

T Research

Research and innovation news at Teagasc

Lough Melvin: working together to protect a unique environment

Interview: Teagasc's new Director,
Professor Gerry Boyle
The new nutraceuticals
Winter feeding of dairy cows



T Contents

Agriculture research: new challenges – new opportunities

The agriculture industry in Ireland appears to be at the start of a very dynamic period. Milk quotas, which have been in existence since 1984, are due to end in 2014. Set-aside has been reduced to a zero rate for 2008. New markets for biofuel and energy are emerging as serious users of croplands. EU farm support payments have largely been decoupled from production and farmers are much more exposed to world market prices and price volatility than before. Currently, milk and grain are enjoying the positive side of this volatility and, while prices can fall as well as rise, a consensus is emerging that food prices will trend at higher levels than in the recent past. In addition to these market-related issues, new issues like climate change have to be addressed. The challenge for agriculture research in Teagasc is to provide leadership to the agriculture industry and rural communities in these dynamic times by generating new knowledge and innovation to underpin competitiveness and sustainability. Knowledge and innovation are key to keeping an industry moving forward and, like other high tech sectors, agriculture must become more knowledge intensive to prosper. To increase the flow of knowledge and innovation to agriculture, we are developing centres of excellence in animal science, crop science, environmental science and economics and rural research. New state-of-the-art laboratories and facilities and an expanded research team will give our research programmes greater capacity and ability to tackle complex issues in a multidisciplinary manner. Our research programmes will embrace the latest techniques and technologies, while remaining strongly relevant to Irish agriculture by focusing on issues and approaches of relevance. In this way, we will be a central player in the next phase of development of the Irish agriculture industry.

Dr Seamus Crosse and Dr Frank O'Mara, Agriculture Research Directorate.



T Feature



Back to his roots 7

Newly appointed Teagasc Director, Professor Gerry Boyle, speaks to CATRIONA BOYLE.

T Forestry



To thin or not to thin? 32

NIALL FARRELLY and STEPHEN HYNES investigate the impact of thinning on financial returns in farm forest plantations.

News 3

Oak Park–UC Davis links
Science Week 2007
Economic outlook for the agri sector

Crops 22

The importance of diversity

Food 9

Gut health in the elderly
The new nutraceuticals

Environment 24

Lough Melvin: a participatory approach to protecting a unique habitat
Should we be glad we have fertile soils? A brief history of soil analysis in Ireland

Livestock 15

Winter feeding of dairy cows: research issues and pasture-based systems
Beef suckler cow genotypes for grass-based systems
Farm factors affecting SCC and TBC

Economics 30

The subsidisation of Irish agriculture

Events 35

Science events 2007/2008

T Credits



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Oak Park–UC Davis links



Oak Park Crops Research Centre.

The Teagasc Crops Research Centre at Oak Park is part of a US National Science Foundation-funded research project recently awarded to University of California Davis, USA.

The Collaborative Research and Education in Agricultural Technologies and Engineering (CREATE) programme will focus on using plant-derived products for biofuels, plant-derived chemicals and industrial products, such as enzymes and biomaterials. The newly funded programme, run by UC Davis, will involve collaboration with Tuskegee University in Alabama and the Teagasc Crops Research Centre, Oak Park, along with researchers at NUI Maynooth. The National Science Foundation (USA) will also provide over \$3 million to support graduate students studying in areas where plant sciences, biotechnology and engineering overlap.

"The research award is timely because it combines plant sciences, biotechnology and engineering, and UC Davis is a leading institution internationally in this area," said Professor Jimmy Burke, Head of Oak Park Crops Research Centre. As part of the programme, postgraduate students from UC Davis will spend six months at the Oak Park Centre and at NUI Maynooth. In total, 16 postgraduate students will participate in this new NSF-funded programme.

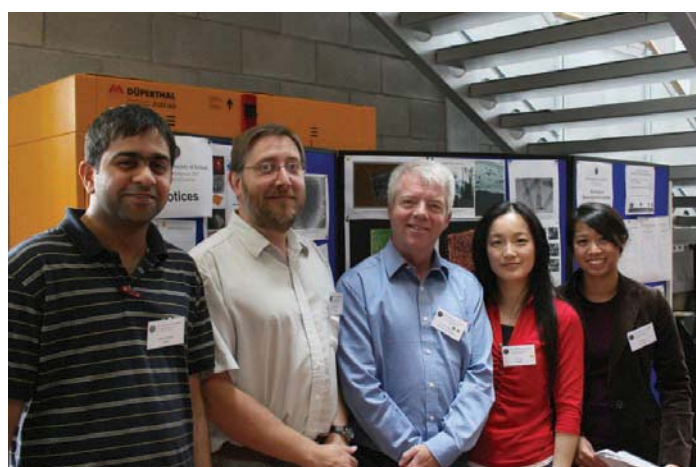
Burren Beef and Lamb Producers launch



Pictured launching the Burren Beef and Lamb Producer Group Ltd. in Ballyvaughan, Co. Clare, are (from left): Minister of State for Food and Horticulture, Trevor Sargent, TD; Joanne Brannigan, RERC, Teagasc Athenry; Christopher Roche, Producer Group member; Thomas Holmes, Producer Group member and Group Chairperson; and, Ruairí Ó Conchúir, BurrenLIFE Project.

The Producer Group is selling the 'conservation grade' (from land with a conservation designation) produce of Burren farmers directly to local consumers and hotels. The group was one of the initiatives of the BurrenLIFE project, the objective of which is to develop a new model for sustainable agriculture in the Burren in order to conserve the habitats designated under the European Habitats Directive.

Moorepark awards for microscopy



Pictured at the Microscopy Society of Ireland Annual Symposium are (from left): Aniket Abhyankar, Walsh Fellow; Mark Auty, Head of the National Food Imaging Centre, Moorepark; Professor Gerry Brennan, Queen's University, Belfast, and President of the Microscopical Society of Ireland; Lizhe Wang, Research Officer; and, Vivian Gee, Research Officer.

Two Teagasc researchers won awards for their work at the 31st Microscopy Society of Ireland Annual Symposium, which was held at the University of Limerick recently. Aniket Abhyankar (Walsh Fellow) won the Best Life Sciences Poster prize and €250. Lizhe Wang (Research Officer) won a Nikon digital camera for her micrograph of crystallised whey protein nanofibrils.

Economic outlook for the agri sector



Teagasc economists Trevor Donnellan, Dr Kevin Hanrahan, Dr Thia Hennessy and James Breen pictured at the RERC 'outlook' launch.

The FAPRI-Ireland policy unit, based at the Rural Economy Research Centre (RERC), launched its annual 'Outlook' for the agricultural sector in the EU and Ireland in October.

As part of the launch, Teagasc hosted a seminar in Dublin to present the findings of the studies and to facilitate discussion on the conclusions. In attendance were representatives from the food industry, farm organisations, the Department of Agriculture, Fisheries and Food, the Environmental Protection Agency and Teagasc. The latest set of reports cover the outlook at commodity and farm level under current policies. In addition, the team has focused on the potential impact of a number of milk quota reform scenarios, in advance of the anticipated elimination of the milk quota in 2015.

The reports indicate that the outlook for the dairy and cereals sectors is quite positive, particularly over the short term, but that prospects for the beef, sheep and pig sectors are less promising.

The reports revealed that Ireland is well placed to increase its milk production and that an early end to the quota constraint would see Ireland benefit at the expense of competitors in the EU. Trevor Donnellan of RERC said that if a significant quota increase was agreed as part of the upcoming CAP Health Check, few other EU Member States would have the potential to increase production significantly. "High feed grain costs have improved the competitiveness of Irish dairy production, which is pasture based and much less reliant on feed grains," he explained.

Thia Hennessy of RERC said that the results show that significant expansion capacity exists at farm level and that the majority of this increase in milk production can be achieved using existing farm resources.

Even though beef production is projected to fall, Kevin Hanrahan said that increased imports were likely to limit the potential for an increase in beef prices. James Breen cautioned that over the longer term cereal prices would decrease and that farmers would need to increase scale to maintain incomes in real terms.

The event was marked by the first public appearance of the new Director of Teagasc, Professor Gerry Boyle, who was instrumental in the setting up of the FAPRI-Ireland Partnership in the 1990s. Professor Boyle indicated that the work that had been produced would be of immense value for policy makers, farmers and for Teagasc itself.

Copies of the reports and related documentation can be downloaded at www.tnet.teagasc.ie/fapri.

ASA President



Gerry Scully, Assistant Director of Advisory Services, was elected President of the Agricultural Science Association at the organisation's recent annual conference. Gerry takes over the role from Dermot Ruane (pictured left).

Accolade for Liam Connolly



Dr Liam Connolly, Head of the Farm Surveys Department in the Teagasc Rural Economy Research Centre, Athenry, will serve as President of the Agricultural Economics Society of Ireland for 2008.

SCIENCE WEEK IRELAND 2007

Teagasc's Science Week committee has planned a range of events for Science Week 2007, which takes place from November 11-18. Visits from secondary schools will take place at Ashtown, Athenry, Grange and Moorepark. Students from the BSc in Biotechnology at Carlow Institute of Technology will also visit the facilities at Oak Park.

The Walsh Fellowships Seminar will take place in the RDS on November 14. The guest speaker will be Professor Patrick Cunningham, Chief Scientific Adviser to the Government.

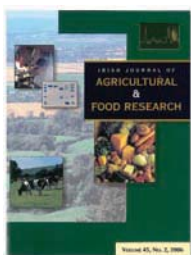
Water Framework Directive



Pictured at the WFD workshop at Johnstown Castle are (from left): Sean Regan, Environment Programme Manager and Mark Gibson, Environment Specialist, both Teagasc Athenry, along with Dr Karl Richards, Research Officer and Dr Noel Culleton, Head of Centre, both Teagasc Johnstown Castle.

Teagasc organised a workshop on the Water Framework Directive at Johnstown Castle on October 25. Mark Gibson, Teagasc Environment Specialist, says, "The Water Framework Directive is the largest single piece of water legislation to date and came into force on December 22, 2000. Teagasc is now developing a strategic environmental programme to support profitable farming into the future where water quality will be top of the agenda."

The Directive aims to maintain the "high status" of waters where it exists, prevent any deterioration in the existing status of waters and achieve at least "good status" in relation to all waters by 2015. Until now, there has been limited discussion of the implications of the Directive for agriculture in Ireland. A panel of eminent speakers from Teagasc, the Environmental Protection Agency, the Department of the Environment Heritage and Local Government, the Department of Agriculture, Fisheries and Food, the Central Fisheries Board, the National Parks and Wildlife Service, and the Western River Basin District Project spoke at the event.



IJAIFR developments

Licensing agreements are being put in place with EBSCO Publishing and JSTOR to bring the *Irish Journal of Agricultural and Food Research*, Teagasc's peer-reviewed research journal, to a wider audience. EBSCO Publishing delivers full-text and bibliographic research databases to the school, public, academic,

Development of food industry

The Minister of Agriculture, Fisheries and Food, Mary Coughlan, TD, has appointed Professor Liam Donnelly, Head of the Teagasc Food Research Directorate, and Declan Troy, Head of Ashtown Food Research Centre, to an industry-led research group to drive the research agenda in food and underpin the development of the Irish food industry. The 'Agri Vision 2015 Research Group' comprises representatives from the food and drinks industry, and the relevant State agencies and research institutes. In addition to providing advice on high level priorities for research under the Department's food research initiatives, the Group will also act as the Irish platform in interacting with and contributing an Irish view to the European Technology Platform 'Food for Life' and the EU Framework Research Programme.

The Investigators

Teagasc researchers are to feature in a new seven-part science series to be aired on RTÉ 1 television called *The Investigators*. Dr Padraig O'Kiely (below left) from Grange will feature in an episode on climate change on November 15, while Professor Liam Donnelly and Dr Catherine Stanton of Moorepark Food Research Centre will feature in an episode on functional foods on December 13. The show will air on Thursdays at 11.05pm.



Dr Padraig O'Kiely



Professor Liam Donnelly



Dr Catherine Stanton

New facilities at Moorepark

The Biofunctional Food Engineering Facility (BFE), recently completed at Teagasc Moorepark Food Research Centre (MFRC), is a state-of-the-art facility enabling food technologists to separate, stabilise and deliver bioactive ingredients in food products with commercial potential. Designed to fast track the transfer of ideas from the laboratory to the pilot plant, the range of operations offered by BFE includes dehydration, separation, encapsulation and thermal processing. BFE investment is intended to improve R&D productivity in advance of pilot scale studies. Ultimately, it is expected that the facility will make a key contribution to the development of foods and beverages containing bioactive ingredients with proven stability and shelf life.

Also at MFRC, the National Food Imaging Centre (NFIC) is the first of its kind in Ireland and is now fully operational. It comprises a suite of imaging equipment, including: a field emission cryo scanning electron microscope, a confocal scanning laser microscope, an atomic force microscope, various light microscopes, and image analysis software. This equipment is available to support both the research community and the R&D activities of the Irish food industry. The primary functions of the NFIC are to: support and expand our understanding of food structure and functional properties; underpin a new food nanotechnology and biotechnology research programme; provide a centre of excellence that will enable Ireland to compete for EU Framework funds; and, provide a consultancy service to the Irish food industry.

WDS 2007



Dr Catherine Stanton (right), Teagasc Moorepark Food Research Centre, and project leader, is pictured receiving the 'milk tankard' award for Best Poster in Functional Foods, on behalf of Fiona O'Halloran, from Professor Rafael Jiménez-Flores (left), Calpoly University, USA, who represented the panel of adjudicators. Also pictured is Dr Phil Kelly, Secretary of the Organising Committee, IDF World Dairy Summit 2007.

Fiona's poster – 'Development of bioactive whey protein hydrolysates for fortification of beverages' – was co-authored by Moorepark colleagues Helen Slattery, Paul Ross and Catherine Stanton.

Over 900 delegates from more than 50 countries attended the International Dairy Federation's World Dairy Summit in Dublin recently. Pat Murphy and his Moorepark colleagues Eddie O'Callaghan, David Gleeson and Bernadette O'Brien, also received an award for the best poster in the Farm Management and Production category for their work on 'Impact of pre-milking teat preparation practices on milk quality'.

IPW5

Two Teagasc researchers, Declan Ryan (Oak Park) and Hubert Tunney (Johnstown Castle) attended the 5th International Phosphorus Workshop (IPW5) in Silkeborg, Denmark, in September. Previous workshops contributed to knowledge of Phosphorus (P) loss from agriculture, transfer of P from soil to water and the effects of mitigation measures.

"The presentations at the workshop showed that the best approach is to reduce surplus P inputs to match agronomic requirements. Animal farming causes a particular problem. Maintaining soil test P (STP) at a relatively low level compatible with good agronomic production and good water quality is recommended," reports Hubert Tunney.

"Several papers dealt with modelling P loss from soils to water and some can give a reasonable estimate at the catchment scale. In the USA, a P Index system is being used at field and farm scale to estimate the risk of P loss to water. The P Index uses a scoring system for a number of parameters, e.g., STP, connectivity to water course, P inputs, etc., to estimate the risk of P loss. This approach is also being studied in Europe.

"Despite efforts over many years to reduce P loss, there are still high P reserves in the sediment of many lakes, rivers and soils. It will take time for waters to return to good ecological quality, as required by the Water Framework Directive, after water P levels have been reduced to acceptable levels."

The proceedings are available on:

<http://www.agrsci.dk/var/agrsci/storage/original/application/115f2ba1481b6a113288c6f9a773d572>.

ISOF

The Irish Science Open Forum (ISOF), an open forum for all those involved in science, has been launched and, at the inaugural meeting at the RDS in Dublin recently, plans were unveiled for a major event to coincide with Science Week 2008. ISOF is guided by a steering Executive Council of 10 members representing a range of interests, and scientists are being invited to join a national council to draw up a programme for a series of high profile presentations highlighting the best in current Irish research.

Catriona Boyle, Science Writer/Editor, is Teagasc's representative on the ISOF Executive Council, and the expanded council, involving Teagasc staff, is in the process of being formed.

The ISOF Council has also initiated a register that anybody with an interest in science can join to receive occasional email alerts about activities. This register is to be one of ISOF's points of contact with the wider science community, and supporting this is an occasional newsletter, available for downloading free from the Science Spin website: www.sciencespin.com

"The plans for ISOF are quite ambitious, in line with the explosive growth in Irish science. In many areas Irish researchers are in the lead, yet awareness of what is going on in the institutions is not that high. The ISOF Council believes that it is important to put this research on the map through initiating a big event celebrating science in a way that will attract attention both at home and abroad. An integral part of this event will be an ISOF R&D exhibition in the RDS Main Hall. This exhibition will provide an open door into an arena where researchers and entrepreneurs can interact," said Tom Kennedy, *Science Spin* magazine.



Who's Who

Soil scientist Dr M. Ibrahim Khalil is included in the 25th Silver Anniversary edition of *Who's Who in the World*, because of the reference value of his outstanding scientific achievements. *Who's Who* is a biographical data source of notable individuals from any significant field of endeavour. Originally from Bangladesh, Ibrahim has been working at Johnstown

Castle Environment Research Centre since April 2007 on subsoil and groundwater denitrification, having worked previously in the UK, Germany, Belgium, Malaysia and Japan. Ibrahim has contributed to over 90 published papers. His achievements include being the first to determine the scientific basis of the relationship between methane oxidation and denitrification, indexing organic matter quality for the availability of nitrogen for crop intake, and his work on technologies/approaches to reduce greenhouse gases from agroecosystems.

Back to his roots

Professor Gerry Boyle took over as Director of Teagasc at the beginning of October. A month into his new position he talks to Catriona Boyle about the future of the agri-food industry in Ireland and his ideas for the development of the organisation.

This is Professor Gerry Boyle's third time to work with Teagasc. After receiving his BA from UCD in 1977, he began his career as a Research Officer in the Rural Economics Division of the Agricultural Research Institute (now Teagasc). The second stint was in the Agricultural Economics Department from 1982 to 1987, during which time he completed his PhD on the technical efficiency of Irish agriculture. He continued his career with a number of positions at NUI Maynooth, where his last position was as Head of the Economics Department. He has also spent time as an Economist with the Central Bank of Ireland. From 1995 to 1997, he served as Economic Adviser to the Taoiseach. Prior to taking up the Director's post, he was a Senior Associate with Farrell Grant Sparks Consulting and a Senior International Consultant, specialising in agricultural policy, with the World Bank. Professor Boyle's main research interests are in applied microeconomics and the economics of public policy.

Professor Boyle has been spending his time so far getting to know the "beating heart" of the organisation. "It's a very big organisation and it's complex. So, I'm spending a lot of time visiting centres and, indeed, I want to continue doing that. The best way for me to learn what is going on is to visit people *in situ*."

Education

With his experience in education, Professor Boyle thinks that there's potential for greater integration of education with the research and advisory services. "In the US, for example, there's been a lot of thinking on the optimal design of an undergraduate programme. The Boyer Commission did a report in 1998 (*Reinventing Undergraduate Education: A Blueprint for America's Research Universities*) on the importance of introducing undergraduates to research activity.

He believes it gives them a flavour of the excitement that's involved in a research career and that the educational programme that integrates some element of research, even at undergraduate level, would provide a powerful learning experience.

"In recent times, students and parents have become much more discerning about course choice and universities have had to adapt. There has been a phenomenal level of innovation in course design. That's something that Teagasc will have to do as well. We have to do it because the agricultural industry is changing but, also, the aspirations of the sons and daughters of farmers are changing. If we respond to that in a creative way, it could offer people a profitable and enjoyable experience."



Photo courtesy of Mark Moore.

Professor Gerry Boyle

Knowledge transfer

The integrated service that Teagasc provides, Professor Boyle continues, is unique in a European context and gives the organisation the potential to really deliver.

"My overriding hope would be that we can have our stakeholders benefit from the collaboration from advisory, research and education services, because if we can maximise that potential we can make a significant difference. And that's really all about concentrating on how we transfer knowledge; that is the challenge for Teagasc and that is the challenge for the entire research programme that has been rolled out in Ireland for the last few years. Certainly the generation of knowledge is critical, but the transfer of that knowledge is more important and more difficult to achieve," explains Professor Boyle.

"It's going to mean that we are going to have to collaborate more closely with our stakeholders and be responsive to their needs and to stretch them as well. We have a responsibility to look ahead and to identify potential requirements for the future and respond to them. Teagasc is an applied research organisation. We are absolutely committed to making a difference to the lives of people out there. We have to have clear 'take home' messages for all of the sectors that we service and the dynamic will be that we are able to change those messages in a way that is profitable for our clients, for our stakeholders, into the future."

Foresight

The Teagasc 2030 Foresight Project, which was launched in December 2006, aims to use Foresight methods and processes in order to develop a long-term vision for Teagasc and a Research and Technological Development and Innovation strategy that will enable the organisation meet the science and technology needs of the agri-food industry and rural economy in the short-, medium- and long-term.

Professor Boyle has already been involved with this exercise through Farrell Grant Sparks Consulting.

"One thing that we haven't had to concern ourselves with in the last two decades is that prices of all commodities haven't changed very much in nominal terms. The move toward world prices conditions means that prices will become more volatile.

"That's going to require new responses on the part of producers and they will look to Teagasc and other bodies to provide advice on how best to cope with

that volatility. There's always a tendency to say that the future will be radically different. We're living through a fascinating period just now, which will have its influence well into the medium-term. We're getting back to the situation in the agriculture and food sectors where the market conditions are really going to drive responses. That's going to affect, and is already affecting, the way farmers do business. That's going to be a feature of the next decades."

Knowledge economy

"You get the impression sometimes that the knowledge economy doesn't apply to the agri-food sector. I think we cannot be competitive in the longer run without upgrading substantially the level of knowledge that we deploy in all aspects of industry. I would have an overall aim that Teagasc would place the agri-food sector at the centre of the knowledge economy. The kind of questions that we are now required to address are crying out for the assembly of multidisciplinary teams."

"There's a lot of talk today of the 'open innovation' society and I think there is a lot in that notion. There's a benefit of looking outwards and embracing the potential that exists through collaboration. We have done that very successfully, for example, with the collaboration between Moorepark and UCC and Ashtown and UCD; that's a very good example of a high level collaboration that's mutually beneficial to all the organisations involved and there are many other examples, the closest to my own area of interest is, of course, the FAPRI-Ireland project. By being open to different ideas, and different ways of doing things, it can be a win-win strategy. By exposing our scientists, advisors and educationalists to influences from further afield, we improve our own performance. And, it's heartening to know that Teagasc is in much demand as a research partner. That's an indication of the significance of the work that it's doing."

Drivers of change

"But, what is going to happen is that the drivers of competitiveness are going to change. When you are producing commodities, basically, as we have been doing predominantly, competitiveness depends on the costs of the raw materials. But, as you shift into the added-value end, the drivers of competitiveness shift to issues such as the deployment of knowledge in terms of product development, innovation and quality. For us to be competitive into the future we will need to deploy knowledge much more effectively - both in the primary sector and in the processing sector.

"We absolutely need to do it and we need to be able to create multi-disciplinary teams that address problems over a period of time and then move on to different problems, disassemble and reassemble with different guises. This is going to have to happen much more and it's a great challenge for all involved." Professor Boyle stresses that Teagasc is in a unique position with its close connections to industry, both in terms of primary production and processing. "We have constant feedback regarding the challenges and issues that face the agriculture and food industry and that's very important, because certainly in my own discipline in economics, it's very evident to me that the best research breakthroughs have always come as a reaction to developments in the economy. We have to respond to change in different markets."

Professor Boyle cites the examples of the effect of the emergence of biofuels as an energy source. "Of course, we are an applied research organisation, so we will work with industry to use knowledge that will have practical economic

benefit. I think the Brazilians have got the right attitude here where they devote the sugar cane land to food products if the market dictates or to ethanol if the market dictates. I think that is the way it will evolve. The market place is the best place to decide how land resources are ultimately allocated."

Communication

"We do have a responsibility to make sure that our research is communicated. Generation of knowledge is one aspect; dissemination of that knowledge is another. We have to constantly keep this in mind and, of course, it's more difficult when the market circumstances are difficult.

"It's a challenge for an organisation like Teagasc, because there are often apparently conflicting objectives, at least as far as our stakeholders are concerned. Sometimes a piece of research is perceived to be not very relevant to farmer income - except maybe in a negative way - because farmers are obliged to implement regulations. You should always be trying to seek out the 'double dividend': Take environmental research, for instance, there will always be a public good outcome, but, there may also be a private (farmer income) outcome. And, in many cases, it is this potential dual outcome that produces the research challenge.

"The Teagasc Authority represents the stakeholder bodies that we have to be responsive to. The situation now is that because of decoupling, to survive and thrive in the agri-food sector, we simply have to be responsive to our customers in terms of value for money, i.e., we deliver in terms of the quality of the product that we deliver, the attractiveness of our product, taste, and so on. Farmers are quite adaptable to the new set of circumstances, as are the food processors. They are very effective at interpreting communication signals coming through from the consumer.

"There probably are ways in which we could look at delivering those signals more effectively from consumer through to the producer and back to the researcher. I'm very interested in some programmes that have been underway in Canada where they have established research and knowledge transfer programmes around the food value chains, which represent various branches of a particular sector, e.g., the dairy sector - where feedback is coming back from the marketplace through to the farmer and the processor and, indeed, to the researcher."

Let the market decide

With a move towards world prices for products, Professor Boyle thinks that it's very important to maintain good lines of communication with key stakeholders. "It's important that we understand their expectations of Teagasc very clearly and that they understand where we are coming from."

"Our job is to generate and disseminate knowledge that is useable in that it delivers real income gains to our stakeholders. And the best way for us to do that is for us to be absolutely independent in the delivery of that information and to be seen to be independent."



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Gut health in the elderly

The world's population is getting older and with an ageing population comes increased health problems. Researchers at Moorepark, in conjunction with University College Cork, are embarking on a research project that will look at ways of improving the quality of life in this demographic through research into gut health.

Perhaps there has never been a better time to grow old in Ireland than the present, with both the current government and Age Action Ireland placing a heightened emphasis on the needs of the elderly, with initiatives such as Positive Ageing Week. What better time to discuss approaches to improve the quality of life of our elderly population?

The elderly population is a dynamic one, growing rapidly, thanks to advances in both science and medicine that have enabled dramatic increases in life expectancy. Indeed, reports suggest that by 2025 nearly one-third of the population in the EU will be over 60, a phenomenon that can also be seen on a global scale (Figure 1). On the other hand, it is predicted that the 20-29-year-old age group will shrink by 11 million (-20%). Such a pattern will undoubtedly place immense pressure on our healthcare resources and create difficulties in future funding of social welfare. It is therefore vital that efforts are made to prevent the onset of age-related diseases such as osteoporosis, cardiovascular disease, inflammatory bowel disease and cancer, to ensure that our elderly population experiences healthy ageing and, thus, healthy living.

Benefits of a healthy gut

Ensuring that the elderly population continues to experience the benefits of a healthy gut microflora may be a key contributor to ensuring a healthy ageing lifestyle. Indeed, it is now widely accepted that the intestinal microbiota is fundamental for maintenance of host health. The relationship between gut flora and human health is the scientific focus of the Science Foundation Ireland Centres for Science, Engineering and Technology Centre, The Alimentary Pharmabiotic Centre (a virtual research centre between University College Cork (UCC) and Teagasc, Moorepark Food Research Centre).

The human intestinal tract is home to almost 10^{11} - 10^{12} bacterial cells/ml, including more than 500 different species. Remarkably, we are born sterile, and acquire our intestinal microorganisms from the external environment (mainly the mother initially). While the intestinal flora of the infant varies depending on factors such as mode of feeding, the microflora becomes more stable, resembling that of an adult by the end of the second year. The microflora of an adult human gut predominantly consists of facultative and obligate anaerobes such as *Bacteroides*, *Bifidobacterium*, *Eubacterium*, *Clostridium*, *Peptococcus*, *Peptostreptococcus*, *Ruminococcus*, *Escherichia*, *Enterobacter*, *Enterococcus*, *Klebsiella*, *Lactobacillus* and *Proteus*.



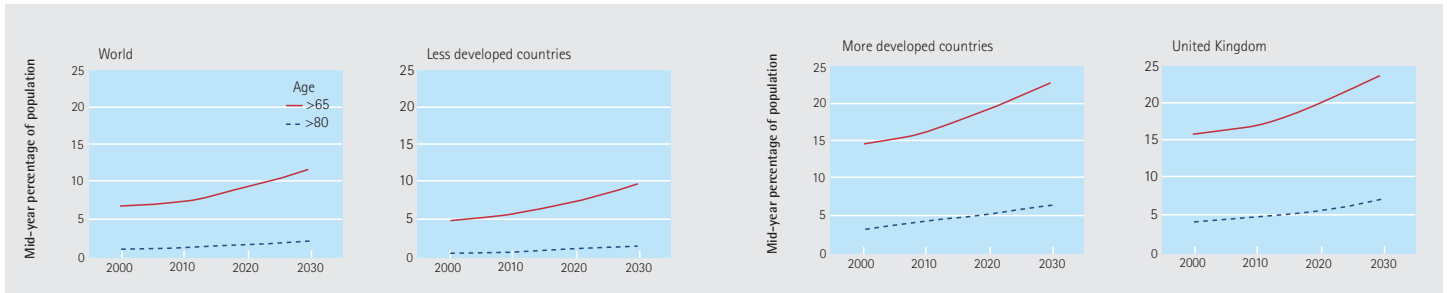


FIGURE 1: Growing proportions of older people are a world wide phenomenon. Data from US Census Bureau.

TABLE 1: Demographic shift in the beginning of the 21st century in the EU.

Age group (years)	1995 to 2015 demographic evolution	
	Numbers of people (millions)	Proportion of the population (%)
0-14	-4.8	-7
15-29	-13	-16
30-49	+0.6	+0
50-64	+16.5	+26
over 65	+17	+30
over 80	+5.5	+39

(Eurostat scenario source, 'Towards a Europe for All Ages', European Commission, 1999.)



FIGURE 2: Electron micrograph of Lactobacillus bacteria isolated from the human intestine.

Limited research to date has demonstrated that, upon ageing, changes occur in both bacterial genera and species. Understanding such changes should indicate the impact these population shifts have upon the beneficial functions normally provided by a healthy gut microflora. A healthy gut flora exerts important and specific physiological functions on the host, which can be broadly classified into three sections: metabolic, protective and trophic.

The metabolic effect of a healthy gut microflora can be predominantly appreciated through the bacterial degradation of non-digestible dietary substrates such as polysaccharides (fibre), which release short-chain fatty acids (SCFAs) into the lumen that are readily absorbed into the bloodstream. SCFAs exert numerous physiological effects and are thus essential biological components in maintaining health and evading disease. It is now known that specific SCFAs may reduce the risk of developing gastrointestinal disorders, cancer and cardiovascular disease. SCFAs may also be responsible for enhancing bone health through promoting calcium absorption in the gut. Moreover, certain vitamins (K, B₁₂, biotin, folic acid, pantothenate) may also be synthesised by the gut microflora.

The healthy resident microflora provides a natural protective barrier against invasive pathogens. Preventing colonisation of pathogens can be achieved through displacement, competition for nutrients and host epithelial binding sites, as well as producing antimicrobial substances such as lactic acid and bacteriocins. In terms of trophic functions, research has demonstrated that the gut microflora has the ability to control both proliferation and differentiation of epithelial cells. In addition, the gut microflora plays a dominant role in the education of the intestinal mucosal immune responses.

Bacterial biodiversity with age

In an attempt to understand the effects of ageing on intestinal health, the EU project CROWNALIFE was set up to decipher the composition of the intestinal flora of different age groups (adult versus elderly) in different countries of Europe. The project also evaluated whether possible changes in composition or functioning of the microflora had negative health implications that could be counteracted by addition of synbiotics (probiotic bacteria in combination with a suitable prebiotic substance(s)) to the diet. The overall outcome of CROWNALIFE suggested that increased bacterial diversity did occur with age, and, while it was possible to modulate the composition of the elderly gut microbiota, modulation of functionality must still be investigated. Such changes in the intestinal flora may have dramatic consequences on overall health, resulting in reduced production of SCFAs, immunosenescence and susceptibility to infection by pathogens. Studies to date demonstrate that the elderly intestinal flora is represented by increased numbers of facultative anaerobes, in conjunction with a decrease in beneficial organisms, such as the anaerobic lactobacilli and bifidobacteria. Studies have also shown that a decline in viable counts of the nutritionally important group Bacteroides with increased age, results in reduced amyolytic activity (conversion of starch into sugar) observed in the elderly. Moreover, a rise in proteolytic bacteria (bacteria that break down protein) such as fusobacteria, propionibacteria and clostridia has also been reported in elderly populations. Fusobacteria, in particular, are known to ferment amino acids, resulting in the production of detrimental end products such as ammonia and indoles. A marked increase in numbers of clostridia has also been documented, particularly after antibiotic therapy. Eubacteria also occur in greater numbers in elderly people's



gastrointestinal tracts than in those of their younger counterparts. Such bacteria may be responsible for the increase in the transformation of bile acids to secondary bile acids (which are considered potential tumour promoters). Moreover, rats inoculated intraperitoneally with cell material from *Eubacterium aerofaciens* were reported to develop moderate to severe arthritis.

Improving gut health

A few studies have indicated that dietary supplementation with beneficial probiotics and synbiotics can markedly enhance beneficial components of intestinal microflora in elderly people. Indeed, consumption of *Bifidobacterium lactis* HN019 or *Lactobacillus rhamnosus* HN001 was shown to enhance some aspects of cellular immunity in the elderly. Similarly, dietary supplementation with the synbiotic containing *B. bifidum*, *B. lactis* and oligofructose increased the size and diversity of protective faecal bifidobacterial populations in the elderly. In conclusion, we feel that there is now an urgent need for research to determine the baseline microbiota in a large cohort of elderly subjects in Ireland. Such a platform will not only give us detailed information on what the profile of a healthy gut population looks like in the elderly, but should also inform us of how it may be perturbed in key disease states including obesity, gut infection, irritable bowel syndrome and hypertension. Such research will also explore how diet can positively influence the microflora, and thus provide the food industry with key information for the design and development of future functional foods to target this highly vulnerable and growing population.

This research is being carried out as an APC initiative.

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The new nutraceuticals



HILDE WIJNGAARD and NIGEL BRUNTON, Ashtown Food Research Centre, describe a number of projects that aim to maximise the potential of bioactive ingredients found in natural products.

The demand for foods that promote health and wellbeing has increased in recent years. At the same time, consumers are demanding convenience and palatability. The response of the food industry has been to produce attractive and healthy products enriched with compounds that give a health benefit beyond that of simple nutrition – nutraceuticals.

What are nutraceuticals?

The terms 'nutraceuticals' and 'functional foods' are generally used synonymously. However, a nutraceutical is the actual substance that confers a health benefit, whereas a functional food is a foodstuff enriched with a health-promoting component. A well known example of a functional food is a probiotic drink (e.g., with added lactobacilli). However, nutraceuticals cover a broad field and can create many possibilities for the food industry. Various ingredients can be used to produce functional foods, including fibre from natural products and antioxidants derived from fruits and vegetables. At the Ashtown Food Research Centre (AFRC), research in this area has been ongoing for several years. At present, various projects are running in co-operation with several other institutions, including the University of Limerick, University College Cork, Dublin Institute of Technology, Trinity College Dublin, University College Dublin and NUI Galway. The main emphasis of the research in AFRC is on bioactive compounds. Below is an outline of the main topics currently under investigation in the nutraceutical area.

Antioxidants

Antioxidants have received much attention recently, as they are bioactive compounds that may reduce the levels of oxidative stress (a condition of increased oxidant production in animal cells characterised by the release of free radicals and resulting in cellular degeneration). Several epidemiological studies suggest that a high intake of food rich in natural antioxidants can moderate oxidative stress and thus help in the prevention of degenerative conditions such as cancer and heart disease. In addition to well known antioxidants such as vitamin C and vitamin E, polyphenols can play a major role in moderating oxidative stress. Several projects are focussed on the use of antioxidants in the design of food products.

Waste not, want not

Fruit and vegetable processing in Ireland generates substantial quantities of waste/by-products. For companies, waste is a nuisance, and, in many cases, is expensive to dispose of. On the other hand, research indicates that fruit and vegetable waste/by-products could serve as rich sources of potentially useful bioactive compounds, especially antioxidants. At AFRC, we are examining typical wastes and by-products of fruit and vegetable processing in Ireland as potential sources of health-promoting compounds for incorporation into functional foods. Initially, a range of typical waste/by-products was obtained from industrial partners. Then, by assessing the distribution of health-promoting compounds in different parts of the samples, their potential as sources of antioxidants was determined. To assess the antioxidant potential of the discards and whole foods, high throughput *in vitro* model systems based on the ability of the extracted antioxidants to react with free radicals are used. Results have indicated that antioxidants are unevenly distributed in fruits and vegetables. For example, onion peels (a common by-product of processing) have a much higher antioxidant activity than their flesh (Figure 1). High performance liquid chromatography (HPLC) analysis of peel extracts has indicated that their relatively high antioxidant activity is most probably due to high levels of flavonols and anthocyanins, two polyphenol subgroups (Figure 2). Other waste/by-products being examined in the study include cut-offs, such as outer leaves of white cabbage, and whole fruit samples that do not meet quality requirements. Quantitative extraction of bioactive compounds from waste streams is currently being carried out using methanol; however, these extracts cannot be used for incorporation into other foods, as they are toxic. Therefore, future research will focus on examining technologies that can extract bioactive compounds with food-grade and environmentally safe methods. The ultimate aim will be to identify three waste streams with potential for incorporation into model foods such as cooked deli turkey, ready meals and drinks.

Spice of life

The chilled ready meal market in Ireland is growing at a rapid rate; however, surveys have shown that some ready meals can deliver up to 50% of the recommended daily allowance (RDA) of sodium. This means that these products

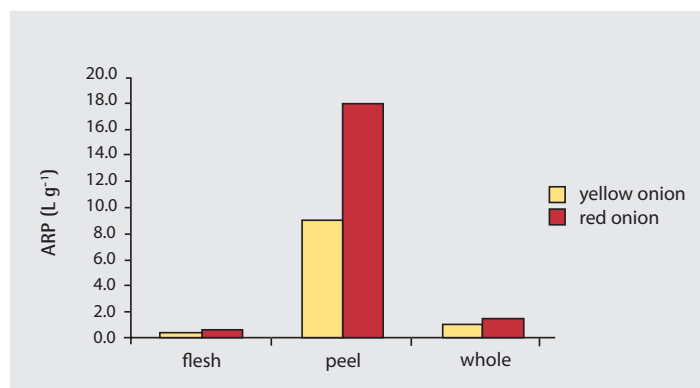


FIGURE 1: The results of the DPPH assay can be expressed in anti-radical power (ARP) units: the higher the ARP, the higher the antioxidant activity of the sample.

are at odds with consumer demands for healthy foods. However, a rapid reduction in salt levels can compromise both microbial safety and taste. In conjunction with the University of Limerick, we are examining a range of herbs and spices as substitutes for flavour and preservative functions lost through the removal of salt. These herbs and spices also contain potent antioxidant compounds and thus can be used to improve the health-promoting profile of the ready meal.

Initial work has focussed on screening 24 herb and spice samples provided by an industrial partner (including black and white pepper, clove, basil and coriander) for antioxidant activity, using methods such as the 2,2-diphenyl-1-picrylhydrazyl

(DPPH) assay and the ferric-reducing antioxidant power (FRAP) assay. In both assays antioxidants react with the relevant substrates and a change in colour can be observed. Since the main antioxidants in spices are phenolic compounds, the polyphenol profiles of the samples are also being studied by HPLC (Figure 3). Results have shown that the level of antioxidant activity depends on the antioxidant potency of the primary polyphenol that is present in the spice. For instance, eugenol is the most abundant polyphenol in clove. As a pure compound, eugenol demonstrated higher antioxidant activity than the synthetic antioxidant Trolox; thus, clove had the highest antioxidant activity of the herbs and spices tested. Future work will focus on identifying combinations of herbs and spices that can be used to enhance sensory and microbiological properties while also working synergistically to enhance antioxidant activity.

Superbreads

Dietary fibre has often been reported as a potent protector against diseases like coronary heart disease and diabetes. In particular, soluble fibre is known to positively contribute to human health by reducing levels of blood cholesterol. To date, in industry, the dietary fibre of choice for use as a functional ingredient is inulin (a fructan extracted from the chicory root). However, for the Irish food industry, oats and barley, the first and third most cultivated cereals in Ireland, may be better sources, since they contain high amounts of another soluble fibre known as β -glucan. β -glucan is a polymer comprised of glucose molecules, which are linked together by a series of β -(1-3) and β -(1-4) linkages, and is naturally present in barley and oats. Research indicates that β -glucan can act as a prebiotic (a non-digestible food

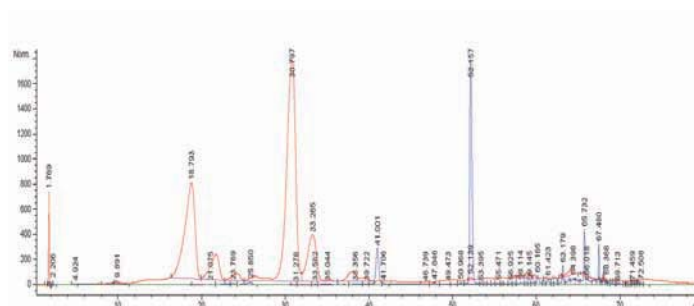


FIGURE 2: HPLC chromatogram of polyphenols in red onion peel. Anthocyanins are indicated by the red curve and flavonols by the blue curve.



FIGURE 3: HPLC system with fraction collector and photodiode array detector at AFRC.

ingredient that promotes proliferation of bifidobacteria and lactobacilli in the colon) and has a positive effect on glycaemic insulin and cholesterol responses. In addition, oats and barley contain other bioactive compounds, including vitamins, minerals and polyphenols.

At AFRC, barley, oats and their fractions are being assessed for polyphenol and β -glucan content, and antioxidant activity. Unfortunately, many of the phenols are bound to the grain cell walls and are therefore not readily available. Therefore, the bioavailability of phenolic compounds for humans will be tested by a gastro-intestinal model simulating the small intestine. The effect of processing (malting, milling and fermentation) on the level of antioxidants and their bioavailability will also be established. Finally, fractions with high levels of fibre and bioavailable antioxidants will be selected for incorporation into breads with enhanced health-promoting properties.

Process optimisation

A diet rich in vegetables has been shown to have a protective effect against a



Herbs and spices contain potent antioxidant compounds and may also be used to replace salt as a flavouring/preservative.

number of degenerative diseases, including cardiovascular disease and certain types of cancer. In addition to antioxidants, a group of compounds called polyacetylenes may be responsible for this effect as they are potent anti-tumour agents. Polyacetylenes are synthesised from unsaturated fatty acids and they occur in certain vegetables, including carrots, parsnips, celery and lettuce. Recent work has indicated that these compounds may have a more significant role in the anti-cancer properties of carrots than well known contributors such as β -carotene.

Due to the consumer's demand for ready-to-use convenience foods, many fruits and vegetables are now sold from the chill cabinet. They can be gas-packed or minimally processed to extend their shelf lives. Preparation of these products involves practices such as peeling, cutting and other unit processes. These processes can bring previously separated oxidative enzymes and their substrates together, which may lead to a decrease in levels of polyacetylenes. This project aims to examine the retention of polyacetylenes following minimal and full-scale processing.

At present, the effect of full-scale commercial practices such as canning, *sous vide* processing and high pressure processing on levels of polyacetylenes in vegetables is being tested in AFRC. The levels of polyacetylenes before and after processing are then measured by HPLC. The study aims to provide recommendations to ensure retention of maximum levels of polyacetylenes.

Foods of the future

Consumer demand for nutraceuticals is often at odds with quality attributes such as sensory acceptability and shelf life. The challenge, therefore, will be to use components such as antioxidants to deliver these attributes without compromising on quality and safety. Currently, the nutraceutical field is a highly competitive area, with new products appearing on a regular basis. At AFRC we are currently building capacity in the area of nutraceuticals. This will



Research indicates that fruit and vegetable waste/by-products could serve as rich sources of potentially useful bioactive compounds.

entail a capital investment of €3.5 million in a new nutraceutical building. The main focus of the nutraceutical initiative will be the extraction, purification and characterisation of nutraceutical components from terrestrial sources such as fruits, vegetables and meats, and marine sources such as algae and fish. The initiative will work in close collaboration with a similar investment at the Moorepark Food Research Centre, where the focus will be on the validation of health claims associated with bioactive components. These investments will mean that Teagasc will keep pace with the significant developments taking place in the nutraceutical area.

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Harvesting forage maize for winter feeding as maize silage.



Recording feed intake in the automated feed intake research facility at Moorepark.

Winter feeding of dairy cows: research issues and pasture-based systems

Are there research issues relevant to grass-based systems of milk production? JOHN MURPHY and JOE PATTON outline recent thinking on dry cow feeding, as well as some continuing and recently completed research undertaken in the area of winter feeding at the Moorepark Dairy Production Research Centre.

The efficient utilisation of pasture is central to the profitability of dairy production in Ireland, and much research has been conducted to maximise the proportion of grazed grass in the diet of the dairy cow. However, the availability of grazed grass during the winter period is restricted to varying degrees by grass growth rates and grazing conditions, depending on local soil type and climate. This can range from zero grass in the diet right through the period to varying proportions of grass during November, February and March. The use of alternative forages and/or concentrate ingredients is therefore required to meet the dietary demands of the dairy herd during the winter period.

The principal research issues concerning winter feeding of the dairy herd are the development of optimal feeding strategies for the autumn-calved cow in early-mid lactation, and the nutritional management of the spring-calved cow during the dry period. Milk production by autumn-calved herds in early lactation has traditionally been from high-cost, high-output systems based on grass silage and concentrates. Issues such as rising cereal prices and the

suitability of grass silage as a forage for milk production are of particular relevance to these systems. The potential benefits of using alternative forages, such as maize silage or whole crop cereals, and the improved utilisation of early/late season grass, have become increasingly pertinent research topics in this regard. With respect to the spring-calving herd, winter feeding primarily corresponds to the dry period, where the objective is to satisfy the nutritional requirements for maintenance and pregnancy in a cost-effective manner. It has been reported, however, that nutrition during the dry period may have a large impact on metabolism and immune function of the cow around calving, during which time about 65% of health incidents occur. Hence, an evaluation of the effects of dry cow feeding strategies on subsequent production and health status is required.

There is an ongoing challenge to develop and investigate the relevance of new concepts in dry cow feeding to our grass-based system of production and, in the current climate of rapidly increasing concentrate feed prices, to define the most economic strategies to feed cows, particularly for autumn-calving in early lactation.



The nutritive value of grazed grass for early lactation autumn-calving cows is currently being assessed.



Making grass silage, the traditional winter forage offered to dairy cows in Ireland.

Nutritional management of the dry cow

Winter feeding for the spring-calving dairy herd is primarily a maintenance exercise, as it coincides, for the most part, with the dry period of the herd. The total dietary energy and protein requirements of the dry cow for maintenance, foetal development, and body tissue accretion are modest in comparison to requirements during the lactation phase. Meeting these requirements on a forage-based diet is, therefore, readily achievable.

The typical dry cow diet consists of grass silage and an appropriately formulated vitamin/mineral mix, with occasional use of concentrates to supplement poor forage quality or improve cow body condition score. This dietary programme developed in tandem with the seasonal pasture-based production system, because the winter feed required for the herd could be generated by conserving surplus grass during the grazing season. Given the simplicity of the feeding system, there has been relatively little research conducted in Ireland on the optimisation of nutritional management during the dry period. In contrast, a significant body of research has been conducted internationally to address this aspect of dairy cow nutrition.

The transition period, defined as the period from three weeks pre-calving until three weeks post-calving, represents the time of greatest risk of metabolic disorders and diseases for the dairy cow. During this time, the cow must negotiate the calving event while simultaneously adapting to the increased nutrient demands associated with the onset of lactation. The metabolic changes that the cow experiences at calving are considerable; mammary gland uptake of glucose and acetate increases by about four- and two-fold, respectively, blood flow to the mammary gland increases by about two-fold, and the cow's energy requirement increases by two- to three-fold. Key areas of investigation in the 'close-up' dry period have included the inclusion of supplemental dietary fat or administration of glucogenic precursors such as propylene glycol to maintain energy intake, the addition of supplemental starchy concentrates to both

improve energy intake and adapt rumen papillae to lactation diets, and the manipulation of the dietary anion/cation balance to control milk fever. However, it has increasingly been accepted that such strategies, while intuitively sound, have provided little or no advantage in terms of improved cow health, energy balance and productivity in practical feeding situations.

More recently, research into dry cow nutrition has become increasingly focussed on the effects of nutrition across the dry period as a whole. This interest has arisen from experimental evidence to indicate that overfeeding during the far-off (early) dry period, even to a moderate degree, can predispose cows to a greater risk of peripartum metabolic disorders. These studies reported lower feed intake, higher plasma non-esterified fatty acid concentrations, and greater triglyceride infiltration of liver in cows that were overfed during the dry period. To counteract the purported effects of overfeeding, a dry cow programme based on offering a high-fibre, low-energy diet throughout the dry period has been developed. In practice, this involves including a large proportion (up to 50%) of chopped straw in a total mixed ration (TMR) diet, which serves to dilute the energy and increase bulk/fibre content. The diet is then offered free choice, which allows the cow to maintain dry matter intake while simultaneously controlling energy intake.

Dry and lactating TMR diets

The extent of controlled research in the area of high-fibre, low-energy TMR diets in the dry period, particularly on the effects of dry cow feeding on subsequent health and fertility, remains limited at present. Furthermore, the high-fibre, low-energy dry period diet approach may be applicable in systems where dry cow diets are maize silage-based and conducive to over-conditioning, but whether it is more beneficial than conventional practice in Ireland, i.e., feeding dry cows grass silage, remains to be evaluated. Little research has been conducted on the use of TMR as a partial supplementation strategy for grass-based milk production in Ireland, principally

because systems involving high levels of supplementary feeding are generally not optimal when operating within the context of the EU milk quota system. However, with the likely phasing out of the milk quota regime, it is now opportune to consider the potential role of such systems in conjunction with pasture. In particular, the efficacy of incorporating TMR into the diet, as a means to facilitate expansion of milk production through increasing stocking rate on a limited land base, requires investigation.

To provide answers to the above issues, a three-year project has been initiated at Moorepark. The initial ongoing study is designed to compare overall cow performance on a TMR diet and the Moorepark blueprint grass-based system for a full lactation. A wide range of measurements is being made, including: production, health and welfare, indicators of fertility, milk composition, and milk processability measurements. Future experiments will evaluate the high-fibre, low-energy dry cow TMR diet, compared with the typical grass silage-based diet conventionally used in Ireland, and investigate the place of a lactating TMR diet as a buffer feed in higher stocked scenarios. These studies will incorporate comprehensive economic as well as biological evaluations.

Alternative forages

One strategy to reduce the cost of winter feeding for spring-calving dry cows is to utilise feeds that can be grazed *in situ*, thereby reducing both variable and fixed costs. Perennial ryegrass, the dominant forage on livestock farms, has limitations for out-of-season grazing. A variety of other crops, which can accumulate higher yields without a decline in feeding value, are available. These include fodder beet, swedes, kale and rape. The yield potential and feeding value of a range of these alternative crops, and the impact of their *in situ* utilisation on cow productivity, welfare and the environment, is being evaluated.

Which forage indoors for cows in early lactation?

Traditionally, in Ireland, grass silage has been the main forage fed to lactating dairy cows housed indoors during the winter. However, this is a very variable feed in terms of its fermentation quality, energy value and intake, and, consequently, there has been interest in utilising other forages produced on-farm in the early lactation period. Maize silage was the first alternative forage evaluated, but more recently there has been increased interest in conserved whole crop cereals. These were initially conserved either as a fermented or urea-treated whole crop feed and, in the last five to six years, the urea treatment process has been developed further where the grain is processed (cracked and/or milled) in the harvester before being mixed with an additive containing urea and urease enzyme at the clamp.

A three-year comparative evaluation of maize silage, fermented whole crop wheat silage, urea-treated processed whole crop wheat, and grass silage for autumn-calving dairy cows was completed last year. Grass silage alone was the control forage and the alternative forages were fed at 0.66 of the forage mixture with grass silage, all of which were offered *ad libitum*. Concentrate supplements were offered at the same level across the forage treatments. Total dry matter intake was increased by approximately 28% with fermented whole crop wheat and maize silage, and by approximately 45% with urea-treated processed whole crop wheat inclusion. Milk yield was increased from 28.3kg/cow daily on the grass silage to approximately 30.5kg/cow daily with both whole crop wheat inclusions, and to greater than 32kg/cow daily with maize silage inclusion. Also, milk protein concentration was increased by all the

alternative forages to greater than 31g/kg compared with less than 30g/kg for grass silage alone. The results obtained clearly indicate that the use of these alternative conserved forages in the indoor early lactation period results in greater dry matter intakes, greater milk yields and increased milk protein concentrations. Of the alternatives evaluated here, maize silage resulted in the best financial return over feed costs.

Grazed grass for autumn-calved cows

Conventionally, autumn-calved cows would be brought indoors following calving in September and October, and maintained on conserved forages and concentrates until turnout in spring. The use of grazed grass for early lactation autumn-calved cows in September, October and November, and again in early spring, is an issue of increasing importance because of the rising costs of conserved forages and particularly of concentrate ingredients. Predictions are that purchased concentrate feed will be €50 to €70/t more expensive this winter than last and, with increasing demand for the use of cereals and oilseeds for fuel production, feedstuffs may remain expensive into the future.

An ongoing systems study is quantifying the impact of four contrasting grassland systems of winter milk production using autumn-calving cows with differing grass varieties, stocking rates and winter forages. All cows calve and remain at grass until farm cover reaches approximately 650kg of DM/ha, usually in late November/early December. Cows are turned out to grass in spring depending on grass availability from late January. A new feeding study has been initiated this autumn to provide an answer to the question of the nutritive value of grazed grass for early lactation autumn-calved cows. Diets consisting of different allowances of grazed grass plus concentrates or TMR are being compared with a high quality indoor TMR diet in the autumn, and these treatments will be combined with two turnout dates to grazed grass in the spring.

Profitability and competitiveness

Winter feeding of the dairy herd represents a considerable economic burden for dairy producers, particularly given the climate of rising costs for fuel, cereals and oilseeds. The issues of interest will vary according to the production system practised, from the potential benefits of alternative forages for winter milk production to the relevance of dry cow TMR for spring-calving herds. The nutritional and physiological principles underlying potential improvements in productivity and health obtained from different feeding strategies are interesting from a basic science perspective, but the consequences of such systems for the profitability and competitiveness of the dairy enterprise must ultimately be evaluated. Research into winter feeding of dairy cows at Moorepark will continue to be important in order to provide information that will allow milk producers to feed their dry and early lactation cows optimally and economically. New concepts from elsewhere, as well as locally developed ideas and initiatives, will require refinement and adaptation to the Irish grass-based system of milk production.



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Beef suckler cow genotypes for grass-based systems

MARK MCGEE and MICHAEL DRENNAN, Teagasc Grange Beef Research Centre, outline the evolution of the Irish beef herd and the need to improve breeding selection strategies without negatively altering performance or carcass traits.

Beef suckler cow numbers have almost trebled in Ireland during the past 25 years and now make up approximately half of the national cow population (2.2 million in total). Simultaneously, an ever-increasing proportion of the genotype of both the dams and sires in the beef herd has come from late-maturing breeds such as Charolais, Limousin and Simmental. These changes have facilitated a dramatic increase in the proportion of our beef exports going to the higher-priced European markets. The scale of change means that over 40% of Irish beef exports now go to higher value markets in mainland Europe, where the quality specifications require lean carcasses of good conformation (i.e., a high proportion of meat in the carcass with a greater percentage in the high-value cuts).

Evolution of female breeding stock

Traditionally, the heifers selected as replacement breeding stock for the national beef suckler cow herd were the product of crosses of early-maturing British beef breed bulls and Friesian dairy cows. Progressively, bulls of later-maturing 'continental' breeds have predominated, and 90% of beef suckler cows are now bred to such sires. Thus, Charolais, Limousin and Simmental breeds currently comprise 40%, 30% and 7% of beef sires, respectively. The increased size of the national beef herd relative to the dairy cow herd has meant that proportionately fewer of the replacement breeding heifers have come from the dairy herd. This process has been accelerated by the dominance of Holstein genetics within the national dairy herd, since the progeny of these cows produce carcasses of lower beef value. An additional benefit for beef farmers that select their replacement heifers from within their own herd is the reduced risk of introducing disease. Such a breeding policy will inevitably result in the genotype of many beef cows being composed almost exclusively of continental beef breeds and, in some cases, of a single breed. For example, 167,000 Charolais crossbred cows were bred to Charolais sires in 2006. The benefits of beef suckler cow replacements from the dairy herd having late-maturing 'continental' breed rather than early-maturing British beef breed genetics were demonstrated at Grange in a comparison of Limousin x Friesian and Hereford x Friesian dams within a calf-to-beef production system. Cow feed intake, live weight, calving difficulty, reproductive performance and calf pre-weaning growth was similar, but the male progeny from the Limousin x Friesian had higher lifetime growth rates and better killing-out rates, resulting in leaner carcasses of heavier weight. Furthermore, the carcass produced was more suitable for the high volume, higher-priced mainland EU markets.

A subsequent study was designed to quantify the effect of increased retention of replacements from within the beef suckler herd by comparing upgraded Charolais (7/8 or greater) dams with beef x Holstein-Friesian dams. Although cow intake and calving difficulty were similar for both genotypes, replacement of the beef x Holstein-Friesian with the upgraded Charolais cow resulted in a reduction in the passive immunity of the calf (due to a lower colostrum immunoglobulin mass produced), a reduction in cow milk yield (due to the reduction in the proportion of dairy genetics in the cow) and, as a result, reduced calf weaning weight. While post-weaning growth did not differ between the genotypes, the progeny of the beef x Holstein-Friesian dams had heavier carcass weights (due to the greater pre-weaning gains). However, the proportion of meat in the carcass was higher for the progeny from the Charolais dams, indicating the better carcass quality of those with a greater amount of late-maturing breed genetics.

Replacement breeding strategies

As a consequence of this research, an evaluation of alternative breeding strategies was carried out over four years in order to facilitate beef farmers in making a more informed decision on the cow genotype most suitable for their particular circumstances. The genotypes compared were spring-calving, Limousin x Holstein-Friesian (LF), Limousin x (Limousin x Holstein-Friesian) (LLF), Limousin (L), Charolais (C) and Simmental x (Limousin x Holstein-Friesian) (SLF) dams and their progeny to slaughter as bulls at 16 months of age and heifers at 20 months of age. This experiment was designed to quantify the effects of, firstly, a stepped increase in the proportion of late-maturing 'continental' breeding in the dam (LF vs. LLF vs. L), secondly, purebred vs. crossbred (C, L vs. LF, LLF, SLF) dams, and thirdly, three-quarter 'continental' breed dams of contrasting genetic potential for milking ability (LLF vs. SLF) within the context of animal populations and breeding approaches in Ireland. The cows were bred to Limousin sires as heifers and Charolais sires subsequently. Thus, it is important to bear in mind that the proportion of continental genetics in all the progeny was 0.75 or greater. Results of the study are summarised in **Table 1**. The data demonstrate the superiority of crossbred dams with maternal (milk) traits in terms of producing progeny with a higher passive immune status, weaning weight and carcass produced per day of age. The advantages of heterosis or hybrid vigour (advantage to crossbreds over the average of the parent breeds) due to enhanced reproductive performance and lower calf mortality amounts to approximately 8% in terms of weight of calf weaned per cow, per annum. This would further favour the crossbred dam genotypes over the purebreds.

TABLE 1: Intake and performance of the cow genotypes and their heifer and bull progeny combined.

Variable	Dam genotype				
	LF	LLF	L	C	SLF
Cow					
Live weight (kg)	552	574	616	702	582
Intake – grass silage (kg DM/day)	8.3	7.8	7.0	8.7	9.2
Calving difficulty score (1–low to 5–high)	1.9	1.4	1.6	2.2	1.6
Milk yield (kg/day)	9.7	7.0	5.5	6.9	8.7
Progeny					
Calf immune status (serum IgG ₁ (mg/ml))	27.1	21.6	20.6	18.1	24.2
Daily gain (g)					
Birth to weaning	1,115	972	912	987	1,060
Weaning to slaughter	960	953	961	985	982
Birth to slaughter	1,014	950	931	969	1,004
Carcass per day of age	614	583	585	596	613
Feed conversion ratio (bull progeny) (Feed energy intake (UFV (I))/kg daily gain)	7.13	7.58	7.64	7.16	7.60
Killing-out proportion (g/kg)	554	562	571	559	558
Carcass conformation score (1–5) ¹	3.23	3.23	3.55	3.54	3.36
Carcass fat score (1–5) ²	2.88	2.81	2.52	2.46	2.83
Meat proportion in pistola (g/kg)	746	748	767	756	748

^{1,2} EU Beef Carcass Classification Scheme Scale: ¹ 1 (poorest) to 5 (best); ² 1 (leanest) to 5 (fattest).

While the purebred continental dams produced progeny with superior carcass traits, the current price differential paid by the meat processors for these carcasses is insufficient. An ongoing study at Grange examining the relationship between carcass classification grades and meat, fat and bone yield, and estimated carcass value, shows that current price differentials per unit increase in carcass conformation score (scale 1–5) should be about 2.5 times higher. Beef farmers require feedback from the market that is reflected in an appropriate pricing structure with adequate remuneration for superior product (high proportions of meat in the carcass with a greater percentage in the high-value cuts). In fact, the future economic viability of the beef suckler herd is dependent on a pricing structure reflecting carcass quality, similar to that in mainland EU markets.

Current research

As legislation limits organic nutrient input, many beef farmers are constrained in increasing beef output per hectare through increased stocking rates. Consequently, to increase the profit of their business, they must increase individual animal output and value and/or reduce the cost of producing that output.

Due to the low biological efficiency associated with producing one calf per cow per annum, the cow herd uses over three-quarters and two-thirds of the total energy requirement in calf-to-weaning and calf-to-beef production systems, respectively, with about two-thirds and half, respectively, of the total energy consumed going towards maintenance requirements of the cow component. As feed costs are a considerable proportion of the total costs of beef production, accordingly, beef breeding selection strategies need to focus on improving feed efficiency without negatively altering performance or carcass traits.

Traditionally, feed efficiency was expressed as the ratio of weight gain to feed intake (FCR) but selection for this measure leads to an increase in animal mature size and maintenance requirements. This has negative ramifications for the efficiency of both the cow and progeny but especially for the cow component, because of the proportionately higher costs associated with it. An alternative measure of feed efficiency is residual feed intake (RFI) or net feed efficiency. This is defined as the difference between an animal's actual energy intake and the calculated energy intake required for bodyweight maintenance and live-weight gain (negative or lower values desirable). This measure is independent of growth and maturity patterns and has moderate heritability. Therefore, it can be used to identify efficient sires and permit selection for feed-efficient animals without an increase in mature size.

The current beef suckler cow research programme at Grange is evaluating the concept of RFI through divergent selection for the trait. The objectives of the project are, firstly, to demonstrate the magnitude of the benefit for beef farmers; secondly, to determine some of the biological basis underlying the trait; and, thirdly, to identify any associated traits or markers. This will entail quantifying all inputs and outputs related to the cow and progeny within the context of a calf-to-beef production system. Detailed measurements will underpin this, involving intake, digestion, metabolism, growth, and physiological, immunological and molecular genetic components. These will be carried out in association with national and international collaborators. Preliminary results suggest that, within breed, the variation in phenotypic RFI for beef suckler cows and pedigree beef bulls is over 20%. In essence, this means that upon identifying the optimal beef suckler cow genotype for their production system, beef farmers should potentially be able to select for a cow and progeny with reduced feed intake for the same output, with associated environmental and economic benefits.

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Farm factors affecting SCC and TBC

Scientists from Teagasc Moorepark, along with colleagues in UCC and UCD, have been investigating the on-farm factors influencing milk SCC and TBC on Irish dairy farms.



Expanding global dairy markets and worldwide consumer preoccupation with food quality and safety continue to place more pressure on dairies to provide high quality milk and safe dairy products. While processing technology can address many product manufacturing problems, it cannot yet overcome the effects of high somatic cell count (SCC) or total bacteria count (TBC) in milk; thus, the responsibility reverts to the producer (farmer). Milk SCC records in Ireland increased at an annual rate of 5×10^3 cells/ml between 2000 and 2004 (Berry *et al.*, 2006). As a consequence of the tiered milk payment system in Ireland, which penalises farmers who have high milk SCC and TBC, this has economic repercussions for dairy farmers. Previous studies have related herd milk SCC to specific farm management practices, such as antibiotic treatment of clinical mastitis, post-milking teat disinfection and dry cow therapy (Barkema *et al.*, 1998). However, such a study has not been undertaken in Ireland, where, in contrast to most other countries, a spring milk production system exists.

Such an investigation is particularly important now due to new pressures from the necessary expansion of herds and the reality of reduced labour supply. There is a general consensus that the quality of milk with respect to SCC and TBC needs to be addressed immediately. Thus, the objective of this study was to identify the causative farm management factors of high milk SCC and TBC and to create an awareness of the findings for the producer population in particular.

Farm survey

In this study, annual milk supply data of farmers supplying milk to one major milk processor in Ireland were obtained. A random sample of farms

representing all farm sizes was selected. This sample of 398 farms was invited to participate in the study. Two questionnaire surveys were then conducted on these farms during the following year. The first survey was concerned mainly with milking management issues and consisted of 70 questions. This survey was completed by interview with the main milking operator during a visit to the farm between April and July 2006. The second survey was concerned mainly with winter housing management issues and consisted of 30 questions. This survey was completed during a second visit to the farm between January and March 2007. A record of the monthly test-day SCC and TBC data of each farm for the previous year (March 2005 to March 2006) was also obtained.

Farm system, milking facilities and practices

Of the 398 farms visited, 92% were engaged in spring milk production systems with an average herd size of 55 cows (range 12-293). The average milk volume supplied per farm was 248,052l (range 7,000-1,324,474l). The average annual bulk tank SCC was 275.4×10^3 /ml (range 82.2-773.0 $\times 10^3$ /ml). The average TBC was 20.2×10^3 /ml (range 10.4-130.5 $\times 10^3$ /ml). In late March, 91% of cows were outdoors by day, while 54% were outdoors by day and night.

There was a similar occurrence of side-by-side and herringbone milking parlours on farms in the study, with an average cow:unit ratio of 7. Milking liners were changed \geq once per year on 64% of farms, while a recommended vacuum level of 47-50kPa (for mid-level plants) was observed on 69% of farms.

Milking operators were utilising a range of teat preparation methods. In almost half of all herds, milking operators did not prepare cows for milking (teat

preparation) at any time of year, apart from strategic washing of a very dirty cow. Alternatively, only 1% of milking operators carried out full teat preparation (drawing foremilk, washing and drying of teats) at each milking throughout the lactation. Post-milking teat disinfection was conducted on 69% of farms after each milking. Almost all farms (96%) used dry cow therapy. Meanwhile, the practice of milk recording was conducted on 50% of farms.

Operating hygiene status of milking infrastructure

The cleanliness of the parlour and related milking facilities was classified and scored subjectively as clean, slightly dirty or dirty. Forty-three percent and 9% of farms were deemed to have clean and dirty milking parlour environments, respectively. The condition of the milking liners was described as good, slightly worn and worn on 81%, 12% and 7% of farms, respectively.

Winter accommodation facilities and cleaning practices

The winter housing facilities consisted of cubicles on the majority of farm holdings (81%), with a cubicle:cow ratio of ≥ 1 on 57% of farms. The main cubicle types were comprised of Newton Rigg, Super Comfort and Dutch cantilever, while bedding material consisted of lime on rubber mats (34%), mats only (20%), lime on concrete floor (17%), concrete floor only, and sawdust on mats (4%).

The cubicle house passageways were cleaned by mechanical scrapers on 55% of farms, and by tractor and scraper on 23% of farms. The mechanical scraper cleaned at more frequent intervals than the tractor and scraper, with which cleaning was conducted once and twice daily on 67% and 18% of farms, respectively.

Operating hygiene status of winter accommodation

The cubicle housing was described as clean on 85% of farms, while cubicle stands were described as clean and slightly dirty on 56% and 35% of farms, respectively. Cow udders, cow legs and cow tails were described as clean on 34%, 30% and 59% of farms, respectively.

Factors having a statistically significant effect on SCC

The practice of post-milking teat disinfection had a significant effect on milk SCC, with SCC levels decreasing with increased use of the disinfectant ($P < 0.05$). The use of dry cow therapy (antibiotics/teat seal) also reduced milk SCC ($P < 0.01$). Milk recorded herds also had significantly lower milk SCC ($P < 0.001$). A higher cleaning frequency of both winter house shed passageways and cubicle stands resulted in lower milk SCC ($P < 0.01$). Bedding material consisting of sawdust on mats was associated with significantly lower milk SCC than that consisting of concrete stand without any covering material ($P < 0.001$). The farms with the cleanest facilities recorded the lowest milk SCC ($P < 0.05$). Thus, the cleanliness of each of the specific instances of parlour, cluster, shed passageway, loafing area and cubicles was a significant factor in lowering milk SCC on farms.

Factors having a statistically significant effect on TBC

The presence of heated water in the parlour had a positive effect on TBC ($P < 0.001$). Increased frequency of liner changing resulted in reduced TBC ($P < 0.05$). The practice of post-milking teat disinfection resulted in significantly lower milk TBC ($P < 0.05$). Milk recorded herds also had significantly lower milk

TBC ($P < 0.001$). Increased frequency of tail clipping also reduced milk TBC values ($P < 0.001$). The overall hygiene of the milking and housing facilities significantly influenced milk TBC level ($P < 0.05$). Clean and dirty hygiene scores were associated with low and high TBC levels, respectively. Degree of cleanliness of cluster, shed, cubicles and loafing area all significantly influenced milk TBC levels.

Management possibilities

The above data present a description of facilities and work practices on farms. Additionally, they indicate the specific variables that significantly influence milk SCC and TBC levels. It is clear from the results that the practice of herd milk recording is a positive factor in reducing both SCC and TBC. Most of the remaining issues found to influence SCC and TBC are associated with the degree of physical hygiene that is attained within the system and the successful reduction of absolute and transferred levels of bacteria within the system.

Finally, further relevant issues arising from this study are: (i) the identified variables are similar to those found to influence SCC and TBC in studies reported from other countries – there are no new or different factors in the Irish context; and, (ii) all of the variables identified as significantly influencing SCC and TBC are management rather than technical issues that should be possible to address.

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The importance of diversity

Why is diversity in a plant species important?
SUSANNE BARTH, SARAH McGRATH, ANDREAS FRÖHLICH and TREVOR R. HODKINSON are looking at diversity from genetic, biochemical and morphological perspectives.

FIGURE 1: Plots in Oak Park, Carlow, with spaced plants of perennial ryegrass used in this study.



Diversity within and among plant species occurs at different levels, such as variation in anatomical and morphological attributes, variation in biochemical features and variation in adaptations to abiotic (caused in living organisms by non-living environmental factors) and biotic (caused in living organisms by other living organisms, e.g., bacteria or fungi) stresses. However, all these differences are ultimately caused by relatively simple molecular genetic changes in the DNA of those organisms. Thus, populations/collections of genetic variants can be viewed as genetic resources and can have considerable socioeconomic value.

In plant breeding, diversity is important for the selection of advantageous genotypes with superior performance. DNA is packaged into three genomes (nuclear, plastid and mitochondrial) in plants and there are complex interactions between each of these. Most DNA occurs in the nuclear genome, but the other two genomes exist in the cytoplasm. Changes in nucleotides cause nucleotide diversity (genotypic diversity) and this can (although not always) lead to changes in phenotypes (phenotypic diversity).

Breeding applications

At Oak Park, in association with our collaborators at Trinity College Dublin, we are interested in investigating diversity for present and future breeding applications in perennial ryegrass (*Lolium perenne*). In recent studies we have examined diversity in the plastid and nuclear DNA, in water-soluble carbohydrates (WSC), in proteins, and in a range of morphological traits. We have used breeding material from the Irish recommended list of ryegrass cultivars, ecotypes (sub-species that are especially adapted to a particular set of environmental conditions) collected from Ireland (Figure 1), widespread European varieties, and European ecotypes from a range of countries, such as Bulgaria, Hungary, Italy and Spain. The Irish ecotypes were selected from the Teagasc Oak Park collection, which holds 419 *L. perenne* accessions collected from old Irish pasture ecosystems (Connolly, 2000). This collection was made between the years 1980 and 1982 as part of the *Lolium* Core Collection Project, which was co-ordinated by the European Co-operative Programme for Genetic Resources (ECPGR). The populations originated from collection sites where, according to the farmer, no reseeding had been done for 50 years or more.

Plastid diversity: Irish germplasm is highly complex

Variation in the plastids/cytoplasm is important for plant breeding and it is not desirable to restrict the diversity of these genomes (lower the genetic base of the crop) because this may leave the crop vulnerable to diseases targeting the cytoplasm. An example is the US maize-breeding programme, where, in 1970, a fungal pathogen targeted the T-cytoplasm of maize leading to a breakdown in hybrid maize production. We have developed and used specific genetic markers targeted towards the chloroplast genome of perennial ryegrass and analysed populations for genetic variation. The genetic variants are called haplotypes. The cytoplasmic variation (as measured by plastid DNA markers) was extremely high in the Irish perennial ryegrass germplasm (see Figure 2), and thus the genetic base of the cytoplasm in the breeding collection (and wild populations) can be regarded as broad. This means that the populations or varieties bred from the breeding collection are likely to be less vulnerable to cytoplasmic diseases or fluctuations in other environmental stresses that may act on cytoplasmic DNA-related traits. Extinction of particular ryegrass genotypes due to such diseases or other environmental stresses can be regarded as less likely than in a scenario where little variation existed in those accessions. It is anticipated that this cytoplasmic diversity will be utilised further in future breeding applications at Oak Park.

Water-soluble carbohydrates

The amount and seasonal distribution of water-soluble carbohydrates (WSC) in *L. perenne* is an important factor influencing the digestibility and energy complex for animal feed. Thus, we considered variation in WSC to be an important trait for diversity studies. We looked at WSC over five cutting time points in a year and used high performance liquid chromatography (HPLC) to quantify the sugars, fructose and glucose that make up total WSC. Depending on the cut, some of the breeding varieties examined were high in WSC compared to the ecotype material. For the earlier seasonal cuts, however, some Irish accessions excelled in their WSC values, and these are being examined further for breeding work focusing on the improvement of feed quality.

Morphology

In general, grasses show a huge diversity in gross morphology, especially in non-reproductive traits. Several reproductive and vegetative traits are used as taxonomic descriptors for the characterisation of species. They are also used for distinctiveness, uniformity and stability (DUS) evaluations, which are an integral part of variety testing. Variability in both types of traits – reproductive and vegetative – within collections is essential to manipulate and improve these traits in plant breeding. For farmers, high yield of the vegetative plant is desirable with an extended growing season, but for the seed multiplier, and seed trade, only varieties with superior seed yield will be multiplied. Thus, an excellent forage variety requires a reasonable seed yield to be brought forward for the market, in addition to high vegetative yield potential.

We selected the following traits for our study: spring growth, late summer growth, date of ear emergence, height at ear emergence, length of the flag leaf at ear emergence, width of the flag leaf at ear emergence, height 30 days after ear emergence, rachis length, glume length, number of spikelets per spike, and number of florets per spikelet. We found surprisingly little variation within vegetative traits in 50 *Lolium* forage accessions, but a large extent of variation for seed yield components. Average values for the seed yield-related traits, such as rachis length, spikelets/spike, florets/spikelet and glume length, were highest mostly in diploid and tetraploid breeding varieties. Rachis length was significantly correlated to glume length, number of spikelets/spike and florets/spike. Highly significant regression models could be built for seed yield-related traits. A large amount of the variation in spikelets per spike was accounted for by the relationship with rachis length. Rachis length could be conveniently used as a predictor for reproductive performance. Generally, in the scores for traits like spring and late summer growth, the breeding varieties excelled, but ecotypes had considerable potential for the seed yield component-related traits.

Since selection and breeding has focused over the last 50 years on the improvement of vegetative growth, more progress has been made in manipulating biomass-related traits than improving seed yield. The results of this study are promising for efforts to improve seed yield in the future.

Exploiting genetic resources

Genetic resources are like a bank containing genes for the breeding of present and future traits. While we may not be interested in certain traits at present, requirements and priorities can change very quickly. Keeping germplasm in seed banks alive for the future, and documenting the germplasm and its properties, are thus important objectives.

This research was funded by Teagasc and the Irish Department of Agriculture, Fisheries and Food under the Genetic Resources for Food and Agriculture Scheme (2003 to 2007).

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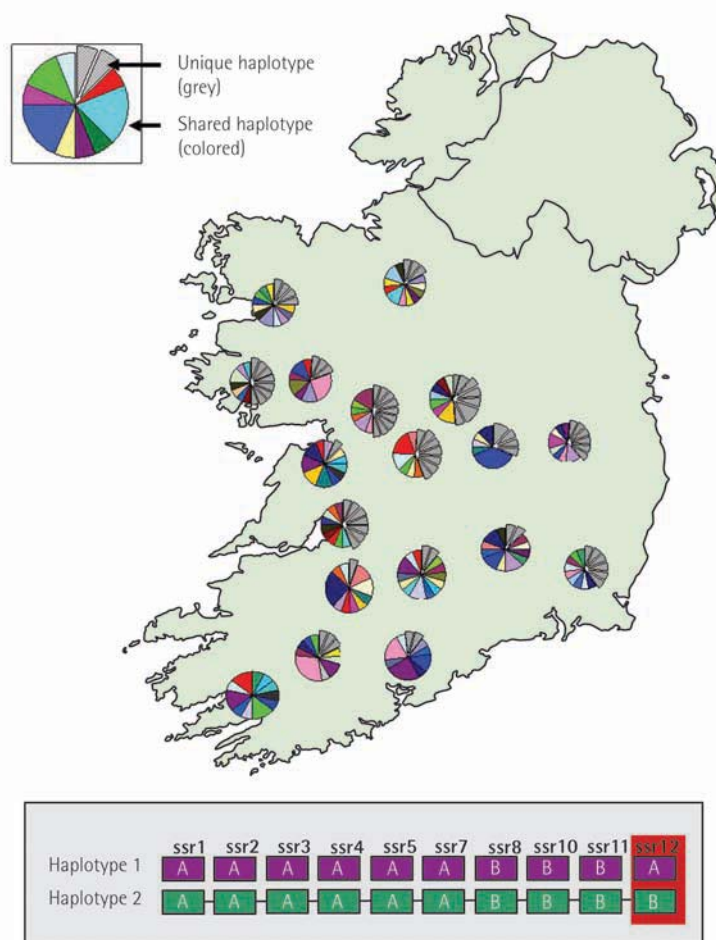


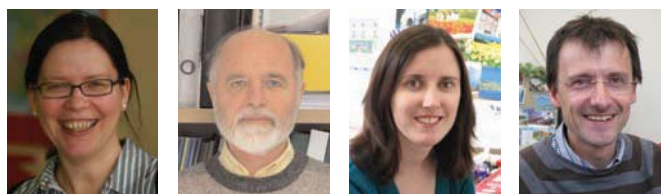
FIGURE 2: Complexity of haplotypes in Irish perennial ryegrass accessions. Extremely high levels of plastid DNA variation have been detected from the Irish accessions.

Dr Susanne Barth is a Research Officer in Teagasc Oak Park Crops Research Centre, working on grass genetics and genomics.

Dr Andreas Fröhlich is a Senior Research Officer in Teagasc Oak Park Crops Research Centre. Andreas was involved in the WSC evaluations and **Dr James Grant** (not pictured) from Teagasc Kinsealy was involved in the analysis of WSC data.

Sarah McGrath, a Walsh Fellowship student, worked on the project from 2004 to 2007. Several summer students have helped with practical work on different aspects of the project in recent years.

Dr Trevor Hodkinson is a Senior Lecturer at Trinity College Dublin with a special interest in phylogenetics and genetic resources.





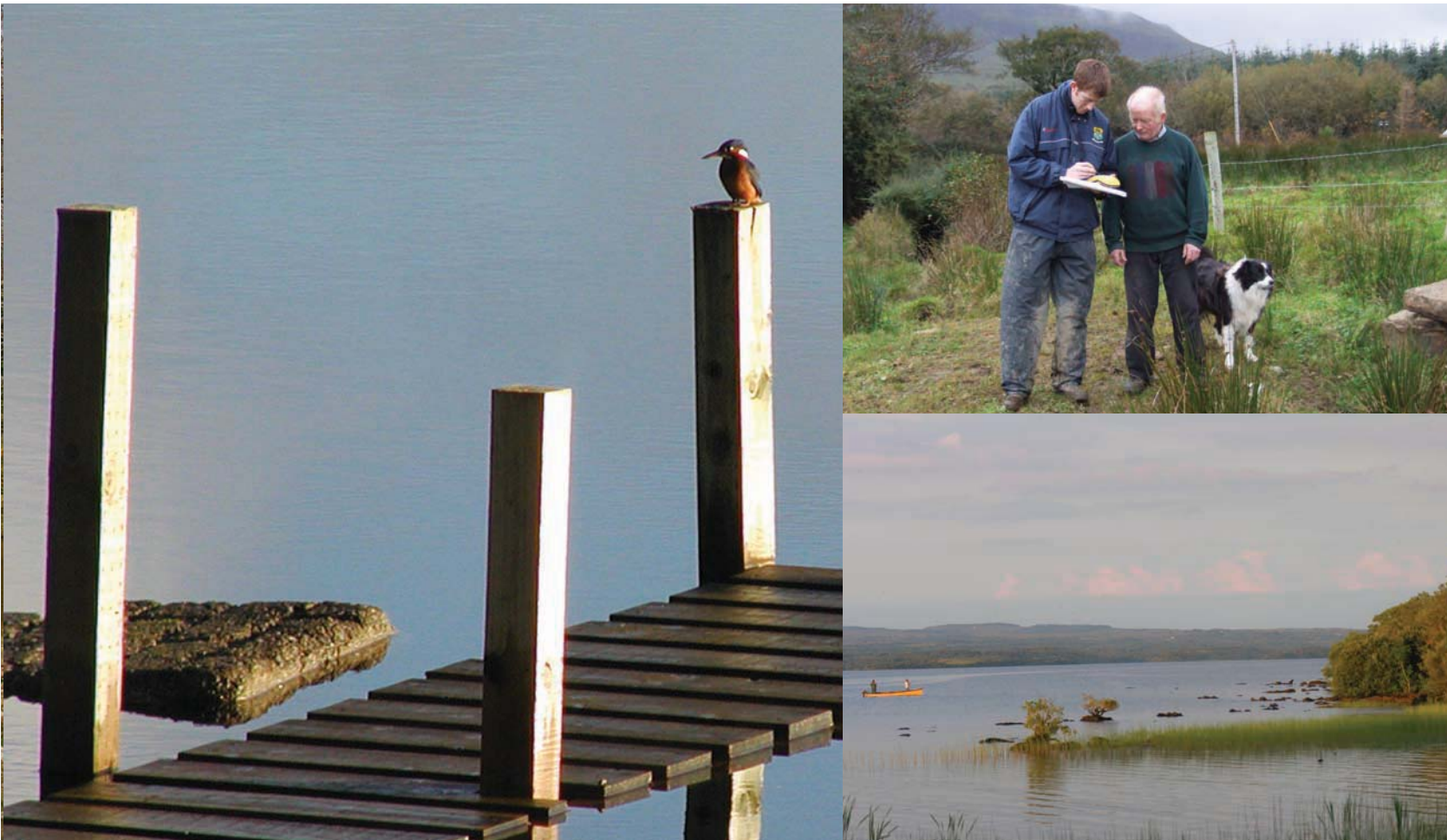
Lough Melvin: a participatory approach to protecting a unique habitat

DONNACHA DOODY, ROGIER SCHULTE, PAUL BYRNE and OWEN CARTON explain how a participatory approach can be used to develop agri-environmental measures that are more appealing to the farming community, while protecting a unique habitat.

Lough Melvin is one of Ireland's most ecologically valuable lakes, boasting a rich community of rare fish species. In recent years, however, water quality has deteriorated, leading to concerns about nutrient inputs from forestry, housing development and agriculture. Researchers at Teagasc Johnstown Castle are taking a participatory approach to the development of agri-environmental initiatives by involving farmers in the area in developing on-farm measures.

Lough Melvin – a unique aquatic habitat

Lough Melvin is located on the Leitrim/Fermanagh border and is unique among Irish lakes, supporting a fish community typical of a natural post-glacial salmonid lake, with three distinct and unique strains of brown trout, Atlantic salmon and the only remaining population of Arctic Char within Northern Ireland. Lough Melvin is a mesotrophic (medium nutrient status) lake, which has



been designated as a candidate Special Area of Conservation (SAC) under the EU Habitats Directive. The biodiversity of the fish population in the lake is recognised as being vulnerable to changes in water quality.

In recent years, however, Lough Melvin has become more enriched with phosphorus. Average total phosphorus concentrations increased from 19 to 29.5 μ /L between 1991 and 2001, raising concerns about potential eutrophication. It is unlikely that this nutrient enrichment originates from a single source, with each of the three main land uses in the catchment likely to be contributing some quantity of phosphorus to the lake, i.e., plantation forestry, agriculture and housing developments.

Towards an integrated catchment management plan

Last year, an EU INTERREG IIIA-funded project commenced involving the Northern Regional Fisheries Board, The Agri-Food and Biosciences Institute of Northern Ireland, Queen's University Belfast and Teagasc. Its aim is to develop an integrated catchment management plan (CMP) for the Lough Melvin catchment that will address the primary threats from each land use. Teagasc has the responsibility of developing a suite of agri-environmental measures to reduce phosphorus loss from agriculture in the catchment.

Due to the predominance of soils with severely impeded drainage, agriculture



Lough Melvin on the Leitrim/Fermanagh Border.

T Environment



in the Lough Melvin catchment generally operates at low intensities, with low phosphorus loads compared to more intensive catchments elsewhere. At the same time, the carrying capacity of the soils in this area is also low (1-1.5 livestock units per hectare), which means that the farming intensity in this context can be considered relatively high. The sensitivity of Lough Melvin is such that further increases in phosphorus loads are undesirable.

Participatory approach to developing agri-environmental measures

Traditionally, initiatives to improve nutrient management on farms have tended to focus on the needs of intensive farming and operate within a framework that will ensure optimum production, and are often not appropriate to catchments where stocking rates and soil phosphorus levels are relatively low. Hence, the aim of the agri-environmental strand of the project is to determine the most appropriate agri-environmental measures to reduce agriculture's contribution to phosphorus loss in catchments with wet soils, extensive agriculture and mesotrophic lakes.

During the winter of 2006/2007, a farm survey was conducted on selected farms in the catchment. The survey involved a detailed discussion with farmers on the management practices on the farm and on individual fields. With the aid of the

farmers, a field-by-field risk assessment was carried out to identify the main factors controlling phosphorus loss at field scale. In addition to informal discussions, farmers completed a questionnaire on agri-environmental schemes and measures. From the information collected during the survey, a preliminary list of agri-environmental measures is currently being developed. A subsequent farm survey in the winter of 2007/2008 will enable the list of preliminary measures to be assessed in order to determine their suitability for targeting high-risk areas for phosphorus loss in the catchment. Farmers will participate in the assessment of the preliminary list of measures to identify the practicalities and costs associated with implementing the measures at farm scale. Preliminary measures for consideration may include riparian (riverbank) zones, wetlands, willow beds and changes to existing manure management activities.

The value of participation

Farmers participating in the farm survey provided valuable insights into the difficulties associated with farming in the Lough Melvin catchment and why the implementation of measures sometimes fails due to farmers' values, traditions and perceptions. For example, the establishment of riparian zones in the catchment could help to decrease nutrient loss from agriculture. However, a review of 44 REPS plans from the catchment demonstrated that although



Images courtesy of Doris Ammann

riparian zones were offered as a supplementary measure in REPS, no farmer had selected this option. Farmers in the catchment suggested that riparian zones are viewed negatively as they restrict cattle access to water sources and are considered as "wasted land".

The community in the Lough Melvin catchment will play a major role in the successful implementation of the measures proposed in the CMP for forestry, housing developments and farming. To maximise the effectiveness of the agri-environmental measures proposed, farmers' opinions and knowledge need to be carefully considered and incorporated into the final suite of measures developed. However, for this approach to be effective, farmers must recognise the need for synergy between protecting their income and maintaining the good ecological status of the lake.

The Lough Melvin project has, with some success, taken a participatory approach to the development of agri-environmental measures and has highlighted the practical difficulties associated with implementing such processes. There is a need to develop effective strategies and methods for farmer participation so as to mainstream their involvement in the development of such measures. The successful integration of farmers into agri-environmental research will facilitate a broader acceptance of recommendations arising from such work in the future.

This project is funded by INTERREG IIIA, administered by the Environment and Heritage Service of Northern Ireland.

Dr Donnacha Doody formerly worked with Teagasc as Agri-Environmental Manager on The Lough Melvin Nutrient Reduction Programme. He currently works as Senior Scientific Officer with the Agri-Food and Biosciences Institute of Northern Ireland.

Dr Rogier Schulte is Head of the Agri-Environment Research Department and **Dr Owen Carton** is a Senior Principal Research Officer at Teagasc, Johnstown Castle.

Dr Paul Byrne is working for Teagasc as the Agri-Environmental Manager on the Lough Melvin Project, and is based at the Northern Regional Fisheries Offices in Ballyshannon, Co. Donegal.



Should we be glad we have fertile soils? A brief history of soil analysis in Ireland

BRIAN COULTER describes how a national programme of soil analysis and nutrient advice, introduced at Johnstown Castle almost 60 years ago, has had a dramatic effect on soil fertility.

In 1954, over 90% of soils had impoverished phosphorus (P) and potassium (K) status that would today be classed in the lowest category for P and K. Crop yields were very low and the unfavourable mineral composition of grass frequently led to health problems, such as aphosphorosis and trace element deficiencies in farm animals. A national programme of soil analysis and nutrient advice, introduced at Johnstown Castle in 1949, had a dramatic effect on soil fertility so that, even by 1960, the percentage of soils with poor P and K availability was dramatically reduced to less than 15%. On the other hand, one-quarter of our soils now have surplus P and K. These no longer need fertiliser to give optimum crop yields; however, nutrient runoff from such soils can have adverse effects on the environment.

After the Second World War, Irish agriculture was in a pretty poor state. Soils were infertile and acidic and, consequently, crop yields were very low. Animals suffered from a variety of health problems with many of the causes still unknown. Research was needed to help solve these problems, and the wrong solutions were often taken from experiences abroad. Two appointments were to have a major influence on the situation: the selection of Tom Walsh as Soils Advisory Officer in the Department of Agriculture in 1944 and that of James Dillon as Minister for Agriculture in 1948. In his first year, Walsh obtained funding, to start a soil testing service, which began in Ballyhaise, Co. Cavan initially, and then moved to Johnstown Castle, which had been acquired by the State in 1946.

The initial research involved ways to measure the lime requirement of soils, the improvement of grassland by reseeded and variety trials for different crops. All of these were concerned with the need for lime, nitrogen (N), P and K by crops, and this research was intimately associated with the soil testing service, which, at the time, was growing in strength and importance. In the beginning, knowledge of the concepts, units and, indeed, the interpretation of soil analysis results was largely confined to a small number of staff in the Department of Agriculture and the universities. However, information on the properties of various soils in different parts of the country and the fertility needs of

different crops was being built up. This was sent to agricultural officers periodically to enable them to interpret the results of soil analysis. In the late 1950s, information on soil analysis interpretation techniques was gathered together in a 30-page guide entitled 'Notes on Soil and Plant Sampling Analysis for the Guidance of Agricultural Officers'. These notes were very detailed and, indeed, complex and were in use until the first 'Guide to Soil and Plant Sampling and Analysis' was published in 1965 by An Foras Taluntais as a booklet for distribution to agricultural advisers. This was followed by further booklets and manuals and, in 2004, culminated in a comprehensive manual: 'Nutrient and Trace Element Advice for Grassland, Tillage, Vegetable and Fruit Crops', the so called 'Green Book'.

Development of methods

Soil acidity has long been recognised as an inhibitor of crop growth, and application of lime was advised to correct acidity problems. The optimum soil pH was known to depend on the crop; cereals and potatoes are tolerant of acidity, grass and clover preferred the soil to be closer to neutrality, and some root crops, particularly sugar beet, thrive in neutral or slightly alkaline soil. Initially, advice on the amount of lime to use to correct acidity problems was determined by the soil pH, with exchangeable calcium, organic matter and texture used as correction factors. Giving a lime recommendation based on these factors was quite complex and, since 1965, lime requirement advice has been based on an alkaline buffer method (SMP), which directly measures the lime needed to bring the soil to the required pH. Today, every soil sample is analysed for pH and the actual lime requirement for the crop is determined. From the earliest days at Johnstown Castle, the P and K status of soils was determined by extracting soil with Morgan's solution, as was proposed in the USA in the 1940s. In most other soil laboratories, this method has now been supplanted by other extractants. However, over the past 40 years, researchers at Johnstown Castle have investigated all the alternatives to find more accurate methods for determining the soil nutrients available to plant roots. Each time,

TABLE 1: Fertiliser application rates from 1958 converted to kg/hectare, assuming that the soil was at P & K Index 1.

	Pasture	Cereals	Potatoes	Beet
N	37	25-50	50-75	50-75
P	18	13	36	36
K	45	22	112	11

TABLE 2. Current fertiliser advice assuming that the soil was at N, P & K Index 1.

	Pasture*	Winter wheat	Potatoes	Beet
N	80-306	190	170	175
P	35-44	45	125	70
K	80-90	95	305	320

* The rates are shown for dairy systems at stocking rates ranging from about 1.7 to 2.5 LU/hectare.

the conclusions were that Morgan's extract was still best for most Irish soils. Indeed, recent experiments showed that it was also a particularly good environmental soil test. The units and the manner of reporting have changed though. Initially, there was a seven-point scale for lime, P and K nutrient levels. This was progressively reduced to a two-point reporting system, i.e., deficient-sufficient, and this was later modified to the present four-point index system for nutrients and trace elements. It uses break points for each element such that Index 1 will show a 'definite' response to fertiliser, Index 2 a 'likely' response, Index 3 an 'unlikely' or 'tenuous' response, and Index 4 'no response.' For most crops, application of P and K fertiliser is recommended to bring the nutrient level of soils to Index 3 and farmers are advised not to use any nutrient if the soil is at Index 4. No successful test has been found for soil N for grassland. For grassland, N advice is based on the stocking rate; for crops, the advice depends on prior cropping and manure applications to the soil.

Changes in fertiliser rates

The fertiliser advice levels for different crops have changed enormously over the years. **Table 1** shows nutrient advice given in the early days. Fertiliser trials were conducted on different soils to determine the optimum N, P and K for grassland and crops. Initially, stocking rates were low and clover supplied much of the N. As yields and productivity increased, the grassland and crops removed much more nutrients from the soil and more nutrients were required to replace them. Today's advice seeks to balance these removals with the fertiliser inputs, taking account of nutrients contained in organic manures produced by grazing animals. This has culminated in the advice given in the latest Teagasc nutrient advice manual (**Table 2**) and helps to achieve optimum grass and crop yields while ensuring that nutrients are not wasted or used to excess at the expense of the water quality.

Fertile soils vs. environmental effects

Sixty years ago, more than 90% of soils had P and K levels in the lowest fertility category. This has now given way to the present fertile era when only 15% of soils are deficient in P or K (**Figure 1**). Productivity has increased greatly and has moved farming from a subsistence level activity to a profitable one that produces large amounts of food for home consumption and export.

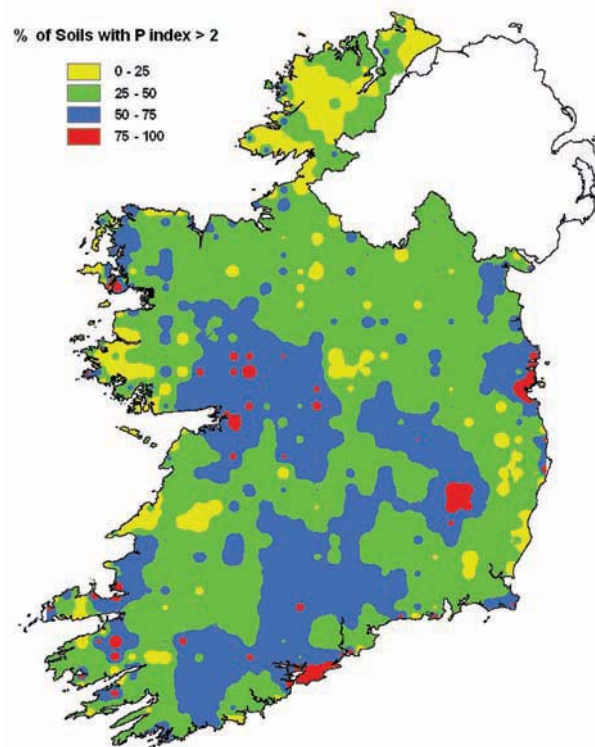


FIGURE 1: Proportion of soils with P Index 3 or 4.

Fertiliser recommendations from Johnstown Castle have always been based on a combination of agronomic and farm economic factors. Environmental protection is embodied in advice by advocating codes of good agricultural practice and, in particular, by taking account of nutrients in organic manures, and by recommending no more nutrients than are necessary to achieve optimum yields of crops. Of course, use of N and P is now controlled by legislation enacted under the European Nitrates Directive. This is based on the same principles, in order to ensure that percolation and runoff of nutrients from soils does not have adverse environmental effects on surface or ground water.

Returning finally to the question posed in the title: should we be glad? From the agronomic aspect, certainly we should for we can now achieve high crop yields even on difficult soils. We have now achieved a balance between agronomic needs and those of the environment. As a result of 50 years of soil fertility research, our new fertiliser advice achieves optimum production while at the same time protecting water quality.

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The subsidisation of Irish agriculture

LIAM CONNOLLY, Head of the Farm Surveys Department, Rural Economy Research Centre, takes a look at the effect of changes in CAP policy on Irish agricultural output.

The main components of farm gross output (GO) are: (i) sales of animals/animal products and crops; and, (ii) all non-capital subsidies, direct payments (DPs), premia and grants. In the Teagasc National Farm Survey, the principal measure of the income that arises from farming activities is called Family Farm Income (FFI). This is calculated by deducting all the farm costs (direct and overhead) from the value of farm GO, as defined above. DPs, therefore, contribute to farm output rather than income (which is a residual of output and costs) and annual changes in the magnitude of DPs should be expressed as a percentage of farm GO and not farm income. FFI represents the financial reward to all members of the family who work on the farm for their labour, management and investment. The increase in the contribution of DPs to gross agricultural output in the period 1990 to 2006 is shown in **Figure 1**. Prior to the 1992 CAP Reform, the major DPs were the headage payments in the disadvantaged areas of the country. Their purpose was to contribute to farm output, thereby supporting farm incomes where natural production conditions were least favourable, so as to conserve the countryside and prevent further depopulation. In addition, sheep and beef farmers were paid a ewe and a beef cow premium, respectively. However, while these DPs made an important contribution to output from the drystock systems of farming, their contribution to total farm GO nationally was only 8% in 1990.

CAP reform

The CAP Reform of 1992 introduced a new complement of DPs to compensate farmers for reduced market support for beef, sheep and cereals. These payments were structured to compensate for the phased reduction of EU intervention support/export refunds and were the first step by the EU in moving towards a market-led price system for meat and cereal products. Dairy farmers' output and

incomes continued to be supported through EU price support mechanisms, rather than DPs or subsidies and, as a result, these payments were not a major contributor to output on dairy farms until the Agenda 2000 CAP Reform.

Impact of EU policy shift

National Farm Survey data in **Figure 2** show the growth in DPs (€) for the average farm nationally over the period 1990 to 2006 and also as a percentage of farm GO. In 1990, total DPs amounted to approximately €2,200 per farm, or 8% of GO, and by 2006 this had increased to €16,400, or 33% of GO.

The impact of the EU policy shift from market support to subsidisation in the meat and cereal sectors is clearly evident in **Table 1**, with approximately 50% of farm output originating in DPs in the drystock sector from 2000 onwards, and 30% in the tillage sector, mainly confined to cereals. The data also show that specialist dairy farmers were obtaining sizeable DPs from 2000 onwards and, in 2006, these averaged €18,790 on specialist dairy farms compared to €12,347 and €16,118 on suckler cow and sheep farms, respectively. All the DPs shown for 2006 are decoupled, i.e., no longer linked to production and, on average, these payments contributed €16,346 per farm, or one-third of gross agricultural output nationally, with specialist dairy farms and tillage farms receiving the highest amounts of DPs.

In recent years, it has become common to express DPs as a percentage of FFI, even though this practice is questionable, based on the factors discussed in the first section of this article. The data shown in **Table 2**, therefore, should be interpreted with caution, as the logic of allocating total farm costs against market-based output is essentially incorrect, given the change in EU policy since 1990 towards subsidies rather than market price support for the main agricultural commodities. The main reason for expressing these payments as

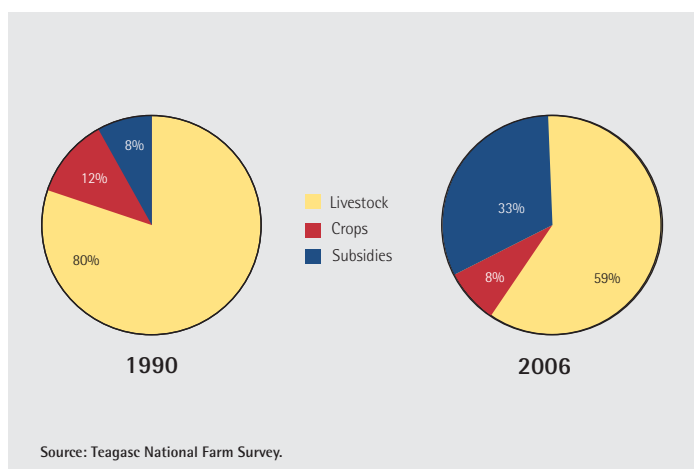


FIGURE 1: Composition of gross agricultural output 1990 and 2006.

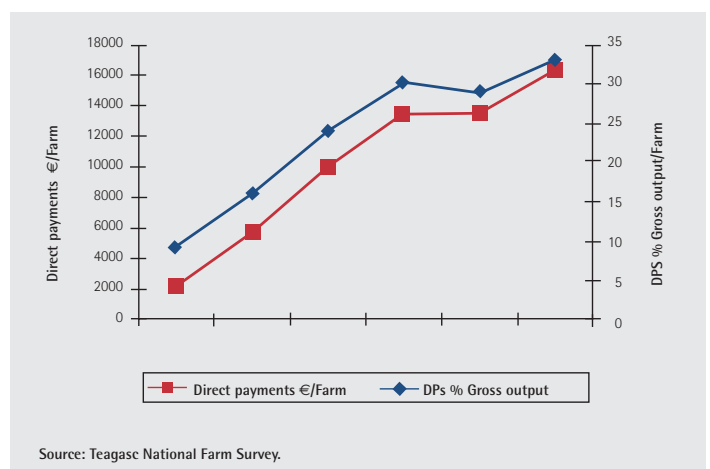


FIGURE 2: Average direct payments (DPs€/farm) on all farms and DPs as % of farm output (% GO/farm) 1990-2006.

TABLE 1: Direct payments (DPs) € per farm and as % of farm gross output (GO) 1990–2006 by farm system.

	Specialist dairying		Cattle rearing		Sheep		Tillage		All	
	DPs €	% GO	DPs €	% GO	DPs €	% GO	DPs €	% GO	DPs €	% GO
1990	572	1	1,537	16	5,880	38	1,814	2	2,209	8
1995	2,700	4	4,174	39	7,603	40	14,012	22	5,783	16
2000	5,561	7	9,202	48	11,317	48	21,938	24	9,931	24
2002	9,169	11	10,850	51	14,694	48	23,407	29	13,436	30
2004	10,702	11	10,152	47	15,017	48	22,087	27	13,549	29
2006	18,790	17	12,347	49	16,118	51	24,203	29	16,346	33

Source: Teagasc National Farm Survey.

TABLE 2: Direct payments (DPs) per farm and as % Family Farm Income (FFI) 1990–2006 by farm system.

	Specialist dairying		Cattle rearing		Sheep		Tillage		All	
	DPs €	% FFI	DPs €	% FFI	DPs €	% FFI	DPs €	% FFI	DPs €	% FFI
1990	572	3	1,537	50	5,880	89	1,814	11	2,209	26
1995	2,700	11	4,174	85	7,603	105	14,012	65	5,783	47
2000	5,561	20	9,202	130	11,317	130	21,938	79	9,931	74
2002	9,169	33	10,850	140	14,694	119	23,407	111	13,436	90
2004	10,702	31	10,152	139	15,017	137	22,087	92	13,549	87
2006	18,790	52	12,347	149	16,118	135	24,203	85	16,346	98

Source: Teagasc National Farm Survey.

TABLE 3: Amount (€) and composition (%) of direct payments/subsidies per farm 1995–2006.

	€/farm		
	1995	2000	2006
DPs/premia/ Single Farm Payment	4,528 (78%)	6,880 (69%)	11,172 (68%)
DAS	573 (10%)	1,109 (11%)	1,943 (12%)
REPS	250 (4%)	1,427 (14%)	2,857 (17%)
Misc. subsidies	432	515	374
Total	5,783	9,931	16,346

Source: Teagasc National Farm Survey.

percentage of farm income is to highlight the growing dependency of a large number of farmers on EU- and government-based subsidies and DPs. The data clearly shows the growing importance of DPs from 1995 onwards, especially in the drystock sector, where their contribution exceeded FFI by over 30% in most years since 2000, i.e., returns from the marketplace were not sufficient to cover total production costs. In 2006, market-based output from the cattle rearing system, which accounts for almost one-quarter of all farms in the country, was €12,828 per farm, while total production costs were €16,884, resulting in a loss from the marketplace of €4,056 per suckler farm. DPs as a percentage of FFI were also high in the tillage sector, at 111%, 92% and 85%, respectively, in 2002, 2004

and 2006. DPs contributed 52% to specialist dairy farmers' income in 2006, as the impact of the decoupled milk payments and an increase in REPS contributions came into effect. The 2006 data show tillage farms and dairy farms receiving the highest DPs, at €24,203 and €18,790 per farm, respectively.

Data in Table 3 show the total subsidies/DPs per farm from 1995 to 2006 and the change in the contribution arising from the Disadvantaged Areas Scheme (DAS), premia and Single Farm Payment, and also the Rural Environment Protection Scheme (REPS) payment. The average subsidy paid per farm nationally increased from €5,783 in 1995 to €16,346 in 2006. The percentage contribution of each category of DPs is shown in brackets, and shows that while the premia and Single Farm Payment category is the main contributor, the REPS contribution to the total has increased from 4% in 1995, to 14% in 2000 and 17% in 2006.

In conclusion, it is clear that the changes in CAP policy (which commenced with the 1992 CAP Reform) from a price and market support mechanism to DPs and environmental payments have resulted in market output per farm remaining static, while the contribution of subsidies to output has grown. This has resulted in the situation where DPs contributed 33% of GO per farm and 98% of average FFI in 2006.



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To thin or not to thin?

NIALL FARRELLY and STEPHEN HYNES investigate the impact of thinning on financial returns in farm forest plantations.

Many plantations planted in the late 1980s and 1990s are now coming to the age of first thinning. It is estimated that some 40,000 hectares of farm forest plantations have now reached or passed first thinning age. The decision whether or not to thin a plantation relies primarily on whether the operation will prove profitable, as it is based on the price attained for produce. The purpose of this research was to examine the effect of thinning on the financial returns of a farm forest plantation. The study used data from Teagasc Monitor forests and used yield model simulations to examine what differences, if any, thinning makes to crop growth and financial returns.

Growth data

Data from two unthinned farm forest plantations located in Co. Laois and Co. Galway were utilised in the study. Both plantations were planted in 1989 and were composed of pure Sitka spruce. Both plantations were on wet mineral gleyed soils showing highly productive yields in excess of 24m³/hectare/annum. Measurements of diameter distribution (diameter at breast height or DBH), stocking (number of trees per hectare), and top height (height of 100 largest diameter trees per hectare) for the plantations can be seen in **Table 1**.

TABLE 1: Growth data of the plantations used in the study.

Location	Age (years)	Yield class (m ³ /hectare/annum)	Mean DBH (cm)	No. of stems/hectare	Mean top height (m)	Basal area/ha (m ²)	Volume/hectare (m ³)	Rotation length (years)
Laois	17	24+	16.5	2,250	14	48.2	308	40
Galway	17	24+	17.8	2,188	15	54.5	375	36

TABLE 2: The final harvest volume (clearfell volume), thinning volume, total volume output and net present value of each stand for thinned and unthinned simulations in the study.

Site	Rotation length	Clearfell volume (m ³)/hectare	Thinning volume (m ³ /hectare)	Total volume output (m ³ /hectare)	NPV €/hectare
Laois unthinned	40	1,059	0	1,059	19,573
Laois thinned	40	670	470	1,140	22,254
Galway unthinned	36	1,035	0	1,035	21,889
Galway thinned	36	681	413	1,094	24,634



Stand projection models

Stand (growing trees) projection models called 'Growfor' (Figure 1) were available from COFORD (The Council for Forest Research and Development). These models require inputs of age, mean DBH, stocking and top height (Table 1) in order to calculate the predicted growth pattern of forest stands at various stages of the life cycle of a forest crop. For various age classes, the development of the forest stand is modelled. Outputs from the modelling process include percent mortality, diameter growth, volume production, and the volume assortments available from the crop. Using growth prediction data, the relative value of the crop at any age can be computed, using the volume assortments and the long-term average standing timber prices (Figure 2) to generate revenue comparisons of thinned and unthinned forest stands.

Net present value

To provide revenue comparisons for thinned and unthinned plantations, the economic method of 'net present value' (NPV) was calculated using the standard formulae:

$$NPV = \sum_{t=0}^n \frac{C_t}{(1+r)^t}$$

Where: C = revenue at each point in time,
 t = time period in which revenue is generated,
 n = the total time of the operation, and
 r = the discount rate.

The revenue generated, C, was discounted over t years, where t was the time of the thinning and/or rotation length. The NPV from timber sales at each thinning age and/or at the end of the rotation period were then summed. The discount rate used was 5%. All revenues were reduced by 15% to account for unproductive areas in forests.

Thinning

Rotation lengths of 40 years for the Laois site and 36 years for the Galway site were chosen as the age of final harvest. A thinning simulation was generated

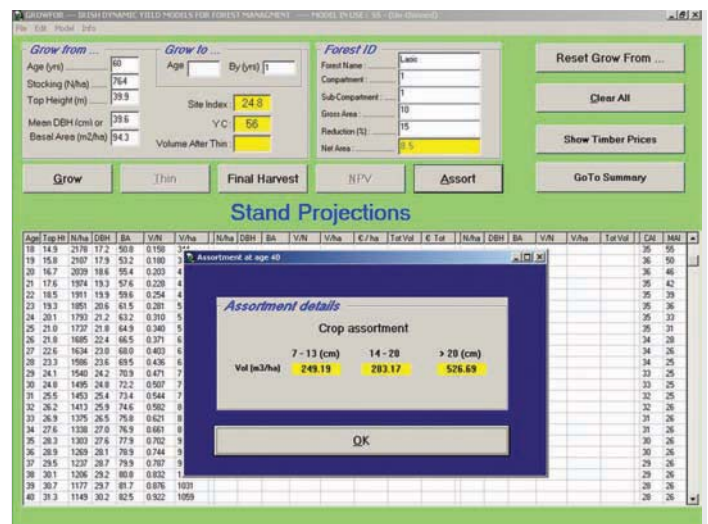


FIGURE 1: The stand projection model 'Growfor' has greatly facilitated the modelling of forest stand development.

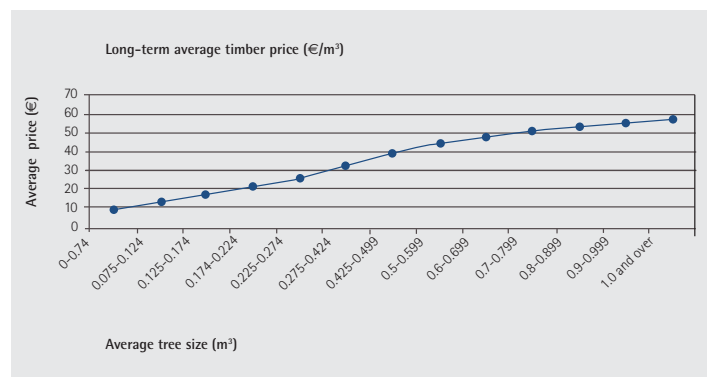


FIGURE 2: Long-term average timber prices for the last 15 years.

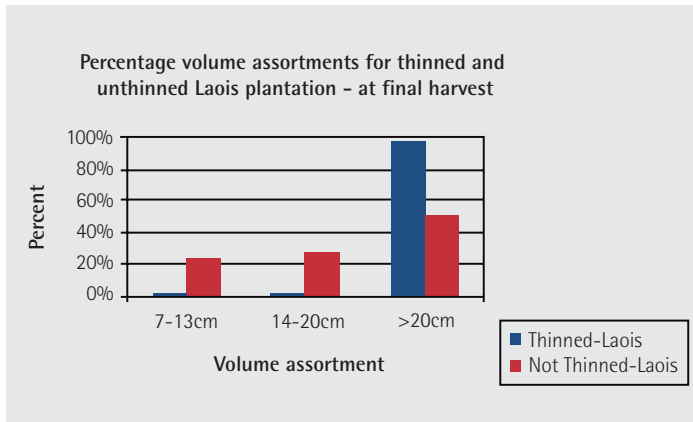


FIGURE 3: A comparison of volume assortments for the thinned versus unthinned Laois plantation at final harvest in the study.

using the growth models for both stands commencing at 17 years of age by removing 33% of the volume per hectare for both sites. For the Laois site, four subsequent thinnings were simulated, removing 92m³ at age 22, 27, 32 and 37 years, with final harvest taking place at 40 years. For the Galway site, a further three subsequent thinnings were applied, removing 98m³ at age 22, 27 and 32 years, with a final harvest taking place at 36 years. The total volumes removed in thinning simulations were 470m³ (Laois) and 418m³ (Galway).

A no thinning simulation was also simulated by growing the stands until 40 years (Laois) and 36 years (Galway) without removing any volume.

Impact of thinning

The model showed that thinning resulted in an increase in total volume production of between 5% and 7% compared to no thinning for the Galway and Laois sites, respectively. Comparisons of thinned and unthinned simulations are available in **Table 2**.

As smaller volume trees are removed during thinning, two effects are noticed. Firstly, the overall mean diameter of the thinned crop is increased and, secondly, the remaining trees are freed from competition and increase in size as a result of increased growing space. The average tree sizes for thinned stands are greater at final harvest compared to unthinned stands, with 98% of all the volume in the thinned stands greater than 20cm, compared to just 50% greater than 20cm in the unthinned stands. Thinning produces a greater amount of larger diameter trees (sawlog grade), which in turn generate more revenue. The unthinned stands produce a smaller proportion of sawlog grade material (50%), with an equal proportion of lower value pulp and pallet wood grade material (50%). The overall effect is that thinning operations produce more valuable trees, resulting in an increase in the NPV of both of the plantations examined. The NPV of the unthinned Laois plantation is €19,573 per hectare, compared with €22,254 for the thinned simulation (an increase of 12%). Similarly, the Galway site increases in value from €21,889 per hectare to €24,634 (an increase of 11%) with thinning.

Implications for plantation management

With an investment over a long period of time, such as forestry, it is



Most thinning in Ireland is carried out by harvesting machines.

important to maximise the revenue potential of the crop. Thinning will increase the value of the crop, as the average tree size is increased and there is a larger proportion of valuable sawlog produced over the rotation than in unthinned plantations. In addition, the value of the crop is released at periodic intervals over the crop rotation in thinning operations, giving periodic income generation, compared with the value of the crop being realised at a later stage in the no thinning scenario. Increases in revenue returns of between 11% and 12% associated with thinning have been demonstrated in this study. This research has demonstrated that, in order to maximise return on investment, farmers should consider thinning plantations to recommended levels rather than allowing plantations to remain unthinned. The exact rate of return is very dependent on timber prices at any moment in time, which can be subject to periodic price fluctuations that can subsequently result in lower returns. However, it must be stressed that other factors, such as the increase in wind risk associated with thinning, will play a key role in the overall profitability of thinning operations, and these are not addressed here. Further research is ongoing to see if thinning lower yielding plantations shows similar results.

This research is funded through Teagasc's forestry research programme.

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Science Events

November

11-18 November

Nationwide

Science Week

Part of Forfás' Discover Science & Engineering (DSE) initiative, the week aims to increase interest in science, technology, innovation and engineering among students, teachers and members of the public.

Teagasc Science Week events: catriona.boyle@teagasc.ie

Walsh Fellowships Seminar: debbie.murphy@teagasc.ie

www.scienceweek.ie

14 November

Teagasc, Kinsealy Research Centre, Dublin

Earth Observation Research in Ireland

Hosted by the Spatial Analysis Unit, RERC Teagasc. Earth observation (EO) and remote sensing research is a fragmented activity in Ireland. This symposium aims to bring together researchers in order to better comprehend the 'state of play' in Ireland and to foster future collaborations.

stuart.green@teagasc.ie

21-22 November

Kilkenny/Castlebar

Teagasc National Dairy Conferences

This year's theme is 'freedom to milk'. With the expectation of dairy quotas being phased out from 2009, an opportunity exists for Irish farmers to increase milk production. Grass-based milk production systems give Irish farmers a comparative advantage. A panel of national and international speakers will explore how farmers can best utilise their resources in this new business environment.

matt.ryan@teagasc.ie www.teagasc.ie

22 November

Moorepark Food Research Centre, Fermoy

Cheese Research Highlights 2000-2010

This workshop will review the outputs emanating from publicly-funded research with commercial application completed between 2000 and 2006, highlight the progress of ongoing cheese-related projects, and discuss the future market opportunities for the cheese industry. It will cover a wide range of topics, including: cheese flavour, cultures, diversification, secondary cheese processing, manufacturing, and the addition of functional ingredients to cheese products.

Tel: 025-42321/42247

info@relay.teagasc.ie www.relayresearch.ie

28 November

NUI Galway

Commercial Opportunity for Seaweed, Plant and Other Bioactive Components in Beverages

This workshop will highlight the scientific research being conducted on functional beverages by Irish research institutes and universities. Research is underway on the benefits of seaweed and plant extracts, milk hydrolysates and oligosaccharides, and the milk fat globule membrane of buttermilk. A number of these projects are near completion, with outcomes that are ready to be exploited by industry.

info@relay.teagasc.ie www.relayresearch.ie

December

11 December

Tullamore Court Hotel, Tullamore, Co. Offaly

Economic Review and Outlook

Covering beef (Liam Dunne), dairy (Thia Hennessy), tillage (James Breen) and sheep (Ann Kinsella), speakers will give figures for 2006 and 2007, and the outlook for 2008. Liam Connolly will present National Farm Survey results for 2006 and CSO estimates for agriculture incomes for 2007. He will also present the results of a survey of farmer investments for 2007 and plans for 2008.

anne.kinsella@teagasc.ie

2008

February

6-7 February

Teagasc Ashtown Food Research Centre

Lean Techniques in the Food Industry

Implementing lean techniques in a food company can help to address the increasing challenges faced by food processors such as: rising energy prices; waste disposal costs; and, international competition. This workshop is presented in conjunction with HOSCA, which has many years of experience in training and consultancy in lean manufacturing across all sectors of industry, including the food sector.

Tel: 01-8059536 aine.sommerfield@teagasc.ie

12 February

Tullamore Court Hotel, Tullamore, Co. Offaly

Bioenergy Conference 2008

barry.caslin@teagasc.ie

22 February

Clayton Hotel, Galway

National Rural Development Conference

cathal.odonoghue@teagasc.ie ger.shortle@teagasc.ie

March

12-13 March

Tullamore Court Hotel, Tullamore, Co. Offaly

Agricultural Research Forum

The objective of the meeting is to provide an opportunity for the presentation and publication of new scientific information relating to agricultural science (including animal and crop science, molecular biology and biotechnology), environmental and soil science, food science, agri-economics and forestry. The forum provides an opportunity for scientists, specialists, advisors and others working in the above areas to interact and exchange views.

Deadline for papers: December 10, 2007

michael.diskin@teagasc.ie www.agresearchforum.com

August

24 -27 August

University College Cork

International Agricultural Biotechnology Conference

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.

www.abic.ca/abic2008.htm