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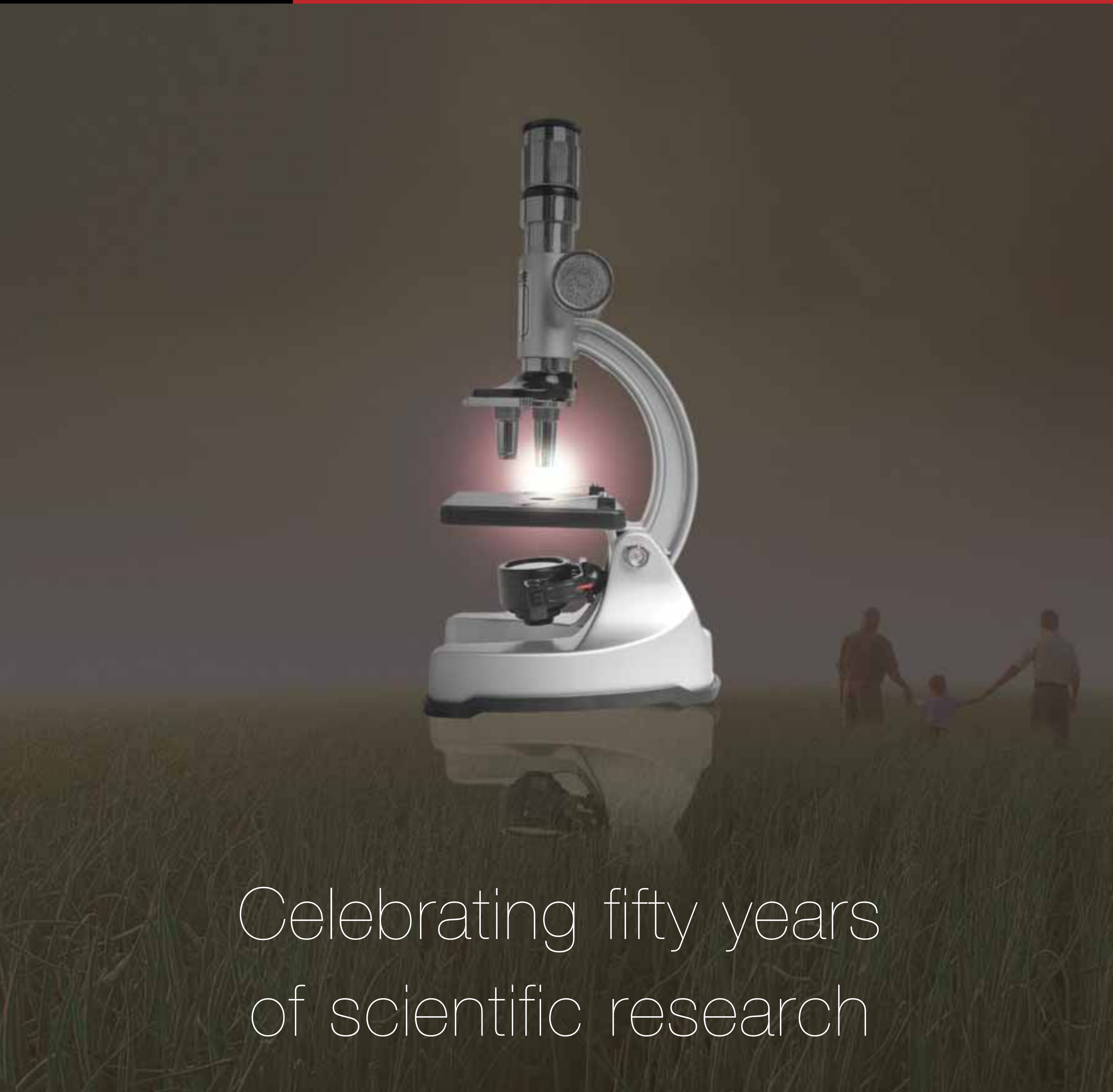
T Research

Research and innovation news at Teagasc



T Contents

Looking back, looking forward

This special anniversary issue of *TResearch* features a collection of some of the main research highlights in An Foras Talúntais (AFT) over the last 50 years. AFT was established in 1958 using funding from the American Government under the Marshall Aid Programme. The ground-breaking research emanating from the organisation provided the impetus for a new era of development in Irish agriculture, founded on scientific knowledge. AFT was amalgamated with ACOT, the advisory and training organisation, to establish Teagasc in 1988.

This is a time for reflection on the achievements of the last 50 years, and a time to look forward to prepare for the challenges ahead.

It is timely that Teagasc 2030, the outcome of Teagasc's Foresight project, which commenced last year, will be launched at a major conference in Dublin Castle on May 30. While commemorating the achievements of the past 50 years, the conference will signpost the development that can take place in agriculture and food over the next 20 years or so, and how Teagasc will contribute to this development.

The onus is on Teagasc to put structures in place to enable it to provide answers to the burning research questions, some of which have been around for some time, while new challenges such as climate change, competitive world food markets and food security, and working in harmony with the environment, will continue to test us.

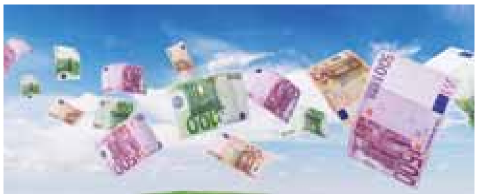
While the article focuses on some of the research that has had the biggest impact on the advancement of the agriculture and food industry in Ireland over the last 50 years, it is not possible to mention every project or every researcher. This broader contribution is duly noted in this editorial. Tribute should also be paid to the technical and farm staff who have supported the research programmes and trials.

The existence of a strong research function, closely integrated with advisory and training services, is an essential component of Teagasc's future and that of the industry that Teagasc has served so well over the past 50 years.

Catriona Boyle
Editor

T Livestock

T Economics



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T News

Honorary degree for Patrick Commins RIP

Patrick (Pakie) Commins was recently awarded an honorary degree by the National University of Ireland, Maynooth. Unfortunately, he passed away less than a week later.

At a special ceremony on March 9 in University Hospital Galway, the Deputy President of NUI Maynooth, Professor Jim Walsh, conferred an honorary doctor of literature degree on Patrick Commins. Throughout his career in Teagasc, Mr Commins held many positions of research leadership, culminating in his role as Chief Scientist for Rural Development. Following his retirement, he held positions as Adjunct Professor in both NUI Maynooth and NUI Galway.

"The degree of DLitt is the highest award provided by the National University of Ireland and it has been granted to Patrick Commins in recognition of his sustained contribution to research on the rural economy and society of Ireland. His outstanding attributes include his vision and ability to think laterally and over the long term, and his extraordinary capacity to conceptualise and contextualise, and to keep pushing out the frontiers of research on several fronts. Throughout his distinguished career he promoted new perspectives on rural Ireland, critically challenged the conventional wisdom, and proposed workable alternative strategies for government departments, among others," said Professor Walsh.

Professor Walsh described Mr Commins as "the most authoritative voice on rural development and on the social aspects of the rural economy in Ireland over the past 30 or more years". He added that Patrick also had outstanding personal qualities that will be treasured by his colleagues and friends, "including his humility, respect, loyalty, comradeship, patience, and personal generosity of time and advice for everybody no matter what their position".

The staff of Teagasc wish to extend their deepest sympathy to his wife Mairin and family.

Greenhouse gas seminar

Harry Clark, AgResearch, New Zealand, giving his presentation on 'New Zealand's Agricultural Greenhouse Gas Emissions – Policies and Approaches', at the recent Teagasc seminar.

The EU has proposed new greenhouse gas emission targets for 2020, which involve a 20% reduction in emissions from the non-emissions traded sector (ETS) by 2020. Considering rising global demand, and the future relaxation and removal of EU milk quotas, which will tend to increase agricultural emissions, this target presents a major challenge to the country, delegates at the recent Teagasc conference on agricultural greenhouse gas emissions heard in Wexford recently. The seminar heard from Teagasc experts in the various sectors, together with a presentation from Dr Hendrick, COFORD, while also looking at the strategies implemented by New Zealand to stabilise greenhouse gas emissions while maintaining production.

Teagasc is currently implementing a substantial programme of mitigation research funded largely under the auspices of the Department of Agriculture, Fisheries and Food. Gary Lanigan summarises this research in his article in this issue of *TResearch*.

The full conference proceedings can be downloaded from: www.teagasc.ie/publications.

Postgraduate education in the agri-food sector

The Minister for Agriculture, Fisheries and Food, Mary Coughlan, TD, recently launched a new initiative in postgraduate education in the agri-food sector. The Food Graduate Development Programme (www.foodpostgrad.ie) has been allocated funding of €1.1 million for a five-year period by the Department of Agriculture, Fisheries and Food under the Food Institutional Research Measure (FIRM).

Pioneered jointly by Teagasc, University College Dublin (UCD) and University College Cork (UCC), the Food Graduate Development Programme will provide skills training to postgraduate students and research staff in universities and research institutions in Ireland engaged in FIRM food research projects. Declan Troy, Teagasc Ashtown Food Research Centre, Kieran Jordan, Teagasc Moorepark Food Research Centre and Professor Liam Donnelly, Head of Food Research, Teagasc, are on the programme's project management group.

T News

Ballydague open day

Teagasc Moorepark held a Dairy Levy research update at Ballydague Research Farm, Co. Cork, recently.

Research and advisory staff from Teagasc Moorepark encouraged dairy farmers to focus on using artificial insemination (AI) to increase the numbers of high-quality dairy replacements. The number of replacement dairy females born over the last two years is inadequate to maintain the present national dairy herd size, and particularly so in an increased national milk quota scenario.

The ICBF Animal Events system shows that the number of AI bred females has increased by 5% per year over the last two years. However, a recent survey carried out by ICBF and Teagasc indicates that as an industry we should be setting a target of a 10% increase in AI use in 2008.

Laurence Shalloo, Teagasc Moorepark Dairy Production Research Centre, explains his work on 'Key Farm Efficiency Factors Required for an Expanding Dairy Industry' to Dr Tom O'Dwyer, Chairman of Teagasc, and Paddy O'Keeffe, Chairman of the Dairy Levy Trust.

SFI Stokes Professorship

Dr Brian Griffiths has commenced a five-year contract to work on important areas of the environment and soil research programme at Johnstown Castle Environment Research Centre as a Science Foundation Ireland Stokes Professor. The Stokes Professorship programme is aimed at attracting senior world-class research academics to provide scientific direction to important research programmes. Dr Griffiths joins Teagasc from the Scottish Crop Research Institute, where he has established an international reputation.

IPSAM award

Bicheng Yang, a Walsh Fellow at Teagasc Oak Park Crops Research Centre, has won an award for the best student oral presentation (session B) at the Irish Plant Scientists Association Meeting (IPSAM) held in Maynooth recently. Her talk was entitled 'Investigation of differentially expressed genes during self incompatibility response in perennial ryegrass'. Bicheng is carrying out a PhD under the supervision of Dr Susanne Barth, Oak Park, Professor Chris Franklin, University of Birmingham, Dr Danny Thorogood, IGER, and Dr Ian Armstead, IGER.

Climate change

The Department of Agriculture, Fisheries and Food has set up an Expert Group to examine the impact of climate change on agriculture and food production and the contribution of agriculture to CO_2 emissions. Dr Frank O'Mara, Assistant Director, Agriculture Research, represents Teagasc on this committee.

Frank has also been appointed as head of the new Animal Bioscience Centre at Grange. This is the largest single capital programme undertaken by Teagasc, and is extremely important in underpinning the research that will increase the efficiency and competitiveness of the livestock industries in Ireland. The position will be for a two-year period. He will continue in his role as Assistant Director during this time.

COFORD Council

Nuala Ní Flatharta, Head of Teagasc's Forestry Development Unit, has been appointed to the Council of COFORD (National Council for Forest Research and Development) by the Minister of State with responsibility for forestry at the Department of Agriculture, Fisheries and Food, Mary Wallace, TD.

APC Junior Scientist of the Year

The Alimentary Pharmabiotic Centre (a joint venture between Teagasc Moorepark Food Research Centre and University College Cork) has awarded Evelyn Clayton the Junior Scientist of the Year award for 2007. Evelyn is in the final stages of her PhD at Moorepark, working on the gut pathogen *Clostridium difficile* under the supervision of Dr Paul Ross, Moorepark, and Professor Fergus Shanahan, UCC. During 2007, Evelyn was awarded a European Marie Curie scholarship to participate in a *C. difficile* workshop in Slovenia.

Agricultural Research Forum

Professor Patrick Cunningham, Chief Scientific Advisor to the Government, is pictured at the 2008 Agricultural Research Forum. Professor Cunningham gave the plenary lecture entitled 'Small Country, Big Ambitions', at the two-day forum.

The forum features current Irish agricultural research relating to soils, crops, livestock, environment, farming systems, labour, economics, etc. This year there was a record number of 85 oral presentations and 75 poster presentations, which can be downloaded from: www.agresearchforum.com.

Food research award

Following his prize for best presentation at last year's Food Science and Technology Conference in Cork, Dr Joseph Kehoe, formerly of Moorepark Food Research Centre, has been nominated by the national panel and selected by the European organisers to be put forward for the Julius Maggi Research Award 2008 (sponsored by Nestlé Product Technology Centre Singen). Joseph will present his work at The Second European Workshop on Food Engineering and Technology in France at the end of May. Joseph completed his PhD in Moorepark in January 2008 and has recently started a post-doctoral fellowship with Professor Allen Foegeding in University of North Carolina, USA.

TResearch readership survey

Thanks to all *TResearch* readers who completed our readership survey. Your feedback is essential to the development of the magazine and is much appreciated.

The winner of the draw for the Casio Exilim digital camera is Charmaine Clarke of *safe*food, based at Little Island in Cork.

Austin Bourke Silver Medal

Agmet (the joint working group on agro-meteorological research) recently held a conference, 'Energy and the Irish Climate: Harnessing the Irish Climate for Energy', at the National Botanical Gardens in Glasnevin. The conference focused on climatic issues associated with sustainable wind, solar, marine and biomass energy supply in Ireland.

At the conference, Dr Anthony Brereton was awarded the Austin Bourke Silver Medal for excellence in agro-meteorological science for his outstanding and life-long contribution to agricultural meteorology. Dr Brereton has had a long and highly-regarded career focusing on grassland agricultural systems. He joined Teagasc (then An Foras Talúntais) at Johnstown Castle in 1976, where he developed an internationally recognised grass growth model. He was among the first to model the impact of climate change for agriculture in Ireland, and was a founding member of the Agmet Group. He retired from Teagasc Moorepark in 1997 and now lives in France, from where he maintains a very active profile within the Irish and international agro-meteorological research community.

Tom Keane (formerly of Agmet and Met Éireann) presenting Anthony Brereton with the Austin Bourke Silver Medal 2008.

A substantial body of scientific knowledge has been generated over the last 50 years by Teagasc and its predecessor, An Foras Talúntais (AFT – the Agricultural Institute). This has been to the enormous benefit of Irish farmers, and the agri and food industries, as they adapted to and utilised the knowledge to modernise the sector and evolve over the decades.

This 50th anniversary allows us to reflect on the achievements of Irish agricultural and food research during that period. Enormous strides have been made, driven by science, and to the credit of all involved in the research projects undertaken over the years.

While each area of research would warrant a publication in its own right, there is such a depth and breadth of research that we can only record some of the highlights. Over the following pages, we are reminded of some of the research achievements of the last 50 years.

Professor Gerry Boyle

Teagasc Director


CELEBRATING 50 YEARS OF SCIENTIFIC RESEARCH
FIFTY

T 50th celebration

Grassland

Michael O'Donovan

The production and utilisation of grass has a central role in maintaining the competitiveness of the Irish dairy industry. Some 60% of agricultural output in Ireland is derived from grassland, and economic analysis shows that maximum profitability within Irish milk production systems requires the optimum management of pasture. As a 10% increase in grazed grass in the feeding system will reduce the cost of milk production by 2.5 cent/litre, one strategy to increase the competitiveness of the Irish industry is to continue to increase the grazed-grass proportion of the diet. Irish dairy farmers can reap greater benefits from improved pasture management compared to any of our main competitors on world markets through the uptake of better grassland management techniques.

Since the founding of An Foras Talúntais (AFT), grassland management practice and knowledge has evolved dramatically. Initial experiments which have applications to the present day focused on stocking rates (McMeekan and Walshe, 1963) and the comparison of set stocking and rotational grazing. Nitrogen input and silage conservation strategies were researched to find the correct balance between input and output balance. In the past 20 years research focus has moved to increased grass utilisation and strategic lengthening of the grazing season. Calving date is now timed to coincide with spring grass growth and to facilitate the incorporation of a greater proportion of grazed grass in the dairy herd diet. The pursuit of a longer grazing season, use of better grass varieties and reduction in conserved forage have all led us to a more efficient grazing system. Sward grass growth potential has increased, achieved by reseeding of older pasture and through the more efficient use of artificial and organic fertiliser. Current grazing technology targets a 300-day grazing season, with a grass input of 3.9t grass DM, 1.1t grass silage and 0.4t of concentrate per cow with an output of 1,250kg of milk solids per hectare.

The role of research in developing efficient grassland systems has been pivotal. Ireland's position as a leader in grassland research reached a new high in 2005, when the International Grassland Congress was hosted in Ireland.

In the past 20 years research focus has moved to increased grass utilisation and strategic lengthening of the grazing season.

Grass and clover breeding

Patrick Conaghan

The science of forage breeding in Ireland began in the early '60s at the Oak Park Research Centre. Breeding has focused primarily on perennial ryegrass and white clover, the most important species in Irish grassland. The initial emphasis, recognising the inadequacies of the available cultivars, was on increasing animal production per unit area of land, with forage yield and persistency traits to the fore. The emphasis on traits has changed over time with seasonal yield distribution and quality traits of primary importance today. The ultimate goal of the forage breeding programme today is to increase the profitability and reduce the environmental cost of animal production from grassland.

The first perennial ryegrass cultivar, OakPark (early diploid), was released in 1972. Tetraploid cultivars of perennial ryegrass offer different but complementary characteristics to diploids. The year 1977 marked the release of the first tetraploid perennial ryegrass cultivar, Green Isle. To date a total of 13 perennial ryegrass cultivars have been released and commercialised. Milestone cultivars include Cashel (intermediate diploid), GreenGold (intermediate tetraploid) and Millennium (late tetraploid).

The white clover cultivar, Aran, was released in 1983. Aran is the only cultivar in north-western Europe that falls into the 'very large-leafed white clover' category. Today Aran still sells on average 97t of seed annually worldwide. To date a total of eight white clover cultivars have been released and commercialised. Other notable cultivars released include Tara (small leaf size), Avoca (medium leaf size) and Chieftain (medium leaf size).

In 1992, the forage breeding programme entered into partnership with DLF-Trifolium, arguably the world's market leaders in the production and distribution of grass and clover seeds. The agreement offers the breeding programme access to a wide cultivar evaluation network, and worldwide distribution and marketing of all new cultivars.

The potential for further improvement in grass and clover cultivars is enormous. Despite the significant progress made, most of the useful genetic variation within and between forage species has yet to be utilised worldwide.

Freshly sown plots of perennial ryegrass at Oak Park.

Forage breeding has focused primarily on perennial ryegrass and white clover, the most important species in Irish grassland.

Silage

Padraig O'Kiely

The productivity of cattle production systems in Ireland was traditionally constrained by an inadequate supply of hay, the quality of which was generally relatively low. Despite the mild, moist Irish climate ensuring ample supplies of feed during the grass growing season, with corresponding excellent animal productivity, few farmers were able to conserve sufficient good quality herbage for winter feeding. The adoption of silage making and feeding systems, by providing cattle with adequate feedstuff of good nutritive value throughout the winter, permitted and underpinned a major increase in the national output and export of beef and dairy products. This progress was based upon the availability of new knowledge relating to crop production, silage-making, storage and feeding, and animal nutrition, together with the availability of technologies such as mechanised harvesting, plastic sheeting, concrete silos, slatted-floor sheds, baled silage, etc.

Early research showed that superior animal productivity was achieved when grass was conserved as silage rather than hay, with the advantage for silage being much more evident when a highly nutritious 'leafy' crop was conserved. In addition, the greater independence from prevailing weather conditions that was feasible with silage helped propel its replacement of hay. Subsequently, it was confirmed that where excellent preservation of the harvested crop was achieved, animal productivity on the silage could match that achievable with the grass from which it was made.

The compilation of a large number of experiments quantified the rate at which the digestibility of different grasses declined with advancing growth stage, and how this rate of change was modified by management practices.

A very considerable amount of research was undertaken to help understand the biological processes occurring during silage fermentation and subsequent feedout, and to develop reliable indices of crop ensilability that could be used in farm practice. The individual effects of prevailing weather conditions, wilting, various additives, alternative harvesting systems, options for sealing and storing ensiled herbage, and contrasting silage feeding systems, on preservation, effluent loss and aerobic stability, were determined and guidelines developed for use in farm practice. Collectively, these provided the information with which excellently preserved silage of high nutritive value could be reliably produced.

The adoption of silage making and feeding systems, by providing cattle with adequate feedstuff of good nutritive value throughout the winter, permitted and underpinned a major increase in the national output and export of beef and dairy products.

Milking technology

Eddie O'Callaghan

The Moorepark milking research story goes back to a discovery by Nyhan and Cowhig at Moorepark in 1967. They showed that inadequate vacuum reserve or low vacuum pump capacity in a milking machine had a negative influence on milk quality, and increased mastitis incidence in dairy cows. Tragically, these Irish scientists died in an air crash en route to an international milking machine conference in 1968.

A subsequent milking trial at Moorepark in 1974 showed that low vacuum reserve and poor liner design caused liners to become unstable on the teats of cows and these slippages induced sharp drops in vacuum, allowing bacteria to be propelled through the teat canal or exit passage of the teat end. Also, liner design was shown to influence milk yield. The levels of residual milk left in the udders of cows were found to be excessive with commercial milking technology of that time.

Many attempts were made to minimise these milking problems and in the early '80s a new research programme attempted to develop new designs of liners and milking systems where liner slippage was low and residual milk left in the udder after machine milking was minimal. After testing about 300 commercial liner designs, a correlation model, linking design features with milking performance, provided guidelines for the development of a new generation of liners. X-ray studies provided detailed information on teat/liner interactions. The unique feature of these milking liners was a wider upper barrel bore and thin walls with new synthetic rubber material. Many commercial liners did not respond to the air/vacuum pulse that causes the liner to open and close and this deficiency caused trauma and inadequate milking. The new liner concept with flexible walls increased milk yield by about 5% and almost eliminated liner slippage. In the early '90s there was widespread adoption of this technology and considerable improvements in national milk quality occurred. Boyle *et al.* (2003) estimated that the internal rate of return for the milking research programme from 1975 to 1998 was 48%.

The new liner concept with flexible walls increased milk yield by about 5% and almost eliminated liner slippage.

T 50th celebration

Dairy technology

Phil Kelly

Ultra-high temperature (UHT) heating was the emerging technology for producing long shelf-life milk when Dr A.C. O'Sullivan took over as the first Head of Dairy Technology in the late '60s. A PhD graduate from Cornell University, USA, he was to apply his expertise to the understanding of whey protein denaturation during UHT processing and milk spray drying. Two former researchers (Drs R.A.M. Delaney and J.K. Donnelly) pioneered the application of reverse osmosis (RO) for recovery and concentration of whey solids – RO having been originally developed for clean up of brackish water. Ultrafiltration as a more porous type of membrane evolved and enabled the selective separation of valuable whey proteins. In the early '90s, Moorepark successfully applied nanofiltration, a new form of membrane, for the combined concentration and partial demineralisation of whey.

In the early '70s, a shortage of calf rennet for cheese making prompted researchers to explore alternative enzymes from microbial and plant sources. While effective in clotting milk, most alternative enzymes turned out to be too proteolytic, resulting in excess bitterness during cheese ripening. The learning experiences from those early days of cheese research have proved valuable in the years that followed, as the programme went on to address the acceleration of cheese ripening and improve the flavour/texture of reduced-fat cheeses.

The dominance of milk powder manufacture as a commodity in the Irish dairy product portfolio was also reflected in the dairy technology research programme, which provided the platform for ingredient innovation in the '90s. An outstanding achievement from that period was the development of Alphalac – an α-lactalbumin-enriched whey protein concentrate, which is now successfully adopted by a multinational infant milk formula manufacturer. Other successful innovations included a microencapsulated smokey bacon-fat flavour powder (runner-up in the New Ingredient Award category at Food Ingredients Europe 1998, Frankfurt), functional spray-dried powders for milk chocolate processing, and milk proteinate – a soluble co-precipitate of casein and whey protein.

Against this background, recent investments such as the BioFunctional Food Engineering Facility and National Food Imaging Centre make dairy technology research at Moorepark exceptional in terms of expertise and facilities, and well positioned to serve national needs, as well as international food companies engaging in open innovation.

The learning experiences from those early days of cheese research have proved valuable in the years that followed.

Functional foods

Paul Ross

In the last 15 years, Teagasc Moorepark Food Research Centre has built up considerable critical mass in the areas of biotechnology and food and health research. In particular, the group at Moorepark has made some very important discoveries, many of which have been patented and subsequently licensed to food companies. These include a functional probiotic cheese, which has been clinically validated and which is now commercially available; and, lacticin 3147, a potent antimicrobial peptide (bacteriocin) which is produced by a food grade starter organism and which has both food and medical applications.

One of the main areas of study at Moorepark relates to how food affects the composition of human intestinal bacteria and how this, in turn, affects human health. Indeed, 'omic' technologies, allied to high throughput sequencing, are transforming our ability to understand such complex interactions. Such approaches are also being applied to the study of obesity, infant and geriatric nutrition, and gut health in a very much expanded programme with University College Cork (UCC) and Cork University Hospital. These are aimed at the long-term development of functional foods for industry.

A major strength at Moorepark is the ability to identify protein and lipid-based bioactive substances from various food sources. In this respect, *in vitro* and cell-based assay systems linked to state-of-the-art analytic equipment (e.g., time of flight mass spectrometry) have been developed for the purposes of high throughput screening. Examples include the isolation of potentially anti-hypertensive peptides from ß-casein and antimicrobial peptides for improving the safety of infant formula – both of which are patented technologies. Such advances have been facilitated through the close partnership built up with UCC, as reflected by some of the major joint initiatives which now exist, including the SFI-funded Alimentary Pharmabiotic Centre, and national and marine functional foods research centres. Moorepark has also amassed considerable expertise in animal biotechnology in the last ten years and now houses a DNA bank of all the dairy animals in Teagasc. A major output of this programme has been a patented probiotic culture for treatment of mastitis which compares favourably to antibiotics in field trials.

One of the main areas of study at Moorepark relates to how food affects the composition of human intestinal bacteria and how this, in turn, affects human health.

Butter quality

Phil Kelly

Research on butter quality at Moorepark in the late '60s and early '70s was dominated initially by concerns about oxidative off-flavour development. In the '80s, butter consumption on the domestic market went into rapid decline as various studies emphasising the need to limit intake of total fat as well as saturated fat in the diet were published. In addition, cholesterol in butter was overplayed in terms of its negative effect on people's health – a factor that was exploited well in marketing strategies by the margarine lobby. Eventually, dairy plants succeeded in initially combining vegetable oils with milk fat in order to produce 'hybrid' products that could be termed 'dairy spread' or 'table spread'. This started off as an adaptation of butter making technology, but very soon progressed to embrace the technology already in use by margarine manufacturers, i.e., water-in-oil (W/O) emulsion behaviour. Moorepark's research was engaged with aqueous phase formulation and stabilisation of W/O emulsions to produce spreads with fat contents that dropped as low as 25% (Dr K. Keogh).

There have been a number of positive outcomes from research on butter over the years:

- modification of milk composition through feeding of dairy cows succeeded in producing milk fat with elevated levels of oleic acid that not alone contribute to improved butter spreadability (Drs K. Keogh, B. Connolly, J. Murphy, C. Cowan), but also improve its nutritional value since oleic acid is a mono-unsaturated fatty acid (also occurs in olive oil);
- Ireland exports most of its butter in 'lactic, unsalted' form as distinct from the 'salted, sweet cream' butter that is retailed on the domestic market. Lactic butter requires fermentation of cream with special cultures that contribute unique flavours (diacetyl and acetaldehyde). The cultures used by butter manufacturers were successfully researched at Moorepark by Dr Tim Cogan; and,
- recent research (Drs. C. Stanton; J. Murphy) on the occurrence and positive health attributes of conjugated linoleic acid (CLA) in Irish milk fat presents new opportunities for dairies to reposition butter and milk fat products in a new and positive light. Meanwhile, Irish butter is well regarded as premium product on the German market where sizeable export volumes are achieved.

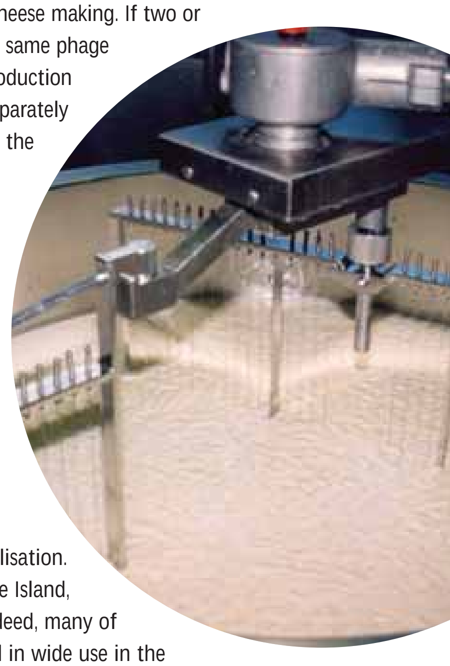
Recent research (Drs C. Stanton; J. Murphy) on the occurrence and positive health attributes of conjugated linoleic acid (CLA) in Irish milk fat presents new opportunities for dairies.

Cheese starter cultures

Kieran Jordan

Traditionally, starter cultures for Cheddar cheese making consist of a mixture of several different strains (undefined cultures), some contributing to acid production, and some to flavour formation, both essential for a well-rounded cheese flavour. However, many of these strains were likely to be inactivated by bacteriophage. So while the potential to produce a great-flavoured cheese existed, the risk of attack by bacteriophage was unpredictable, resulting in 'slow' and 'dead' vats of cheese, variable quality, and costing the manufacturers a considerable amount of money.

This was the background to the Cheddar cheese starter culture industry when Dr Tim Cogan (Moorepark) and Dr Charlie Daly (UCC) began to develop a new starter culture system in the late 1970s. The Moorepark team of Dr Cogan, Finbarr Drinan, Mark Hurley and Paddy Timmons began to study the bacteriophage resistance patterns of the strains isolated from the undefined cultures. They identified bacteriophage-resistant strains that could be added as individual cultures during cheese making. If two or three strains that were not attacked by the same phage were added at the same time, then acid production was guaranteed. The strains were grown separately and then mixed after growth and added to the cheese making process. This was called a defined strain starter culture as the strains added were known. The result was a more consistent cheese, more dependable production and great savings for the industry. In 1983 Drs Cogan and Daly were honoured with a RDS–Bank of Ireland Award for Scientific Achievement. For a few years the cultures were produced at Moorepark, but as the production requirements increased, the new starter culture system was sold to Chr. Hansen's Laboratory, for the purposes of commercialisation. A new production facility was built at Little Island, from where production is still ongoing. Indeed, many of the cultures identified at that time are still in wide use in the industry today.



They identified bacteriophage-resistant strains that could be added as individual cultures during cheese making.

Moorepark Technology Ltd

Liam Donnelly

The MTL management team at the company's official opening in 1993. W.J. Donnelly, Managing Director; Sean Tuohy, Technical Manager; technical staff Tony O'Brien, Joe Roche and Pat Cavanagh; and, Phil Kelly, Head of Food Technology Research at Moorepark.

Moorepark Technology Ltd (MTL) was established in 1993 as a joint venture between Teagasc and dairy companies to facilitate, encourage and support research and development in the Irish dairy industry.

The significance of MTL for Teagasc Moorepark Food Research Centre (MFRC) and for Teagasc was enormous. Its establishment greatly increased Moorepark's capabilities to support product innovation and provided a powerful conduit for technology transfer from public research. Today MTL is a financially stable company, generating almost €1.3m of rental business. Usage of the plant has grown steadily throughout the 15 years and it has succeeded in its financial targets since it first achieved profitability in 1996. Re-investment in the plant is continuous and the facilities have never dropped short of being the finest internationally. In short, MTL is a valuable asset to its shareholders, and it has succeeded in its primary objective of bridging the gap in technology infrastructure that exists between Irish dairy companies and many of their biggest competitors.

A feature of the company's development has been the diversity of products, processes and customers that the plant has embraced. Much of this diversity arises from the changing nature of dairy companies themselves to being more diversified food ingredient companies. It also relates to the success of the company, and of MFRC in general, in reaching out to new food sector customers, including multinationals.

Looking to the future, MTL can be confident that it will continue on the upward curve in relation to usage level, impact on customer innovation and service of Moorepark's technology transfer needs. A major opportunity is presented by the increasing emphasis that is being placed on development of foods for health. The associated requirement for fermentation and downstream bioprocess technologies is one in which the company has ambitious investment plans. The future of MTL is closely linked to the future of MFRC itself and it will share in the expansion that is currently taking place in the Centre's programme, staff and research facilities as a result of Teagasc's investment in a new 'vision' programme.

MTL has succeeded in its primary objective of bridging the gap in technology infrastructure that exists between Irish dairy companies and many of their biggest competitors.

Sheep – the Belclare

Seamus Hanrahan

Prolificacy is the major determinant of output and profitability of lowland sheep systems. Early studies in An Foras Talúntais (AFT) showed that while genetic selection would increase litter size, the likely annual rate of improvement would be very low for a multiplicity of reasons, ranging from the low heritability and sex-limited nature of the trait, to the limited scope of AI in sheep and the structure of the industry. Against this background, a variety of genetic strategies were employed leading to the development of a composite breed, the Belclare, as a source of genetic material that could significantly increase prolificacy without the need for complex breeding and selection programmes. The average litter size is 2.2. This increased prolificacy can be harnessed through the simple strategy of using Belclare rams as the sire of flock replacements.

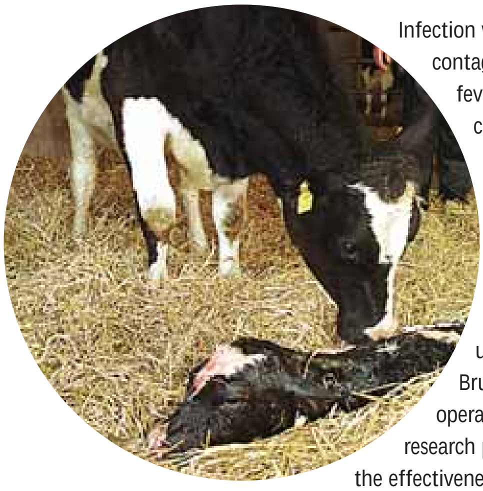
Following the initial development of the Belclare breed between 1978 and 1984, the Belclare Sheep Society was formed in 1985 by a group of farmers who had been involved in field trials during the development phase. In subsequent years, crossbred ewes from Belclare rams were evaluated, both in research centre flocks and on farms, alongside crossbreds by rams from other breeds. The results of these extensive evaluations show that the Belclare-cross ewes wean between 0.15 and 0.2 extra lambs per ewe put to the ram, depending on the alternative breed used for comparison. The impact on financial returns, at current prices and costs, is an increase of between €10 and €15 in the annual profit per ewe – equivalent to an increase of one-third in gross margin per ewe.

A significant discovery during the development of the Belclare was a small number of ewes with exceptional ovulation rates (7-18 eggs per cycle vs. the more usual 2-4). This discovery suggested that a gene(s) mutation(s) with a large effect on ovulation rate was involved. Subsequent research led to the discovery of mutations in two genes that accounted for the occurrence of animals with exceptionally high ovulation rate and this has provided valuable insights into the control of ovarian function in mammals. Thus the development of the Belclare breed has yielded new evidence on the genetic control of ovarian function that may ultimately impact on the control of human fertility.

A variety of genetic strategies were employed leading to the development of a composite breed, the Belclare, as a source of genetic material that can significantly increase prolificacy.

Brucellosis

John Mee



Infection with *Brucella abortus* causes contagious abortion in cattle and undulant fever in humans. Research on brucellosis control in dairy herds began at Moorepark in 1974 as a collaborative project between An Foras Talúntais (AFT) and UCD. Prior to this, over 30% of herds in the intensive dairying areas of the south were brucellosis-positive and remained so until the late '70s despite the National Brucellosis Eradication Scheme being in operation since 1966. The brucellosis research programme at Moorepark evaluated the effectiveness of five simple management procedures to control within-herd transmission of this disease. It also established the relative merits of the various blood and milk tests in use by the Department of Agriculture at that time. The management procedures evaluated were: identification of brucellosis–positive cows; separation of positive cows from negative cows throughout pregnancy; segregation at calving; vaccination of replacement heifers and cows; and, implementation of strict disinfection protocols.

This five-point control programme was carried out in six dairy herds at Moorepark over five years. The percentage of reactor animals was reduced from 21% in 1974 to 8% in 1978 with no newly-infected animals identified in 1978. In addition, a three-year study showed a 96% agreement between the milk ring dilution test (MRDT) and the blood serum agglutination test (SAT) for brucellosis herd screening and identified suspect animals requiring re-testing. This research programme also demonstrated that a milk test (Rose Bengal test) could be used to screen herds and animals for brucellosis, even in the presence of a brucellosis vaccine. The results from this research programme indicated that brucellosis could be eradicated from an infected herd within three years using the AFT brucellosis control programme without herd depopulation. In 1986, cattle herds in Ireland were declared officially brucellosis free (OBF, i.e., <300 net restricted herds tested positive for brucellosis) by the EU, a status still held to this day. By 2005, the national prevalence of brucellosis had been reduced to less than 0.15% of herds and 2006 was the first year since the creation of the Veterinary Laboratory Service in which brucellosis was not diagnosed in a single case of cattle abortion. Brucellosis is no longer a threat to the Irish national cattle herd or to the agricultural community.

Infection with Brucella abortus causes contagious abortion in cattle and undulant fever in humans.

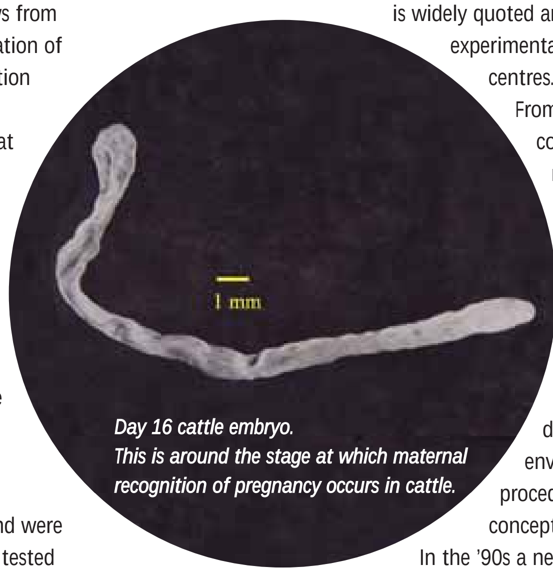
Cattle reproduction

Michael G. Diskin and Dermot Morris

Following the establishment of the Western Research Centre at Belclare in 1973, An Foras Talúntais initiated a cattle reproduction research programme under the direction of Dr Joe Sreenan. The background was the necessity for very high herd fertility to exploit pasture growth in a seasonal production context.

The programme initially focused on developing oestrous cycle control and induction of twinning to increase the calf crop. During these early years the first studies in Ireland involving prostaglandin analogues for oestrous cycle control were carried out and the protocols developed are now widely used. This programme also developed many of the embryo manipulation transfer procedures, both *in vivo* and *in vitro*, that are in current practice.

Towards the end of the '70s the research programme identified early embryo death as the major cause of reproductive failure in cows, with 80% of embryos lost within the first two weeks after fertilisation. The research went on to show that the cattle embryo at this time undergoes an exponential rate of growth, with its protein content increasing by 2,600-fold and, as a result, is susceptible to even small changes in environmental conditions such as may be induced by diet. This information on the pattern of cattle embryo growth, development and viability is internationally accepted as the definitive piece of research in this area, is widely quoted and is the basis for much of the experimentation currently ongoing in many centres.



Day 16 cattle embryo.
This is around the stage at which maternal recognition of pregnancy occurs in cattle.

From this work, Teagasc (AFT) won and co-ordinated a series of EU Framework multidisciplinary research contracts across UK, French, German and Italian laboratories establishing the molecular, endocrine, physiological and developmental characteristics of the early cattle embryo.

This work ultimately led Teagasc to determine a number of optimal environmental and management procedures capable of increasing cow conception by up to 30 percentage points.

In the '90s a new beef cow reproduction programme was developed. This programme clearly delineated the role of maternal offspring bonding pre- and post-partum and nutrition as regulators of the post-partum anoestrous interval in beef cows. It also provided new information on the resumption of oestrous cycles post calving in beef cows and is internationally accepted as the definitive piece of research in this area.

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Beef cattle production

Gerry Keane and Michael Drennan

The dairy and beef cow herds combined are the source of raw material for the beef industry. Research has had a considerable influence on cow numbers, particularly beef cow numbers and breeds. As research got underway in Grange in 1960, total cow numbers were about 1.28m, of which 0.2m were beef (non-dairy) cows. In the early '60s, dairy cow numbers increased while beef cow numbers declined. The introduction of the "calved heifer" scheme in the mid-'60s gave a temporary boost to beef cow numbers but real expansion did not begin until 1969 with the introduction of the "beef cattle incentive" scheme, which grant-aided herds not engaged in commercial milk production. By 1974, total cow numbers had reached 2.15m, which was the highest level seen until 1992 and approximates to today's number.

Developments in beef production systems paralleled changes in cattle numbers and breed types, with suckler beef systems less important in the '60s and '70s and more important in recent years. By the early '90s, as suckler cow numbers exceeded 1m, a suckler beef system had been developed in which a cow plus progeny to slaughter, plus the requisite replacement proportion, were carried on 0.85ha. The male progeny were reared as steers and slaughtered at two years of age, while the heifers were slaughtered at 19-21 months. Fertiliser N application approximated to 200kg/ha and total concentrate input was about 700kg per cow unit. Weaning weight of spring-born calves was around 320kg for steers and 290kg for heifers. Corresponding slaughter weights and ages were 690 and 560kg, and 730 and 610 days, respectively. Carcass weights of steers and heifers were 390 and 310kg, respectively, giving an approximate carcass output (including cull cows) of 490kg/ha.

For dairy beef systems, as with suckler systems, the '60s and early '70s were devoted mainly to component research and the development of partial systems such as production of stores, summer grazing and winter finishing. Integrated dairy calf-to-beef systems were first established in Grange and Ballinalack (a field station of Grange) in the '70s and Flynn (1981) described the first two-year-old system. It comprised Friesian steers slaughtered at about 290kg carcass weight. Stocking rate was 0.45ha per animal unit (yearling and calf), total lifetime concentrate input was 600kg and carcass output was 640kg per ha. The evolution of dairy calf to beef systems is summarised in **Table 1**.

TABLE 1: Evolution of dairy calf-to-beef systems

Period	Stocking rate[1]	Breed type[2]	Carcass weight(kg)	Concentrates (kg/animal)[3]	Output (kg/ha)[4]	Reference
Late 1970s	0.45	FR	290	600	640	Flynn, 1981
Early 1980s	0.45	FR	330	600	730	Keane, Flynn & Harte, 1986
Late 1980s	0.50	FR	330	750	660	Harte, 1989
Late 1980s	0.45	FR	320	850	710	Keane & Drennan, 1991
Early 1990s	0.48	FR	320	850		Keane & Darby, 1992
		CH	380	1150	730	
Mid 1990s	0.60	FR	320	1000		Keane & Drennan 1995
		CH	380	400	600	
Early 2000s	0.60	FR	320	1050		Keane & Drennan, 2001
		CH	360	1130	570	

[1]ha per animal unit (yearling + calf); [2]FR = Friesian, CH = Charolais x Friesian; [3]Lifetime total; [4]of cold carcass.

Pigs

Brendan Lynch

There were about 120,000 farms in Ireland with at least one pig according to CSO records from around 1960. Most of these had a few finishing pigs only. Where sows were kept, the average herd size was small (under five sows) and the standard of management was poor.

Today, about 450 pig units hold more pigs than were in the national herd in 1960.

Sow nutrition was in its infancy and the concept of a balanced diet was largely unknown. Breeding sows were underfed, housed in cold, damp conditions, and their general health neglected. Infertility in sows, mainly delayed return to oestrous after weaning, was a serious problem.

It was clear from early trials at Moorepark that the herd there was far too small for statistically sound sow feeding experiments where fertility and litter size were the response criteria. Jim O'Grady, as head of the Pig Husbandry Department, linked up with several UK research centres, all of whom had sow herds comparable in size to the Moorepark one. Co-ordinated trials where each centre fed the same diets under the same experimental protocol gave the necessary statistical power.

What followed is now seen as the golden age of sow nutrition research. Over a 20-year period, a series of experiments on sow feeding in pregnancy, in lactation and over the lifetime, laid the foundation for present day sow feeding recommendations. Over time it became clear that nutrition management affected what happened in the next lactation, that lactation feeding affected fertility, and that how the breeding gilt was reared affected her lifetime productivity.

While litter size changed little, the number of litters produced per sow per year did improve rapidly. The result was that sow productivity went from about 15 pigs produced per sow per year around 1960 to 22 or more today.

Pig producers who adopted the new technology at an early stage benefited greatly from the higher productivity. Over time those who failed to adapt became uncompetitive and ceased production. The major beneficiaries of the efficient production systems were consumers through low-priced pork, with a high lean content produced to the highest standards of food safety.

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Soil survey

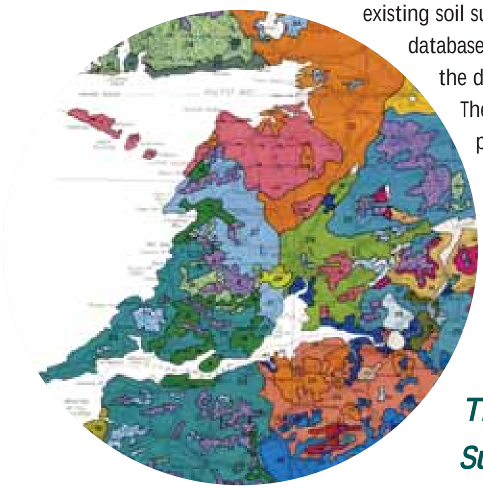
John Lee

The National Soil Survey was established in 1959. This marked the first real attempt to survey, classify and map the soil resources of Ireland in a systematic manner. From the beginning, modern scientific methods were used to classify the soils and emphasis was placed on the interpretation of the results for agricultural development in particular and for land use planning in general.

The first *Generalised Soil Map of Ireland* was published in 1969 but the information for many areas was not very reliable. A 10-year programme was then started, the aim being to produce an improved version at the end of that period. This was achieved in 1980 with the publication of a second edition of the *Generalised Soil Map* together with an explanatory bulletin (Gardiner & Radford). A Peatland Map of the country, together with an explanatory bulletin, was published in 1979.

As part of a systematic county soil survey, some 44% of the country was surveyed and mapped. Complete reports on 10 of the 26 counties were published, together with reports on a number of regions and districts. The 10 full counties with published soil surveys are Wexford, Carlow, Limerick, Clare, Westmeath, Meath, Laois, Kildare, Leitrim and Offaly. Soil maps have also been published for west Mayo, west Donegal and west Cork. The field programme was discontinued in 1988 when the research programme changed from one that was mainly concerned with soils and land use to one mainly relating to environment and land use. A Soil Survey GIS programme was initiated in 1988 with a view to capturing existing soil maps in digital form to facilitate the environmental brief, and so that geocoded data collected in environmental surveys and experiments could be related to soil survey data. The programme involved digitisation of existing soil survey and related maps, creating databases of soil information and linking the digital maps and databases.

The advent of the Soil Survey provided an essential framework for elucidating the role of soil type in nutrient/production responses and in defining and elucidating regional/geographic variability in land productivity.



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Phosphorus

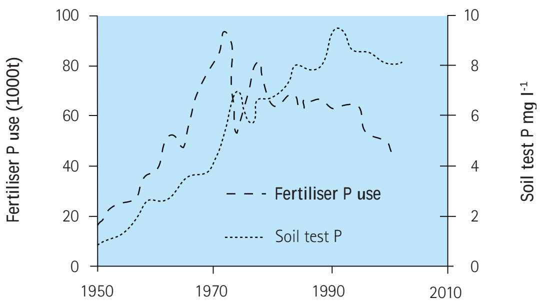
Hubert Tunney

In the '50s and '60s the main aim of the plant and animal nutrition research work by the fledgling research institute (An Foras Talúntais) was to correct the widespread phosphorus (P) deficiency that existed in Irish soils. Based on the research results, a state subsidy on P fertiliser was introduced to encourage farmers to use it.

Research and advice was developed in that period to improve soil fertility and increase production. Since then, the P status of agricultural soils has increased eight-fold to a national average of over 8mg P per litre of soil (Morgan's P test). The trends in fertiliser use and the average soil P test, based on samples from farmland analysed at the Johnstown Castle soil laboratory, are shown in Figure 1.

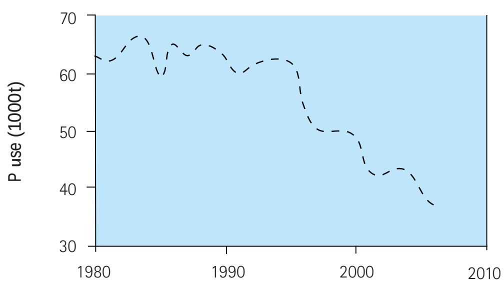
In the late '80s and the '90s there was a renewed interest in reducing farm input costs. This led to work on minimising P for silage production, which started in 1986. At the same time, the eutrophication of waters became an increasing problem and agriculture was considered as a significant contributor of P loss to water. In recent years, there has been considerable discussion on P needs for agriculture and agriculture's contribution to P loss to water in Ireland, as in many other developed countries.

FIGURE 1: Trends in chemical fertiliser P use and soil test P over the past half century.



Using this research, Teagasc revised downwards the P advice for grassland in Ireland in 1997. This revision, supported by the Teagasc education and advisory services, led to a reduction in chemical fertiliser inputs from over 60,000 tonnes P in 1995 to under 40,000 tonnes at present. This has led to an annual saving of more than €20 million.

FIGURE 2: The decline in the use of chemical fertiliser P use in response to Teagasc research, education and advice.



In the past decade there has been considerable research in Ireland on the loss of P from agriculture to water. The results of this research and advice have been the basis of recent policy in Ireland on nutrient use and management in agriculture.

Trace elements

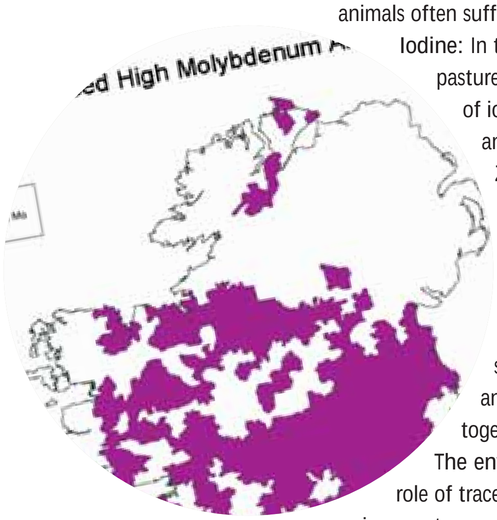
G.A. Fleming

While An Foras Talúntais was established in 1958, trace element research was well established by then. Work on boron, copper, molybdenum, selenium and cobalt had been carried out during the previous decade and prior to that, studies on manganese in grasses, cereals and swedes, and iron in some horticultural crops was undertaken. The amount of trace element research carried out prior to World War II was minimal, though the importance of boron for sugar beet in particular was well recognised.

Cobalt: Studies on cobalt followed on from work by Department of Agriculture staff in the early '50s when problems of cobalt deficiency in sheep and cattle were tackled. Cobalt deficiency was associated with animal ill-thrift and 'pining', a condition known in the west of Ireland as 'Angalartrua'.

Selenium: Interest in selenium (Se) emerged in the early '50s when reports of animal ill health were received from Co. Limerick and Co. Meath. Horses and cattle suffered hair loss and sloughing of hooves. Following work in the US, it was recognised that the problem was caused by an excess of SE in soils and herbage in the above areas.

Molybdenum and copper: These two trace elements are taken together though both can be of importance in their own right. Molybdenum (Mo) deficiency in clover has been demonstrated on blanket peats at AFT's research station at Glenamoy, Co. Mayo. In cobalt- (Co) deficient areas in the west of Ireland, animals often suffer from copper (Cu) deficiency.



Iodine: In the '80s, iodine levels in soils and pastures were measured. The importance of iodine lies in its requirement by animals rather than by plants.

Zinc: In the late '60s, zinc deficiency was recorded in onions and beans on a limed spaghnum peat at Lullymore, Co. Kildare.

Multi trace element investigations: Besides this work, studies concerning the occurrence and behaviour of trace elements together have been undertaken.

The environment: From the '80s on, the role of trace elements/heavy metals in the environment scene was expanded. In particular, the heavy metal content of sewage sludges, and their possible deleterious effects on soils on which sewage sludge was spread, was examined.

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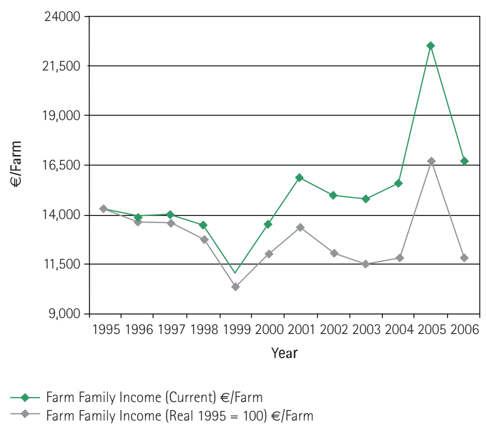
National Farm Survey

Anne Kinsella and Liam Connolly



The National Farm Survey (NFS) is the longest running research project in Teagasc, having commenced in 1960, and is a key provider of micro economic and analysed data to agricultural economic and rural development research and advisory programmes. The survey is carried out on an annual basis by the Farm Survey Research Department staff, located in the Rural Economy Research Centre, Athenry.

National farm surveys commenced in Ireland in 1955. Earlier surveys were carried out by the Central Statistics Office (CSO) but were not on a continuous basis. In 1960 the survey was taken over by An Foras Talúntais (AFT) and during the '60s the farm accounts book was revised and extended. In 1966/'67 the sample was improved and a full survey was undertaken in the three-year period from 1966 to 1969, which provided detailed financial and technical reports on farm incomes and enterprise performance. The survey ceased from 1969 to 1971 but commenced again in 1972 and has been carried out on an annual basis since then by Teagasc (AFT).

The main aim of the NFS is to determine the financial situation on Irish farms, to measure standards of farm management and to provide a database resource for Irish and international use. The random stratified sample of 1,200 farms used by the NFS is selected and provided by the CSO and a weighting is applied to the sample to ensure it represents agriculture nationally. The NFS fulfils Ireland's statutory obligation to provide data on Irish agriculture to the EU Commission through the Farm Accountancy Data Network (FADN) in Brussels.

The NFS is the main source of data for policy analysis and the data is used extensively for farm level modelling and in the FAPRI-Ireland project. NFS data is also used in the calculation of standard gross margins, which are provided to EUROSTAT annually for determining Irish farm typology based on EU Commission requirements. NFS data are also used to underpin Teagasc Advisory and training programmes by providing key benchmark data on financial and technical performance for the main farm enterprises at farm level.

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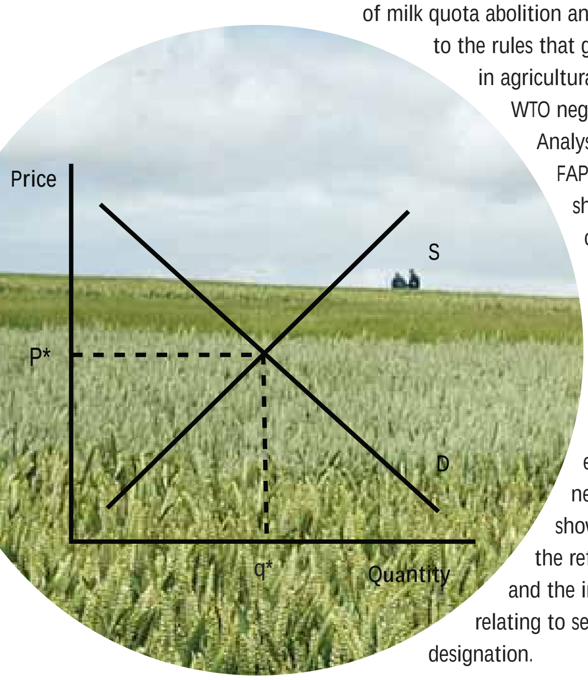
FAPRI-Ireland

Kevin Hanrahan and Trevor Donnellan

The FAPRI-Ireland model, developed by staff at the Rural Economy Research Centre (RERC) in co-operation with researchers from the University of Missouri (Professors Bob Young, Pat Westhoff and Julian Binfield), places Teagasc at the heart of agricultural policy debates in Ireland and the EU.

The FAPRI-Ireland model is an econometrically estimated, dynamic partial-equilibrium model of the Irish and EU agricultural sectors and is used to analyse the impact of agricultural and trade policy changes on the economic fortunes of Irish agriculture. The model is also linked with farm-level linear programming models. These linear programming models, by combining the FAPRI-Ireland projections of the future with data from Teagasc's National Farm Survey (NFS), allow analysis of the impact of policy changes and other market developments at farm level.

Since the collaborative project first began in the late '90s, the FAPRI-Ireland model has been used to analyse policy proposals associated with every significant change in the Common Agricultural Policy. This work has included analysis of the Berlin Agreement of 1999, the CAP Mid-Term Review proposals of 2002 and the Luxembourg Agreement that reformed the CAP in 2003. Most recently, analysis by Teagasc researchers using the FAPRI-Ireland model has focused on the impact of milk quota abolition and on the impact of reforms to the rules that govern international trade in agricultural and food products (the WTO negotiations).



Analysis conducted using the FAPRI-Ireland model has shown that Ireland, given its comparative advantage in dairy production, would be better off with a more rapid abolition of the milk quota regime. FAPRI-Ireland analyses of the impact of possible reforms emanating from the WTO negotiations in Geneva have shown the negative impact of the reforms on Irish agriculture, and the importance of provisions relating to sensitive product designation.

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Mushrooms

Gerry Walsh, Jim Grant and Helen Grogan

The mushroom industry in Ireland has been one of the big success stories of the Irish food industry. From small beginnings the value of the industry has grown from an output of €8m in 1980 to a current value in the region of €100m, 75-80% of which is exported to the UK.

The modern Irish mushroom industry can be traced back to a novel, low-cost system of growing mushrooms in bags in polythene tunnels that was developed during the '70s at Kinsealy Research Centre. This was led by the innovative and enthusiastic Cahal Mac Canna. In 1980, the first group of eight growers using the bag system started growing mushrooms in Co. Wexford in conjunction with entrepreneur Pat Walsh, who produced and distributed bagged mushroom compost from a central location. This was followed soon after by another group in Co. Monaghan with 70 growers.

One of the reasons bag cultivation was so successful was the use of another innovative technique, again pioneered by Cahal Mac Canna at Kinsealy, of mixing some compost into the top layer of casing soil to produce "spawned casing". Spawned casing - now used worldwide - results in earlier cropping and more uniform, high-quality mushrooms. Cahal was recognised for his work with the Sinden Award from the UK Mushroom Growers Association in 1994.

By the early 1990s, the Irish mushroom industry, as well as the mushroom research group at Kinsealy, had attained an international profile and the 13th International Mushroom Congress was hosted by Teagasc in Dublin in September 1991.

New production and disease problems provided fresh stimulus for the research programme and very close links developed with the industry. Research projects addressing pest and disease problems, micro-climate control, ventilation and air distribution systems were undertaken.

In the past 10 years the industry has changed dramatically. The bag system has been largely replaced by the more intensive and mechanised Dutch shelf system; grower numbers have fallen dramatically from a peak of over 550 in the late 1990s to 85 in 2007; however, farm size has increased and production per farm has intensified such that overall production has decreased by only 20%.

The industry can be traced back to a novel, low-cost system of growing mushrooms in bags in polythene tunnels that was developed during the '70s at Kinsealy Research Centre.

Walsh Fellowships

Lance O'Brien

The first AFT Director, the late Dr Tom Walsh, instituted scholarship and university research grant schemes for postgraduates in 1959. These two initiatives helped to strengthen AFT's scientific base in its formative years by linking the organisation's mainly applied research programme to the more basic research activity of the third-level sector.

In the first few decades, AFT awarded up to ten grants and scholarships annually. The severe financial cutbacks, coinciding with the merger of AFT into Teagasc in 1988, resulted in the suspension of the postgraduate scholarships and a limitation of the research grants. However, improved finances from the mid-'90s, and in particular the availability of EU Structural Funds, facilitated a significant expansion of the scheme to its current level of around 165 ongoing fellowships and a turnover of about 40 new fellowships each year.

To coincide with its expansion, Teagasc restructured the scheme in 1995. New procedures were approved and the Authority Research Committee assumed a more significant role. The then Minister for Agriculture, Ivan Yates, re-launched the revamped scheme as "The Walsh Fellowships" in Johnstown Castle in December 1995.

More than 2,000 postgraduate students have participated in the scheme over the past 50 years. A number of these are now (or have been) Teagasc staff members and others are employed in the agri-food industry in Ireland and abroad. The annual budget is now well over €3 million, consisting of the basic student stipend and fees, and other essential direct costs (travel, materials, consumables, etc.). This level of investment meant that for many years the Walsh Fellowships Scheme was the largest postgraduate scheme in Ireland, providing research opportunities for significant numbers of high calibre graduates.

The scheme represents a cost-effective means of initiating new research in Teagasc, which otherwise could not be attempted. It has been invaluable in developing new relationships with universities outside of Ireland in a number of key areas. The Walsh Fellowships will remain as a vital and dynamic element of the Teagasc Research Programme.

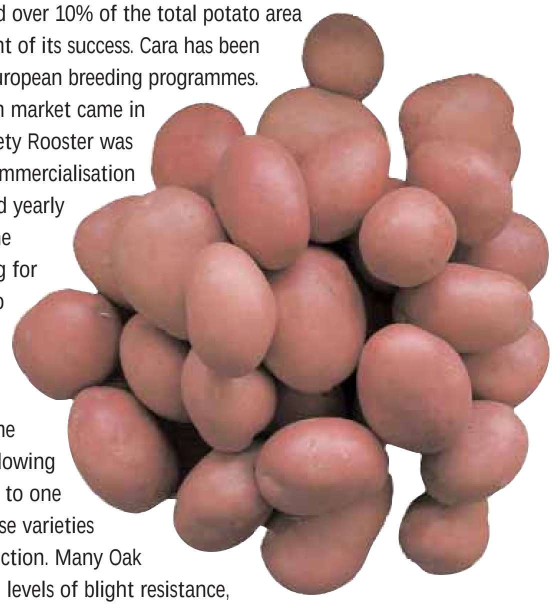
More than 2,000 postgraduate students have participated in the scheme over the past 50 years.

Potato breeding

Denis Griffin, Henry W. Kehoe, Dan Milbourne and Leslie Dowley

The potato breeding programme in Oak Park is one of Teagasc's longest running research programmes. It was initially set up by An Foras Talúntais in 1962, to breed a late blight-resistant variety to replace Kerrs Pinks, the dominant variety on the Irish market. The original breeder, Harry Kehoe, was soon joined by Leslie Dowley as plant pathologist. Early varieties released included Clada and Amber. Ireland was a major exporter of seed potatoes at the time and the advent of plant breeders' rights ensured a steady demand for new potato varieties. A partnership was formed with Irish Potato Marketing Ltd, which still exists to this day, to commercialise and market the varieties globally.

Initial success was with the variety Cara, which marked a milestone in modern potato breeding. The variety was resistant to both blight and the golden potato cyst nematode. These attributes, combined with superior agronomic performance, saw the variety become a major seed export variety to Egypt and the Canary Islands, while it also occupied over 10% of the total potato area grown in the UK at the height of its success. Cara has been widely used as a parent in European breeding programmes.



The breakthrough in the Irish market came in the early '90s when the variety Rooster was launched. Since Rooster's commercialisation the area grown has increased yearly and it is now the number one variety in Ireland, accounting for over 40% of the total potato area.

A total of 35 potato varieties have been released from the Oak Park programme since its inception, which, allowing for a lead-in period, equates to one variety per year. Most of these varieties are still in commercial production. Many Oak Park varieties have very high levels of blight resistance, especially two recently developed varieties, Orla and Setanta.

Greater emphasis is now placed on disease resistance by consumers, supermarkets and growers in a continual drive to lower chemical inputs. New technology such as marker-aided selection and the sequencing of the potato genome (Teagasc is a partner in this initiative) will greatly aid the selection of new high-performing, disease-resistant cultivars in the future.

A recent publication, *The Oak Park Potato Varieties*, documents each of the varieties.

Since Rooster's commercialisation, the area grown has increased yearly and it is now the number one variety in Ireland, accounting for over 40% of the total potato area.

Biofuels

Bernard Rice

The first vehicle to run on rapeseed oil in Ireland pictured at Oak Park in 1980.

Teagasc research on the production of biomass for energy use can be traced back to the mid-'70s, and the oil crisis that followed the Yom Kippur war. An in-house committee produced the first ever estimates of the energy consumed by agriculture; it also listed actions that might be taken to reduce energy consumption and produce native renewable fuels.

In the late '70s, research was initiated as follows:

- a screening trial of the suitability of various tree species for coppicing to provide fuel for heat or electricity got underway. Willow and poplar were quickly identified as the most promising species. Establishment difficulties and disease problems with poplar led to the emergence of willow as the favoured species;
- the first trials were carried out on the use of rapeseed oil as a fuel for diesel engines. A Toyota 4-wheel drive operated on unprocessed rapeseed oil in Oak Park; engine starting problems and incomplete combustion were soon identified as challenges to be overcome before this use could become widespread. Special vegetable oil engines were designed and produced in Germany; they worked very well but were too expensive. Vegetable oil conversion kits are now available for most standard engines; they are reasonably priced, and by and large they work very well. Oak Park work has focused mainly on achieving the oil quality necessary for trouble-free motoring in engines using these kits; and,
- to allow the use of vegetable oil in unmodified engines, the most widely-used option is to convert the oil to biodiesel, a more engine-friendly free-flowing fuel. Oak Park led a search for lower-cost oils and fats for this process. As a result, a new biodiesel plant currently being built in New Ross will use recycled cooking oil and beef tallow as feedstocks in addition to rapeseed oil.

Nowadays, the combined threat of global warming and exhausting oil reserves are sufficient to justify an expansion of the research programme to other feedstocks and technologies. The supply of suitable biomass will provide a variety of challenges for researchers for the next 50 years.

… the combined threat of global warming and exhausting oil reserves are sufficient to justify an expansion of the research programme.

Crop agronomy

Jimmy Burke and Richie Hackett

Teagasc Oak Park Crops Research Centre is well known nationally and internationally for its work developing new technology used by farmers and industries involved in malting, brewing, flour milling and animal feed compounding. At the establishment of An Foras Talúntais (AFT), crop production in Ireland was largely based on spring crops, and average national yields for barley, wheat and oats were 3.5, 3.0 and 2.5t/ha, respectively. At that time the use of technology was minimal; crops often received low fertiliser inputs and perhaps a herbicide spray between sowing and harvest. Fungicides and insecticides were unheard of. There were no winter crops grown in the country. Crops such as maize and oilseed rape would have been regarded as exotic. The results from the research work carried out at Oak Park have always been quickly taken up by tillage farmers, who can now produce yields consistently among the highest in the world, despite relatively unpredictable and often challenging weather patterns.

Spring barley has remained the most important arable crop, and Ireland is internationally renowned for the production of high-quality malting barley. The development of production systems at Oak Park that consistently produce grain of the desired specifications for this exacting market has received considerable attention over the years. Concurrently, Oak Park staff pioneered the use of near infra red spectroscopy in Ireland for the measurement of grain quality at merchants' premises around the country.

From its commercial re-introduction in the late '70s, winter wheat has become the second most important arable crop in Ireland. Grain yields in excess of 10t/ha are now common and are at the top of the world league in terms of productivity per hectare. This is despite environmental conditions conducive to high levels of disease.

In recent years, Oak Park staff were to the forefront of a Europe-wide effort to come to terms with the failure of a group of fungicides (strobilurins), which heretofore had given excellent control of septoria disease.

Apart from cereals, Oak Park has also led the way in Ireland in devising production strategies for a number of other crops, including maize, oilseed rape and a range of energy crops, including miscanthus.

Grain yields in excess of 10t/ha are now common and are at the top of the world league in terms of productivity per hectare.

Plant biotechnology

Ewen Mullins, Dan Milbourne and Susanne Barth

The Teagasc plant biotechnology initiative was established with the strategic objective of complementing and strengthening the existing conventional plant breeding and physiology research programmes at Oak Park.

Since its inception in 2002, DNA markers linked to genes that confer strong resistance to the economically important potato pest potato cyst nematode (PCN), also known as eelworm, have been developed. These molecular tools have now been integrated into the Teagasc potato breeding programme to assist in its production of high-quality potato varieties. Into the future, this successful strategy of developing markers to streamline the potato breeding process will continue, with a special focus on traits required for food processing.

The team has also developed biotechnology-based tools to monitor the emergence and spread of fungicide resistance in the primary fungal disease of Ireland's winter wheat crop. Such technology transfer provided critical support to the tillage sector at a time when the efficacy of certain fungicides was in doubt. Similarly, molecular markers have been designed to investigate the transfer of genes from field to field across a landscape. Forming part of the GM risk assessment programme of research, the output from this work is intrinsic to establishing coexistence regulations for the potential cultivation of GM crops in Ireland.

To underpin the grassland industry, biotechnology processes have been adopted to exploit the genetic diversity within Irish populations of perennial ryegrass, thereby facilitating the development of improved grassland varieties through the Teagasc grass breeding programme. This work is assisted by parallel research tasked with identifying novel molecular markers for key agronomic traits such as flowering, self-incompatibility related genes, drought tolerance, biomass heterosis (vigour in hybrids), flowering, self-incompatibility and crown rust resistance.

In addition, the entire *Lolium* chloroplast genome has recently been sequenced and numerous chloroplast markers have been developed for progeny studies, breeding applications and phylogeny of the grasses.

The team has also developed biotechnology-based tools to monitor the emergence and spread of fungicide resistance in the primary fungal disease of Ireland's winter wheat crop.

Chemical residues in food

Martin Danaher

The research programme on chemical residues at Teagasc Ashtown Food Research Centre (AFRC) is led by Martin Danaher and Michael O'Keeffe. The residue group has carried out research on a wide range of chemical contaminants such as pesticides, growth promoters, veterinary drugs and mycotoxins for some 20 years. They make a significant contribution to maintaining the safety of Irish food through research in the chemical analysis, investigative work, and provision of advice to various stakeholders, including regulatory agencies and the food industry.

Research has been achieved through successful competition for funding from sources such as the FIRM programme (Department of Agriculture, Fisheries and Food), *safe*food and the EU. A major highlight in recent years was the development of the technology to detect nitrofuran residues on the EU Project entitled FOODBRAND. This project led to the identification of nitrofuran residues in some foods produced within the EU but highlighted major contamination problems in imported foods, particularly aquaculture, poultry and honey. FOODBRAND technology is now used worldwide for control of residues.

At a national level, *safe*food-funded research on anti-coccidials led to the identification and elimination of lasalocid residues in eggs. The research also resulted in the development of a national programme for monitoring nicarbazin residues and their steady reduction in poultry. More recently, investigations into the safety of health foods have identified the presence of a kidney cancer toxin, namely aristolochic acid, in four herbal products. These products have been withdrawn from the market in Ireland and the UK as an outcome of research.

In parallel to laboratory-based activities, the National Food Residue Database (NFRD) was developed through FIRM funding. While early research on the NFRD involved the investigation of chemical contaminants in food, more recently, it has evolved into the definitive online database on chemical residues in Irish food with public access. Research on the NFRD has recently been extended through funding under the Food and Health Research Initiative (FHRI) programme entitled Safe and Healthy Foods, led by Martin Danaher. In this €4.6 million programme, the annual expansion of the database will continue through the inclusion of residue data from existing and new sources.

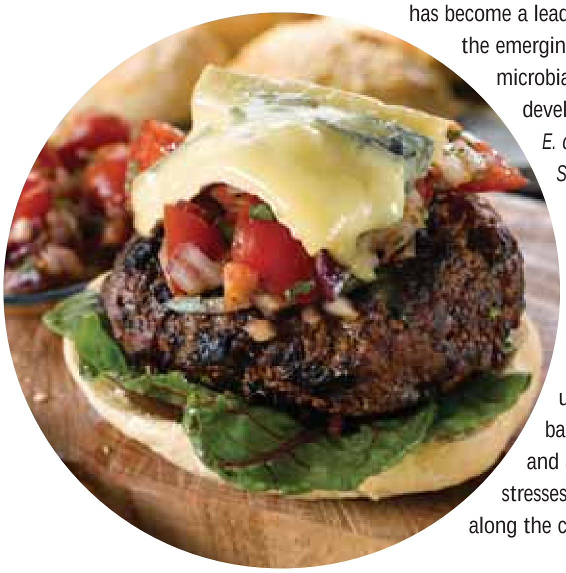
…investigations into the safety of health foods have identified the presence of a kidney cancer toxin, namely aristolochic acid, in four herbal products.

Food safety – microbiology

Declan Bolton

Zoonotic microbial pathogens, transmitted from animals to humans through the food chain, cause a significant burden of illness and related economic losses to the agri-food sector and society each year. Fifty years ago, many of the common food-borne bacterial pathogens of clinical significance today were relatively unknown or yet to emerge. Detection was based solely on agar-based culture methods, which took many days to carry out. In the intervening years, and especially in the last 10 years, molecular technologies have been developed that can detect and characterise pathogens at the genomic level. Teagasc Ashtown Food Research Centre (AFRC) has been at the forefront of this research, developing molecular methods to detect and genetically track a range of pathogens along the total chain including *E. coli* O157:H7, *Salmonella* and *Campylobacter*. These tools are now being used to categorically track the route(s) by which pathogenic bacteria pass through the food chain so that routes of transmission and sources of cross-contamination are identified, allowing measures and resources to be targeted at the high-risk stages of the chain. These tools are also being used to establish virulence potential of pathogens recovered from food for humans so that a true assessment of risk posed can be made.

Since its formation in 1998, the Microbial Food Safety Group at AFRC has established itself as an internationally-recognised centre of excellence, particularly in the areas of emerging pathogens (*E. coli* O157 and other verocytotoxigenic *E. coli*) with efforts focusing on identification of sources, assessment of the risk posed and control measures. In collaboration with UCD, it has become a leading international group in the emerging field of quantitative microbial risk assessment. It has developed total chain models for *E. coli* O157:H7 in beef and *Salmonella* in pork.



The research programme has supported stakeholders in Ireland in improving food safety and will continue to focus research efforts to increase our fundamental understanding of how key bacterial pathogens survive and adapt to the stresses/controls they encounter along the complete food chain.

The research programme has supported stakeholders in Ireland in improving food safety.

Meat quality

Declan Troy

Teagasc (and formerly An Foras Talúntais) has always prioritised meat research because of its importance to the Irish economy and the farming community. The Teagasc centre for meat research, Ashtown Food Research Centre, is now internationally recognised as a centre for excellence in this field. This is measured by its leadership in major international meat research programmes, its international publications output and the profile of its scientists.

The main focus for our research has been into the quality and safety of fresh meat. Research in the past, for instance, demonstrated how beef processors could improve the eating quality of meat by various methods. Meat quality research was then further expanded to include the total meat chain. In partnership with Grange, the Teagasc Beef Production Research Centre, critical control points along the meat chain were examined in order to reduce the inconsistency of beef quality. This was further investigated at molecular level using DNA technologies to identify specific genes that are associated with eating quality.

At factory level, the focus of meat research was aimed at ensuring the product had excellent keeping qualities in terms of colour, water-holding capacity and flavour. An export-dependent industry such as Ireland's meat sector required careful storage conditions to reach its market. A major breakthrough was the development of vacuum packaging of beef. Research carried out at Ashtown helped develop extended storage packaging systems of up to eight weeks at 0˚C. This greatly contributed to simplifying the beef supply chain to overseas markets.

Automatic beef carcass classification was introduced to Irish beef export plants after thorough investigation and analysis carried out by the meat research team at Ashtown. No other country in the world is as advanced in implementing this technology so widely.

Today there are new areas of exciting meat research at Ashtown; meat science is still a major priority for the Teagasc Food Research Directorate and recent successes in EU Framework Programmes have placed Ashtown Food Research Centre on the international meat research stage. Our science has underpinned the excellent quality of our beef in global markets today and helped ensure demand for it on the world stage.

Automatic beef carcass classification was introduced to Irish beef export plants after thorough investigation and analysis carried out by the meat research team at Ashtown.

50 years of research

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Crossbreeding the dairy herd – promising results from Moorepark

Jersey x Holstein cow.

Norwegian Red x Holstein-Friesian cows.

Researchers at Teagasc Moorepark Dairy Production Research Centre have been investigating the potential of crossbreeding Jersey and Norwegian Red cow breeds as an alternative strategy to provide genetic improvement in the dairy herd.

Until recently in the world of dairy cattle breeding, the term 'high genetic merit' was synonymous with high milk production potential. Now it is acknowledged that the term 'high genetic merit' should reflect as many characteristics as are required to reflect total economic profitability. In particular, the greatest challenge is to overcome the decline in reproductive efficiency that has been observed in the Holstein-Friesian (HF) as a result of past selection programmes that were geared towards maximising production potential. Although many countries have diversified their breeding goals to include measures of survivability or functionality, it is arguable that few have weighted fertility sufficiently to counteract the decline. Even in Ireland, where the weighting on fertility is currently at 37%, change will take some time (realistically many decades). Poor fertility performance is the primary constraint to maximising profitability from our seasonal grazing system because of: 1) an inability to capitalise on a long grazing season (due to delayed calving); 2) shorter lactations; and, 3) a limited supply of replacement heifers. The potential to expand in an era post quota is compromised currently and exacerbated even more by the fact that profit will be maximised post quota with a slightly earlier mean calving date than that recommended heretofore. The 'high genetic merit' cow going forward must have an innate ability to deliver a high volume of milk solids per hectare, and a propensity to do this almost entirely from grazed grass. She must be robust and 'easy care' and, given the seasonal nature of the Irish production blueprint, optimal performance requires a 365-day calving interval and an empty rate after the breeding season (12 to 13 weeks) of less than 10%. Recent research carried out by Moorepark suggests that crossbreeding may offer what is often referred to as a quick fix solution (relatively speaking). However, utilising the best available genetics ultimately based on the Economic Breeding Index (EBI), from appropriate 'alternative' breeds, is essential to ensure real genetic improvement.

The fundamentals of crossbreeding

A successful crossbreeding strategy aims to: 1. introduce favourable genes from another breed selected more strongly for traits of interest; 2. remove the negative effects associated with inbreeding depression; and, 3. for many traits to capitalise on what is known as heterosis or hybrid vigour (HV). HV means that crossbred animals usually perform better than that expected based on the average of their

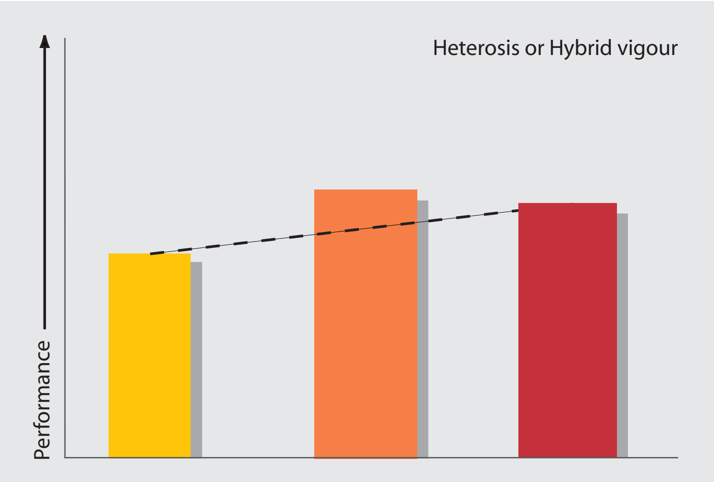

FIGURE 1: Heterosis or hybrid vigour is defined as the advantage in performance of crossbred animals above the mid-parent mean of the two parent breeds.

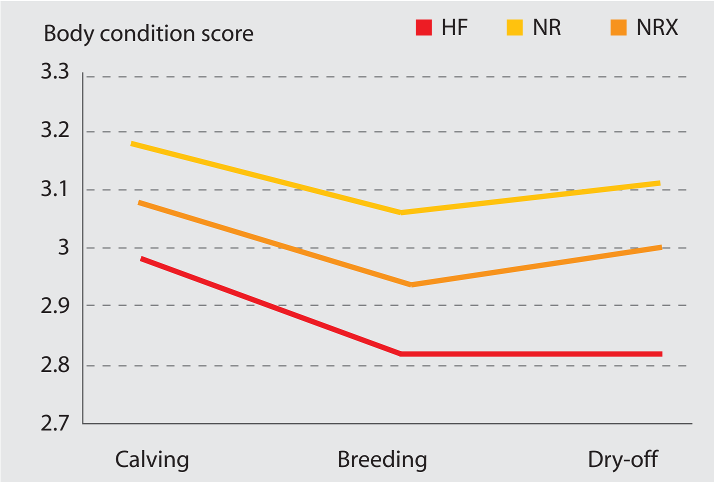

FIGURE 2: Body condition score pre-calving, during the breeding season and prior to dry-off for the HF, NRx and NR.

parents (Figure 1). HV will generally be higher in traits related to fitness and health, i.e., traits that have lower heritabilities.

In New Zealand, however, crossbreeding has been recognised as a sound breeding strategy for many decades. Currently, over 35% of dairy cows are crossbred and this figure has been increasing steadily of late. In New Zealand, it has been demonstrated that crossbred (Jersey [J]xHF) cows are the most profitable, with much of this resulting from superior longevity. On average, crossbred cows survive 227 days longer (almost one lactation more) compared to the average of the parent breeds. It has been calculated that at current rates of genetic gain for longevity (9.5 days per year) it will take 24 years of selection before a similar rate of survival is reached with cows within the straight breeds. For the most part, this means Friesian and J. So, crossbreeding in the dairy herd is not a new phenomenon.

Crossbreeding research at Moorepark

Since 1996, studies have been run at Moorepark evaluating the merits of a number of alternative breeds for crossbreeding under Irish conditions. The ultimate aim of the research is to provide a greater insight into the potential of these breeds via crossbreeding, and to assist the identification of a greater variety of top EBI, i.e., high profit sires, for use by Irish dairy farmers. The breeds of particular interest currently are the Norwegian Red (NR) and the J. The studies underway will assist in the development of an across breed evaluation. Paramount is the requirement to determine the relative breed effects (difference between alternative breed and the HF), and the level of HV observed in the crossbred animals. Two studies are underway: 1. evaluation of NR and NR crossbreds across 46 commercial dairy herds; and, 2. evaluation of J and J crossbreds at the Moorepark Ballydague research farm. The animals in both studies have just completed second lactation, and results from both studies suggest a favourable response from crossbreeding.

Evaluation of NR and HFxNR

NR cows have been on trial at the Ballydague research farm since 2001. Interest in evaluating the breed arises from the fact that since the 1970s female fertility, resistance to mastitis, and other functional traits have been included in the breeding programme of the breed. The reputed characteristics of the breed – ease of calving, high female fertility and low SCC/mastitis incidence – have been observed with the small numbers on trial at Ballydague. Consequently, in 2004, a large-scale study was set up by Moorepark involving the importation of almost 400 purebred NR heifer calves. These animals were spread across 50 dairy farms and, along with a similar number of crossbreds (HFxNR) and HF, now form part of one of the most unique research studies in the world, i.e., a very comprehensive study aimed at conclusively evaluating the merits of the NR breed and the potential benefits of crossbreeding under Irish conditions. Currently the study includes just over 1,300 cows across 46 herds. The Norwegian and crossbred cows are sired by 10 proven bulls. The HF group represents a mix of HF genetics from around the world, having been sired by a broad spectrum of North American Holstein, and New Zealand and British Friesian type sires.

Results – milk production and udder health

The 305-day predicted milk yield of the HF and HFxNR was similar at 6,194kg and 6,081kg, respectively. That of the pure NR was slightly lower at 5,867kg. The level of HV is indicated to be around 50kg of milk, or about 1%. Fat content was highest for the HF at 3.95%, slightly lower for the pure NR and crossbred cows at 3.90%. Milk protein content was not different across groups, averaging 3.49% for all three groups. SCC was lower for the pure NR cows compared to the HF and HFxNR. Based on information provided by participating herds, the NR and HFxNR also had slightly better udder health, as indicated by a lower proportion of cows recorded with mastitis at least once during lactation. Also, the data thus far suggest a greater degree of culling for poor udder health for the HR compared to NR and HFxNR.

Body condition and live weight

Body condition score (BCS) and live weight were measured on three occasions during 2006: pre-calving, during the breeding season, and at dry-off. The NR consistently had the highest BCS: 3.18 pre-calving, 3.05 at breeding, and 3.11 at dry-off (Figure 2). Comparable values for the HF were 2.97, 2.83 and 2.83. The BCS of the crossbreds on the occasions averaged 3.08, 2.94 and 3.00. Averaged over lactation, HV for BCS is estimated at less than 1%.

The NR consistently had the lowest live weight: 549kg pre-calving, 501kg at breeding, and 574kg at dry-off, approximately 20kg lighter than the crossbred cows at all stages. Except at dry-off (585kg vs. 592kg in favour of the HFxNR) the HF and HFxNR tended to have similar weights. Consistent with the increases in BCS during late lactation, the NR (73kg) and HFxNR (73kg) cows gained more weight compared to the HF cows (65kg) from mid lactation. HV estimates averaged less than 2% for live weight over lactation.

Reproductive efficiency

While the calving to service interval for all groups was not different (averaging 73 days), large differences in pregnancy rates were observed. The pregnancy rate to first service was 46% for the HF and 55% and 56% for the NR and HFxNR, respectively. The proportion of cows pregnant after six weeks was also in favour of the NR and HFxNR cows at 68% and 71%, respectively, compared to 58% for the HF. Empty rates at the end of breeding were 16%, 13% and 13% for the HF, HFxNR and NR cows, respectively. However, had the breeding season on each herd been restricted to 13 weeks, the empty rates of the HF, HFxNR and NR cows would have increased by a further 4%, 1% and 2%, respectively. Based on the data collated, differences in calving to conception intervals between the breed groups indicate a slippage of seven days in calving interval for the HF in second lactation. However, in total, a difference of 13 days has now developed between the HF and the crossbred cows in terms of expected calving date in 2008. Both the pure NR and crossbred cows are expected to maintain a 365-day calving interval. Survival from first to third lactation has also been estimated to be 67% for the HF, 74% for the crossbreds and 78% for the pure NR cows.

Results – J and JxHF at Ballydague

Worldwide, the J is one of the most popular breeds after the HF. Here in Ireland, many are asking if the J (JxHF) is the cow of the future. Interest here is likely being fuelled by the breed's popularity in New Zealand, where crossbreeding with the J is considered to leave the most profit; high solids production at high stocking rates, coupled with increased survival. High solids production in conjunction with lower milk volume will be favoured with the imminent multiple component milk pricing payment system, i.e., the 'A+B-C' system.

In the Ballydague study, numbers are small (approximately 40 per genotype); however, trends in performance mirror that of the large on-farm trial. The J and HFxJ cows at Ballydague are by sires from both New Zealand and Denmark. Mean calving date was February 22. A total of 275kg of concentrates per cow were offered during lactation. As illustrated, differences in both milk yield and milk composition were observed across the breeds/crossbreeds. Milk yield ranged from 5,612kg for the HF cows to 4,329kg for the J cows. The HFxJ cows were intermediate at 5,014kg. Large differences in milk fat content were also evident: 3.90% for the HF, 5.36% for the J, and 4.73% for the JxHF. The J also had the highest milk protein content at 3.98%, compared to 3.41% for the HF and 3.76% for the JxHF. However, in terms of milk solids (fat + protein yield), no significant difference was observed between the breed groups, although numerically a higher yield was observed with the HFxJ.

Body condition score and live weight

BCS was lowest at all stages with the HF and highest with the HFxJ. The BCS of the HFxJ was higher than that of either the HF or the J cows throughout lactation and HV is estimated at 8%, higher than that observed between the NR and HF breeds on the on-farm study. In terms of live weight, the HF cows were heaviest, averaging 525kg throughout lactation, compared to 390kg for the J cows. The HFxJ averaged 478kg. This means a HV estimate for live weight of about 20kg or 4.5%, again larger than that observed with the HFxNR cows.

Fertility performance

The breeding season began on the last week of April and ran for 13 weeks. All cows were bred by AI only. Tail paint was used throughout the breeding season as an aid to heat detection. Large differences in pregnancy rates were observed between the crossbred cows and that of both groups of purebred cows. The pregnancy rate to first service observed with the HFxJ cows was exceptional at 75%. By comparison, that observed with the HF and J cows was poor at 38% and 39%, respectively. The six-week in-calf rate of the crossbred cows was again superior at 76%, while that of the HF and J cows was 56% and 62%, respectively. The resultant empty rate after 13 weeks breeding for the HF, J and HFxJ was 9%, 15% and 4%, respectively. Overall, the reproductive performance of the three groups was such that the expected calving date for 2008 is expected to average March 15, March 4 and February 19 for the HF, J and HFxJ, respectively. The survival rate from lactation one to lactation three for these cows is 50%, 79% and 90% for the HF, J and HFxJ, respectively.

Conclusion

Data has been presented from the second year of two research studies being carried out by Moorepark, the objective of which is to evaluate the potential of dairy crossbreeding for Irish dairy farmers. It is expected that both studies will be continued for a further year. This is essential to capture differences that may arise in traits such as milk yield, fertility, health and survival as cows mature. The ultimate aim for all Irish dairy farmers must be to generate cows that will maximise profitability in our system. Experience to date strongly suggests that we can have confidence that crossbreeding works. However, to utilise the best available genetics, this must be ultimately based on the EBI, to ensure real genetic improvement takes place.

Acknowledgements

The commitment and efforts of the farmers involved in the Norwegian Red crossbreeding study is to be commended. Milk recording is being provided free of charge for the experimental cows on the Norwegian Red crossbreeding study. This support, provided by Progressive Genetics, Dairygold, South Western Services and the Irish Cattle Breeding Federation, is very much appreciated. This research is funded by the Teagasc Core Programme, Dairy Levy Trust and the Research Stimulus Fund (Department of Agriculture, Fisheries and Food).

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Promising legumes for beef pastures

Legumes such as clover can provide both economic and environmental benefits, yet they are under-utilised on beef farms. ALISTAIR BLACK and PADRAIG O'KIELY from Teagasc Grange Beef Research Centre are looking at some promising legume varieties for beef pastures.

Increasing prices of fertiliser nitrogen and concentrate feed make legumes an option worth considering for beef production systems. Legumes such as clover have a higher digestibility than grasses. Root-nodule bacteria (rhizobia) that live in nodules on the roots of legumes provide nitrogen for plant growth. Pasture mixtures that include legumes can increase herbage intake and live weight gain of beef cattle, and require low inputs of fertiliser nitrogen.

The Rural Environment Protection Scheme (REPS) now aims to encourage farmers to use more clover and less fertiliser nitrogen. In REPS 4, the incorporation of white clover (*Trifolium repens*) into pastures is one of several 'Options' and is also a 'Supplementary Measure' worth €30 per hectare subject to a maximum of 40 hectares. Most beef farms are already managed to benefit from the positive economic incentives of REPS. Now, beef farmers can be financially rewarded for incorporating clover into their pastures.

In order to maximise farm profit, beef farmers are considering methods to enhance live weight gain of cattle from pasture while minimising farm inputs. One of the cheapest methods of reducing inorganic nitrogen and imported feed requirements is to maximise legume content in pastures.

Incorporating clover into pastures

A recent experiment is challenging our traditional ways of incorporating clover into reseeded pastures. The pasture seed mixtures used by farmers are generally two-species mixtures of perennial ryegrass (*Lolium perenne*) and white clover, often with more than one cultivar of each species. Alternatively, other grass and clover species with different growth and nutritional characteristics could be included in the seed mix to improve the yield and quality of the sward. Grange participated in a European project (COST Action 852 – reported in the autumn 2007 issue of *TResearch*), which studied the relationships between four-species seed mixtures and pasture herbage yield and composition.

Two legume and two grass species were sown into plots at two locations – Athenry and Moorepark. The two legumes were 'Avoca' white clover and 'Endura' Caucasian clover (*Trifolium ambiguum*), and the two grasses were 'Spelga' perennial ryegrass and 'Motim' timothy (*Phleum pratense*). The swards were sown with a wide range of proportions of each species in the seed mix on the basis of seed biomass. All combinations were repeated at two overall seeding rates (12 and 20kg viable seed/ha) and some were also repeated with two levels of fertiliser nitrogen (100 and 200kg/ha/year).

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

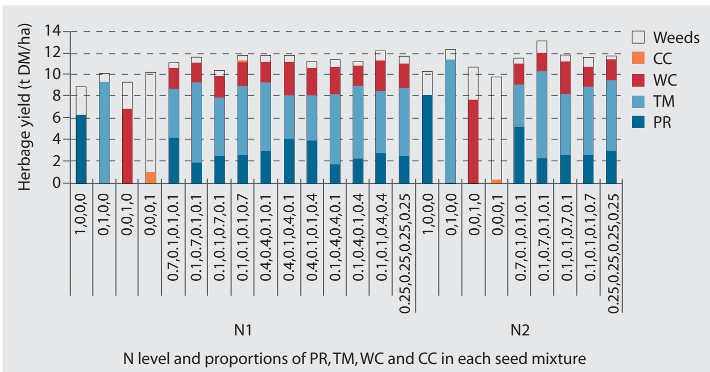

FIGURE 1: Mean annual herbage yields of perennial ryegrass (PR), timothy (TM), white clover (WC), Caucasian clover (CC) and unsown (weeds) species in the second year after sowing from seed mixtures with different species proportions and two levels of N fertiliser (N1: 100kg N/ha/yr and N2: 200kg N/ha/yr). The numbers underneath the bars represent the proportions of perennial ryegrass, timothy, white clover and Caucasian clover sowed, respectively.

FROM FAR LEFT: Red clover, white clover and Caucasian clover.

and seeding rates, timothy was consistently the highest yielding species after two years (Figure 1). The seed mixtures that 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 implication is that more varied pasture seed mixtures could have something to offer in low input beef systems.

The role of red clover

Red clover (*Trifolium pratense*) has traditionally been considered a species mainly for hay or silage production rather than grazing. Most commercially available cultivars have an erect growth form and are high yielding. There is increasing interest in red clover for both conventional and organic beef systems. However, there are no red clovers on the Department of Agriculture, Fisheries and Food's recommended list of grass and clover varieties for Ireland. The limited authoritative information on the performance of red clover in Ireland has encouraged our evaluations of some new and promising cultivars from north-western Europe and New Zealand. The aim is to evaluate their performance under different management conditions and to give beef farmers the confidence to use the best available cultivars.

Red clovers performed beyond expectation

Red clover usually persists for only two to three years, but at Grange two cultivars continued to produce high yields in their sixth year. The cultivars 'Merviot' and 'Ruttinova' were sown into 96 plots and four cuts were taken each year for six consecutive years. Swards with either cultivar were capable of producing more than 16 tonnes of herbage dry matter per hectare per year. Management factors that favoured high yields and persistence included growing the red clovers in a mixture with perennial ryegrass rather than as monocultures. This also increased the digestibility of the cut herbage. Yield was increased by harvesting the first cut of each year in late May rather than mid-June. In contrast, applying nitrogen fertiliser in mid-March produced no benefits.
The generally higher buffering capacity and lower dry matter and soluble carbohydrate contents of red clover herbage make it more difficult than grass to successfully preserve as silage. Growing red clover with perennial ryegrass improved the ensilability of the sward by providing more soluble carbohydrates in the ryegrass herbage and by lowering the overall buffering capacity. Ensilability of the first cut sward was also improved by the earlier harvest date, particularly when ryegrass was included, while the fertiliser nitrogen had no measurable effect. The results indicated that these management strategies, when combined with extensive wilting and/or the addition of effective additive, can enhance the yield and preservation of red clover swards for silage.

Red clover for grazing

Red clover swards have the potential to yield more than 16t DM/ha/year with no nitrogen inputs. However, since most of the yield is achieved by early July, a non-cutting strategy such as grazing is needed for the remainder of the year, and red clover has traditionally not persisted when grazed. Therefore, a new experiment at Grange aims to compare two new spreading or prostrate red clovers ('Broadway' and 'Sensation') from New Zealand with two common European cultivars ('Merviot' and 'Britta') in grazed swards. The expectation is that the prostrate and spreading type red clovers will be potentially more grazing tolerant, but possibly lower yielding, than the two cultivars with erect growth forms. The challenge is to identify the critical morphological and physiological characteristics of red clover for yield and persistence, and how defoliation management practices and cultivars modify these.

Alternatives to white and red clovers

Throughout the temperate grassland regions of the world there have been numerous quests to find alternative legume species to replace or complement white and red clovers, and most have met with limited success. Those which have received some interest in Ireland include lucerne (*Medicago sativa*), *Lotus pedunculatus,* sainfoin (*Onobrychis viciifolia*) and sulla (*Hedysarum coronarium*) as special-purpose legumes.
There is also interest in Caucasian clover (aka kura clover) for its high persistence in low input pastoral systems. Research has also highlighted its potential as a secondary gene pool for white clover breeding through *T. repens* x *T. ambiguum* hybridisation. However, results from two sites at which Caucasian clover was sown (Figure 1) suggest that the cultivars tested were not suited to Irish conditions. The likely reasons for its failure include its very slow rate of seedling development. It also requires a specific strain of rhizobia (*Rhizobium leguminosarum* biovar *trifolii* strain ICC148) which, unlike the root-nodule bacteria that fix nitrogen for white clover, is not present in Irish soils and, therefore, was inoculated onto the seed in our trials. The potential for breeding towards improved establishment in Caucasian clover will need to be investigated before it can be of any use in the foreseeable future.

This research is funded by the Teagasc Core Programme.

Reference

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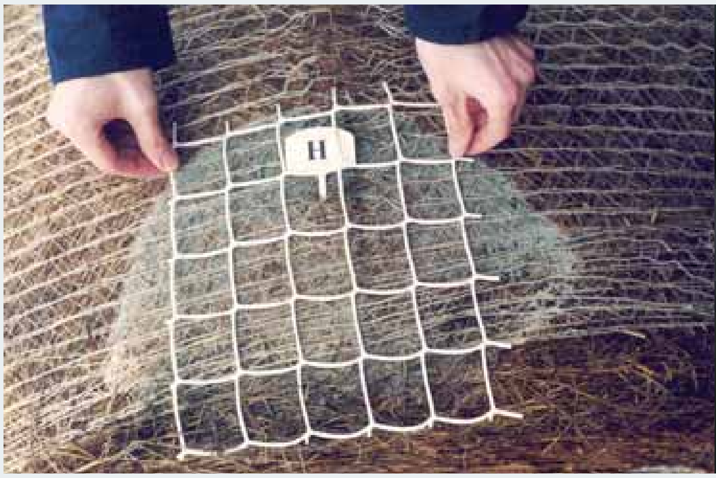
Preventing mould growth on baled silage



Measuring the area of Penicillium roqueforti *growth on the surface of a bale.*

Schizophyllum commune *growth protruding through the plastic wrap surrounding stored bales.*

Core sampling a bale using a sterilised mechanical bit.

Baled silage has become an extremely popular method of preserving grass since its introduction in the 1970s. However, fungal growth on baled silage poses economic and health problems. Researchers at Teagasc Grange and Oak Park have been looking at ways to reduce the growth of mould on baled silage.

Fungal challenge

Baled silage is made on two-thirds of Irish farms and accounts for about one-third of all the silage fed to livestock. Among its attractions are that it can be produced and subsequently used in relatively small quantities, and that the capital investment required for its storage and feeding can be much less than for conventional silages. In some circumstances it can then be a cheaper feed source than other silages. Provided the principles of making good silage are fulfilled, silage can be produced as efficiently by the baled silage system, and support similar performance by cattle, as silages made by other systems. However, on many farms, baled silages have a lower quality than conventional silages, and some of this difference is related to the higher incidence of visible fungal growth frequently found on baled silages. Fungal growth is often ignored by farmers unless it is very extensive, but needs to be prevented as it represents a loss of feedstuff and feed value, and can present a health challenge to both the farmer and livestock, as well as potentially impacting negatively on the quality of animal produce.

Likely causes

Fungi generally require oxygen to grow, so their visible occurrence on baled silage indicates a failure of the plastic film surrounding the bales to function successfully as a barrier to oxygen ingress throughout the entire storage duration. Among the factors associated with this are the thinner and more delicate barrier of plastic used on bales (a thickness of 70μm for an average of four layers of stretched film wrapped around bales versus 250μm for two sheets of film evenly covering conventional horizontal silos), that the heavy bales are mechanically handled and transported after being wrapped in plastic film, and that they are damaged by invertebrate or, more frequently, vertebrate wildlife. If any damage does occur to the plastic film surrounding a bale, the extent of damage to the silage due to mould growth can be considerable due to the proximity of most of the forage to the bale surface (compared to conventional silos).

Fungal types

O'Brien and co-workers (2007) undertook a comprehensive survey of baled silage making and storage practices on almost 300 farms throughout Ireland, together with a detailed study of the extent of fungal growth and identification of fungal types on bales on these farms. Visible fungal growth was evident on the surface of over 90% of the bales examined, with an average of five visible colonies covering a total of 6% of the surface of affected bales. Whereas visually non-contaminated baled silage had a mean pH of 4.5, which is satisfactory for wilted silage, silage visually contaminated with fungal growth had a much deteriorated quality, as indicated by a pH value of 6.7.

In general, moulds accounted for over 80% of the fungal growth, with yeast making up the remainder. The predominant mould, *Penicillium roqueforti,* was

Aseptic sampling of Penicillium roqueforti *growth on a bale surface.*

Penicillium roqueforti *colonies growing on selective media in the laboratory.*

almost ubiquitous on baled silage. *Schizophyllum commune* was the most common of the other moulds, followed by Mucoraceous moulds and *Penicillium paneum*, with much lesser amounts of *Fusarium culmorum*, *Fusarium avenaceum*, *Trichoderma* and finally *Coprinus*. Among the yeasts, *Pichia fermentans* was the most common, followed in order by *Geotrichum*, *Pichia anomala* and, to a minor extent, *Candida boidinii*. These were identified using a combination of conventional and molecular microbiology techniques, and on the basis of their secondary metabolite profiles.

Fungal growth was most prevalent on bales where the surrounding plastic film was visibly damaged. The latter was caused, in declining order, by birds, machinery and cats, while livestock and rodents were problematic in a small number of cases. Factors associated with a lower level of fungal growth included rapid effective wilting, using netting rather than twine to tie bales, wrapping bales at the site of storage rather than at the site of baling, and very gentle handling of bales by machinery operators. Bales stored on their flat ends had a lower incidence of plastic film damage than those stored on their curved barrel, but mould growth was particularly extensive if it occurred with bales stored on their flat end. If bales were stored on their curved barrel the incidence of fungal growth was less if the bales were located on a concrete base rather than on grass or gravel. Different fungi were favoured by different conditions, and these were identified using sophisticated statistical analysis techniques.

Mycotoxins and other secondary metabolites

Mycotoxins are poisonous substances produced by fungi. In this study, O'Brien and co-workers also established the secondary metabolites produced *in vitro* by about 80 isolates of both *P. roqueforti* and *P. paneum*. Approximately 90% of *P. roqueforti* isolates were consistent producers of roquefortine C, andrastin A and mycophenolic acid, but varied greatly in their ability to produce roquefortine A, citreoisocoumarin, andrastin C, PR toxin or eremofortin C. Most *P. paneum* isolates were producers of andrastin A, citreoisocoumarin, marfortines and roquefortine C, but were not consistent in their ability to produce roquefortine A, andrastin C, gentisic acid or patulin.

In addition to the above, the morphological and molecular characteristics of these isolates of *P. roqueforti* and *P. paneum* were also determined.

Conditions within bales

The fermentation characteristics of baled silages generally differ from conventional silages such as precision-chop silage. The higher dry matter content and pH, and lower concentration of fermentation products usually present in baled silage are less inhibitory to fungal growth than the conditions in other silages. McEniry and co-workers used conventional and molecular microbiological techniques to establish that the onset of fermentation and decline in pH are slower in baled silages. This permits the continuation of plant enzyme activity (especially in wetter herbage) and the persistence of greater numbers of Enterobacteria in the early stages of ensilage, both of which could impede successful preservation. The use of the terminal restriction fragment-length polymorphism (RFLP) molecular technique confirmed that the profiles obtained using traditional culturing methods of microbiological identification were reliable. Detailed factorial experiments indicated that the overwhelming objective with baled silage systems must be to rapidly achieve adequately anaerobic conditions and maintain them thereafter. Failure to achieve this will lead to progressively greater losses, especially with drier forage. The impacts of forage chopping (i.e., slicing forage during baling) or compaction are relatively minor if anaerobic conditions prevail.

T Livestock

TABLE 1: Numbers of mould and yeast propagules in the visually non-contaminated parts of silage bales.[1]

	General standard of sealing bales with stretch-film	
	Excellent	Normal
MOULDS		
Penicillium roqueforti	0	100,000
Penicillium paneum	0	46,000
Other *Penicillium*	<10	0
Trichoderma	0	770
Cladosporium	<10	0
Byssochlamys	<10	0
Mucoraceous mould	<10	760
Other moulds	<10	<100
YEASTS		
Saccharomyces exiguous	8,400	27,000
Pichia fermentans	<100	120,000
Candida glabrata	360	<10
Saccharomyces cerevisiae	<10	0
Torulaspora delbrueckii	<10	0
Issatchenkia orientalis	<10	70,000
Pichia anomala	<100	16,000
Candida rugosa	<10	0
Kluyveromyces marxianus	<10	0
Geotrichum	<10	260
Debaryomyces hansenii	0	<10
Other yeasts	890	0

[1]*Colony-forming units/g silage (values >10,000 suggest aerobically unstable feed)*
Source: O'Brien et al. *(2007)*

Further research indicated that there will sometimes be a greater need to assist fermentation in baled silage by more extensive wilting and/or by evenly applying adequate effective additive. The effects of different additives with contrasting modes of action were also defined.

Characteristics of plastic film

The plastic stretch film used to wrap silage bales needs to allow carbon dioxide produced within the bale during ensilage to escape (most likely between the layers of film) while simultaneously preventing oxygen entry (through the film). Most commercial film is currently made using a blend of low density polyethylene (LDPE) and linear low density polyethylene (LLDPE), with polyisobutylene (PIB) included to help the stretched layers adhere to one another. This type of film has both advantages and disadvantages compared to the use of film containing nylon, polyvinyl chloride (PVC) or metalo-plastics.

Laffin and co-workers found similar gas permeation coefficient and Young's modulus values for a number of commercially available stretch-films (25µm thick layers prior to stretching). In contrast, a thinner film (12µm), which was pre-stretched during its production, was less permeable to gas transmission per unit of film thickness.

Extrusion processing conditions were shown to have a major impact on the gas permeation properties of the film. Thus, comparisons of LDPE/LLDPE (70/30 w/w) manufactured using cast film extrusion highlighted the importance of the film polymer being sufficiently dense if low permeation coefficients are to be achieved. Perhaps the most significant finding was the effect of stretching on gas barrier properties. Stretching film at bale wrapping decreased the gas permeation coefficient, thereby improving its gas barrier properties. This effect was mediated through increased crystallinity and aligned molecular orientation within the film. The optimum effects were achieved when the film was stretched by 70%. While stretching beyond this point continued to improve permeation coefficient values, the gain was less marked and mechanical properties of the film disimproved, making it more susceptible to damage. Although the largest response to stretching was exhibited by the film of lowest polymer density ($0.903g/cm^3$), this latter film never achieved the permeation coefficient of the denser ($0.918g/cm^3$) polymer film. These results indicate the scope for alternative wrap configurations on the bale, possibly using greater numbers of highly stretched or pre-stretched layers to improve gas barrier properties.

The inclusion of PIB did not alter the gas barrier properties for blown films manufactured with the octene co-polymer. However, with hexene and butene co-polymers there was a reduction in permeation coefficient and an increase in crystallinity with increasing rates of PIB inclusion.

A series of comparisons of PVC and LLDPE blown films, each at a range of film stretch levels, concluded that when both mechanical and gas permeation properties were considered, films manufactured from PVC resins demonstrated inferior properties to those of polyethylene produced for wrapping baled silage.

Guidelines

Optimal baled silage making, handling and storage practices were defined. Thus, when these recommended practices were fully implemented, the extent of visible fungal growth on bale surfaces and the enumerated counts in visually non-contaminated silage (Table 1) were massively reduced compared to normal farm practice.

This research is funded by the Teagasc Core Programme.

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The practice of piglet castration in Europe

Researchers at Moorepark Research Centre are involved in an EU-wide project on the practice of piglet castration in Europe.

The regulations governing the slaughter and processing of boar meat were relaxed in Ireland during the late 1970s. Entire male pigs were demonstrated to be more efficient converters of feed to gain (10%) in the grow-finisher period (Hanrahan, 1982). Because of this, castration ceased in the mid 1980s and entire male pigs have been produced on Irish pig farms up to the present day. Like our UK neighbours, we have been able do this because slaughter weight was low relative to that in other EU countries, thus reducing the likelihood of boar taint in meat from these pigs. However, it is important to note that carcass weight in Ireland has increased by more than 13kg (about 17kg live weight) since 1990. Most other EU countries have higher slaughter weights and still castrate male pigs. Where surgical castration is practised after the seventh day of life, it can only be performed under anaesthetic and additional prolonged analgesia by a veterinarian (Council Directive 91/630/EEC). Castration allows males to be taken to heavier slaughter weights without the risk of boar taint, a distinct, unpleasant, perspiration-, faecal-, or urine-like smell, when fat or meat from some entire mature boars is heated. Skatole and androstenone are believed to be the two main contributors to boar taint. However, the practice of castrating male pigs is coming under increased pressure in the EU on welfare grounds. Council Directive 91/630/EEC called on the Commission to present a report on the development of techniques and systems of pig production and meat processing that would be likely to reduce the need to resort to surgical castration. Further to this, the European Food Safety Authority (EFSA, 2004) highlighted in a scientific opinion that more information needed to be gathered on methods currently used to castrate male (and occasionally female) pigs.

'PIGCAS' is the acronym for the project 'Attitudes, practices and state-of-the-art regarding piglet castration in Europe', which is a Specific Support Action in the Sixth Framework Programme in the EU. The overall objective of the project was to provide information on piglet castration for the purpose of supporting EU policy. The specific objective of work package 2 in PIGCAS, the results of which are presented here, was to improve knowledge on the extent of the practice of piglet castration and how it is performed in different European countries. The project aimed to gather and evaluate information about the extent of the practice, conditions under which castration is performed, and variations between countries. All production systems, however insignificant, that operated in a country were considered.

T Livestock

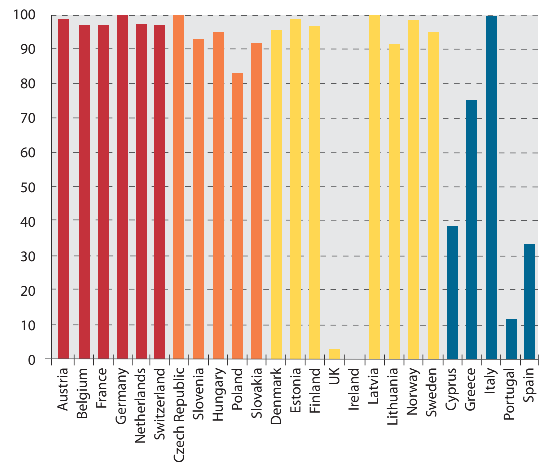

FIGURE 1: Percentage of pigs castrated by country.

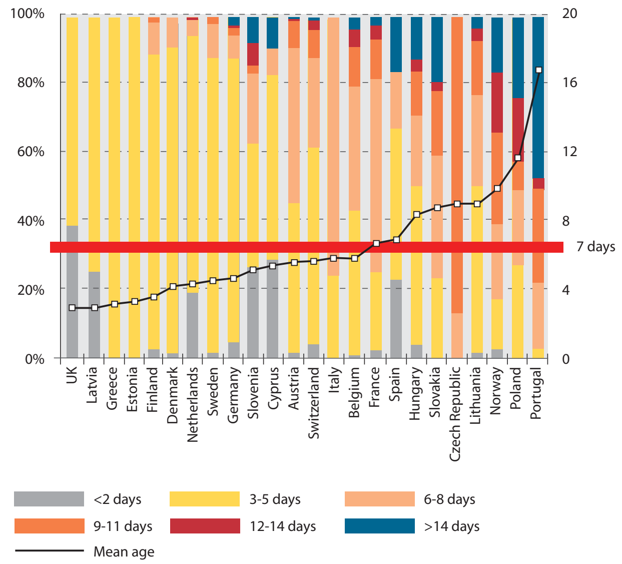

FIGURE 2: Age of piglets when castration is carried out by country.

Information from each participating European country was collected by one national contact person. Stakeholder organisations representing farmers/breeders, veterinarians, the meat industry and pig health services were contacted and interviewed or asked to fill in a common questionnaire. The data presented are means and distributions of the answers from each country.

Results

Extent of practice

In most of the European countries, castration is performed on 80-100% of the male pigs in conventional production. The exceptions are Ireland and the United Kingdom, where castration is hardly performed at all. In some of the southern countries (Cyprus, Portugal and Spain), a limited percentage of the male pigs are castrated. In these countries, meat from castrates is mainly used for export and production of high quality cured products. Also, in Greece, production of entire males seems to be quite common (24%). In most countries, there seems to be little difference between the percentage of piglets castrated in conventional and non-conventional production systems. The exceptions to this are the Netherlands, where there exists a non-conventional production system where no castration is performed at all, and Spain and Portugal, where an extensive production system exists where all piglets are castrated because they are slaughtered at higher weights (150-180kg).

Age at castration

For most countries, the mean age at castration is estimated to be between three and seven days after birth. However, age at castration and the procedure used for castration differ widely both within and between countries. Nations with a higher estimated mean age at castration are Portugal (17 days), the Czech Republic (nine days), Hungary (8.5 days), Poland (12 days), Lithuania (nine days) and Norway (10 days). At least for a minor part of production, many countries still perform castration at more than two weeks after birth.

Who performs the castration?

In most countries, castration is performed almost exclusively by the farmers. Exceptions to this are the Czech Republic, Slovakia, Estonia, Lithuania and Norway, where the majority of castrations are performed by veterinarians. Also, in Slovenia, Hungary, Poland and Cyprus, a considerable percentage (>20%) of the castrations are performed by veterinarians. Trained medical technicians also castrate pigs in some countries (Slovenia, Hungary, Latvia, Lithuania, Italy and Cyprus).

Anaesthesia

In most countries anaesthesia is not used or very seldom used. The exceptions are Norway, Lithuania, Hungary, Poland and Slovakia. In Norway, anaesthesia is used for practically all castrations, because it is mandatory by law since 2002. In Lithuania, two of four respondents answered that anaesthesia was used commonly or very commonly. In Hungary, Poland and Slovakia most of the respondents answered that anaesthesia was used seldom or not at all, while a few respondents answered that it was used very commonly or always. The explanation is probably that anaesthesia is used routinely at castration in a very low percentage of the herds. Different variants of local anaesthesia with lidocaine seemed to be most common. The combination of subcutaneous and intratesticular injection was most common, followed by testicular injection alone and a combination of injection subcutaneously and in the spermatic cord. In some countries (Poland, Slovenia, Slovakia, Switzerland, Austria and Sweden), general anaesthesia by injection (ketamine, azaperone, metomidate, mopenthium, natricum or pentobarbital) was also reported. In most cases where anaesthesia was reported to be used very commonly or always, the percentage of veterinarians performing the castration was reported to be high. However, in Hungary and Poland, a high percentage of farmers perform the castration and a very common use of anaesthesia is also reported.

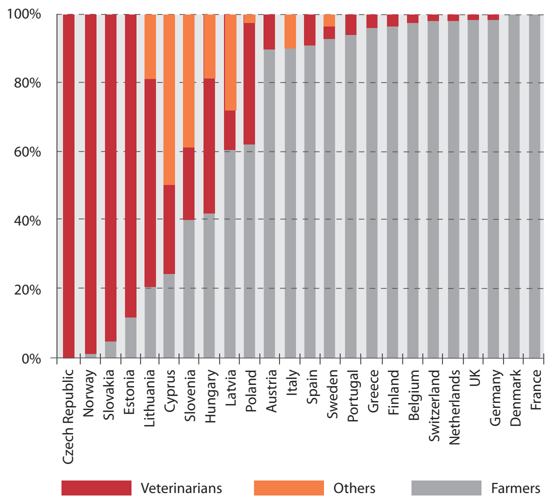

FIGURE 3: Percentage of pigs castrated by veterinarians, others and farmers by country.

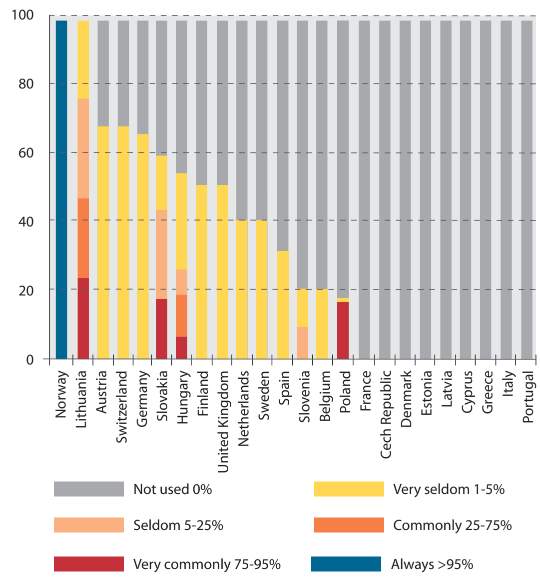

FIGURE 4: Percentage use of anaesthesia for piglet castration by country.

Complications

Overall, complications due to castration do not seem to be a common problem in any country. However, variations were reported within countries, and it seems to be a problem in some individual farms. Occurrence of abscesses was the complication reported to be most common, but was very seldom reported to occur in more than 5% of the cases.

Interaction with other potentially painful procedures

Within the PIGCAS project, the extent of other possibly painful practices was assessed. Tail docking and teeth resection were reported to be performed on the majority of animals in most countries. These are most commonly done before castration (probably most commonly just after birth), but they are also quite commonly performed on the same day as castration. Iron injection is most commonly performed on the same day as castration, while ear tagging, vaccination and tattooing are usually performed later.

Discussion

The results of this project show that castration of male pigs is common in most European countries, but also that some countries, like Ireland and the UK, find it possible to produce entire male pigs. Practices concerning age at castration and how castrations are performed differ markedly both within and between countries. Castration practices are similar in conventional and organic systems, but differ markedly for some extensive production systems.

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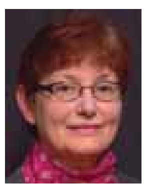

Food and health – the consumers' perspective

SINÉAD McCARTHY, Ashtown Food Research Centre, discusses some consumer issues surrounding health and wellness, with a focus on functional foods in particular, and outlines a strong new research programme in the area.

Consumers tend to have a good understanding of what constitutes a healthy diet.

The quest for health and wellness has been spurred on by increasingly health-aware consumers. This trend is played out in a myriad of complex consumer behaviours, with an emphasis on wellness. Some of these behaviours include taking responsibility for one's health, achieving better mental well-being and embracing the notion of 'positive nutrition', where consumers focus on what is inherently healthy about foods rather than dwelling on the less favourable content (Datamonitor, 2007). The dynamic changes occurring in the demographic profile will be one of the major drivers of the health and wellness trend. In an ageing population, where life expectancy is on the rise, the demand for health-enhancing and disease-prohibiting foods will be immense as consumers take increasing levels of responsibility for their own health decisions. Lifestyle-related diseases such as obesity and type 2 diabetes will continue to rise. Given the right communications strategy, consumers will embrace modern technology and what it has to offer to counteract the negative health effects of their lifestyles. The health trend will also be driven at government level. The immense gap between 'life expectancy' and 'healthy life expectancy' will drive government policy for public health, given the potential strain that an unhealthy ageing population will impose on the country's healthcare system.

Consumers' health concerns

A recent Irish consumer study conducted by the Nutrition and Health Foundation found that while 90% of people surveyed claimed that they were happy about their overall health, many still had health concerns. The biggest health concern was cancer (31%) followed by heart disease/cholesterol and high blood pressure (19%), while 20% expressed no health concerns (Figure 1). Men and younger age groups were more likely to have no health concerns and less likely to have specific health concerns compared to women and older age groups.

In general, consumers tend to have a good understanding of what constitutes a healthy diet; however, this may not always be reflected in actual consumer behaviour, given that there is such a high prevalence of obesity and other diet-related diseases worldwide. In addressing these concerns, and the gaps in actual versus intended behaviour, functional foods can play a vital role and this increases their likelihood of market success.

Functional foods and health

This quest for health and wellness is one of the main drivers for the success of functional foods. Functional foods incorporate science into everyday eating with the suggestion of specific and targeted health benefits for the consumer, making it the fastest growing segment in the food market. Margarines and spreads enhanced with plant sterols to reduce cholesterol are typical of this category of foods. This market will continue to grow successfully if credible science is integrated with consumer understanding, uncompromised taste and effective communication (Weststrate *et al.*, 2002). Consumer acceptance has regularly been identified as the decisive factor in the successful marketing of functional foods (Bech-Larsen and Scholderer, 2007). Consumers' willingness to use functional foods will vary depending on the perceived reward from the particular functional food and the necessity for the actual food (Urala and Lähteenmäki, 2007). Many aspects of functional foods will influence consumers' acceptance of the product, as illustrated in Figure 2.

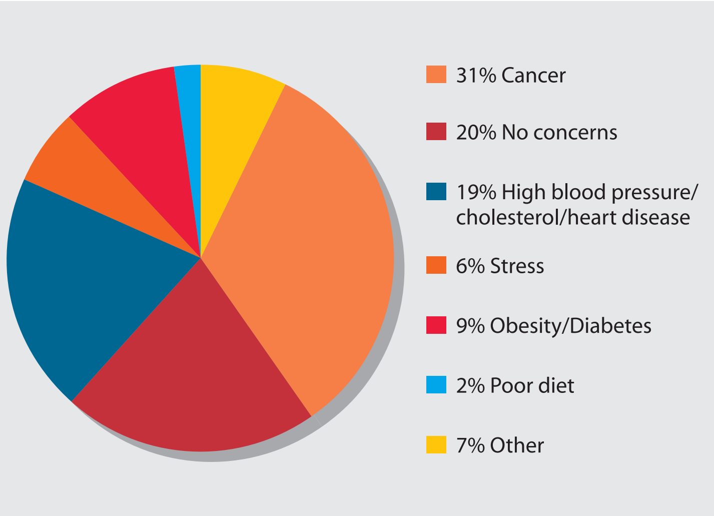

FIGURE 1: Health concerns of Irish consumers (NHF, 2005).

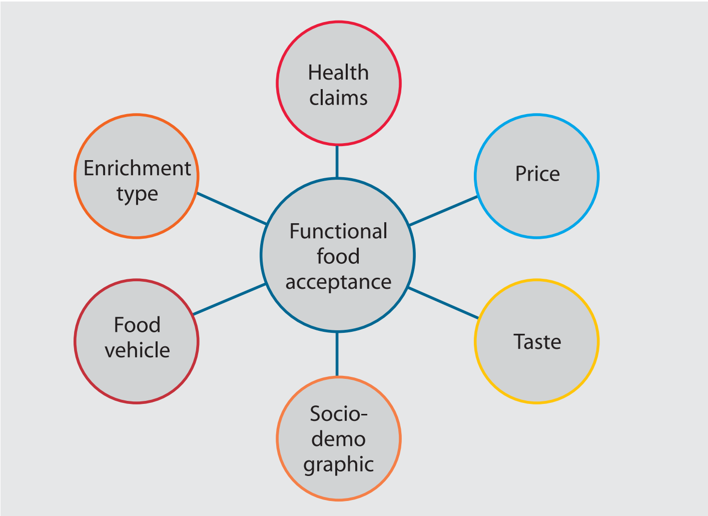

FIGURE 2: Factors influencing consumer acceptance of functional foods.

Consumers' acceptance of a specific functional ingredient is linked to their knowledge and understanding of the health effects of that ingredient. To enhance consumer acceptance, it is important that the health message/claim is transferred in a simple and comprehensive way that is easy to understand. Women and the elderly tend to be more interested in functional foods than other consumers and are therefore target segments for the marketing and promotion of these products (Poulsen, 1999). These gender and age influences are probably due to the differences in health concerns between men and women and younger versus older age groups. The purchase of functional foods has been associated with higher socio-economic groups, which might be an indication of better knowledge and increased awareness, as well as greater ability to afford the higher price premia. Taste is of profound importance with respect to the acceptance of any new foods and consumers will not compromise taste for eventual health benefits (Grunert *et al.*, 2000; Verbeke, 2005). Consumers also demonstrate a preference for the various health aspects they want functional foods to influence. In a study undertaken by Bech-Larsen *et al.* (2001), prevention of cardiovascular/heart disease had the highest priority in all three countries examined (the US, Denmark and Finland) followed by stomach/intestine cancer and enhanced immunity (see Figure 3). Consumer acceptance of functional foods is frequently neglected and has a significant influence on the successful marketing and eventual acceptance of these foods. Therefore, all of the attributes discussed above should be considered in the development of new functional food products.

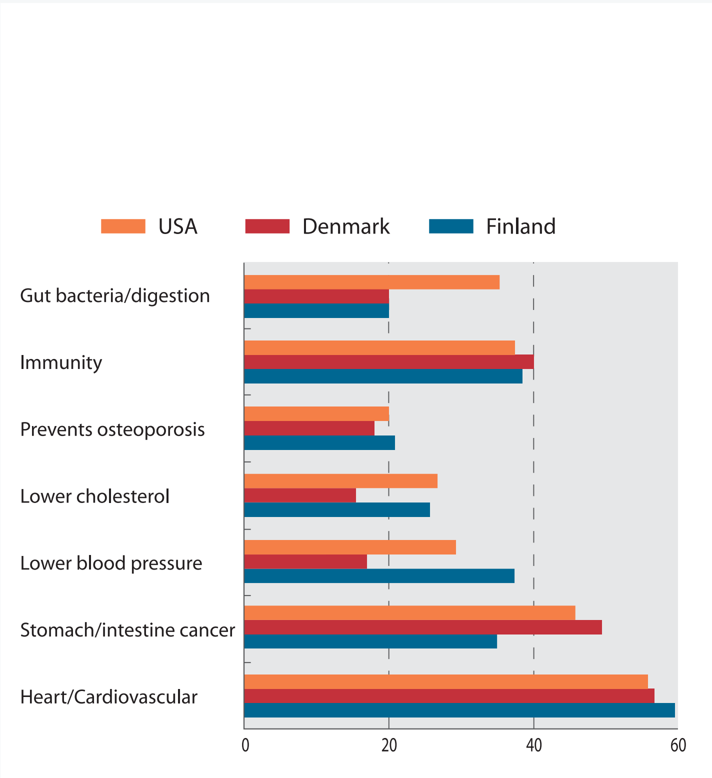

FIGURE 3: Consumers' preferred health claim for functional foods (Bech-Larsen et al.*, 2001).*

T Food

AFRC has made considerable progress in developing a research programme to better understand consumer behaviour in relation to food and health.

New consumer behaviour research programme

The Food Market Research Unit (FMRU) at Ashtown Food Research Centre has made considerable progress in developing a research programme to better understand consumer behaviour in relation to food and health, and in new food product development. It has been awarded funding through the Food Institutional Research Measure (FIRM) of the Department of Agriculture, Fisheries and Food (DAFF), the Health Research Board (HRB) and the Teagasc Walsh Fellowship scheme, to progress research in this area.

> *Consumer acceptance of functional foods is frequently neglected and has a significant influence on the successful marketing and eventual acceptance of these foods.*

Under FIRM, €5 million has been awarded to a consortium, of which the FMRU is a member, for the development of food consumption databases. The FMRU is leading the 'consumer science' work package, which will involve developing and administering a questionnaire to a representative sample of 1,500 adults. Results of this attitudinal survey will provide a basis for understanding the motivations for, and barriers against, healthy lifestyles, which, when coupled with actual behaviour data from the food consumption database, will provide very powerful consumer information for the development of food and health policy, and industry initiatives.

The FMRU is also a member of a consortium that was awarded funding by the HRB to establish a National Research Centre for Diet, Obesity and Diabetes (NRC). It will participate in one of the five research clusters to be examined in this project, which will address consumer cognitive response to food, with a focus on the socio-demographic, psychological, physiological and health status factors that drive consumer food choice.

The food-related lifestyle (FRL) model has been used previously in the FMRU to examine the UK market for convenience and speciality food. A new Teagasc Walsh Fellow will revise and modify the FRL to use it for the first time in an Irish setting to investigate if differences exist in the health-related beliefs, social norms, attitudes and behaviours of the various FRL segments. Using the FRL, information on specific groups of consumers can be collected and targeted initiatives that are appropriate for the individual's food lifestyle can be developed. This will help industry to develop new products and appropriate marketing strategies to capitalise on consumers' increased awareness of diet and nutrition.

The FMRU will also be involved in the Marine Functional Foods Research Initiative in 2008. As a part of this large-scale project, the FMRU will conduct qualitative focus group research to probe the market and explore consumer perceptions, intentions and attitude formation regarding functional foods, with specific emphasis on marine functional foods.

This new research programme in the FMRU supports many of the research objectives at both European and national level. At European level, this work complements the mission of the European Technology Platform 'Food for Life', which is "to more fully understand consumer food choice behaviour and to stimulate the consumers' selection of foods in order to arrive at a healthy diet

Women and the elderly tend to be more interested in functional foods than other consumers.

('to make the healthy choice the easy choice'), and to create trust and confidence in food production, service development and consumption of (novel) foods". At a national level, it supports the key action for food and agriculture in the government's Strategy for Science Technology and Innovation (2006) to "ensure that food research provides a base of knowledge and expertise in generic technologies to support a modern, innovative and consumer focused food industry, with attention to food safety and quality issues". Finally, it also complements and develops the research strategies of Teagasc, which have a strong emphasis on 'food for health'.

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Dr Sinéad McCarthy is a Research Officer in the Food Market Research Unit at Ashtown Food Research Centre. She has an extensive background in public health nutrition, population surveys and consumer studies, and will lead Teagasc's consumer research programme of food for health. The Walsh Fellowship will be carried out by Ciara O'Flaherty. E-mail: maeve.henchion@teagasc.ie.

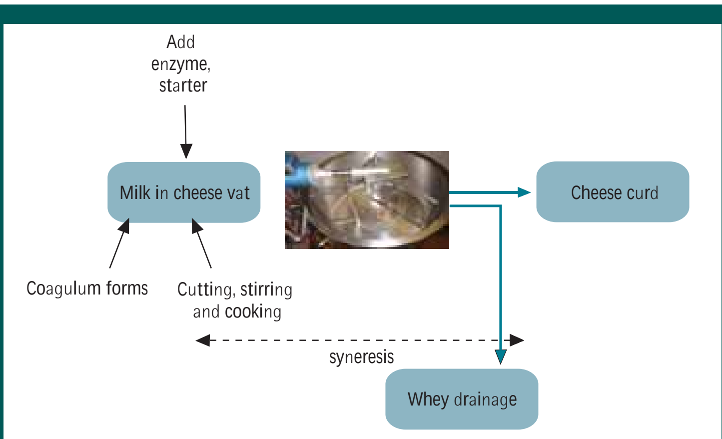

FIGURE 1: The coagulation, syneresis and whey drainage steps in cheese manufacture.

FIGURE 2: Light backscatter syneresis sensor design and optical configuration used for monitoring coagulation and syneresis to improve control of curd moisture content.

Sensors in food manufacture – the next generation

A new generation of sensors is being developed for in-process monitoring in the food manufacturing sector. DONAL J. O'CALLAGHAN and COLM D. EVERARD describe their work in on-line sensors for the food industry.

Food manufacturing and preservation technology developed rapidly through the 20th century and now bears little resemblance to the ways that earlier generations would have prepared food. Nowadays, food production lines consist of a sophisticated series of batch continuous or semi-continuous steps, e.g., milk standardisation, blending of ingredients, thermal treatment, fermentation, concentration, cooling, storage, etc., with associated process variables that affect the efficiency of the process and/or the quality of the product. Process conditions influence food characteristics in many complex ways and, therefore, need to be measured and controlled within tight specifications. An ongoing evolution of process monitoring and control techniques, involving sensors for capturing more comprehensive fingerprints of process and product history, is being applied to improve product quality and consistency in the food and drink industries.

Scale

Modern large-scale plants are difficult to inspect; hence, nowadays, an operator must control a complex process remotely through the use of instruments (as opposed to using sensory information), analogous to an aeroplane pilot. It is very costly to stop–start a large modern food plant in the event of a malfunction, such as cyclone blockage, evaporator tube blockage, fluidised bed blockage, a problem in a packing line, etc. There is also greater potential for harm due to out-of-specification product and greater risk in terms of value of lost or downgraded product.

Some objectives

A strategic objective in operating a food plant is to maintain conditions that produce good product characteristics consistently. A consequent benefit of stable operation is that product yield can be improved through tighter variation on moisture content of the finished product, enabling a given amount of solids to be converted into a slightly greater amount of finished product. Sensors work with process models to establish process conditions for optimum exploitation of process equipment, e.g., evaporators and/or dryers, and this has implications for energy consumption and product quality.

Sensors, such as those for temperature, pressure, density and flow rate, are well established in food process plants. A further generation of on-line sensors is under development for more challenging and product-specific applications, such as viscosity of concentrated milk, moisture of cheese curd, and colour of food products. Biosensors, which are at a basic level of development with regard to food processes, offer potential advantages over conventional methods in the field of food processing and quality control, with their inherent specificity, simplicity and quick response.

Sensor developments

Milk powder

A range of sensor techniques was investigated at Moorepark for monitoring online viscosity of concentrated milk in the manufacture of spray-dried milk powder. Vibrational techniques were found to be promising because they do not involve moving parts. Such on-line techniques reflect the effect of varying solids content, but also give a truer measurement of the critical parameter (viscosity), which directly controls atomisation, than the measurement of specific gravity alone.

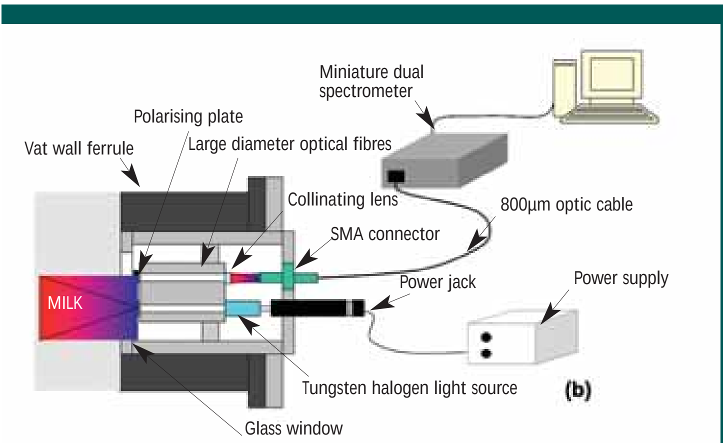

FIGURE 3: An on-line large field of view (LFV) light backscatter sensor adapted and fitted to a pilot scale cheese vat for monitoring of the coagulation and syneresis phases of cheese making.

Cheese making

Cheese is produced in a series of steps, including coagulation, syneresis and whey drainage, as shown in Figure 1. The extent of syneresis during cheese making controls the moisture, mineral and lactose content of the curd, which affects cheese ripening and, subsequently, the final sensory attributes of the cheese. Research at Moorepark has shown that existing commercial scale cheese vats can be adapted and fitted with fibre-optic probes using hygienic fittings, that such techniques can be used to detect coagulation during the renneting stage, and that this, in turn, can be used to fine tune the coagulum cutting operation. This type of sensor measures light backscatter as milk is coagulated. Building upon this technology, current research at Moorepark is aimed at developing a novel light-scatter sensor technology to monitor both the coagulation and syneresis phases during cheese making (Figures 2 and 3). Improved control of the syneresis phase in cheese making will allow the cheese maker to produce a more consistent cheese and will give a more accurate determination of conditions for draining of the cheese vat, thus improving cheese vat efficiency.

Computer vision was investigated for monitoring syneresis in the vat. During cheese manufacture there is a colour change from that of milk before cutting the coagulum to a mixture of white curd particles in mostly clear yellowish whey during syneresis. The study found that a computer vision system had potential for monitoring syneresis over a range of stirring speeds and milk pH using colour parameters.

It is expected that European consumption of cheese will continue to expand in the post quota situation, and modernisation and further development of technology will be required, especially with regard to quality control. The production of more consistent cheese products would reduce the amount of substandard or reduced shelf-life product, and contribute to food safety, helping to maintain Ireland's reputation for producing top quality food.

Soft sensors

In some situations, product quality – e.g., moisture and insolubility index – cannot be measured readily, but can be estimated or inferred in real time from readily available measurements, allowing for inferential control of product quality. The term 'soft sensors' refers to the use of computer modelling (or inferential) techniques for this purpose. Soft sensors play various useful roles. Soft sensors can also add robustness to a system by overriding an instrument reading (e.g., of moisture) where an instrument becomes faulty, an aspect of fault-tolerant process control.

Conclusions

Increasing use of on-line sensors (e.g., for viscosity) is emerging in food manufacturing. Future developments are likely to include online biosensors for quality control in food-processing plants, e.g., for detecting *E. coli,* and *Salmonella*. At present such sensors are not sensitive enough for on-line application but it is conceivable that in the future biosensors could be used to test every product, or every batch, on a food line. Micro-electronic-based soft sensors/intelligent field devices are emerging with built-in diagnostic capabilities.

Acknowledgements

Funding for this research was provided under the National Development Plan, through the Food Institutional Research Measure (FIRM), administered by the Irish Department of Agriculture, Fisheries and Food.

The research was carried out in collaboration with University College Dublin and the University of Kentucky, USA.

Further information on these technologies, which have been protected by patent application, is available from Miriam Walsh, Intellectual Property Officer, Teagasc, E-mail: miriam.walsh@teagasc.ie.

Dr Donal O'Callaghan is a Principal Research Officer in the Food Processing & Functionality Department at Moorepark Food Research Centre and carries out research on process monitoring and control. Dr Colm Everard is a researcher currently engaged in a research project on monitoring syneresis in cheese making. E-mail: donal.ocallaghan@teagasc.ie.

Reducing greenhouse gas emissions from agriculture

TOP LEFT: Collars to measure methane from cows.

BOTTOM LEFT: Static chambers for nitrous oxide measurement.

LEFT: Field-scale CO_2 quantified by eddy covariance.

Reducing greenhouse gas emissions from agriculture is one of the biggest challenges the industry will face in the coming decades. GARY LANIGAN describes some multidisciplinary strategies that Teagasc is engaged in to do just that.

Due to the combined effects of unprecedented economic growth and population increase, greenhouse gas (GHG) emissions are currently running at 23% above 1990 levels (10% above our Kyoto targets). Significantly, Ireland is unique among the EU countries in that 27.7% of national GHG emissions originate from agriculture. Indeed, among the developed economies, only New Zealand has a higher proportion of national GHG emissions associated with agriculture (see Figure 1).

Agricultural emissions are dominated by methane (CH_4) and nitrous oxide (N_2O), which are 21 times and 310 times, respectively, more effective as GHGs than CO_2. CH_4 emissions are primarily due to livestock enteric fermentation and manure management, while N_2O emissions result from chemical/organic fertiliser application and animal deposition.

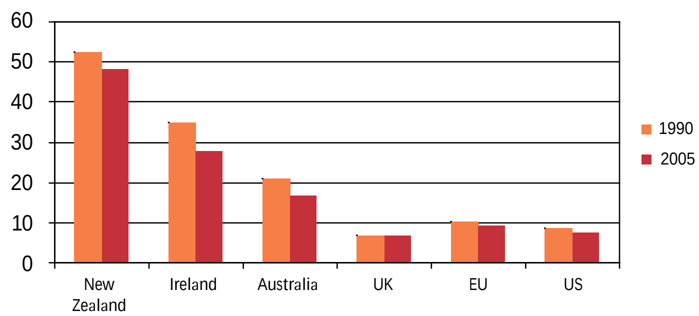

FIGURE 1: Agricultural GHG emissions expressed as a percentage of total national emissions for a range of Annex 1 (developed) countries.

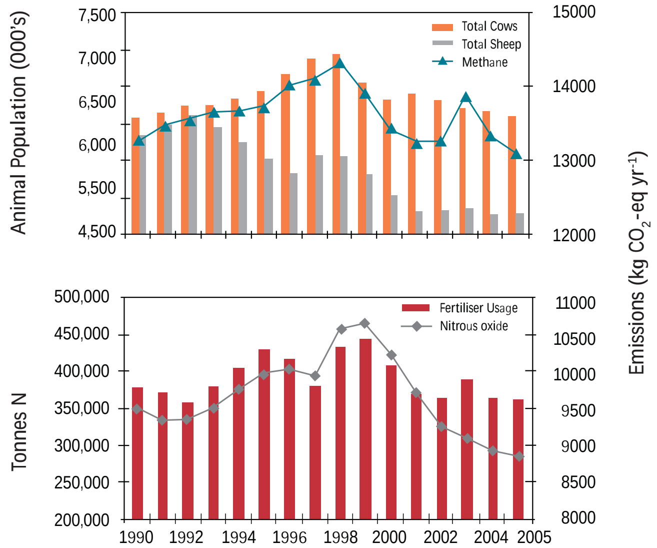

FIGURE 2: Trends in: a) national methane emissions (kT CO_2-eq) and animal numbers; and, b) national nitrous oxide emissions and fertiliser consumption from 1990-2005.

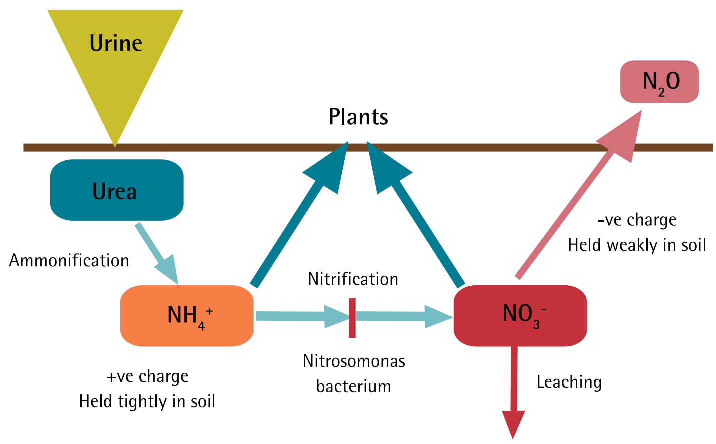

FIGURE 3: Schematic of the nitrogen cycle in soils.

It's not all bad news though. Despite being a high percentage of total emissions, agricultural GHGs have decreased by 3% relative to 1990, and 8% relative to 1998. These reductions are driven by decreases in the total number of beef cattle and sheep, leading to reduced CH_4 emissions. In addition, reductions in N_2O emissions are coupled to decreased fertiliser usage (Figure 2). By contrast, emissions associated with both transport and power generation have risen by 160% and 46%, respectively. Ultimately, increases in these categories have driven the large rise in national emissions.

The 20/20/2020 proposals and challenges for agriculture

The EU Commission's recent package of proposals, known as 20/20/2020, envisages a 20% EU-wide cut in emissions relative to 1990 levels (or 14.2% relative to the new proposed baseline year of 2005). This target will increase to 30% in the event of a global agreement. In addition, 20% of total energy and 10% of fuel must come from renewable sources. The burden-sharing of these cuts between member states has been allocated on a GDP per capita basis and, as a result, Ireland has been set a target of reducing emissions by 20% from the non-emissions traded sector (ETS) by 2020 compared to 2005 levels.

Why does this pose such a particular challenge to agriculture?

- As these non-ETS sectors comprise only agriculture, transport and residential, there are relatively few sectors among which to share the burden. Considering that agriculture makes up 40% of non-ETS emissions, the sector could be targeted to shoulder a large share of the burden;
- earlier projections had forecast a decrease in agricultural emissions by as much as two million tonnes by 2020. However, the effects of increased and/or abolition of quotas, combined with higher global demand, may limit the potential for reductions; and,
- in the context of increased food demand, there is a conflict between the need to meet world food demand and the 10% biofuel target (and, to a lesser extent, the renewable energy target), which will put pressure on agricultural land use.

Greenhouse gas mitigation

The proposed targets are onerous. However, GHG mitigation and the application of best management practices can provide some opportunities to optimise production efficiency. For example, N_2O emissions represent a decrease in soil N available for plant uptake, while CH_4 emissions from enteric fermentation imply a loss of carbon (C) and an unproductive use of energy. Teagasc is currently engaged in a large programme of research across all centres to elucidate the potential of some of these mitigation options.

This greenhouse gas mitigation research can be placed into three main categories:

- abatement strategies for reducing enteric CH_4 production;
- mitigation of N_2O production from agricultural soils; and,
- C sequestration via land management or land-use change.

In addition, biomass production can displace fossil fuel emissions associated with heating and electricity generation, and also carry energy security benefits.

Abatement strategies for reducing enteric methane production

CH_4 is a by-product of the fermentation of carbohydrates in the rumen's anaerobic environment, resulting in the production of hydrogen. Methanogenic bacteria utilise this excess hydrogen to reduce CO_2 into CH_4. Because enteric CH_4 production is influenced by feed quality, manipulating animal diet is the principal mitigation strategy. Currently, research into abatement strategies for beef and dairy cows is being conducted by Grange Beef Research Centre and Moorepark Dairy Research Centre, respectively. These strategies include:

Improving pasture quality

This lowers the proportion of dietary roughage, which reduces emissions by more rapid processing of food through the rumen, reducing the time available for fermentation and increasing the proportion of propionate in rumen volatile fatty acids (VFAs), which means that there is less H_2 available for CH_4 synthesis.

T Environment

Replacing roughage with concentrates

This also increases the proportion of propionate. In beef cattle, if concentrates are supplied *ad libitum* the rate of daily carcass gain increases, thereby reducing finishing times. The lifetime production of CH_4 by beef cattle can also be shortened by finishing at a lighter weight. A large-scale shift to concentrates would depend on the price and would lead to the need to import large quantities, thus reducing its GHG mitigation potential.

Extending the grazing season

This can decrease emissions because enteric CH_4 production from a grass diet is lower than that from a silage-based diet. Also, lower emissions are associated with reduced quantities of stored manure.

Supplementing diets with oils

This has been shown to substantially decrease emissions by reductions in rumen protozoa that can form symbioses with the methanogens. The emissions associated with the production and importation of these oils must also be taken into account.

The quantification of the emissions associated with different breeds and cow genetic merits will identify low emission breeds and also enable a greater refinement of the CH_4 emission factors that are inputted into the national emission inventories. In addition, life-cycle analyses will allow a more accurate assessment of the most effective strategies.

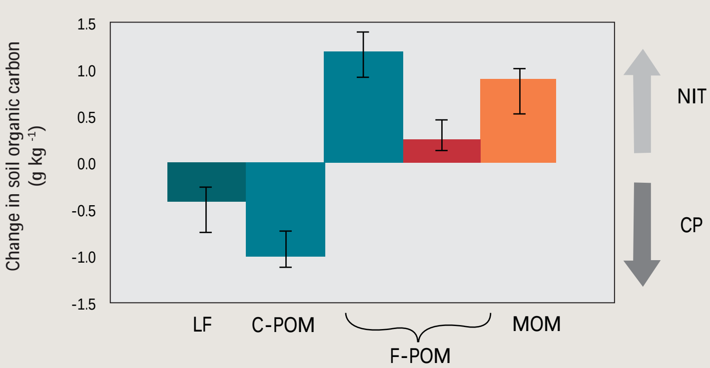

FIGURE 4: The difference in C content (g/kg^{-1}) of various aggregate-size classes between non-inversion tillage (NIT) and conventionally ploughed (CP) plots.

Abbreviations:
LF = light free C;
C-POM = coarse particulate organic matter;
F-POM = fine particulate organic matter; and,
MOM = mineralisable organic matter.

The residence time of C fractions in the soil is MOM>F-POM>C-POM>LF. Positive values indicate that a higher amount of C is associated with non-inversion tillage, with a negative value indicating a higher proportion associated with ploughing.

Mitigation of N_2O production from agricultural soils

N_2O production in agricultural soils primarily results from nitrification and de-nitrification processes (Figure 3). The Inter-governmental Panel on Climate Change (IPCC) Guidelines estimate direct emissions of N_2O from agricultural soils as a fixed percentage of the additional N inputs. These 'default' emission factors are 1.25% of applied N for fertiliser application and 2.25% for urine-deposited N. Also, indirect N_2O formation is induced by emissions and consecutive deposition of reactive nitrogen species (NOx) and ammonia, and nitrogen leaching and runoff.

Mitigation research conducted by Teagasc Johnstown Castle Environment Research Centre, in association with partners from UCD and AFBI Hillsborough, is focused on four main questions:

Manipulating animal diet to reduce the amount of N deposited by livestock

Reducing the amount of crude protein or supplementing the diet with amino acids has been shown to decrease the amount of N excreted. Also, feeding maize grain can reduce excreted N without impacting performance, as it is a low protein feed with a higher content of net energy than most concentrate feed ingredients.

Nitrification inhibitors in pasture and tillage

Nitrification inhibitors, such as nitrapyrin and dicyandiamide (DCD) can reduce the nitrification of ammonium to nitrate by inhibiting nitrifying bacteria. As a result, both N_2O and N leaching can be reduced. Inhibitors are most efficient at reducing N_2O emissions if used in conjunction with urea or on N excreted from animals in the form of urine. As the rate of urine N application to patches can reach over 800kg per hectare per year, and this is in excess of what the plants can utilise, it is available for nitrification to nitrate (which is also vulnerable to leaching) and for de-nitrification to both N_2O and N_2 – with some being lost as N_2O as a by-product of these processes. Soils are most vulnerable to N_2O losses during autumn, as the highest emission rates occur when soil moisture is high and sward C/N ratio is low. Current work on DCD application to urine patches has shown that N_2O emissions can be reduced by up to 50% on heavy soils, while there may be reductions in leaching on lighter soils. New work includes research into the application of DCD in association with different tillage methods.

Increasing clover in swards

Conversion to clover pastures is a multi-gas abatement measure. Teagasc Moorepark, in association with UCC, is investigating N_2O mitigation associated with clover pastures. Lower N_2O emissions are essentially based on a reduction in the fertiliser N requirement. As clover is more digestible than grass, there is also the opportunity to reduce CH_4 emissions. Other legumes containing high levels of condensed tannins can further reduce CH_4 and N excretion from animals. In addition, clover has a high rate of photosynthesis, and is efficient at sequestering C, with this sequestration potential increasing at higher CO_2 levels relative to ryegrass.

Altered timing of fertiliser application/land-spreading techniques

Optimal timing of fertiliser application matched to plant growth can reduce excess N availability. The relationship between reduced ammonia volatilisation and indirect N_2O emissions is unclear. Early season spreading of slurry or conversion from splash-plate to trailing shoe will also reduce atmospheric N deposition, thus reducing indirect N_2O emissions. However, associated N_2O emissions could, in fact, be higher, as these practices should increase the soil N pools. New projects investigating these trade-offs and adding inhibitors to slurries are being undertaken at Johnstown Castle.

Carbon sequestration

GHG emissions can also be reduced by removal of a proportion of CO_2 via photosynthesis. These 'carbon sinks' can be either perennial woody tissue or soil organic C (SOC). Land-use and land-use conversion to forestry (LULUCF) is the principle C sink used under the Kyoto Protocol, and Irish forests currently sequester approximately one million tonnes CO_2-equivalents/yr^{-1}. Altered land management practices can also increase soil C sequestration. For pasture systems, sward diversity and increases in clover can also increase total sward productivity and SOC sequestration.

Ireland is unique among the EU countries in that 27.7% of national GHG emissions originate from agriculture.

The highest losses of C from agricultural systems are associated with tillage practices. Research by Teagasc Johnstown Castle Environment Research Centre, in conjunction with University College Dublin, Trinity College Dublin and Teagasc Crops Research Centre Oak Park, is seeking to quantify the effects of reduced tillage, cover cropping and residue incorporation on ecosystem C balance. Alternative tillage practices can reduce the amount of C lost by reducing soil disturbance, reducing fallow season C losses and increasing C inputs. Most importantly, increases in the amount of resilient C that persists for long periods of time can be promoted by adoption of these practices (Figure 3). In addition to reducing C losses, these measures can improve soil quality and reduce erosion.

Current/future issues and research gaps

Realignment of agriculture and forestry

Following a meeting of officials in Bangkok to set rules for C sinks in the context of future agreements, it was recommended that the LULUCF sector be merged with agriculture to form agriculture, forestry and other land-use (AFOLU). This realignment will allow agriculture to claim credit for C sequestered in agricultural land converted to forestry.

Threats to C sink inclusion

However, the use of C sinks to 'remove' CO_2 may not be included in 20/20/2020 proposals as mentioned above, unless there is a global agreement. This would take away a large proportion of the abatement potential available up to 2020. COFORD (National Council for Forest Research and Development) estimate that between three and five million tonnes CO_2-eq could be sequestered by 2020. Therefore, it is vital that sinks be included in any final agreement.

Concept of leakage

A unilateral EU emissions reduction target may also not produce a reduction in global emissions, particularly from the agricultural sector. Reductions in Irish agricultural output would simply be balanced by increased production elsewhere. Considering that the GHG efficiency (unit product per unit GHG emitted) of Irish agriculture is relatively high, especially compared to the developing world (where emissions from deforestation are particularly high), the net effect could be an increase in global agricultural emissions.

Effects of climate change on emissions

While higher CO_2 levels and the extension of the growing season due to global warming may result in higher rates of photosynthesis, increased soil temperature will increase microbial activity. This will increase soil CO_2 emissions from both short-term and long-term soil C stores and will reduce soil SOC. N_2O emissions also increase with temperature. Ultimately, some ecosystems that are currently C sinks may flip and convert to C sources. However, there is currently a deficit of research, which needs to be addressed.

Effects of climate change on agricultural production

The effects of future climate change on agricultural productivity need to be addressed. Increased warming in the medium term could extend the grazing and growing season, and permit the cultivation of new crops. However, summer water deficits could have implications for summer sward production and push up costs with the requirement to irrigate. There may also be a shift in disease threat. While a decrease in fungal pathogens is predicted, increases in insect-borne diseases and pests are also predicted. Indeed, the spread of blue tongue disease from the Mediterranean region to northern Europe and the UK has been attributed to viral survival and vector longevity during milder winters, which are a consequence of climate change.

Future research

Current mitigation research will deliver some reductions in agricultural GHG emissions. However, it is clear that there is no single 'magic bullet' and significant reductions will involve implementation of a mosaic of solutions. Research priorities include the development of farm-scale management systems of soil C and N cycles that result in reduced GHG emissions and are attractive to uptake by the farming community. The development of farm-scale GHG decision-support models that incorporate C and N-cycle flows is, therefore, crucial. Underpinning future mitigation strategies is the need to further understand the interaction between the C and N cycle processes. Also, given that a degree of climate change is already inevitable, the effects of climate change scenarios on both agricultural production and GHG emissions/abatement strategies is vital.

Teagasc recently held a seminar on 'Greenhouse Gas Emissions – A Role for Agriculture', the full proceedings of which are available at: www.teagasc.ie/publications.

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Liming grassland soils in Ireland

HUBERT TUNNEY, Teagasc, Johnstown Castle Research Centre, Wexford, explains why now is the time to review the current guidelines on liming grassland soils.

Liming to maintain soil pH is necessary for good grassland in order to maintain it at a near neutral level, where nutrients for plants are most available and the risk of aluminium and manganese toxicity is prevented. Lime also supplies calcium and some limestone also contains magnesium. Lime use is advised by Teagasc and is a requirement in REPS (pH 6.3 is currently advised by Teagasc for grassland). The SMP buffer method, developed in the USA (Shoemaker *et al.*, 1961) to estimate lime requirement (LR), was introduced in Ireland in 1964 to replace the method based on pH and soil texture. New buffer methods are now being developed in the USA (Sikora, 2006) to replace the SMP method, which contains toxic p-nitrophenol. After 44 years, the time is now opportune to review and, if necessary, revise the LR advice and the method used in Ireland. This article presents information on current lime use, and estimates the pH and LR status of Irish grassland mineral (<20% organic matter) soils and how they compare with Teagasc advice for pH and liming of grassland.

Study methods

This study is based on: a) lime use statistics compiled by the Department of Agriculture, Fisheries and Food; and, b) pH and LR results from the National Soil Database (NSD; Fay, 2007). Between 2003 and 2005, 1,015 grid-based soil samples were collected (1 per 50km^2 or 1 per 5,000ha) for the NSD. In addition, 295 grid samples were collected from the south east of Ireland from 1995 to 1996, but LR results are not available for the latter samples. A total of 1,310 grid-based soil samples were collected for the whole country. A total of 624 grassland mineral soils (with pH and LR results) were included in the 1,015 samples collected from 2003 to 2005, and these soils were used for this study. The soils were analysed for pH, LR and available nutrients according to the methods in use at the Teagasc, Johnstown Castle Labratory.

Results and discussion

The trend in agricultural lime use is shown in Figure 1. The mean annual agricultural lime use was 1.7 x 10^6 tonnes in the decade between 1975 and 1984, and was only half this level between 1995 and 2004. The small increase in recent years (e.g., 1995-1996) is partly related to the requirement to lime soils in REPS. Summary statistics for soil analyses on the 624 NSD grassland mineral soils are shown in Table 1.

Figure 2 shows a near normal distribution for LR on the 624 NSD soils; 26% had an LR of 8-12t ha^{-1}, 21% had an LR of 4-8 and 12-16, and 7.5% had an LR of 0

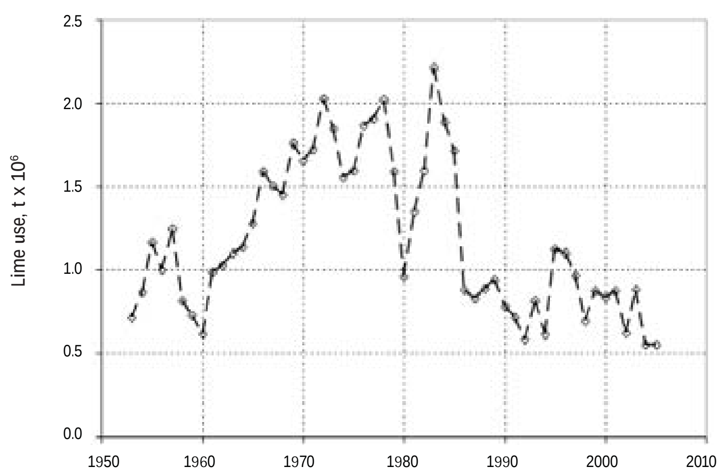

FIGURE 1: 50-year trend in agricultural lime use in Ireland.

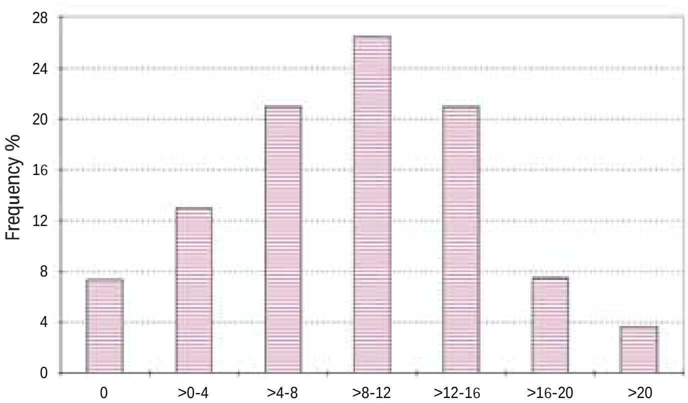

FIGURE 2: Lime requirement frequency for 624 NSD soils.

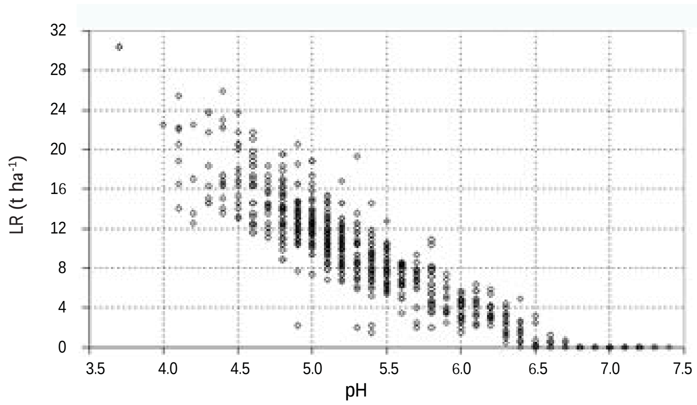

FIGURE 3: pH and LR for 624 grid-based grassland mineral soils in NSD.

TABLE 1. Mean, maximum, minimum and standard deviation of soil pH, LR, P, K and Mg from 624 NSD grassland mineral soils.

	pH	LR	P	K	Mg
		($t\ ha^{-1}$)	($mg\ L^{-1}$ soil)		
Mean	5.4	9.3	9.6	150	181
Maximum	7.7	30.4	143.0	693	1,002
Minimum	3.7	0.0	0.7	21	19
Standard deviation	0.7	5.6	10.6	96	99

and 16-20t ha^{-1}. The mean pH of the soils was 5.4 and mean LR was 9.3t ha^{-1} (Table 1). This compares with the pH 6.3 advised by Teagasc for grassland. Two-thirds of the soils were lower than pH 5.6. To meet current LR advice on grassland (excluding rough grazing) would require a maximum of 32.6 million tonnes of lime (3.5 x 10^6ha grassland x 9.3t lime ha^{-1}) at a cost of €750 million (€23t^{-1} lime). This is an overestimate, as some extensively farmed soils are not limed. Furthermore, on high molybdenum soils, LR advice is reduced by 5t ha^{-1}; this is not taken into account in the calculation above. Figure 3 shows a scatter plot of pH and LR for the 624 NSD soils.

In addition to the financial cost–benefit of lime, it is estimated that one tonne of limestone applied releases about one tonne of carbon dioxide. If the 32.6 million tonnes of lime was applied to meet advice over the next decade, the release of carbon dioxide would be equivalent to about half of one year's total current annual national emission. The carbon dioxide comes from the dissolution of the carbonate in the lime after it is applied to the soil and the increased mineralisation of soil organic matter after the application of lime.

Conclusions

Lime use is declining, and less is being applied than advised by Teagasc. This is in contrast to nitrogen and phosphorus fertiliser use. The NSD results show that most mineral grassland soils have a low pH (66% under pH 5.6). In light of these results, it is now time to review and revise, as necessary, the optimum pH and lime advice for grassland production on Irish soils. This is necessary in order to: a) find out if reduced liming is limiting grassland production; b) establish the carbon dioxide loss from liming; and, c) find a non-toxic, more environmentally friendly LR test.

This research is funded by the Teagasc Core Programme.

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New strategies for drying willow chips

Harvested willow chips need to be dried before they are ready for combustion in boilers. Drying willow chips can be a costly exercise, but researchers at Oak Park have developed a low-cost alternative.

FIGURE 1: Willow harvesting.

FIGURE 2: Drying willow at Oak Park.

FIGURE 3: Willow chip combustion at Oak Park.

Interest in alternative sources of energy first accelerated after the 1973 oil crisis, which followed the Yom Kippur war. Different approaches were followed. Brazil, whose economy had suffered badly as a result of the crisis, developed an indigenous bioethanol industry that used sugar cane as a feedstock. Interest in Europe focused on the use of biomass to generate heat and electricity. In the northern European countries, keen interest developed in the use of a technique known as short rotation coppicing (SRC). This technique involves cutting back (coppicing) certain tree species at regular intervals to exploit juvenile growth. SRC trials by An Foras Talúntais (Teagasc's predecessor) commenced in the late 1970s under the leadership of the late Dr Michael Neenan. Species evaluated for SRC included willow (*Salix* spp.), poplar (*Populus* spp.), alder and Spanish chestnut. Willow and poplar were quickly identified as the most promising species.

Interest in alternative sources of energy has increased again in recent years following new concerns about the availability of fossil fuels and their effect on climate change. Recent work in Northern Ireland and in Sweden has developed the use of willow as an SRC species. In Ireland, establishment grants are available for planting willow and 100ha have been planted in the country thus far. The principal market is likely to be combustion in chip form to generate heat in medium- to large-scale boilers (>35kW). This market is expanding rapidly at present, with more and more biomass boilers being installed in commercial premises. At present, the feedstock is being supplied from forestry, but there are increasing indications that demand for feedstock exceeds supply. Such developments provide encouragement for farmers interested in getting involved in the energy market, but supply chains still need to be developed between growers and consumers.

TABLE 1: Results of the Oak Park and Grangecon willow chip drying trials.

	Oak Park	Grangecon
Initial moisture content (%)	53	53
Final moisture content (%)	16	20.4
Dry matter loss (% DM)	4.6	11.7
Power consumed (kWh per tonne DM)	124	104
Ventilation rate (m^3/hr per tonne DM)	307	182

Willow is planted from stem cuttings and is cut back after the first year of growth to allow extra stems to sprout. The first harvest takes place either two or three years after cutback and, thereafter, every two or three years. Harvesting is generally carried out in spring and is typically accomplished by cutting and chipping the stems (Figure 1) in one operation in the field using a modified maize harvester. An alternative harvesting technique harvests whole stems, which are collected as bundles. All tree species contain in excess of 50% moisture at harvest, necessitating further drying before the biomass can be used for combustion. Willow harvested as whole stems can be left to dry over the summer period before being chipped. However, harvested willow chips need to be dried immediately if self-heating and mould formation are to be avoided (see panel). Purpose-built drying facilities can be used effectively to dry willow chips, but such facilities are capital intensive, expensive to run and are typically unavailable to most farmers contemplating willow growing as an enterprise. Previous work at Oak Park established optimum ventilation rates for drying willows as whole stems and chips. A need was identified to develop a low-cost method for drying willow chips, which could be used by farmers without access to purpose-built drying facilities.

Moisture and combustion

The heat released during biomass combustion decreases with increasing moisture content of the biomass (Figure 4). This is because some of the heat from the combustion process is needed to dry excess moisture in the biomass. Increasing moisture content will also reduce the maximum possible combustion temperature and increase the necessary residence time in the combustion chamber. Emissions will also increase.

High moisture content also gives rise to serious problems in storage, including self-heating, decomposition, dry matter loss and spontaneous combustion. Such processes occur because of high rates of respiration in biomass with high moisture content. Chipped material needs to be dried to below 25% to ensure that respiration rates fall to acceptable levels. Piles of chips with high moisture content also become infected with microorganisms such as *Aspergillus fumigatus* and thermophilic actinomycetes. These organisms are associated with the complaint of 'farmer's lung'. Thermophilic actinomycetes are considered more hazardous, as they are smaller in size and can penetrate deep into the bronchial tract. They are typically found when self-heating occurs.

FIGURE 4: Biomass combustion.

Drying trials

Two willow chip ventilation trials were carried out in 2007, at Oak Park Crops Research Centre, Carlow, and at a farm near Grangecon, Co. Wicklow. The storage pile at Oak Park was constructed from ordinary wooden pallets, and measured 5.5m in width, 7m in length and 2m in height (Figure 2). The pile was ventilated using a 375mm axial fan blowing through a similar sized perforated tube on the floor of the storage pile. The pile at Grangecon was larger in dimension (7.5m wide, 12m long and 3m high) and was constructed using large square bales. Two fans and ducts of the same size as those used in the Oak Park trial were used for ventilation. A total of 25 tonnes of willow chips were loaded into the Oak Park pile on April 10, while 80 tonnes of chips were loaded into the Grangecon trial on April 4. Both piles had an initial moisture content of 53% and were covered with a woven cover. The piles were ventilated for 12 hours a day between 8.00am and 8.00pm. The Oak Park trial was ventilated until August 23, while ventilation in the Grangecon trial continued until August 28. The results of both trials are presented in Table 1.

In Ireland, establishment grants are available for planting willow and 100ha have been planted in the country thus far.

The trial results have demonstrated that it is possible to construct a simple, low-cost drying system for willow chips capable of drying chips to a moisture content <20% over a four- to five-month period. The chips can then be sold off the farm to supply the winter heat market. The trial results suggest that ventilation rates close to those in the Oak Park trials need to be provided to achieve complete drying of the stack with low dry matter loss. Willow chips dried in the Oak Park trial are currently being used to heat the engineering building at Oak Park (Figure 3).

Conclusions

It was previously thought that drying willow chips was an expensive business for which purpose-built facilities were necessary. Preliminary trials have demonstrated that farmers thinking of growing willow can construct a simple, cost-efficient system to dry willow chips on their own farm. Further work is ongoing to optimise energy use in this system. The development of low-cost drying systems for willow chips is but one aspect of the development of bioenergy supply chains. Robust, well-thought out supply chains give confidence to producers that a market exists for their produce and offers security of supply to consumers.

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Farm numbers and viability

LIAM CONNOLLY, ANNE KINSELLA and BRIAN MORAN, Rural Economy Research Centre, Athenry, use data from a number of studies categorising farm populations to make projections regarding future farm numbers and viability.

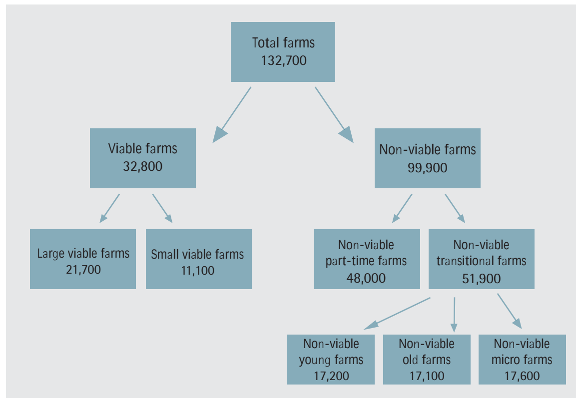

FIGURE 1: Categories of farms – 2006. Source: Teagasc National Farm Survey 2006 and Central Statistics Office.

The decline in farm numbers and employment in agriculture has been an ongoing process in the changing structure of Irish agriculture and is similar to trends in all developed economies. In the period 1993 to 2005 (Table 1), farm numbers declined by 28,800, a fall of 18%, or 1.4% on an annual basis. The rate of decline was slightly less than 50% of the rate in the previous decade, when the annual rate of decline was 3%. There was a considerable decline in farms of less than 30ha (-30%), while the percentage of farms in the over 50ha size category increased from 12% to 18%. The average farm size has increased from 26.8ha in 1993 to 31.8ha in 2005, with the south-east having the largest farm size of 41.4ha on average in 2005. This average farm size in Ireland is considerably higher than the EU-25 average of 15.8ha, or the EU-15 average of 20.2ha. However, there is considerable variation in the EU average farm size, ranging from 1ha in Malta to 79.4ha in the Czech Republic.

TABLE 1: Number ('000) and percentage of farms by size 1993 and 2005.

Size	1993	2005
Ha	No. (%)	No. (%)
<10	38.8 (24)	27.7 (21)
10<20	44.9 (28)	30.1 (22)
20<30	29.4 (19)	22.5 (17)
30<50	27.4 (17)	28.7 (22)
50<100	16.9 (9)	19.6 (15)
100+	4.0 (3)	4.0 (3)
Total	161.4 (100)	132.7 (100)

Source: Central Statistics Office.

Farm viability

Traditionally, farm management analysis examined farms by size, system of farming and location. However, in the context of rural development and business and technology policies, and advisory/research programmes, it is also useful to categorise farms on the basis of their viability. Viability has many dimensions, and can be examined under an array of headings, e.g., financial viability, demographic viability, the presence/absence of off-farm employment, etc. Data from the National Farm Survey (NFS) can be used to categorise all farms nationally on the basis of some or all of the above criteria.

Operationally, the NFS defines a "viable" farm as one having:

(a) the capacity to remunerate the unpaid family labour at the average agricultural wage rate; and,

(b) the capacity to provide at least an additional 5% return on non-land assets.

The NFS uses two other variables to classify viability:

(c) demographic status – households where the holder is over 55 years of age and where there is nobody else under 45 years in the house are classified as having poor demographic status; and,

(d) other activity status, i.e., to take account of whether the farm operator and/or spouse has an off-farm job. The categorisation of the national farm population based on the 2006 NFS is shown in Figure 1.

Viable farms

This group consists of 21,700 large farms, which make up the larger and more commercial sector of Irish farming. This group accounts for the bulk of farm output and investment in the farming sector due to the scale of operations relative to the other categories. Approximately 60% of these farms are in dairying, with the remainder being large drystock and tillage farms. There are also 11,100 small farms in this category, which meet the returns to labour and capital criteria, but are relatively small and only marginally "commercial".

Non-viable part-time farms

The 48,000 farms in this category are predominantly non-viable, small drystock farms, where the owner and/or spouse have off-farm employment. This is the expanding category of farms due to the growth in off-farm job opportunities for the farming sector, and in 2006 they accounted for an estimated 36% of all farms nationally.

Non-viable transitional "young farms"

In 2006 there were approximately 17,200 non-viable farms with "good household structure" operated by younger farmers (holder under 55 years), but with no off-farm employment. This group includes small dairy farms, but is predominantly made up of drystock farms. Farms in this group are categorised as transitional, as it is likely that many of these farms will become part-time and avail of off-farm employment.

Non-viable transitional "old farms"

These are non-viable farms with poor household demography, where neither the holder nor their spouse has off-farm employment and where the household structure can be described as "poor". Again, farms in this category are predominantly drystock farms operated by older people on low levels of intensity. Overall, farm incomes are low and are mainly made up of subsidies. Given the level of activity and age structure of the holder, it is likely that many of these will cease production. However, those existing will be replaced by other transitional farmers.

Non-viable "micro" farms

There are approximately 17,600 farms whose output/turnover is so low that the size of the business measured in European Size Units (ESU) is less than 2ESU, where 1ESU is equal to €1,200 of Standard Gross Margin (SGM). This group effectively comprises non-farmers, produces very little agricultural output and has a minimal impact on the overall sector.

Future farm numbers and viability

The rate of decline in farm numbers in Ireland has slowed down from 3% per annum in the 1980s to 2% in the 1990s and to 1% from 2000 to 2005 (Table 1). Data from the CSO also shows that a major decline took place in the number of smaller farms (less than 20ha) in the period 2000 to 2005, with farm numbers in the under 20ha size group declining by 2% per annum, while the number of farms in the 20 to 50ha size group declined by 0.8% per annum and the numbers of farms in the over 50ha size group increased by 0.8% per annum. Projecting these rates of change over the decade 2005 to 2015 would result in the outcome shown in Table 2.

TABLE 2: Projected* farm numbers by size 2015.

Ha	Number of farms	%
<20	45,440	38
20-50	45,630	39
>50	27,110	23
Total	118,180	100

** Derived from the CSO (2005 Farm Structure Survey) – www.cso.ie.*

This decline is less than previous projections for farm numbers, but given the linkage of entitlements and land to the drawdown of the Single Farm Payment (SFP), it is not surprising that the rate of decline has slowed. The decoupling of the SFP has also facilitated continuing in farming while having an off-farm job.

Projecting forward to 2015 on the basis of this rate, farms in this category would decline to approximately 17,000 large viable farms.

A number of reports (Agrifood 2010; Agrivision 2015 Committee – www.agriculture.gov.ie) have projected the number of viable farms in the future. As mentioned earlier in this article, there are a number of methods for defining and measuring viability. The definition of viability used here is based on the farm's ability to provide a return on non-land assets and reward unpaid family labour at the agricultural wage rate. Many very small farms could meet these criteria, but at low farm income levels. In order to exclude this latter group and measure the larger, more commercial viable sector, a further criterion was included, i.e., farms must require a minimum of 0.75 Labour Units to operate the farm business measured on a 'Standard Man Day' basis. NFS data show that between 2001 and 2006, the full-time viable category measured on this basis declined by 7%, or 1.4% per annum. Projecting forward to 2015 on the basis of this rate of decline would result in the number of farms in this category declining to approximately 17,000 large viable farms. This would be equivalent to 15% of the farm population projected to 2015. This group represents the larger, more commercial sector of agriculture and will comprise mainly dairy farms, tillage farms and large cattle farms. Based on overall farm numbers projected to 2015 in Table 2, this would result in 101,000 non-viable farms, which would be mainly cattle, sheep and smaller dairy farms. The majority of these farms would require off-farm employment or other income sources. It is likely therefore that the steady increase in off-farm employment (assuming such opportunities are available) since the early 1990s will continue over the next decade.

As stated at the outset, there are numerous methods of analysing and categorising the farm population. Segmenting on the basis of viability provides an overview of the groups who will survive and continue to farm on a full-time basis in the long term, those who will need additional off-farm income support, and also those that will exit the sector. It also provides the basis on which to develop appropriate and targeted advisory and research programmes to address the needs of these different categories of farmers.

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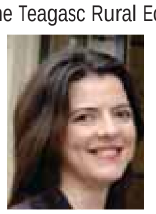
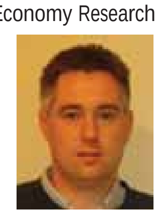

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The CAP Health Check: a potential reform of the Single Farm Payment?

The ongoing review of the Common Agricultural Policy, the so called 'Health Check', proposes to reform the Single Farm Payment scheme. Economists at the Rural Economy Research Centre (RERC) explore the possible implications for Irish farmers.

Direct payments were decoupled from production in January 2005 and, since then, farmers have been paid a decoupled Single Farm Payment (SFP). When this policy was first implemented, EU Member States could choose from a number of SFP models:

(i) the historical model, meaning that a farmer's SFP was determined by the number of direct payments received in a reference period;

(ii) the flat rate payment model, whereby the same area-based payment is paid to all farmers nationally; or,

(iii) a number of hybrid versions of the two models were also possible.

The historical model was implemented in Ireland and various other payment methods exist across the EU.

In November 2007 the European Commission published a Communication on the CAP Health Check. It states that it is the Commission's objective to "streamline the CAP" by making the SFP scheme simpler and more efficient. To this end, a shift from the historical model to the flat rate model is proposed, along with increased modulation. Modulation is the process of transferring funds out of direct aid to agriculture (Pillar 1 of the CAP) and into rural development measures (Pillar 2). The desire for a simpler payment scheme was reiterated in the draft legislative proposals released this spring, but the shift to flat rate payments was proposed as "optional". It is as yet too early to say whether this policy proposal will come to fruition, or if indeed there is any political appetite in Ireland for flat rate payments. However, policy analysts argue that it will be difficult in the longer term to justify paying farmers on production decisions taken in the early 2000s, and so an eventual shift to the flat rate payment model is inevitable.

The other major proposal contained in the Communication that is of relevance to Ireland, is the reform of the EU milk quota regime. The implications of initial

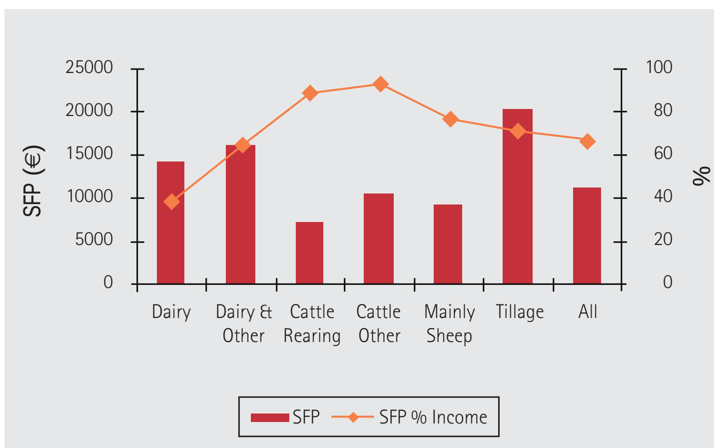

FIGURE 1: Single Farm Payment in 2006 and its contribution to farm income. Source: National Farm Survey Data (2006).

TABLE 1: Percentage change in Single Farm Payment due to flat rate payment and percentage of farm population (in brackets).

Size (hectares)	<10	10-20	20-30	30-50	50-100	>100	All
Dairy *(% of population)*	n/s *(0.5)*	+25 *(1.5)*	+15 *(2.5)*	-8 *(6)*	-3 *(4)*	Same *(0.5)*	-2 *(15)*
Dairy and Other *(% of population)*	n/s *(0.2)*	n/s *(1)*	n/s *(1)*	+8 *(2)*	-11 *(3)*	-12 *(1)*	-6 *(8.2)*
Cattle Rearing *(% of population)*	n/s *(3.2)*	+17 *(7.5)*	+41 *(5.5)*	+19 *(5.5)*	+9 *(2)*	+7 *(0.2)*	+19 *(23.9)*
Cattle Other *(% of population)*	-11 *(4.6)*	-6 *(7.8)*	-6 *(5.5)*	-9 *(6)*	-16 *(3.5)*	-19 *(0.6)*	-10 *(28)*
Mainly Sheep *(% of population)*	n/s *(3)*	+3 *(4.8)*	+13 *(3.5)*	+9 *(4)*	+4 *(2)*	+95 *(0.7)*	+15* *(18)*
Tillage *(% of population)*	n/s *(0.6)*	n/s *(1)*	n/s *(1)*	-11 *(1.5)*	-20 *(2)*	-10 *(0.8)*	-13 *(6.9)*
All *(% of population)*	n/s *(12.1)*	+7 *(23.6)*	+11 *(19)*	Same *(25)*	-8 *(16.5)*	+6 *(3.8)*	Same *(100)*

Source: National Farm Survey Data.
n/s – sample too small to quote data.
**May be underestimated due to problems of allocating commonage.*

proposals on quota reform were analysed by the FAPRI-Ireland Partnership and published in November 2007. This policy analysis remains ongoing and more results are likely to be published as more definite policy scenarios emerge. This article focuses exclusively on the proposed changes to the SFP.

The SFP in Ireland

Since its inception in 2005, the SFP has become a significant component of farm income. According to 2006 National Farm Survey (NFS) data (**Figure 1**), the SFP comprised almost 70% of total farm income across all systems, increasing to over 90% on the "Cattle Other" farm system (Connolly *et al.*, 2007). Clearly, the long-term sustainability of many farm households hinges on the future of the SFP.

Shifting to flat rate area payments

If Ireland shifts to the flat rate payment model, then payments will be redistributed among farmers and, consequently, there will be winners and losers. Farmers that established large entitlement rights in the reference period, such as cattle farmers and cattle finishers in particular, are likely to lose out to farms that were less reliant on direct payments.

Using NFS data, it is possible to estimate the average flat rate payment by aggregating the SFP paid per farm and allocating it across land area farmed. It is not possible to identify eligible hectares from the NFS data and so it is assumed that the flat rate payment is allocated across all land area. Using 2006 data, the flat rate payment is estimated to be €314 per hectare. At this rate of payment, almost one-third of farmers would experience a change of 20% or less to their SFP. A small proportion of farmers (<3%) would experience very large losses, with reductions in their SFP of 50% or more. About 15% of farmers would stand to double their SFP. **Table 1** quantifies the percentage change to the average SFP by farm size and system. The figures in red are those experiencing losses.

If Ireland shifts to the flat rate payment model, then payments will be redistributed among farmers and, consequently, there will be winners and losers.

"Cattle Rearing" and "Mainly Sheep" farms gain from the flat rate payment model, by an average of 19 and 15%, respectively. These farm systems tend to be very reliant on the SFP. In 2006, approximately 88 and 77% of income on "Cattle Rearing" and "Mainly Sheep" farms was derived from the SFP. Hence, increases in the SFP on these farms will have more considerable implications for income than for dairy farms, for example.

T Economics

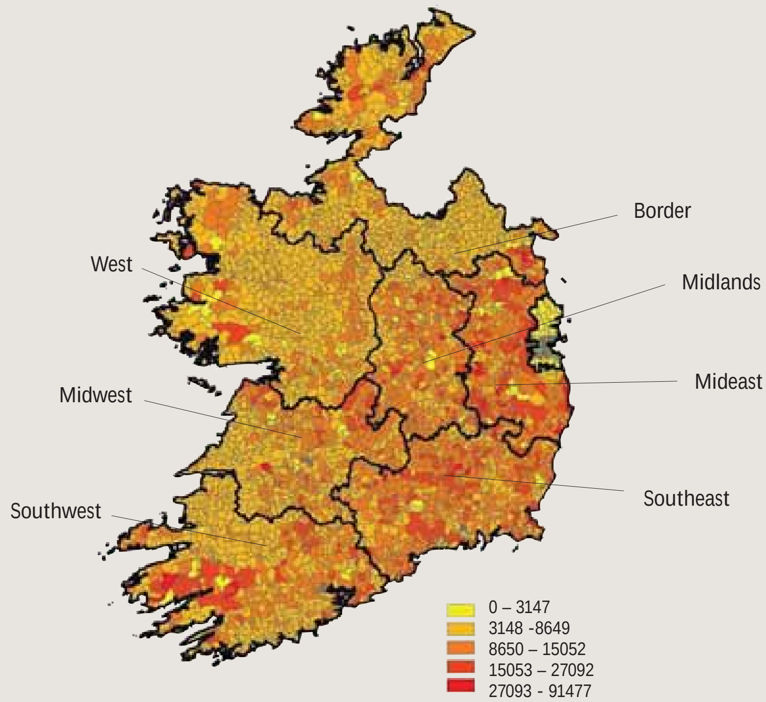

FIGURE 2: Geographic distribution of the Single Farm Payment (historical payment model).

In 2006, 113% of income on "Cattle Rearing" farms in the 20-30 hectare size group was derived from the SFP. Under the flat rate payment model, these 6,200 farmers would experience an increase of on average 41% in their SFP. Assuming their market-based income remains unchanged, their total family farm income would increase by 47% from €4,809 to €7,050. It is evident then that small farms that are highly reliant on the SFP could benefit significantly from the move to a flat rate payment model.

Clearly, the long-term sustainability of many farm households hinges on the future of the SFP.

The data shows that very large sheep farms, farming 100 hectares or more, are the main beneficiaries of the flat area payment model. This group, representing <1% of the total farm population, would on average increase their SFP by 95%, from an average of €42,000 to €82,000.

On the other hand, "Cattle Other" and "Tillage" farms stand to lose most under a flat rate payment model (by 10 and 15% on average, respectively). Given that the SFP accounts for on average 93% of income on "Cattle Other" farms and 71% on "Tillage" farms, it can be argued that the loss is more significant to the "Cattle Other" farm group. For example, the "Cattle Other" farms with 100 hectares or more stand to lose almost 20% of their SFP, which translates to a 21% loss in farm income, declining from €44,600 to €35,234. The very large "Tillage" group (100 hectares or more) would lose 10%, causing farm income to decline by 7% from €81,322 to €75,600.

The changes on the two dairy farm groups are relatively small, although small "Dairy" farms do experience more considerable increases. Given that the SFP comprises a much smaller proportion of income on dairy farms, the changes do not have a significant impact on farm income.

The regional implications

It is also interesting to consider the regional implications of shifting to a flat rate payment model. Using the Spatial Microsimulation Model of the Irish Local Economy (SMILE), developed in the Rural Economy Research Centre, we are able to use GIS tools to map variables from the NFS. Figure 2 maps the average SFP per farm in each electoral division under the historical payment model, i.e., as the SFP is currently paid. The imaginary line running from Drogheda to Tralee, which divides the supposedly agriculturally and economically advantaged southeast, mideast and southwest of Ireland from the border, midlands, west and midwest, is evident from the map. It is apparent that the larger, more intensively operated farms in the southeast region have higher SFP per holding than the smaller more extensive farms in the west and border regions.

The second map (Figure 3) shows the change to the SFP as a result of the shift to the flat rate payment model. The map shows that decoupled payments would move from the southeastern half of the country to the northwest if the flat rate payment model was adopted. Under the flat rate payment model, extensively farmed holdings located along the western seaboard and border regions would gain significantly at the expense of the southeast.

Proposed changes to modulation

The Commission's draft legislative proposals on the CAP Health Check also contain proposals relating to increased rates of compulsory modulation. Modulation is the process of transferring funds out of direct aid to agriculture (Pillar 1 of the CAP) and into rural development measures (Pillar 2). Under the

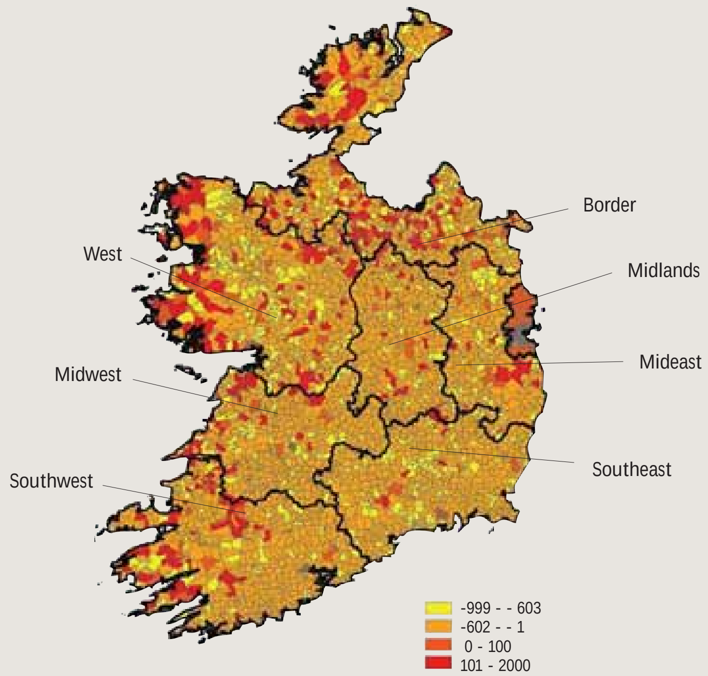

FIGURE 3: Map of the financial impact for farmers of shifting from the historical to the flat rate payment model.

2003 reform of the CAP it was agreed that the SFP would be reduced by 3% in 2005, 4% in 2006 and 5% from 2007 onwards, although payments of up to €5,000 per farm would remain free of reductions.

The latest proposals from Brussels involve increasing modulation rates. The first €5,000 would still remain exempt from modulation, but payments between €5,000 and €100,000 would be subject to larger reductions; a further 2% in 2009, 4% in 2010, 6% in 2011 and 8% in 2012, in addition to the 5% agreed in the last reform. Payments in excess of €100,000 per farm are subject to higher rates of modulation.

According to 2006 NFS data, about one-third of farmers have a SFP of €5,000 or less and, therefore, are not affected by modulation. The other two-thirds have SFP between €5,000 and €100,000 and so would experience some losses. Of the approximately 73,000 farmers who would be affected by the proposed changes, the average loss per farmer is estimated to be €843 by 2012. Nationally, the transfer of funds from Pillar 1 to Pillar 2 amounts to approximately €62 million according to NFS data. It should be noted that farmers can still benefit from Pillar 2 funding through schemes such as the Rural Environment Protection Scheme.

Concluding remarks

With the SFP accounting for almost 70% of average family farm income, it is evident that the future viability of many farms is contingent on the continuation of the SFP. The Commission is committed to sustaining the SFP scheme until 2013 at least; however, whether there will be any changes to the scheme between now and then remains to be seen. The proposed shift to the flat rate payment model is currently an optional one, while the proposals on modulation are compulsory, but still subject to negotiation.

It is too early to say what new policies might emerge from the CAP Health Check; however, it is clear from the analysis presented above that a shift to a flat rate payment model would lead to a considerable redistribution of decoupled payments in Ireland, while an increase in modulation would negatively affect almost two-thirds of farmers. Given the significance of the SFP to their total farm income, cattle farmers would experience the greatest changes as a consequence of flat rate payments. Small cattle rearing farms would gain at the expense of large cattle finishing businesses.

It is envisaged that the CAP Health Check will be concluded within the current year and so there is no doubt that, once again, interesting times are in store for agricultural policy.

This research is funded by the Teagasc Core Programme.

All data used are taken from the National Farm Survey.

Connolly, L., Kinsella, A., Quinlan, G. and Moran, B. (2006) National Farm Survey 2006. Teagasc, Athenry, Ireland.

Dr Thia Hennessy is a Principal Research Officer and Drs Stephen Hynes and Shailesh Shrestha are Research Officers in the Rural Economy Research Centre, Teagasc, Athenry. E-mail: thia.hennessy@teagasc.ie.

Rural men and suicide: risks and vulnerabilities

The first qualitative study of rural suicide in Ireland commenced last year at Teagasc's Rural Economy Research Centre.

In response to the problem of male suicide in rural Ireland, Teagasc has funded, through the Walsh Fellowship Scheme, a three-year PhD research project. The project involves a qualitative study of male suicide in rural Ireland, exploring the broader rural sociological context in which suicidal behaviour occurs and identifying the contributory factors. This is the first qualitative study of rural suicide to be undertaken in the Republic of Ireland and will focus on the west of Ireland.

Suicide in Ireland

Irish suicide rates have risen dramatically in the last 15 years, particularly among men. In 2006, there were 409 officially recorded suicide deaths in Ireland and 77.8% of these were male. The number of young males (15 to 24 years) who died by suicide in 2006 was over five times greater than the number of deaths for the same group in 1980. While the number of male suicides decreased nationally by almost 10% between 2005 and 2006, the numbers in some rural areas increased during the same period (e.g., a 17% increase in male suicides in the predominantly rural region of Connaught [see Table 1]). Similar to other EU countries, the rate of suicide in Irish rural areas is higher than in urban areas (Kelleher *et al.*, 1999). Male vulnerability to suicide and suicidal behaviour is also affirmed in rates of deliberate self-harm among males in rural districts, which are significantly higher than the national rate.

Methods of suicide

Although there has been a rise in the number of female suicides associated with more 'lethal' methods, Table 2 demonstrates the particularly strong association between males and methods of 'high lethality' (i.e., methods with a high rate of fatality, such as firearms and hanging).

Psychological ill health in the agricultural sector

The broader social and economic environment is implicated in understanding the growing incidence of suicide among young males in rural Ireland. It has been noted in many studies that farmers experience high levels of work-related and personal stress (Gallagher and Sheehy, 1994; Ní Laoire, 2005). An examination of the stresses experienced by farmers point to factors such as "financial worry, uncertainty, and excessive bureaucracy" (Simkin *et al.*, 1998).

Analyses of suicides across various occupational categories in countries such as Australia, England, Wales and Scotland, show that farmers/farm managers and agricultural workers/labourers have a higher incidence of death by suicide in comparison to other occupational groups (Page and Frager, 2002; Pickett *et al.*, 1998). Since 1963, both the National Psychiatric In-Patient Reporting System and the Irish Psychiatric Units and Hospitals Census indicate that agricultural workers as a socio-economic group are significantly and consistently over-represented in terms of admissions to Irish psychiatric units and hospitals.

Factors contributing to the rise in suicide

It is acknowledged that the problem of suicide (and vulnerability to suicide) does not affect all groups of the population equally. Differentials in suicide rates are correlated to personal traumas (e.g., loss, separation, divorce), occupation, ethnicity, social disadvantage/marginalisation and location (e.g., urban/rural). Characteristics of the rural environment and changes in rural societies and economies are linked with the high level of male suicide. Changes in agriculture have presented many challenges to the traditional hegemonic forms of masculinity. 'Reach Out', the National Strategy for Action on Suicide Prevention 2005-2014, noted the vulnerability of young rural males to suicide since they "no longer have a clear pathway into farming as a way of life due to the modernisation of agriculture". According to Ní Laoire (2005), the traditional masculine form in rural Ireland was that of a farmer, landowner, 'custodian' of the family farm, and head of the family. Today, factors such as changes in agricultural policy, the rise of off-farm employment for both farmers and their spouses, and more general societal changes in family structures and relationships, are challenging traditional farming identities.

While the number of male suicides decreased nationally by almost 10% between 2005 and 2006, the numbers in some rural areas increased during the same period.

It is also evident that men experience particular difficulties in confiding and discussing personal problems with their peers (Cleary, 2005). Male vulnerability to death by suicide may therefore be explained, in part, by the fact that men do not actively seek help (from healthcare professionals, family or friends), unlike the majority of females. The existence of the social stigma surrounding suicide, deliberate self-harm/suicide attempts and poor mental health can give rise to feelings of shame and embarrassment, and can often be a barrier to seeking help. The problem is exacerbated due to lack of information on symptoms of psychological ill health, and where and how to seek help.

Preliminary interviews with members of the stakeholder group that has been established to oversee the study have revealed that social isolation in rural areas may be a contributory factor. Other life stresses, specifically, the loss of relationships (through death or estrangement), 'loss of role', loss of self-esteem,

TABLE 1: Numbers of male suicides by year at county, provincial (in the study area) and national level.

Year	Roscommon	Mayo	Galway	Connaught	Ireland
2006	5	19	10	48	318 (409)*
2005	4	10	16	41	353 (431)
2004	2	11	7	44	356 (457)
2003	2	10	18	41	358 (444)
2002	4	16	20	51	371 (451)
2001	4	15	15	50	356 (448)

** Numbers in brackets reflect total national suicide numbers for both male and female suicides*
Source: Central Statistics Office.

TABLE 2: Percentage and frequency (in brackets) of completed suicides and methods used (2006)

	METHOD OF SUICIDE			
Number of suicides	Firearms/ explosives	Hanging	Submersion/ drowning	Cutting
356	27	253	63	13
Male 281 (78.9%)	26 (96.3%)	213 (84.2%)	34 (54.0%)	8 (61.5%)
Female 75 (21.1%)	1 (3.7%)	40 (15.8%)	29 (46.0%)	5 (38.5%)

In 2006, 356 (87.0%) suicides occurred as a result of using the four methods categorised above from a total of 409 suicides. Methods are classified in accordance with the World Health Organisation International Classification of Diseases, Version 9 (ICD 9: E950-E959).
Source: Prepared on request by the CSO.

TABLE 3: Hospitalisation rate in Irish psychiatric units and hospitals 1963-2006. Socio-economic group – rates per 100,000.

	YEAR					
Socio-economic group	1963	1971	1981	1991	2001	2006
Farmers	664	476.6	397	277.5	111.8	82.7
Other agricultural workers	3,465	1,771.7	1,206.3	621.9	252.8	264.6
Higher professional	736	450.8	276	109.7	49.9	35.5
Lower professional	380	428.8	285.4	117.4	75.8	48.8
Employers and managers	123	183.1	65.8	26.9	30.4	13.2
Salaried employees/ own account workers	144	179.6	175.2	83.8	5.8	7.4
Intermediate non-manual/ non-manual	762	264	333.1	158.6	91.8	69.1
Other non-manual	481	932.2	651.2	279.4	-	-
Skilled manual/manual skilled	508	218.5	160.7	77.3	61.0	63.3
Semi-skilled	780	454.1	278.5	138.6	46.9	82.0
Unskilled manual	944	617.2	838.9	583.5	314.3	249.9

Source: Daly, A., Walsh, D. (2006).

and lack of satisfaction in terms of their careers and personal relationships, are also identified as crucial determinants in the growing problem of male suicide.

Approach of current study

The study will examine the suicidal experiences of men from the west of Ireland (counties Mayo, Roscommon, and Galway). Unstructured in-depth interviewing will allow for an exploration of the broader rural sociological context influencing individuals' decisions to engage in suicidal behaviour.

A key aspect of the study has been the interaction with the stakeholder group. The purpose of this group is to assist with identifying crucial areas of consideration within the remit of the project. The group consists of representatives of key rural and health organisations: Irish Farmers' Association (IFA); Irish Creameries' and Milk Suppliers' Association (ICMSA); Samaritans; Mental Health Ireland; Irish LEADER Support Unit (ILSU); National Office for Suicide Prevention (NOSP); Department of Community, Rural and Gaeltacht Affairs; and, the Irish Psychiatric Association (IPA).

It is hoped that results from this study will have implications for regional health and public service provision. Teagasc, through its Rural Economy Research Centre, will play a key role in advising and steering national policy in both the health and rural development sectors.

This research is funded through the Teagasc Walsh Fellowships Programme.

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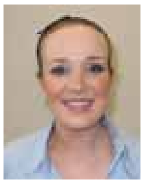
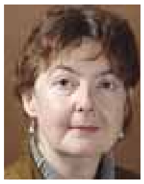
Maria Feeney, Walsh PhD Fellow, commenced work on this project in September 2007 under the supervision of sociologists and Dr Áine Macken Walsh, Teagasc Rural Economy Research Centre (RERC), Athenry and Dr Anne Cleary (UCD). The study is being conducted in liaison with Frank Laffey, Teagasc's National Health and Safety Officer.






A healthy mushroom crop in a shelf growing system.

Mushroom casing colonised with fungal mycelium and showing the substrate below and the fruitbodies above.

Mushroom casing: science catching up with technology

In keeping with the ever-evolving demands placed on the modern mushroom farming industry, Teagasc researchers and collaborators have just completed a project to optimise new blends for mushroom casing.

Casing is a shallow layer of peat and lime that is placed on top of the substrate (mushroom compost) used in mushroom (*Agaricus bisporus*) production. It is an essential component that triggers fungal growth to change from a vegetative to a reproductive growth phase with the formation of fruitbodies. Casing affects both the yield and the quality of the crop.

Technology before science

Casing (materials and process) is a very good example of a well controlled, but not well understood, technology. During the development of the Irish system of mushroom production at Kinsealy Research Centre in the 1970s, fundamental practices were introduced that are now used worldwide. These broadly optimised the use of casing and provided a key aspect of the quality and shelf-life advantages that the industry enjoyed on export markets.

As competition increases and more efficiency is needed from every aspect of the production system, a collaborative project has just been completed to optimise anew the casing parameters critical to Irish production. The project was undertaken by researchers at Teagasc, University College Dublin (UCD), and at Queen's University Belfast, and the Agri-Food and Biosciences Institute, Loughgall. While the Northern Ireland partners concentrated on developing rapid diagnostic tools for assessing physical and chemical properties of peat and neutralising additives, the Teagasc and UCD team investigated a number of production issues.

Industry needs

When a new industry has become established and successful, its needs evolve and new pressures emerge. Food safety requirements demanded a study of the effect of sterilisation/pasteurisation treatments for casing on the microbiology of mushroom casing and mushroom formation. Increasing environmental pressures on the disposal of spent mushroom substrate (SMS) suggested the use of reprocessed SMS as a casing material/ingredient, while an examination of the processing of spent sugar beet lime (SSBL) was driven by reduced access to suitable supplies. The impact of combinations of these changes on mushroom cropping was assessed over a comprehensive series of trials under commercial conditions.

A trial of various SMS blends in the Irish bag growing system.

Thermal treatment of casing and/or casing components

Sanitising casing is beneficial from the point of view of health and safety, because it destroys organisms harmful to human health, e.g., *Salmonella* spp. Trials incorporating heat-treated casing and additives were carried out with a range of time and temperature treatments. The untreated control consistently outperformed all the other treatments, while casing that was thermally treated for shorter time periods outperformed those treated for longer periods at the same temperature. The higher temperatures in the operating range from 65°C to 80°C reduced yield, but not significantly. Incidences of diseases like dry bubble (caused by *Verticillium* spp.) and green mold (caused by *Trichoderma* spp.) were observed more frequently in the thermally treated casings and contributed to loss in yield. However, thermal treatment of SSBL alone as a component had no negative effect on yield when incorporated into a peat-based casing.

Casing using SMS

The introduction of SMS as a casing component is not a new idea, but it produces profound changes in the properties of casing and is associated with a drop in efficiency that would not be sustainable in the modern industry. Re-adjustment of casing formulation to recover crop yield and quality was likely to have more than one solution and required extensive factorial experimentation.

Electrical conductivity

The first problem to be addressed was the reduction, by leaching, of salt levels in recomposted SMS. Electrical conductivity (EC) was used as the indicator during washing, and levels ranging from 11 to 1mS/cm were produced. An inverse relationship was found between the EC of SMS and mushroom yield, with the yield potential increasing as EC fell, down to a value of 3mS/cm (when blended in a 1:1 ratio with a peat-based casing). EC levels below this value did not confer any advantage in terms of yield. Leaching efficiency was addressed by optimising the volumes of water applied with a variety of depths of SMS.

Blending

Leached SMS was then blended at various rates with two types of raw peat (a black peat and brown peat, harvested by two different methods) and two different types of lime (ground lime [GL] and SSBL). Blending rates tested ranged from 10 to 40%. Overall, greater yields were achieved with black peat/SSBL casing blends than with black peat/GL, brown peat/SSBL and, finally, brown peat/GL casing blends.

Physical properties

One of the most important reasons for underperformance with blends including SMS was the change in physical properties and, in particular, water-holding capacity and air-filled porosity. Formulations were designed to assess means of improving the physical structure of casing recipes. Vermiculite, perlite and grit were considered as additives, and screening of SMS to remove fine material could make a contribution. Results showed that greater yields were achieved with SMS/vermiculite casing blends. It was also found that incorporating vermiculite into the SMS before blending could raise the inclusion rate of SMS significantly due to improved physical structure, and improvements were obtained with vermiculite mixes up to a 70% (v/v) SMS inclusion rate when compared to all other additive blends.

Unscreened SMS casing outperformed the SMS casings that were screened with aperture sizes of 16 and 10mm, and there was no significant difference between the unscreened SMS casing and treatments with 20mm screening. The overall conclusion was that screening confers no commercial benefit and SMS should be used unscreened in casing.

Processing of spent sugar beet lime

SSBL is widely regarded in the industry as an important liming agent for casing because growers find that it has crop management advantages. Handling protocols require that SSBL must undergo a period of 'weathering' for one to two years before it is considered suitable for use as a casing material and this places limits on industry access to supplies.

Trials were conducted to examine whether 'fresh' SSBL could be hygienically and more rapidly processed than in the normal timeframe of 12 to 24 months. Bulk processing of 'fresh' compressed SSBL was set up with four turning cycles of three, seven and 28 days, and no turning. At eight, 16 and 24 weeks, sugar beet lime was sampled to examine effects of processing time in cropping. The SSBL was initially incorporated in peat-based mushroom casing at different rates, i.e., 10, 12, and 15% (v/v).

Commercial casing was shown to outperform, to varying degrees, most of the alternative casing recipes, but there were combinations that provided very good performance.

Turning fresh SSBL had no commercial gain in terms of yield benefits to the mushroom grower, or to the casing manufacturer in producing a more consistent product. There was no significant effect of turning over time on either crop outturn or mycelial development. There was no interaction between turning cycle and the liming rate, and the addition of higher rates of lime (12 and 15% rates as opposed to the 10% industry norm) significantly increased yields, with 12% proving to be the optimum rate. Results suggested that, from a cropping point of view, there was no reason why SSBL could not be used after eight weeks of ageing.

In testing rates of addition to those casing formulations incorporating SMS, adding SSBL at the rate of 7.7% (v/v) produced the highest yields, produced cleaner, whiter mushrooms, retained more water, reduced bulk density and increased porosity, made more water available to the mushroom over the course of the cropping cycle, and resulted in more even pinning (the growth stage where the mushroom fruitbodies begin to form).

Formulation of casing mixtures

A very wide range of casing formulations was tested in the course of this project. Heat-treated casings, processed and unprocessed SSBL, SMS processed by leaching and heat treatment, and the use of novel materials like vermiculite and perlite formed a selection set for generating the formulations.

Commercial casing was shown to outperform, to varying degrees, most of the alternative casing recipes, but there were combinations that provided very good performance. A novel casing blend consisting of an 80:20 (black:brown) peat mix, incorporating 18% SMS by volume with an EC of 4mS/cm, using spent sugar beet waste lime, was found to be comparable to current commercial casing. It was also shown that an inclusion rate of up to 18% SMS into a peat-based casing using SSBL can be used without significant effects on cropping results.

Biocontrol

In a wide-ranging investigation like the one in this project, many interesting avenues for future research are suggested by observations not directly part of the experimental protocols. Some particularly interesting observations concerned biocontrol potential:

- heat-treated casing was demonstrated to be more susceptible to disease than standard casing, but this feature could form part of an integrated pest management system because a quantity of the susceptible material could be used as an early indicator for the presence of disease in a cropping tunnel; and,
- another complementary aspect was the possible biocontrol properties of the casing components. Observational evidence suggested that weathered SMS could have a role in minimising damage due to sciarid fly larvae. It was noted that the high dry matter of mushrooms produced on SMS casings may offer some form of resistance to sciarid penetration of the stem. This was not easily analysed because complicating factors like differences in number and size of mushrooms can interact with the damage levels due to sciarids. Further investigation beyond the current project would be useful.

Conclusion

Irish mushroom growers are not under immediate pressure to find alternatives to peat as a casing material, but it is crucial to realise that uptake in commercial practice of these new blends is not dependent solely on their yield characteristics. Consumer and regulatory pressures are increasing and will have a major impact in the near future. This project has provided a resource that the industry can draw upon without suffering large yield losses.

There are other operational factors to consider before these formulations enter commercial practice. New investment by the casing manufacturers, food safety regulations and marketing concerns have to be addressed, but the results of the work reported here provide scientific underpinning for development in this area. Further challenges are posed by the demise of the Irish sugar beet industry, which means that most of the SSBL must be imported, which adds to costs, or an alternative found.

Acknowledgements

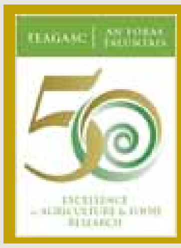
This work was made possible by the support of the Research Stimulus Fund of the Department of Agriculture, Fisheries and Food.

It was not possible to include here a report on the rapid measurement tools developed by the partners in Northern Ireland, or on the many interactions between the two teams. One important resource is a database of casing component properties based on extensive sampling. Further information can be obtained from Mairead Kilpatrick, AFBI (Loughgall), Manor House, Loughgall, Co. Armagh BT61 8JB, Northern Ireland, Tel: (028) 3889 2300, Fax: (028) 3889 2333.

Jason Barry is a Teagasc Walsh Fellow based at Teagasc Kinsealy Research and Development Centre, and the School of Biology and Environmental Science in University College Dublin. Drs Jim Grant and Helen Grogan are researchers at Teagasc Kinsealy Research and Development Centre. Dr Owen Doyle is a lecturer in the School of Biology and Environmental Science in University College Dublin. E-mail: jim.grant@teagasc.ie.




T Events



This year marks the 50th anniversary of AFT (now Teagasc). AFT 50 events will take place at all Teagasc research centres, and at the events marked below. A DVD marking the anniversary will be launched at the Foresight conference and a commemorative book will be launched later in the year. There will also be a lecture series.

Events highlighted are part of the celebrations.

May

8 May — *Grange Beef Research Centre*

National Beef Open Day

The Grange spring-calving suckler beef blueprint will be outlined at this open day. Steers are finished at 20-24 months and heifers at 18-20 months, with information on components such as breed of cow, sire selection, and management of cows and calves at grass to maximise weight gains, outlined to producers. Information on intake, milk yield, calf weight gains, progeny performance to slaughter, and carcass conformation and fat scores, will also be presented.

Other topics to be addressed will include systems economics, profit targets, quality beef, organic beef, beef from the dairy herd, grassland management for the suckler herd, and winter feeding of the suckler herd and progeny.

Edward.oriordan@teagasc.ie www.teagasc.ie

13 May — *Ashtown Food Research Centre*

Food Standards Workshop for SMEs

Margaret Hennessy/Anne Harrisson T: 01-8059520 F: 01-8059570
margaret.hennessy@teagasc.ie or book online

21 May — *Ashtown Food Research Centre*

Interpretation of Microbiological Criteria for Foodstuffs

Margaret Hennessy/Anne Harrisson T: 01-8059520 F: 01-8059570
margaret.hennessy@teagasc.ie or book online

30 May — *Dublin Castle*

Teagasc 2030 International Foresight conference

This conference will celebrate 50 years of agricultural and food research, and present the results of the Teagasc Foresight exercise. With a panel of eminent international speakers, the keynote address will be given by Dr Gale Buchanan, Under Secretary for Research, Education and Economics, United States Department of Agriculture.

eilish.cray@teagasc.ie; sheila.gibbons@teagasc.ie www.teagasc.ie

June

8 June — *Tullamore Court Hotel*

Role of Site Classification in Forest Productivity and Management

This seminar is jointly organised by Teagasc and COFORD, to highlight the importance of site classification in choosing species of trees and subsequent forest management. An exciting panel of national and international scientists will address the conference.

info@coford.ie www.coford.ie

18 to 19 June — *Ashtown Food Research Centre*

Laboratory Auditing (FETAC)

Margaret Hennessy/Anne Harrisson T: 01-8059520 F: 01-8059570
margaret.hennessy@teagasc.ie or book online

20 June — *Teagasc Athenry*

Farmfest 08

Teagasc's major outdoor event of 2008. The exhibits at Farmfest will bring together contributions from across the Teagasc advisory, research and education centres, showing the breadth of services and activities undertaken by the organisation. Exhibits on the day will include dairy, beef, sheep, tillage, bioenergy, forestry, environment, food, science, education, land use, equine and health.

There will be a kid's corner with entertainment and a major trade exhibit.

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August

5-9 August — *University College Dublin*

42nd Congress of the International Society for Applied Ethology

The ISAE provides technical evidence on topics relating to animal behaviour and animal welfare, contributing to policy and regulations at national, European and International level. laura.boyle@teagasc.ie www.isae2008.com

24-27 August — *University College Cork*

International Agricultural Biotechnology Conference

Hosted by Teagasc Oak Park, the theme for this year's conference is 'Agricultural biotechnology for a competitive and sustainable future'. The conference is the largest agricultural biotech conference in the world and provides a unique opportunity for Irish academia and business sectors to discuss the issues, options and challenges being met by the biotechnology industry. T: +353 1 2062900

info@platinumone.ie www.abic.ca/abic2008.html

November

9-16 November — *Teagasc research centres nationwide*

Science Week

This year's theme is 'Science is all around us'. Teagasc research centres will hold open days for secondary school students. There will also be a series of events aimed at the adult audience in conjunction with the Irish Science Open Forum. The Walsh Fellowships seminar will take place on November 13 at the RDS.

www.scienceweek.ie

13-14 November

Sustainable Grassland Production in Europe and the Water Framework Directive

International Conference.

This conference will include policy makers, researchers, farmer representatives, local and regional authority staff and River Basin District experts.

The objectives are:

- to provide background on the EU Water Framework Directive (WFD) and implications for sustainable grassland production;
- to present the water quality standards to be achieved under the WFD;
- to identify the challenges facing grassland agriculture from the WFD in light of trade liberalisation and the end of the EU milk quota system; and,
- to present strategies that will help intensive grassland systems comply with the WFD.

The programme will include presentations by national and international experts in this area. There will also be a poster presentation session. The local organising committee for the Conference includes Hubert Tunney, Karl Richards, Owen Fenton, Rogier Schulte and Mairead Esmonde. www.teagasc.ie

Leading the knowledge-based development of Ireland's Farming and Food Industry

Teagasc, the Agriculture and Food Development Authority, generates and applies new knowledge for the sustainable development of agriculture and the food processing industry to enable it to respond profitably to consumer demands and requirements and contribute to a vibrant rural economy and society.

Through the continuing development of Centres of Excellence in biotechnology, Teagasc will implement new research strategies based on scientific excellence, to underpin the long term knowledge needs of the agri-food industry.

Teagasc research science focuses on:

- Enhancing competitiveness through innovation in sustainable agricultural production and the food-processing sector
- Strengthening our capacity in molecular biology and gaining an increased understanding of living organisms with a view to increasing their application in the agri-food industry
- Providing sound scientific basis for decision-makers in protecting the integrity of the food chain, protecting the rural environment and addressing the concerns of the consumer
- Analysing and projecting the impact of policies for the agri-food sector
- Nourishing links with academic institutions through the Walsh Fellowship Postgraduate Programme

To deliver our ambitious scientific programme,
Teagasc needs to continuously attract and recruit the best and brightest people.

Details of opportunities are available on
www.teagasc/careers.ie

NDP
National Development Plan 2007 - 2013
Transforming Ireland

Teagasc
Agriculture and Food Development Authority