrated nematocidal capability post gastrointestinal passage.

A further study was to examine the abundance of *Lymnaea truncatula* and the prevalence of *F. hepatica*, within snail populations on the Teagasc hill sheep farm in the west of Ireland in relation to rainfall and temperature. Both habitat and season had significant effects on the proportion of infected snails observed. The proportion of snails infected depended on location within the farm and ranged from 6-21%. The highest incidence of infected snails was observed in 2007: summer (21.3 %) and autumn (27.2%). The warm dry summer of 2006 delayed the development of *L. truncatula* populations resulting in a peak abundance occurring later than expected (October) in all habitats. Milder wetter weather enabled snails to remain present on the soil surface throughout the winter (> 130 mm total monthly rainfall, temp. 6.6°C). A smaller peak in snail abundance was subsequently observed in March 2007 in all habitats. Following a very wet summer in 2007, peak abundance of snails was observed in late August. Contrasting seasonal weather conditions clearly influenced snail abundance and the maintenance of the *F. hepatica* life cycle. A milder winter clearly facilitates over-wintered infection on pasture.

Another liver fluke study examined the efficacy of triclabendazole, closantel, oxclozanide and nitroxynil against *F. hepatica* in naturally infected ewes in the lowland flock system at the Leenane hill sheep farm. The results for closantel, oxclozanide and nitroxynil treatments indicate that these drugs are highly effective compounds for the treatment of fluke in sheep on this farm. In contrast, the results for triclabendazole indicated low levels of efficacy which is indicative of the presence of triclabendazole resistant *Fasciola hepatica*.

In the organic sheep flock at Athenry, roundworm parasite levels were monitored weekly in ewes, lambs and hoggets during the grazing season. The faecal egg count values in the replacement hoggets were negligible throughout the grazing season. Up until mid-June the faecal egg count values for the lambs remained near or below 500 eggs per gram, and similar to last year, the counts rose quite sharply in late June. On the basis of escalating counts, levamisole was administered to all lambs on the 17 July. The subsequent mean egg count (excluding *Nematodirus* spp and *Strongyloides papillosus*) on day 0, 7 and 23 were 1353, 88 and 27 eggs per gram of faeces, respectively. Anthelmintic resistance was not evident.

The organic sheep flock consisting of 119 ewes were put to the in autumn 2006 of whom 111 lambed. The mating plan involved use of Belclare rams on a proportion (1/3) of the flock to generate ewe replacements whilst the remainder was joined with Texel rams. The litter size

averaged 2.22 and mean lambing date was 8 March. Peri-natal lamb mortality was high (10 %) and the loss rate of live (tagged) lambs was also high (16 %). These loss rates are partly a reflection of the high litter size but are also likely to be a reflection of the generally low birth weight which 0.5 to 0.6 kg less for singles and twins when compared with 2006 results and triplets were 0.4 kg lighter. Lamb growth rate up to 5 weeks of age was satisfactory but declined substantially between 5 weeks of age and weaning (21 June). Thus, 23 May and 21 June daily gain for lambs reared as twins or triplets averaged only 197 g. This was probably a consequence of the increasing parasite challenge during this period. Breed of sire had no significant effect in either birth weight or growth rate.