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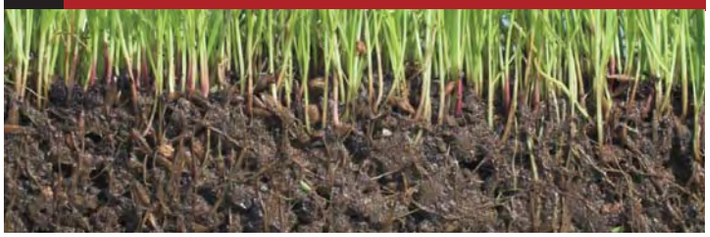

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T Editorial

The Innovation Taskforce and the agri-food sector

Taoiseach Brian Cowen announced in June of this year the appointment of an Innovation Taskforce to advise the Government on its strategy for positioning Ireland as an international innovation hub and to assist in making the "smart economy" a reality. The taskforce is to advise the Government on options to increase innovation and entrepreneurship, and to ensure that investment in science, technology and research translates into high-value jobs and sustainable economic growth.

In a submission to the taskforce, Teagasc makes a case for continuing investment in the applied research and technology transfer capabilities needed to enable Ireland to develop its indigenous agri-food sector and wider bio-economy as a core element of a smart economy. Existing STI policies have reduced the status of, and investment in, applied research in the agri-food sector at a time when the national priority is necessarily focused on emerging basic and strategic research. The innovation needs of many of our smaller indigenous enterprises in the agri-food sector can only be delivered by applied research and technology transfer, supported by applied scientists and technologists with an intimate knowledge of existing technology and markets. The maintenance of strong public research supports for the sector, combined with measures to enhance the internal innovation capability of food companies, are prerequisites for ensuring that our principal indigenous industry has a significant place in the smart economy of the future.

Teagasc has a long and successful history of promoting innovation in the agri-food sector and ensuring the transformation of knowledge into value for the benefit of the sector. The creation, for example, of Moorepark Technology Ltd. (MTL) is widely viewed as a successful model in ensuring that investment in food research is quickly translated into economic benefits. Moreover, our agricultural advisory service has over the years pioneered many new and innovative approaches to technology transfer and has assisted our farming industry to enhance its productivity levels, while meeting more stringent consumer food demands and complying with a broad range of legislative requirements.

Dr Lance O'Brien
Head of Teagasc Foresight Unit

An Tascfhórsa Nuálaíochta agus an earnáil agraibhia

I mí Lúil na bliana seo d'fhógair an Taoiseach Brian Ó Comhain ceapachán Tascfhórsa Nuálaíochta chun comhairle a chur ar an Rialtas ar a straitéis chun Éire a ullmhú mar mhol nuálaíochta idirnáisiúnta agus chun cabhrú le "Geilleagar Cliste" a bhaint amach. Cuirfidh an tascfhórsa comhairle ar an Rialtas i ndáil le roghanna chun nuálaíocht agus fiontraíocht a mhéadú agus lena chinntiú go mbeidh poist ardluacha agus fás eacnamaíoch inbhuanaithe mar thoradh ar infheistíocht in eolaíocht, teicneolaíocht agus taighde.

In aighneacht chuig an tascfhórsa, ardaíonn Teagasc cás d'infheistíocht leanúnach sna cumais aistrithe taighde agus teicneolaíochta feidhmigh a bhfuil gá leo chun cur ar chumas na hÉireann a hearnáil agraibhia dúchasach agus a bhith-gheilleagar níos leithne a fhorbairt mar chuid lárnach de gheilleagar cliste. Tá stádas, agus infheistíocht i dtaighde feidhmeach na hearnála agraibhia laghdaithe ag polasaithe STI atá ann cheana ag am ina bhfuil an tosaíocht náisiúnta dírithe go riachtanach ar thaighde bunúsach agus straitéiseach atá ag teacht chun cinn. Ní féidir riachtanais nuálaíochta iliomad na fiontraíochtaí dúchasacha níos lú san earnáil agraibhia a sheachadadh ach amháin trí aistriú taighde agus teicneolaíochta feidhmeach, arna tacú ag eolaithe agus teicneolaithe feidhmeacha a bhfuil dlúthfheasacht acu ar theicneolaíocht agus ar mhargaí atá ann cheana. Tá cothabháil na dtacaíochtaí taighde poiblí láidre don earnáil, mar aon le bearta chun cumas nuálaíochta inmheánach na gcuideachtaí bia a fheabhsú, ina réamhchoinníollacha lena chinntiú go bhfuil áit shuntasach ag ár bpríomhthionscal dúchasach i nGeilleagar Cliste na todhchaí. Tá stair fhada agus rathúil ag Teagasc maidir le nuálaíocht san earnáil agraibhia a chur chun cinn agus a chinntiú go n-aistrítear feasacht isteach ina luach chun tairbhe na hearnála. Breathnaítear go forleathan ar chruthú Moorepark Technologh Ltd. (MTL) mar shamhail rathúil a chinntíonn go n-aistrítear go tapa infheistíocht i dtaighde bia isteach ina dtairbhí eacnamaíocha. Sa bhreis ar sin, bhí ár seirbhís chomhairleach thalamhaíochta ina ceannródaí thar na mblianta ag cur chuigí nua agus nuálaíochta agus chabhraigh sí lenar dtionscal feirmeoireachta a leibhéil tháirgiúlachta a fheabhsú, agus í ag freastal ar éileamh bia tomhaltóra níos déine agus ag cloí le réimse leathan riachtanas reachtúla.

An Dr. Lance O'Brien
Ceannaire Aonad

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T News

Teagasc activity highlights – July to September 2009

The following are some highlights of Teagasc activities and initiatives in the period July 1 to September 30 aimed at supporting science-based innovation in the agri-food sector:

- 57 new refereed papers and 176 other articles were published by Teagasc researchers and their collaborators.
- The first ever Irish Rural Studies Symposium was hosted by Teagasc's Rural Economy Research Centre in Athenry on September 1. The event brought together Irish, UK and Polish researchers examining the impacts of contemporary and longer-term social and economic trends on farm households and rural communities. They presented the results of their work to an audience of about 100 participants. The key themes were the role of innovation in supporting rural development, artisan food products as a primary resource supporting the development of farm enterprises, and the potential of social farming.
- A major international dairy company with a track record in the production and marketing of functional foods has initiated a project at Moorepark Food Research Centre (MFRC) in the area of probiotics, which involves the placement of a company researcher at the research centre for a two-year period.
- Scientists at the Moorepark Dairy Production Research Centre are part of a new INTERREG project – DAIRYMAN. This is a collaborative project between ten research and development partners in North West Europe. The objective is to improve the economic and environmental performances of dairy farming by demonstrating best practices on one research farm and on a network of 10 to 20 commercial dairy farms in each region.
- A scientist at MFRC was awarded an Enterprise Ireland Commercialisation Fund 2009 Proof of Concept grant for a proposal with the acronym KINTRAP. This process exploits natural energy to reduce the production costs of creating new functional ingredients.

Teagasc appoints new Director of Research

Dr Frank O'Mara has been appointed as Teagasc's Director of Research. As part of its change programme, Teagasc is combining food and agriculture research to create a single research directorate, which will be led by Dr O'Mara. Combining the agriculture and food research directorates places Teagasc in the unique position of being one of the few organisations in the world that can examine the whole food chain, from animal nutrition and agriculture, to food processing and production, through to consumer health and nutrition. Dr O'Mara will lead Teagasc's research programme into its next phase of development, working in partnership with the advisory and education functions, the farming, food and bioindustries, the third-level sector, and other state support organisations and international partners. This will ensure that Teagasc is positioned as a scientific leader in the strategic areas of food and agriculture science. Having completed his PhD at Teagasc Moorepark, Dr O'Mara worked in UCD for a number of years, before rejoining Teagasc as Assistant Director of Agriculture Research in 2006, and has been Acting Director of Agriculture Research since March 2009. He was recently elected President of the Agricultural Science Association.

First prize at soil conference

Congratulations to Órlaith Ní Choncubhair (left) and Dominika Krol, who received first prize for poster presentations at the recent international soil quality conference 'Soil Quality = Environmental Quality', organised jointly by the British Soil Science Society and the Soil Science Society of Ireland, and hosted by Johnstown Castle. Órlaith and Dominika presented on greenhouse gas emissions and land use change, based on their lysimeter study on the effect of ploughing techniques and associated CO_2 and N_2O losses. Órlaith and Dominika are Teagasc Walsh Fellowship students at University College Dublin and Trinity College Dublin, respectively, and are supervised by Dr Gary Lanigan at Teagasc, Johnstown Castle. Their studies are part of a research project funded by the Research Stimulus Fund, administered by the Department of Agriculture, Fisheries and Food.

Highly accessed paper

A paper by Teagasc Moorepark Food Research Centre, the Alimentary Pharmabiotic Centre, Cork, Ireland, and University College Cork researchers has been designated as 'highly accessed' by BioMedCentral. The paper was published online in *BMC Microbiology* on March 5, 2009, and can be accessed at: http://www.biomedcentral.com/1471-2180/9/50. The paper is: **O'Sullivan, O., O'Callaghan, J., Sangrador-Vegas, A., McAuliffe, O., Slattery, L., Kaleta, P., Callanan, M., Fitzgerald, G.F., Ross, R.P.** and **Beresford, T.** 'Comparative genomics of lactic acid bacteria reveals a niche-specific gene set' (*BMC Microbiology*, 9: 50 [05 Mar 2009])

AVTRW win

Aran O'Loughlin, a Teagasc Walsh Fellow at Teagasc Grange Beef Research Centre, was awarded the best postgraduate poster at the Association for Veterinary Teaching and Research Work (AVTRW) scientific meeting recently. Aran is under the supervision of Dr Bernadette Earley, Teagasc Grange, and Dr Sean Doyle, NUI Maynooth. The title of Aran's poster was: 'Impact of weaning strategy on haematological variables of beef calves'.

Science Week

Science Week 2009 takes place from November 8 to 15. Teagasc will support Discover Science and Engineering's goal of "promoting the relevance of science, engineering and technology in our everyday lives and to demonstrate just how important it is to the future development of Irish society and the economy" by holding a number of events at centres around the country. Teagasc research centres at Ashtown, Athenry, Grange and Moorepark and Kildalton College will hold open days for local schools. Oak Park Crops Research Centre will host BSc students from Carlow IT. Researchers from Ashtown will also give a public lecture at a local library. The theme of this year's annual Walsh Fellowships seminar (November 11 at the RDS) is the scheme's contribution to innovation in the agri-food sector. This reflects Teagasc's mission of supporting " ... science-based innovation in the agri-food sector". It provides a unique opportunity for the fellows, Teagasc and third-level partners to showcase the knowledge outputs and potential impacts of the scheme within this nationally important sector. Ms Damini Kumar of NUI Maynooth and Ireland's ambassador for the "European Year of Creativity and Innovation" is guest speaker.

Alimentary Glycoscience Research Cluster

The Alimentary Glycoscience Research Cluster (AGRC) was launched at NUI Galway recently by Conor Lenihan, TD, Minister for Science, Technology and Innovation. AGRC is an NUI Galway-led collaboration of research institutions (including Teagasc) and industry partners, and was established following a grant earlier this year of €5.2m from Government through Science Foundation Ireland (SFI). Teagasc's involvement at MFRC, led by Dr Rita Hickey and Dr Raj Mehra, is to identify milk oligosaccharides from human and domestic animal milk, which can induce reprogramming of the epithelial cell glycome, and also to optimise extraction, fractionation and enrichment of glycan-containing fractions from colostrum and milk. MFRC's glycoscience programme began in 2005, when a project to exploit the beneficial health properties of milk oligosaccharides was initiated with the support of Dairy Levy funding. Additional support from the Food Institutional Research Measure (FIRM) was awarded in 2006 to Dr Mehra, for the development of bioactive oligosaccharide-enriched ingredients derived from whey. Glycoscience topics are also prioritised in the Teagasc Vision programme. This existing knowledge offers the food and dairy industry a range of leading edge technologies to support glyco-ingredient development.

APC to lead superbug fight

Thuricin CD, a new antibiotic agent that specifically targets the hospital 'superbug' *Clostridium difficile*, and developed and patented jointly by UCC and Teagasc, has been licensed to Alimentary Health, a spin-out from the Alimentary Pharmabiotic Centre (APC) in Cork. Thuricin CD kills *C. difficile* but not the beneficial bacteria in the intestines, and was discovered by scientists at the APC, a research centre based in University College Cork and Teagasc. Teagasc researchers involved in this technology include Professor Paul Ross and Dr Mary Rea from Moorepark Food Research Centre.

Looking to the sea for foods for health

Pictured at the recent NutraMara industry day are (from left): John O'Doherty, UCD; Nigel Brunton; and, Maria Hayes, AFRC. NutraMara is a marine functional foods joint research initiative, led by AFRC and funded by the Marine Institute and the Department of Agriculture, Fisheries and Food. Launched in April 2008, the initiative is led by Declan Troy, Teagasc Ashtown, and involves collaboration of up to 30 scientists working in Teagasc Moorepark Food Research Centre, University College Cork, University College Dublin, NUI Galway, University of Limerick, and the University of Ulster. NutraMara aims to identify novel marine food ingredients and products, allowing Ireland to become players in what is already a multi-billion dollar worldwide market for functional foods.

MFRC *Listeria* conference

Listeria monocytogenes is a food-borne pathogen that causes listeriosis and is of considerable public health concern. Organised by Dr Kieran Jordan at Moorepark Food Research Centre, the national conference on *L. monocytogenes* featured guest speakers Dr Paul Neaves from the UK and Professor Martin Wagner from Austria. The key message from the conference was that, due to its widespread occurrence in nature, learning to control *L. monocytogenes* is essential.

At the MFRC Conference on Listeria are: Triona Hunt; Dr Kieran Jordan (organiser); Martina O'Brien; Professor Martin Wagner; Sol Schvartzman; and, Ed Fox (presenters).

T News

Head of food industry development

Teagasc has appointed Pat Daly as Head of Food Industry Development. Pat is responsible for providing overall leadership for a new Teagasc food industry development programme, which is being delivered by a team of food scientists and technologists working from the Teagasc food research centres at Ashtown in Dublin and Moorepark in Cork. This programme provides direct technology development support for the food processing industry through programmes in product development contract research, training, consultancy, marketing and information services. This programme will help to ensure early transfer to industry of knowledge and technologies generated from an extensive food research programme at Teagasc.

Wellcome Trust scholarship

Simon Faulkner of the Animal Bioscience Centre, Athenry, has been successful in obtaining a Wellcome Trust scholarship to participate in a Wellcome Trust Advanced Course, Proteomics Bioinformatics, at the European Bioinformatics Institute at Hinxton, Cambridge, in November. The week long course, worth €1,800, includes guest lectures by leading European scientists, and will focus on mass spectrometry, sequence databases, ontologies, IntAct, Reactome and Interpro protein databases, protein 3-D structure and pathway analysis. Simon began his Walsh Fellowship with Teagasc in September 2008 and is supervised by Dr Dermot Morris, Athenry, and Professor Mike Dunn, Conway Institute, UCD. His project is entitled 'The effect of stage of cycle and steroid environment on the uterine proteome of the cow and differences from plasma'.

Potato genome sequence released

The Potato Genome Sequencing Consortium (PGSC), an international team of researchers including scientists from Teagasc, has announced that it has released the first draft sequence of the potato genome.

Potato, a key member of the *Solanaceae* family, is a close relative of tomato, pepper, and eggplant. It is the world's third most important crop and the most important vegetable crop. Access to the potato genome sequence, the "genetic blueprint" of how a potato plant grows and reproduces, is anticipated to assist scientists in improving yield, quality, nutritional value and disease resistance of potato varieties. More importantly, the potato genome sequence will permit potato breeders to reduce the 10-12 years currently needed to breed new varieties. Teagasc's contribution to the project was carried out at the Crops Research Centre, Oak Park, Carlow.

International forage legume conference

Pictured in Cork at the Teagasc International Conference 'Forage legumes in temperate pasture based systems', are: speakers Richard Dewhurst, Animal Bioscience Centre, Grange; Dave Barry, Goldcrop; Derek Woodfield, AgResearch Ltd, New Zealand; Stewart Ledgard, AgResearch Ltd, New Zealand; Alistair Black, Teagasc Grange; and, James Humphreys, Teagasc Moorepark (Head of the Organising Committee). The proceedings of this conference will appear in a special conference issue of the peer-reviewed Irish Journal of Agricultural and Food Research *(Volume 48, No. 2, 2009) on www.teagasc.ie.*

BPS service launched at AFRC

Blown pack spoilage (BPS) represents a major cost for the Irish beef industry. Meat spoiled in this way has no commercial value and blown pack spoilage represents a considerable loss to meat processors in monetary terms. Recent research at Teagasc Ashtown Food Research Centre (AFRC) discovered a new Clostridial species capable of causing BPS that was more common in Irish abattoirs and spoiled meat more rapidly than previously known BPS agents. The results of a detailed analysis of this new bacterium are due for publication in the *Journal of Systematic and Evolutionary Microbiology*. An RT-PCR assay was developed and patented., which is essential to test to assure product quality, validate in-plant decontamination activities and investigate the cause/source when a BPS incidence occurs, thereby facilitating control and the prevention of the major financial losses incurred by the meat industry as a result of BPS. This technology is in great demand and was recently transferred to the Irish meat industry as a BPS Clostridia testing service (T-bio) based in AFRC, which has already developed a considerable client base. For further information contact Dr Declan Bolton (declan.bolton@teagasc.ie).

APC key role in the smart economy

Pictured at the launch of phase 2 of the Alimentary Pharmabiotic Centre (APC) at University College Cork and Teagasc are (from left): Professor Fergus Shanahan, Director, Alimentary Pharmabiotic Centre; Dr Michael Murphy, President, UCC; Mr Conor Lenihan, TD, Minister for Science, Technology and Innovation; and, Professor Paul Ross, Head of Food Research at Teagasc. Minister Lenihan said that the APC is playing a very important role in exploring commercial opportunities in both the pharma and food sectors here, and this emerging area offers enormous possibilities in the future for Ireland.

Head of the new Animal Production and Grassland Research Centre

Dr Pat Dillon has been appointed as Head of the new Animal Production and Grassland Research Centre. As part of its change programme, Teagasc is bringing all its ruminant animal and grassland research programmes into a single centre to create a powerful unit with the critical mass to deliver significant benefit to the Irish agri-food sector and to be internationally competitive in scientific terms. This new Centre will encompass the work being carried out at existing locations at Moorepark, Grange, Athenry and the Animal Bioscience Department, as well as the grass breeding programme currently located at Oak Park. Dr Dillon will play a key role in establishing the centre and providing leadership, strategic management and direction, ensuring integration in the research programme across the different sites, and building effective linkage between the animal bioscience and applied research programmes.

Researcher profile

Susanne Barth

Susanne Barth is a plant geneticist at the Teagasc Crops Research Centre, Oak Park, Carlow, where her research focuses on forage and grass species with an emphasis on perennial ryegrass (*Lolium perenne*), white clover and Miscanthus.

Her current projects include: developing advanced technologies and resources for conventional and '-omics'-based white clover breeding strategies (with Dr Dan Milbourne); elucidating abiotic stress tolerance in perennial ryegrass; developing sustainable low-input fodder and energy maize production systems for temperate conditions; genomics of the biomass crop Miscanthus; organelle genomics of perennial ryegrass, and baseline studies into self-incompatibility in perennial ryegrass and white clover. Her work is funded in part by the Department of Agriculture, Fisheries and Food.

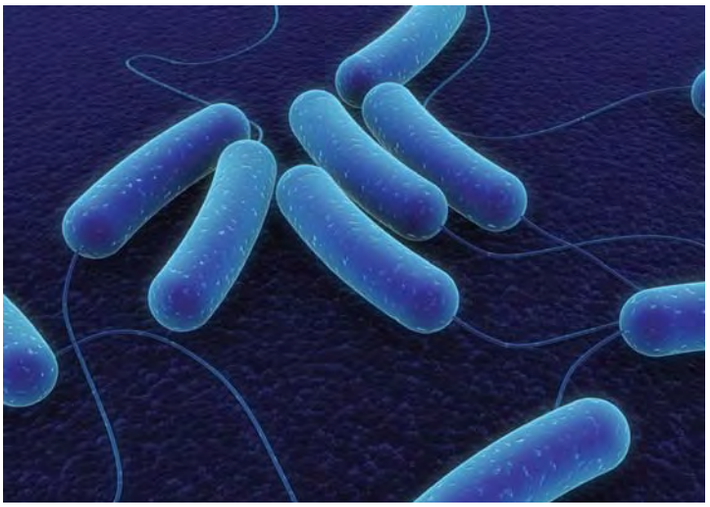
Originally from Auerbach in Germany, Susanne is married with one child. Her interest in agricultural sciences stems from a childhood spent on her parents' farm in Northern Bavaria. Completing a thesis in crop agronomy led to an interest in the genetic variability of the plant species *Chenopodium quinoa* (a pseudocereal plant species used for gluten-free nutrition of patients with coeliac disease), and this thesis focused her career path on plant genetics and breeding. After studying Agricultural Sciences, majoring in plant sciences, at the University Hohenheim and Technical University Munich Weihenstephan, Susanne obtained her PhD in 2001 from the Institute of Plant Breeding at the University of Hohenheim on 'Studies on the variability of recombination frequencies in *Arabidopsis thaliana* L. Heynh'. Susanne is an experienced supervisor who works with a large number of graduate students and one postdoctoral researcher. She is an editor of *Annals of Botany* (2009-2012), a board member of the EUCARPIA (European Plant Breeders Association) 'forage crops and amenity grasses section', a member of the forage working group of ECPGR (European Cooperative Programme for Plant Genetic Resources), ELFIN (European Lolium and Festuca Initiative), COST 851 (EU programme), the Irish Cytometry Society, GPZ (German Plant Breeding Society), and the German Genetics Society. She served as referee for numerous peer refereed journals and grant agencies. She is the author of more than 20 refereed publications in scientific journals, including *Plant Biotechnology Journal*, *New Phytologist*, and *Plant Molecular Biology*.

New member appointed to Teagasc Authority

Marie Christie has been appointed to the Teagasc Authority for a five-year term by the Minister for Agriculture, Fisheries and Food, Brendan Smith, TD. Marie fills the staff representative seat vacated by Stephen Flynn, who completed a five-year term on the Authority in June.

International pathogenic *Escherichia coli* conference

Two Teagasc researchers, DECLAN BOLTON and GERALDINE DUFFY, presented their findings at a recent international conference on *E. coli* in AFRC.



E. coli *are the predominant facultative organisms in the human gastrointestinal tract.*

Teagasc–Ashtown Food Research Centre (AFRC) recently hosted a two-day international conference on food safety entitled: 'The Control and Management of Pathogenic *Escherichia coli* '. This was the fifth and final international conference on pathogenic *E. coli* that formed the European Framework Coordination Action "Pathogenic *E. coli* Network" project, a multinational project co-ordinated by Dr Declan Bolton (AFRC) and involving 40 leading international research institutions from several different countries including most European countries, Canada, the United States of America, the Middle East, South America, Africa, Australia and New Zealand.

E. coli are the predominant facultative organisms in the human gastrointestinal tract. While most are harmless, some are pathogenic, and these *E. coli* can cause a variety of diarrhoeal diseases because of the presence of specific colonisation factors, virulence factors and pathogenicity-associated genes, which are generally not present in other *E. coli*. Of the strains that cause diarrhoeal diseases, six pathotypes are now recognised. Of particular significance are the verocytotoxigenic *E. coli* (VTEC). VTEC infection occurs via the faecal–oral route and results in symptoms ranging from mild uncomplicated diarrhoea to severe bloody diarrhoea. Complications including haemolytic uraemic syndrome (HUS) and thrombotic thrombocytopenic purpura (TTP) can occur in some cases, both of which can result in death.

Ruminant animals, in particular cattle, are the main reservoir for VTEC. Beef has historically been most linked to VTEC infections; however, a wide variety of other sources have been implicated in infection, including unpasteurised milk and fruit juice, sprouts, lettuce, spinach, cantaloupe, cheese, mushrooms, sprouts and salami. Water-borne transmission occurs through swimming in contaminated lakes or pools, or drinking untreated water. Direct contact with animal faecal material through recreational activities, and person-to-person contact, are also sources of infection.

The Conference was opened by Brendan Smith, TD, Minister for Agriculture, Fisheries and Food, with a welcome address by the Director of Teagasc, Professor Gerry Boyle, and the 211 delegates heard presentations on the current state of the art in pathogenic *E. coli* epidemiology, probiotics and vaccine technologies. Clinical aspects including virulence factors, their expression in the human host and therapeutic innovation were also discussed. Among the 23 international speakers, the latest Teagasc advances in VTEC research were presented by Dr Declan Bolton, who presented on the serotypes and virulence gene profiles of Irish farm and abattoir VTEC, and Dr Geraldine Duffy, who presented on novel biocontrol agents for the control of VTEC in the beef chain.

Virulence of VTEC in Ireland

Over 380 different VTEC O:H serotypes have been isolated from humans with gastrointestinal disease worldwide. However, most clinical infection in humans is associated with O157:H7, O111:H-, O26:H-, O103:H2, O145:H- and O145:H28. A minority of sporadic cases have also been attributed to O113:H21, O91:H-, O146:H21 and O128:H2.

The ability to cause disease is associated with the presence of a range of virulence factors, including those encoding verotoxins (*vt1*, *vt2* and variants). Haemorrhagic colitis (HC) and HUS are generally associated with VTEC types that have the capacity to produce attaching and effacing (A/E) lesions on intestinal mucosa, a property mediated by the *eae* gene for intimin. Other enterocyte effacement (LEE) proteins involved in the formation of A/E lesions include Tir (*tir*) and the Esps (*espA*, *espB* and *espD*), which code for a type III secretion system. However, the production of intimin is not essential for pathogenesis and a minority of sporadic cases of HUS have been caused by *eae*-negative non-O157 strains, such as O104:H21 (USA) and O113:H21 (Australia). In recent years, as more *eae*-negative VTEC strains were reported, several proteins have been proposed as novel adhesion factors, including SAA (an autoagglutinating adhesin) and LPF (a long polar fimbriae). The *saa* gene was originally isolated from an *eae*-negative O113:H21 VTEC strain, but is also present in other serotypes including O91:H21. Other virulence factors include haemolysin (*hlyA*), serine protease (*espP*), catalase peroxidase (*katP*) and a type II secretion system coded by *etpD*.

Irish abattoir study

In this study, 20 beef farms from around the country and three beef abattoirs

Pictured at the conference in Dublin are (from left): Dr Geraldine Duffy, AFRC; Professor Gerry Boyle, Director of Teagasc; Declan Troy, Head of AFRC; Brendan Smith, TD, Minister for Agriculture, Fisheries and Food; and, Declan Bolton, AFRC.

were sampled every two months over the course of one year. An increase in VTEC isolation was observed during the summer months on the farm, where 24 different VTEC serotypes were detected, with O113:H4 being the most prevalent. O157, O111 and O103 were not obtained. Of those detected, O26:H11, O145:H28, O2:H27, O13:H2, O150:H2 and ONT:H27 carried *vt1* and/or *vt2* and *eaeA* and were therefore potentially clinically significant. ONT:H27, ONT:H4, ONT:H18, O20:H19 and O86:H21 carried the *saa* gene while O145:H28, ONT:H4, O20:H19, O109:H5 and O119:H5 had the *lpfA* gene. Both *vt1* and *vt2* were represented among 16 different serotypes with vt_{2d} being the most common variant of the latter.

In the abattoir, 12 different serotypes were obtained with O128:H8 being the most prevalent. O157, O111, O145 and O103 were not detected. O5:H-, O13:H2, O150:H2 and O26:H11 had *vt1* and/or *vt2* and *eaeA* and were therefore potentially clinically significant. ONT:H11, O33:H11 and O128:H8 had the *saa* gene, while O138:H48 had the *lpfA* gene. Both *vt1* and *vt2* were present in 10 different serotypes with vt_{2d} again being the most common variant of the latter.

Overall, 18% of VTEC isolates had the *eaeA* gene, considerably higher than previously reported but lower than the 17/20 *eaeA*-positive *E. coli* O157:H7 reported in a related Irish bovine study. However, the presence of a broad range of non-O157 VTEC serotypes carrying the genes required for pathogenesis in humans is a cause for concern and this study strongly suggested that VTEC O26:H11 will emerge as a serious threat to public health in the future.

Biocontrol agents to control VTEC in the beef chain

Healthy ruminants, particularly cattle, can harbour *E. coli* O157:H7 and other VTEC in their gastrointestinal tract and can shed the organism in their faeces. Risk assessments have reported that contamination from the hide and/or faeces onto the carcass can occur during slaughtering and processing. Reducing the risk of contamination and transfer of VTEC from animals to food can reduce the risk of infection. The development of intervention strategies to control these food-borne pathogens in the food chain is therefore a growing area of research. In this study, a selection of biocontrol agents, namely: caseicin A and B, which are casein-derived antimicrobial peptides (AMPs) generated by *Lactobacillus acidophilus* DPC6026; essential oil components – thymol and carvacrol (the most active components of thyme essential oil); and, two anti-O157 bacteriophages – e4/1c and e11/12 – against VTEC was tested in a model broth system under different environmental conditions. In addition, the ability of selected agents to reduce *E. coli* O157:H7 in a model rumen system was also determined.

All biocontrol agents tested inhibited *E. coli* O157:H7 and/or other VTEC in a model broth system; however, their ability to inhibit or kill *E. coli* O157:H7 varied between the agents and in different environmental conditions tested. Although caseicin A inhibited *E. coli* O157:H7 in a broth system, it was ineffective at reducing the pathogen in some environmental conditions (for example, 4°C) and in a model rumen system. The AMPs used in the study were in a purified powder, which is costly to synthesise in large amounts and is not ideal for use in further application in its current form. Inhibitors in the rumen system such as proteases may have impeded the antimicrobial activity of the AMPs in this system. Further studies are required to determine whether another format of the AMP could be used in application. In contrast, carvacrol had a strong antimicrobial activity against *E. coli* O157:H7 and other VTEC in the model broth system in all environmental conditions tested. In addition, carvacrol was also effective at reducing *E. coli* O157:H7 in the model rumen system; however, the concentrations needed to inhibit *E. coli* O157:H7 also inhibited other bacterial species involved in rumen fermentation, which can cause detrimental effects in animal production. There is a potential to use carvacrol in beef products and in animal production, but further research is required to determine an appropriate concentration that would not hinder fermentation and perhaps could be used in combination with other antimicrobials. The O157-specific bacteriophages e11/12 and e4/1c were stable in a range of environmental conditions and were also effective at reducing *E. coli* O157:H7 in a model rumen system. The phages did not affect rumen fermentation, suggesting a potential use in further animal application. Results from this study are promising and suggest that all of the biocontrol agents have a potential for further application in the biocontrol of *E. coli* O157:H7 at key stages of the beef chain, but further study is required to fully optimise the use of these agents.

Further information on this and all of the conference presentations, including the 60 posters, can be found at www.pen-europe.eu.

The Pathogenic Escherichia coli *Network Project is funded by the European Commission under the Sixth Framework Programme.*

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Teagasc research supports the farmhouse cheese industry

Researchers at Moorepark Food Research Centre have been helping the farmhouse cheese sector to support improved production and safety standards.

Photo courtesy of Bord Bia

Farmhouse cheese production began in Ireland in the 1970s, when it was as much a lifestyle choice as a business opportunity. Since then the sector has grown to be a very important part of the image of Ireland as 'The Food Island'. In order to ensure the sustainability of the speciality cheese sector, research on topics relevant to the producer is essential.

Currently, there are about 60 farmhouse cheese manufacturers in Ireland, producing about 1,250 tonnes of cheese with a value of about €9 million. The varieties manufactured include those made from pasteurised and unpasteurised milk, hard, semi-hard, soft, semi-soft and blue cheeses from cow, sheep and goat milk. Cáis, the Association of Irish Farmhouse Cheesemakers, represents most of these producers, who manufacture on a small scale using milk from one or a limited number of sources.

Interest in farmhouse cheese production is growing, with an increased number of enquiries to Teagasc for training and advice in the last few years. As we import over 18,000 tonnes of cheese per annum and the export market for cheese is growing in Asia and beyond, growth in this sector has good potential.

The need for research

Producers are generally small family-run units, providing local employment in rural areas. They do not have the resources (in terms of time or money) or expertise to undertake the research needed for development. To date, little research has been carried out. Some was undertaken with individual producers and some on the development of continental varieties; however, little or no research has been undertaken on the safety of indigenous varieties.

Research undertaken

To address these issues a national project team, which included research partners from Teagasc, Ashtown and Moorepark Food Research Centres (AFRC and MFRC) and the Food Safety Authority of Ireland (FSAI), was established. Funded by projects supported by the National Development Plan under the Food Institutional Research Measure (FIRM) programme, and by an EU Sixth Framework project, BIOTRACER, the objective of this research was to provide scientific data on the microbiological and compositional status of cheeses and environments, and to support improved production/safety standards in the farmhouse cheese sector.

To achieve this, the project team monitored the compositional and microbiological quality and anti-parasitic drug residue status of 15 cheeses from different farmhouse cheese manufacturers by sampling cheeses, raw materials (milk, brine, water) and cheesemaking environments (food contact and non-food contact surfaces) on a monthly basis throughout the year. Analyses included enrichment and direct detection of *Listeria monocytogenes*, detection of *Staphylococcus aureus*, *Escherichia coli*, coliforms, and total bacterial counts in relevant samples, and determination of pH, percentage salt and moisture in cheeses.

Cheese results

The data indicated a relatively low level of contamination in the cheeses (**Table 1**). Where problems were identified, the project team worked with the producers to eliminate them.

There are no regulations with regard to the levels of anti-parasitic drug residues in cheese. The work in this part of the project was undertaken to establish if a problem exists and to act as a baseline. Of the 351 cheeses tested, 97% were free of all residues tested. Low levels (four times less than the permitted level in milk) of albendazole and moxidectin residues were found in two cheeses and, again, working with the producer, the problem was identified and corrective action recommended. However, taking the concentration effect of cheesemaking into account, the levels were very low in the original milk.

Cheese quality indicators including pH, salt and moisture are not regulated, but their values are very helpful for the cheese manufacturer and can be used to produce consistently good quality cheese over the entire season.

Environmental sampling results

Table 2 summarises the sample results (% samples free from issues) for the main pathogens, residues and quality indicators tested from environmental samples. Where milk was positive for *L. monocytogenes*, further milk samples and the cheese manufactured from the milk were analysed. *L. monocytogenes*-positive milks were always sporadic and all of the cheeses made from that milk were negative.

Of the milk samples tested, 96% were free of all residues. Low levels (20 times less than the permitted level) of moxidectin were found in five milk samples and this was not considered an issue.

Regulation

In accordance with Article 3 of Regulation (EC) 2073 of 2005 on microbiological criteria for foodstuffs, there is an onus on farmhouse cheesemakers to ensure that the food safety criteria laid down in the regulation are met under reasonably foreseeable conditions. These regulations, along with other regulations applying to the sector, are complex and difficult to interpret. Unlike larger cheese manufacturers, who have the capacity to absorb these costs into overheads and management costs, farmhouse cheesemakers do not have the expertise or resources to achieve this. Therefore, a considerable amount of support has been given to farmhouse cheesemakers to explain the regulations in understandable terms and to clearly explain how they are applied.

Focus on *Listeria monocytogenes*

From a food safety perspective, the organism of greatest concern is *L. monocytogenes*, which causes listeriosis in vulnerable populations (elderly, young, immunocompromised and pregnant) and has a mortality rate of about 30%. For this reason, our research has focused on identifying the source of *L. monocytogenes*, monitoring its occurrence in the environment and understanding its growth. It is generally accepted that elimination of *L. monocytogenes* is not possible and therefore control measures are essential. It was not surprising that in the farm environment, 19% of samples (faeces, water, feed, etc.) were found positive for *L. monocytogenes*, and it was shown that improved farm hygiene could reduce its occurrence. Further isolates of *L. monocytogenes* were obtained from the cheese processing environment. Based on the results of the farm survey, it is not surprising that isolates of *L. monocytogenes* were obtained from 13 of the facilities tested. These were mainly from the processing environment (drains, walls, etc.), although a few were from cheese. Of the 351 cheeses tested, 94% were free from *L. monocytogenes*. Where *L. monocytogenes* was found, additional sampling of the environment post cleaning was undertaken to ensure its removal, and where it was found in milk the cheese made from that milk was sampled to ensure its absence. Using pulsed field gel electrophoresis (PFGE), the strains isolated were compared in order to identify the source of the contamination. In 70% of the facilities where *L. monocytogenes* was found, the farm was identified as the source. This shows the importance of control measures.

Control and risk management

This work shows the importance of environmental sampling in pre-empting problems with *L. monocytogenes*, and shows that improved farm hygiene can contribute to reduced process environment contamination and, therefore, a reduced risk of product contamination. Barriers from farm to processing environment, care in handling raw milk and sterilising areas of spillage are essential as part of a hygiene programme.

During this work, a database of genetic profiles for each strain isolated was generated using PFGE. This will contribute to a database of strains from other foods and clinical sources to facilitate epidemiological studies on the source of strains, and to study strain diversity and persistence.

Table 1: Percentage of cheese samples below the maximum allowable limits for food pathogens.

Free from *L. monocytogenes* (%)	Free from *E. coli* (%)	Free from *S. aureus* (%)
94	100	96

Table 2: Percentage of samples within the limits for pathogens and residues.

	S. aureus	*E. coli*/ *coliform*	*L. monocytogenes*	Total bacterial count	Residues
Milk	97	-	92	98	100
Water	-	96	-	-	-
Brine	91	-	99	-	-
Food contact	-	90	-	-	-
Environment	-	-	85	-	-

Future

The data obtained will be used to draw up hygiene and process guidelines for the entire speciality dairy sector and this will be incorporated into a HACCP workbook specifically for farmhouse cheesemakers. This is currently under development by the FSAI and Teagasc, in conjunction with the Department of Agriculture, Fisheries and Food, and members of Cáis. The projects have encouraged a close relationship between researchers and cheesemakers, with the result that further opportunities for EU funding under the 7th Framework Programme are being actively pursued.

This work was supported by FIRM, the EU Sixth Framework Programme project BIOTRACER, and by the Department of Community, Rural and Gaeltacht Affairs.

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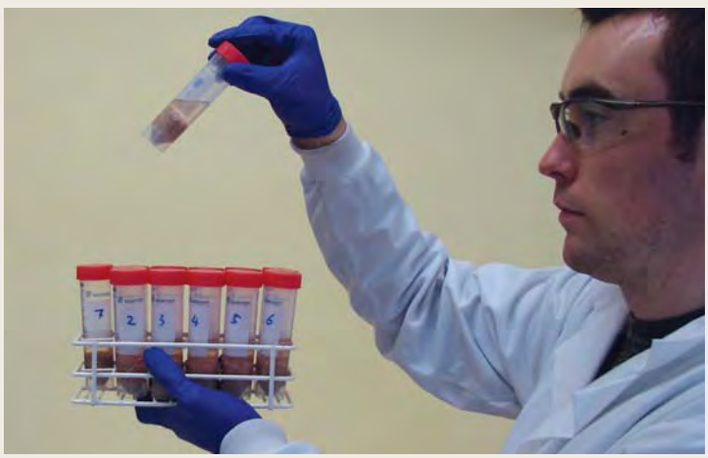
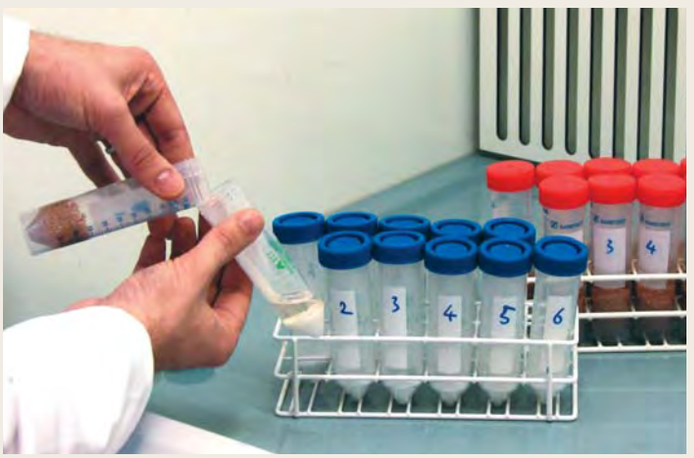


Sample extraction.



Dispersive-SPE clean-up.

Anthelmintic drug residue analysis

Teagasc researchers have developed a gold standard method in anthelmintic drug residue analysis.

Helminths are the single most important group of parasitic infections in livestock and include three types: cestodes (tapeworms), nematodes (roundworms) and trematodes (liver flukes). Helminth infections are controlled through the administration of anthelmintic agents, which are essential for maintaining production yields and reproductive performance in livestock. During the 1980s, there was a shift from therapeutic treatment to chemoprophylactic (preventive) control of infections, which was supported by the widespread availability of anthelmintics, including over-the-counter veterinary medicines and the launch of cheaper generic products. This has led to concerns that anthelmintics are often unnecessarily administered to animals, resulting in the development of drug resistance and increased risk of residue contamination in food.

Food safety

To minimise the risk to human health associated with consuming food containing veterinary drug residues, the European Union has established maximum residue limits (MRLs) for a number of anthelmintics in milk and edible tissues (muscle, liver, kidney and fat). Anthelmintic residues pose no human health risk if veterinary drugs are properly administered and the recommended doses are correctly adhered to. However, there is concern over extra-label usage of products, particularly in dairy animals, because many drugs have no MRL set for milk and, as a result, a zero tolerance applies (Danaher *et al.*, 2009).

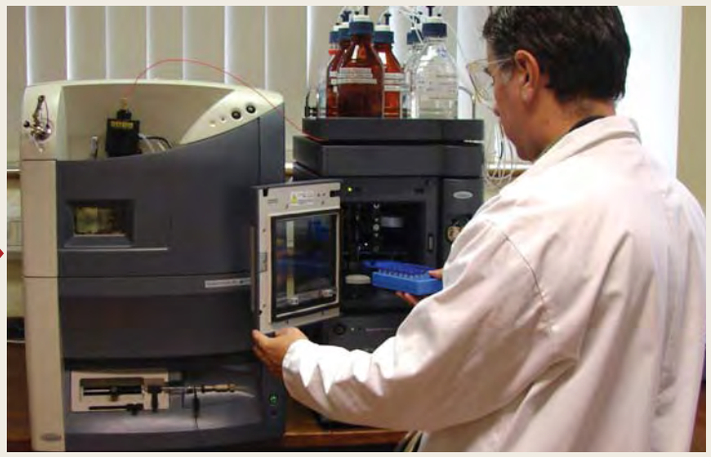
QuEChERS – the answer to the bottleneck in sample preparation

Sample preparation is a major bottleneck in trace residue analysis (Kinsella *et al.*, 2009a). If this problem is overcome scientists can harness developments in chemical analysis to improve food safety. In response, Anastassiades and Lehotay (2003) at the USDA, Eastern Regional Research Centre, developed QuEChERS as a method for the sample preparation of pesticide residues in fruits and vegetables. QuEChERS (standing for "quick, easy, cheap, effective, rugged and safe") has been applied to the analysis of hundreds of pesticide residues. Most sample preparation methods involve many multi-step procedures, but QuEChERS streamlines these steps in a simpler procedure; precision and accuracy are typically improved along with time, labour and cost savings.

In QuEChERS, the sample is extracted with an organic solvent in the presence of salts to induce phase separation of the solvent from the water. Sample extracts are purified using dispersive-SPE, which entails mixing with sorbents. Afterwards, the mixture is centrifuged and the resulting supernatant can be analysed directly, or can be subjected to a concentration and/or solvent exchange step if necessary. The approach uses very little labware and generates little waste. The technique provides high recovery for many liquid chromatography- and gas chromatography-amenable analytes, gives high reproducibility, and costs less than many typical sample preparation approaches.

Teagasc and USDA collaborative project

In early 2006, Martin Danaher and Steve Lehotay held initial discussions about the application of QuEChERS in the area of veterinary drug residue analysis at a ***safe*food** network meeting at Ashtown Food Research Centre (AFRC). Later in the year, the two researchers developed a joint project proposal to meet a Food Institutional Research Measure project call. The goal of the project was to develop an analytical method that would detect flukicide residues in food. At the time, no



UPLC-MS/MS detection system.

BENEFITS

- ✔ **Reduction in solvent waste (x10)**
- ✔ **Reduction in analysis time (x5)**
- ✔ **Increase in result output 45,600 (2009) vs. 10,500 (2008)**
- ✔ **Improvement in food safety**

multi-residue methods were available for these substances and little monitoring was carried out in the EU. The project was successfully funded under the Food Institutional Research Measure (FIRM) and started in November 2006. In January 2007, a Teagasc Walsh Fellow, Brian Kinsella, travelled to spend a 12-month placement at the USDA. In May 2007, the first promising results were achieved with QuEChERS and the technology was expanded to an additional 29 anthelmintic drugs, including six avermectins, 20 benzimidazoles and three pesticides. AFRC was using four methods at the time that analysed for six avermectin and 13 benzimidazole residues, while using large quantities of organic solvent.

Further improvements were made throughout 2007, and the method validation was finalised towards the end of the year. The method was subsequently published in 2009 and is the only method reported in literature that includes all major anthelmintic agents (Kinsella *et al*., 2009b). In 2008, the method was transferred to Teagasc and further improved through application of a more sophisticated ultra high performance liquid chromatography (UPLC)-mass spectrometry (MS)/MS detection system, reducing analysis time to 12 minutes per injection and detection capability to sub part per billion (ppb) levels. By mid-2008, the UPLC-MS/MS method was validated in milk and liver according to EU guidelines (2002/657/EC criteria).

In 2009, the method was submitted for accreditation to the Irish National Accreditation Board to ISO17025 standard and is currently being applied to monitor the safety of Irish food produce at AFRC. The technology has been applied in a number of research projects at AFRC, including the EU-funded project, *ProSafeBeef*, to investigate the safety of EU beef. The technology has also been demonstrated at the European Community Reference Workshop in Berlin to national reference laboratories from 27 EU states in May 2009, where it was found to out-perform conventional methods.

The technology has now been established in seven countries, which is impressive considering the first publication of this work was in 2009. It is expected that as many as 20 countries will be using this technology within the next 12 months. Researchers at AFRC are coupling QuEChERS to rapid diagnostic assays to provide low cost detection of residues in food (Keegan *et al*., 2009). These methods will have significant impact in monitoring the safety of food.

This research was part-funded under the FIRM and by the EU Framework VI programme on Food Quality and Safety, ProSafeBeef integrated project. Dr Helen Cantwell, Mr Martin McCormack and Dr Mary Moloney are acknowledged for technology transfer and preparation of the method for accreditation in the National Reference Laboratory, AFRC.

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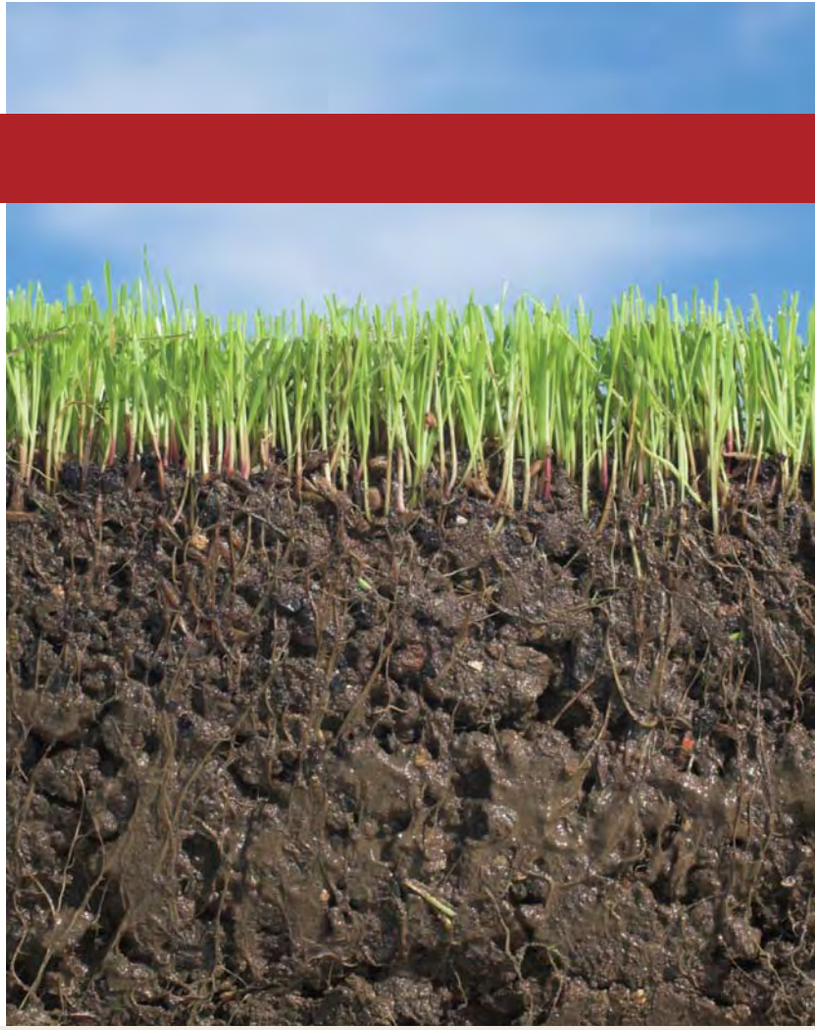
Soil searching



This article summarises the outcomes of a recent international conference on soil husbandry at Johnstown Castle and explores how Irish farmers can benefit from a global approach to soil husbandry.

"Can we look after farming and the environment, simply by looking after our soils?" That was the theme of the recent international Soil Quality Conference at Johnstown Castle, organised jointly by the Soil Science Societies of Ireland and Britain. Soils are where farming and the environment meet; soils are the basic medium for all forms of agriculture, providing nutrients, substrate and water, and for most environmental processes, including gaseous emissions and carbon-sequestration. In today's science, five 'soil functions' are widely recognised: provision of food and fibre; nutrient cycling; carbon-sequestration; water purification; habitat for soil organisms; and, platform for infrastructure (e.g., roads, buildings). The relative importance of each of these functions may differ between countries or regions, and depends primarily on land use.

From "food vs. environment" to "food and environment"

During the last two decades, the emphasis in soil research has been on the protection and enhancement of the environmental functions of soil. However, with the world population expected to rise to nine billion people in this generation, for the first time in modern history, global demand for food is now increasing more rapidly than the technological advances and the global increase in food production; as a result, world stocks of grain and other staple foods are now at an all-time low. There is urgent need to plan and manage our agricultural – and hence soil – resources at a global scale.

Managing threats to soil quality

Worldwide, soil quality is endangered by a variety of threats; examples in warmer regions include salinisation, desertification and excessive erosion, effectively taking previously productive land out of the agricultural equation. But in Europe, too, soil threats are slowly eroding the future functioning of even our best agricultural soils. The proposed EU Soil Framework Directive recognises six threats relevant to temperate agriculture: compaction; erosion; loss of organic matter; landslides; contamination; and soil sealing (i.e., taking soils out of production by "sealing" them with buildings or infrastructure). None of our soils suffer from all these threats simultaneously. In Ireland, erosion, loss of organic matter and landslides are relevant to upland peats, but compaction is likely to be the most important challenge for permanent grassland soils. International research has now developed tools to combat these threats to soil quality. The question is whether all these tools are synergistic or whether attempts to reduce one threat may inadvertently increase another. The conference heard examples of this issue from Switzerland, the USA and New Zealand, and the consensus was that not all tools for soil protection are necessarily synergistic, e.g., measures to reduce erosion may, paradoxically, reduce carbon-sequestration in some places. This has significant implications for policies on soil quality: measures to combat threats should always be implemented with great care to avoid negative "side-effects".

Soil husbandry: getting the most out of our soil functions

A similarly cautious approach is required if we aspire to selectively increase individual soil functions, e.g., food production or carbon-sequestration. The conference heard an example from New Zealand where an attempt to increase grass productivity through irrigation had reduced the carbon-sequestration potential and increased risk of nutrient losses. However, more successful examples included a potato experiment in Canada, where the land spreading of external carbon sources, in this case residue from the paper-industry, simultaneously increased soil carbon levels and productivity. The keynote speaker, Professor Johan Six (University California, Davis), presented examples from the USA, Latin America and Africa, where the combined input of organic and mineral fertilisers (as opposed to relying on either source only) had consistently increased agricultural productivity and environmental quality. The consensus at the conference was that we need to develop a 'toolbox' for active soil husbandry, similar to the established programmes for animal and grassland husbandry.

Towards functional soil planning

Making the most of soil functions is by no means a local issue. After all, soils differ in their capacity to perform each of these functions. For example, it may be easier to sequester carbon on very wet soils, but harder to increase food production; the opposite is true for many well-drained tillage soils. With regard to water purification , plans are advancing for the construction of a pipeline from the Shannon basin to Dublin to supply the capital with drinking water. This raises the question which soils are best suited for water purification, without reducing agricultural output. At a European scale, a relatively new threat to maximising the

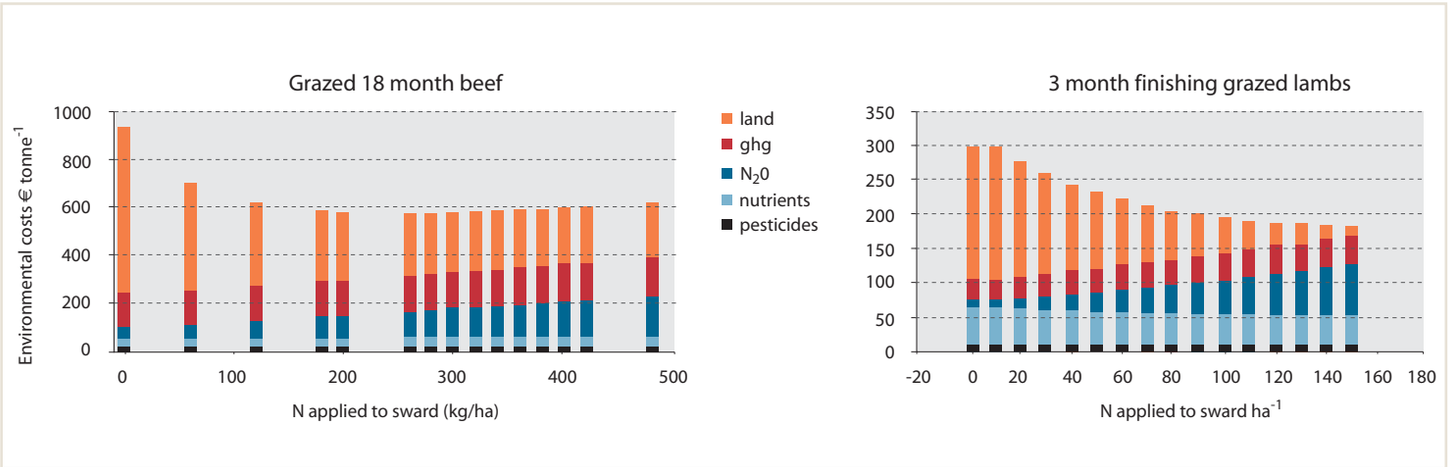


FIGURE 1: Environmental costs associated with different intensities of beef and lamb production in the UK. "Land-cost" refers to the environmental cost of land required for the production of 1 tonne of meat. Edited and reprinted from Glendining, M.J., et al. *(2009) 'Is it possible to increase the sustainability of arable and ruminant agriculture by reducing inputs?'* Agricultural Systems, *99: 2-3: Copyright (2009), with permission from Elsevier.*

potential of our soil functions is the 'land-take' and sealing resulting from urbanisation. Across the EU, up to 100,000ha of land is taken out of production for housing and infrastructure each year. Most towns across Europe originally developed as market places in the middle of the most productive farming areas; as a result, this land take around existing towns represents a large bite from our best agricultural soils. The conference heard a stimulating presentation from Henk van der Kamp, former president of the Irish Planning Institute, who suggested that current planning laws could, in principle, be employed to 'zone' our most productive soils for 'agricultural use only'.

Global land-grabbing

However, there is little benefit in reducing threats to soil quality in Europe, if this results in 'exporting' these threats to developing countries. The destruction of rainforests is a well-known example of attempts by developing countries to meet the global demand for food and fibre. At the conference, Dr Claudia Olazabal (DG-Environment, Brussels) gave haunting examples of a new global phenomenon: 'land-grabbing', where agricultural companies from Western nations buy up large areas of land in Madagascar for industrial agriculture, with little benefits, if any, to the local communities or environment.

This has significant implications for what we perceive to be the 'ideal balance' of our soil functions back home in Europe, specifically the balance between food production and environmental services. The conference heard a thought-provoking presentation from Dr Andrew Whitmore (Cranfield University/Rothamsted Research, UK), on calculating the environmental costs of temperate farming systems in monetary terms, e.g., the financial losses associated with greenhouse gas emissions, reduced water quality and loss of biodiversity. When only direct costs were included, agricultural intensification was associated with significant environmental financial costs. However, this picture changed once we account for the fact that agricultural extensification at home inevitably leads to an increased global demand for agricultural land elsewhere, at the expense of environments abroad. Once these "land-costs" were taken into account, the optimum agricultural intensity came out close to the current level of most full-time farms in Ireland (**Figure 1**). The exact location of this optimum is subject to discussion and further research; the point is that at a global scale, productivity and environment are by no means mutually exclusive.

Do we need a Kyoto for soil quality?

Soil husbandry has implications at local, national, and global level. Locally, the challenge for research is to develop a toolbox for farmers to safeguard their soil functions in the long term. At national level, the question arises whether soil functions should be part of planning strategies. However, the benefits of such an approach can only be reaped if there is a level playing field at international level. The proposed EU Soil Framework Directive aims to provide this level pitch at European scale. In principle, Ireland has subscribed to the Soil Framework Directive, as have the majority of EU member states; however, it is currently being blocked by a small qualified majority of five countries: Germany, France, Austria, the Netherlands and the UK. If we seek to pursue an agenda in which well-managed intensive agriculture can have added benefits to the environment, then consensus in Europe is a first and essential step towards the global approach that is needed to secure our soil resources for food production and the environment for the next generation.

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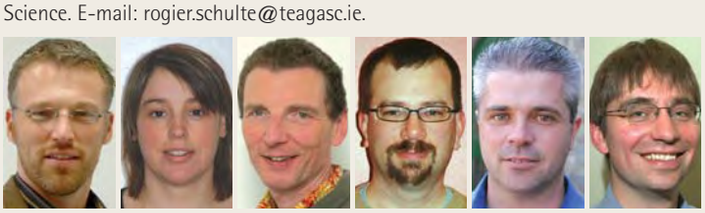

FIGURE 1: MVX-infected mushrooms.

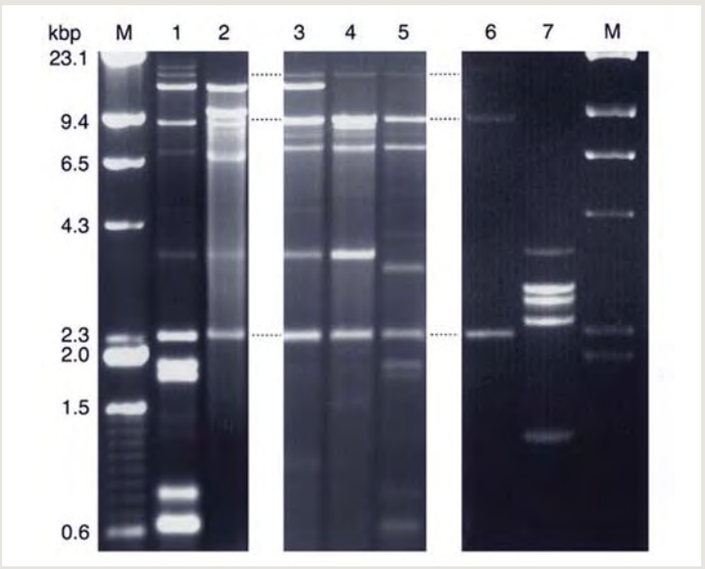

FIGURE 2: dsRNA profiles in mushrooms. Lanes 1-5: MVX; Lane 6: Control; Lane 7: La France virus; M: molecular weight markers. (Reprinted from Grogan *et al. Mycological Research* 2003; 107, with permission from Elsevier).

An elusive virus

The European mushroom industry has been affected by a new virus in recent years known as mushroom virus X. Teagasc researchers are working to offer insights into this ongoing problem.

Mushroom virus X (MVX) disease of the edible mushroom *Agaricus bisporus* was first described in Britain in 1996 at one farm. It was known initially as the 'patch problem' because of the patchy nature of affected crops. By the early 2000s many British farms had closed owing to the devastating effects of the disease on crop production and profitability. Symptoms included disruption of fruit body formation (resulting in the unproductive patches originally observed on mushroom beds), poor quality mushrooms, crop delay and discoloured mushrooms ranging from off-white to brown. The problem became an international one when brown mushroom symptoms started to occur in white mushroom crops in Ireland, followed by The Netherlands, Belgium, Germany and Poland (**Figure 1**).

Diagnosis

MVX disease is diagnosed by the presence of a complex of unencapsidated (i.e., naked) double-stranded ribonucleic acids (dsRNAs) – the genetic material of many fungal viruses. Diagnosis is by nucleic acid extraction and gel electrophoresis to identify the dsRNA banding profile of a mushroom sample. The interpretation of results can be problematic owing to the wide variety of dsRNAs that may be present. A survey undertaken in 2001 by Warwick (HRI) Horticultural Research International in the UK identified 26 dsRNAs associated with MVX, but they do not all occur together. Three dsRNAs are consistently found in mushrooms from uninfected sites, showing that viral dsRNAs can co-exist with their fungal host with no detrimental effects (**Figure 2**). One MVX-associated dsRNA has been fully sequenced but further work is needed to determine the relationship between individual dsRNAs and symptoms.

Brown mushrooms

Four low molecular weight dsRNAs (2-0.6kbp) appear to be required for the browning phenomenon to occur (Lane 1, **Figure 2**). **Figure 1** shows a pale brown MVX-infected mushroom emerging from a crop of white mushrooms. However, the nearby white fruit bodies also possess the same dsRNAs as the brown one, but are asymptomatic (although some may turn brown prematurely once they are harvested). The occurrence of brown mushroom symptoms in an infected crop is therefore very variable. The transient nature of the problem can lead to a false sense of security that the disease has gone away, only for it to recur at intervals, disrupting the supply of good quality white mushrooms to the retailer.

All in the genes

In order to understand what is happening within the mushroom to produce such a variable and transient symptom we have been looking at gene expression profiles in mushrooms in different pathological states.

We created suppression subtractive hybridisation (SSH) expression libraries of MVX-infected brown and MVX-infected asymptomatic mushrooms and healthy non-infected controls. One hundred and ninety-seven unique MVX-related gene transcripts were isolated by this qualitative technique. The majority were matched to known sequences in the host, *A. bisporus*, encoding for various

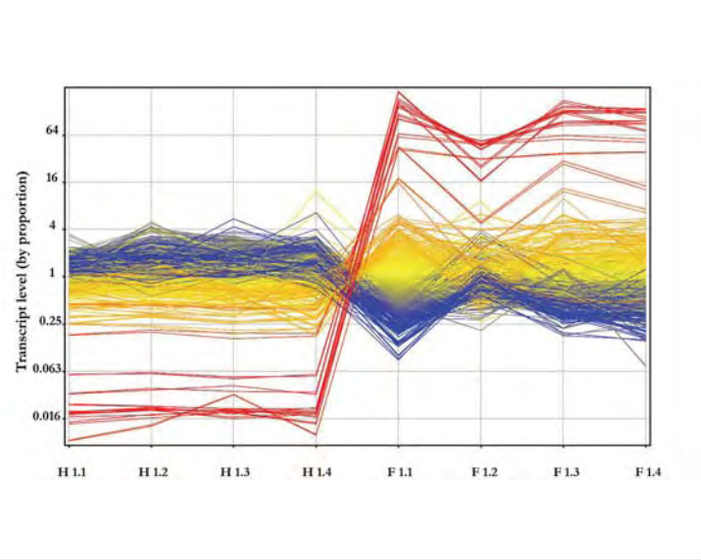

FIGURE 3: Gene expression for four non-infected controls (H1.1-1.4) compared with four MVX-brown mushrooms (F 1.1-1.4).

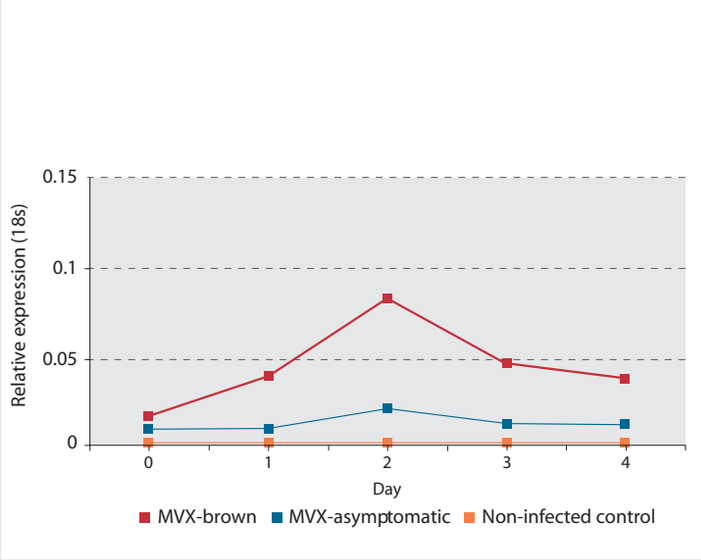

FIGURE 4: Time-course Q-PCR analysis of an 'MVX' transcript.

metabolic and structural components but, interestingly, a small proportion (presumably MVX in origin) could not be identified.

Analysis by high-throughput micro-array technology was used to identify differences in gene expression between diseased and healthy mushrooms. Arrays were custom designed and manufactured to our own specifications, each comprising probes for 1,300 putative *A. bisporus* genes including the 197 MVX-related SSH transcripts. MVX-infected brown mushrooms from various Irish and UK farms were compared with corresponding healthy controls. An output is illustrated in **Figure 3**: in red are 10 genes at background levels in non-infected controls (on the left), but which are consistently highly up-regulated in infected mushrooms by between 148-fold and 4,019-fold. In yellow and blue, respectively, are genes that are moderately up- and down-regulated in infected mushrooms. The 10 red genes originate from our SSH work.

Statistical analysis pinpointed a total of 58 genes that show significant and consistent differences in expression in the infected mushrooms at all farms: 25 up- and 33 down-regulated during infection. Nine of the up-regulated transcripts come from *A. bisporus*; the other 16 we infer to be viral. The host up-regulated genes code for amino acid metabolism, proteinases and a protein involved in anti-viral response. All down-regulated genes are host in origin; many are associated with widespread suppression of host transcriptional and translational processes and related functions.

Using quantitative PCR (Q-PCR) of selected transcripts as well as simultaneous colorimetric analysis, we monitored MVX-infected mushrooms developing the browning symptom over a five-day period. MVX-infected browns had the lowest whiteness values compared to the controls and asymptomatic infected mushrooms. In the Q-PCR analysis, we followed changes in transcript levels in 21 genes in infected fruit bodies developing the brown symptom, as well as adjacent mushrooms that remained white. Relative expression of the 10 'MVX' genes highlighted in **Figure 3** were again high in the infected mushrooms that turned brown while the pattern of transcript accumulation was similar in the asymptomatic mushrooms, but at much lower levels (**Figure 4**). Levels in the control mushrooms were negligible. Thus, high accumulation of the 10 putative MVX transcripts correlates positively with brown colour development in infected samples, but is unrelated to normal colour deterioration in healthy mushrooms. The underlying cause for MVX browning, however, remains unresolved, and is the subject of ongoing research.

Prospects

We believe that the unidentified 'MVX' transcripts from our SSH work are viral in origin and are testing this hypothesis at the moment. We are hopeful that our sequences may form part of a new Q-PCR-based diagnostic test for MVX disease and the presence of this elusive virus, even in the absence of symptoms. The new test aims to be vastly more sensitive, allowing detection at earlier stages of the crop. An Agriculture & Horticulture Development Board (UK) project has been approved to explore development of a predictive test upon completion of the present work.

This research is funded by the Teagasc Core Programme and Walsh Fellowship Scheme, in collaboration with Warwick HRI.

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Understanding bioinformatics

DAVID LYNN and CHRIS CREEVEY introduce bioinformatics, systems biology and metagenomics at the Animal Bioscience Centre.

Bioinformatics research can be loosely described as the use of computational techniques to analyse biological problems. This includes a wide range of research areas and techniques ranging from designing better algorithms for searching biological databases, or unlocking the structure and interactions of proteins, to annotating newly sequenced genomes and reconstructing the tree of life. Equally, bioinformatics research is also finding a niche in diverse agricultural research areas such as in the improvement of insect resistance in crops, selection of cattle for breeding and the genomic sequencing of agriculturally important organisms.

Perhaps the area in which bioinformatics has had the most impact is in the analysis of data from molecular biology studies. Since the advent of DNA sequencing the amount of data available to analyse has risen to such high levels that whole areas of bioinformatics research have arisen, just to develop new ways of visualising and handling the data (currently, on the National Center for Biotechnology Information, USA [NCBI] website – www.ncbi.nlm.nih.gov – which acts as a repository of all sequenced genes, there are nearly 80 million DNA sequences). It is the ability to handle and analyse large datasets in a high-throughput manner that has led bioinformatics to become a cornerstone in many areas of biological research.

Bioinformatics analyses are by their nature collaborative, and generally involve the input of a multidisciplinary team of scientists. For instance, the computational analyses may require the use of data from an external source (whether created as part of a larger project or from publicly available datasets) or predictions from computer simulations may require verification in the laboratory. This multidisciplinary approach allows the analysis of biological problems in a manner not previously possible.

The recently established Animal Bioscience Centre (ABC) in Grange is based around this concept and at its core are two bioinformatics research groups headed up by Dr Chris Creevey and Dr David Lynn, respectively. The publication of the bovine genome sequence earlier this year, along with the bovine HapMap project's effort to catalogue genetic diversity across the genome in 19 breeds of cattle, will greatly accelerate animal genomics research and innovation at Teagasc and worldwide. (Dr Lynn was a senior author on the bovine genome project paper and an author on the bovine HapMap paper published in *Science* in 2009.) In this post-genomics era, Teagasc researchers are already utilising genome-wide analyses, such as gene expression and genome-wide association (GWA) studies, to investigate important aspects of bovine biology with significant economic impact including production, reproduction, immunity and disease. Such analyses, however, generate vast quantities of data, and efficiently analysing such large complex datasets requires advanced computational approaches.

Systems biology

One such approach is the adoption of systems-level analyses. Systems biology is a relatively new field of molecular biology (not to be confused with production systems, etc.), which moves away from reductionist approaches. Using such approaches, researchers have previously attempted to understand a disease or phenotype of interest by investigating the components of a system in relative isolation; for example, studying a particular gene or protein of interest. Instead, systems biology attempts to consider, and ultimately model, as many components and parameters in a system as possible. Such parameters may include the catalogues of genes, proteins and RNAs and measurements of their expression over a range of conditions. Importantly, systems biology approaches also recognise that the molecular components of a system are not related through simple linear pathways but rather through complex molecular interaction networks (**Figure 1**). The catalogue of all molecular interactions in a species is known as the 'interactome'.

The value of bovine gene expression and GWA studies could be greatly enhanced through the adoption of more systems-oriented analyses. GWA studies, for example, which have provided a powerful new approach to identifying genes contributing to disease susceptibility in humans, are now becoming possible in cattle due to the availability of genome-wide SNP data and platforms to assay them. Studies currently underway or proposed at Teagasc include investigations of milk production traits, reproduction, fertility and susceptibility to disease. Systems biology promises to provide new insight into the molecular mechanism behind these traits by allowing investigation of the relationships between associated regions of the genome in terms of the genes involved and how those genes may interact to contribute to the observed trait/phenotype.

It is clear that the employment of systems biology approaches to complex bovine genomics data would be enormously beneficial. Currently, however, no such systems biology bioinformatics resources are available for cattle. At the ABC, Dr Lynn's group is building upon an existing resource, InnateDB, to enable the systems-level analysis of bovine genomics data. Over the last two years, Dr Lynn has led the development of InnateDB (www.innatedb.ca) with colleagues in Vancouver, Canada. InnateDB is a database and analysis platform facilitating systems-level analysis of genome-wide quantitative data from human and mouse DNA in the context of their molecular interactions and pathways. InnateDB is now being developed to enable the systems-level analysis of bovine gene expression and GWAS data through the prediction and integration of a bovine whole-genome interactome, along with bovine-specific gene and protein annotation. InnateDB will be a key enabling technology for the other researchers at the ABC and at other Teagasc centres, and will be used to analyse bovine gene expression and GWA data in a network and pathway context providing novel insight into animal health and production.

Metagenomics

Another novel approach that takes advantage of recent advances in high-throughput sequencing is metagenomics. Traditionally, bacterial and archaeal species have to be cultured in the lab before their genome can be sequenced. However, estimates place the proportion of species that can be successfully cultured in the lab at just 1%. Metagenomics solves this problem by skipping the culturing step altogether and sequencing the DNA directly from the environmental sample taken. This allows an unprecedented look at all the genes contained by all the microbes in an environment – the 'metagenome'.

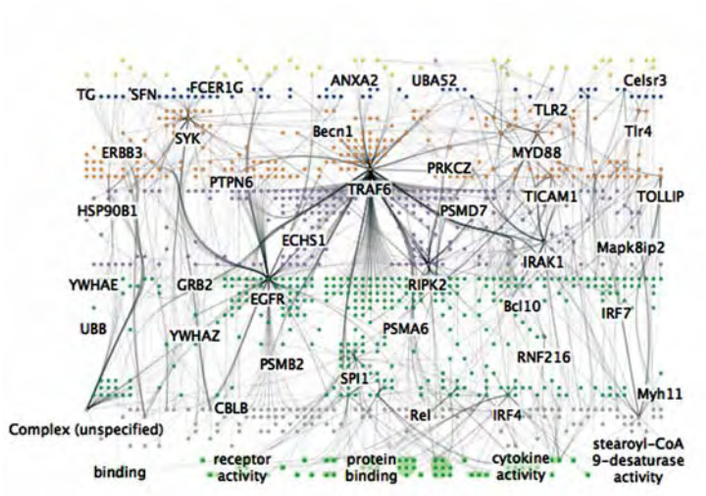

FIGURE 1: A molecular interaction network of interactions between molecules involved in Toll-like receptor signalling (a pathway involved in the innate immune response). The network is visualised using Cerebral, software that was developed as part of the InnateDB project.

Metagenomics has the potential to reveal how microbial communities interact with each other and their environment. At the ABC, Dr Creevey's group will use this approach to reveal the complex interactions between the rumen microbial population and the cattle that act as their host, addressing questions such as if there is an animal genomic control over the structure of the rumen microbial population, or how the microbial population adapts to changes in diet.

These technologies and techniques offer an opportunity to examine agricultural systems in more detail than previously possible, and should provide the impetus to develop larger, more complex research goals across many disciplines in Teagasc.

InnateDB is being developed jointly by the Brinkman Laboratory, Simon Fraser University and the Hancock Laboratory, University of British Columbia, Vancouver, British Columbia, Canada, and Dr Lynn's group at the Teagasc Animal Bioscience Centre, Ireland. Funding is provided by Genome Canada through the Pathogenomics of Innate Immunity (PI2) project, and the Foundation for the National Institutes of Health through the Grand Challenges in Global Health initiative and through the Teagasc Walsh Fellowship programme.

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Molecular pathways in the dairy cow immune response

The competing energy demands of increased milk production and the maintenance of an effective immune system make the post-partum dairy cow susceptible to uterine diseases contributing to decreased fertility. A Teagasc–Royal Veterinary College London research project looked at the molecular mechanisms involved.

Successful genetic selection programmes over the past 30 to 40 years, together with improved nutrition, have resulted in a modern dairy cow, which is biologically efficient at producing large volumes of milk during each lactation. This increase in milk production has been accompanied, however, by a corresponding steady decline in fertility, with conception to first service in many dairy cow herds now below 40%. Increased milk production also causes severe metabolic demands for increased energy; however, despite increased energy intake, cows are unable to ingest sufficient feed to meet these demands. This typically results in extensive mobilisation of body reserves in early lactation in order to make up the deficit, culminating in a period of 'negative energy balance' (NEB). This period of NEB can persist for many weeks and fatty acid catabolism (break down) can result in the accumulation of triglycerides in the liver and increased systemic concentrations of lipid metabolites in the blood resulting in a period of oxidative stress. The catabolism of fatty acids results in a number of metabolic changes. Non-esterified fatty acids (NEFAs) are produced by the liver as the fatty acids are metabolised and their systemic concentrations increase in proportion to the degree of fat mobilisation. Oxidation of NEFAs in the liver results in increased production of reactive oxygen species (ROS), decreased paraoxonase activity and the onset of oxidative stress. Short-chain volatile fatty acids such as β-hydroxy butyrate are also formed during the ruminal fermentation of dietary fibre and are directly absorbed at the site of production. Butyrate is a potent inducer of apoptosis (programmed cell death) and an inhibitor of cell proliferation, differentiation and motility.

Cows with high serum NEFA pre partum have an increased incidence of mastitis and retained placenta post partum and neutrophil and lymphocyte function have been shown to decrease following calving. Most dairy cows suffer uterine microbial contamination post partum. Metritis (inflammation of the uterus) is present in 40% of cows within two weeks of calving and 15% have a persistent endometritis in the three- to six-week post partum period. Sub-clinical endometritis, from six weeks post partum onwards, is characterised by an extensive leucocytic infiltration of the endometrium and chronic inflammation, and is associated with longer

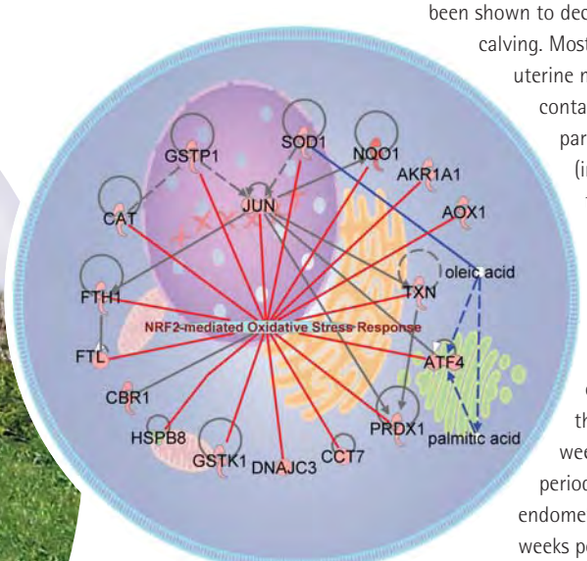

FIGURE 1: Molecular interaction of palmitic and oleic acids involved in cellular oxidative stress and apoptosis.

intervals to conception and a greater likelihood of culling. This may be linked to depression of the immune system in early lactation, resulting in dairy cows becoming more vulnerable to bacterial infections at this time. Poor fertility is a serious economic cost in the dairy industry and is strongly linked to the animal's health around calving. Uterine defences rely initially on classical innate immunity and mucosal defence systems rather than adaptive immunity. Failure in this defence system results in uterine disease.

Macrophages

Increased milk production post partum exerts a heavy demand on energy production. Equally, the maintenance of an effective immune system exerts a high metabolic load. Clearing the system of disease-causing bacteria is the job of specialised white blood cells called macrophages. 'Macrophages', which comes from the Greek meaning "big eaters", are part of the innate immune system and gobble up invading bacteria and infected cells and help to remove cell debris. Many immune cell types are energy-demanding. Macrophages are among the most metabolically demanding cell types in the body and require almost as much energy as maximally functioning heart muscle. The increased energy demands of a high yielding dairy cow for milk production, therefore, compete for energy required for a fully functioning and effective immune system. Production and disease susceptibility have been shown to go hand in hand in pigs, cattle and dairy cows. Before being domesticated, natural selection was based on fitness and resistance to disease. Artificial selection in contrast, has focused on traits associated with production capacity at the expense of resistance to disease. As well as a decrease in body mass due to the demands of lactation, the competing demands of an overloaded immune system post partum can only serve to exacerbate the effects of NEB.

Stressful alliance

Recent studies (Morris *et al.*, 2009; Wathes *et al.*, 2009) supported by the Wellcome Trust compared global gene expression in the uterine tissue and spleen of cows with severe (SNEB) and mild negative energy balance (MNEB) post partum. White blood cell count and lymphocyte number were reduced in SNEB cows. Based on the pattern of gene expression, these studies indicated that cows in the SNEB group had increased expression of many key genes known to be involved in inflammatory responses consistent with the processes known to be required to remodel the post-partum uterus and to clear any microbial infections likely to be present. SNEB animals were still undergoing an active uterine inflammatory response two weeks post partum, by which time MNEB cows had more fully recovered from their energy deficit and the endometrium had reached a more advanced stage of repair. SNEB may therefore prevent cows from mounting an effective immune response to the microbial challenge experienced after calving, prolonging the time required for uterine recovery and compromising subsequent fertility.

The pattern of gene expression in the spleen indicated that part of the reason for this delayed response to infection is that, in SNEB cows, immune cells were exposed to an environment of increased oxidative stress compared to MNEB animals. This was evident by the increased production of genes involved in coping with or ameliorating the effects of oxidative stress. It also indicated that this battle was being lost as there was also an increased activation in genes associated with apoptosis, or cell death. Of the immune cell types present in the spleen, this specific pattern of gene expression indicated that cell death was associated with macrophages. Macrophage cell death in turn caused a reduction in genes encoding cytokines (cell signalling molecules), which are essential for a normal immune response cascade.

The two most significant gene regulatory pathways were those associated with the NRF2 mediated stress response and mitochondrial dysfunction. A significant number and proportion of genes involved in the endoplasmic reticulum (ER) stress pathway were also up-regulated in SNEB. The ER is required for the folding, processing and export of newly synthesised proteins. Prolonged or severe ER stress results in the accumulation of misfolded proteins in the ER and activates the unfolded protein response (UPR) signalling pathway, which includes up-regulation of two key transcription factors (proteins that activate gene expression): ATF4 and X-box binding protein-1 (XBP1).

Activation of the NRF2 and ATF4 transcription factors initiates the convergence of ER stress and oxidative stress signalling with widespread alteration of multiple cellular processes, which, although distinct, also overlap. The two major products of fatty acid breakdown in SNEB, palmitate and oleate, are known to interact with these transcription factors (**Figure 1**). Prolonged or severe ER stress, as found in SNEB cows, is widely accepted to trigger apoptosis and, by affecting immune cells, may render animals in SNEB more susceptible to infection. Understanding the molecular mechanisms involved in these pathways is essential in developing nutritional strategies and/or breeding programmes designed to reduce or eliminate the effects of these fatty acids on cow health. This would have significant effects on reducing the incidences of infectious diseases (mastitis, uterine infections), improving fertility, reducing the number and costs of veterinary interventions required, reducing antibiotic usage and improving animal health and welfare, product quality and a more sustainable environment for agriculture.

This research was funded by the Wellcome Trust and the National Development Plan.

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Grassland reseeding

A three-year ongoing grassland experiment began in Moorepark in 2007 to investigate the effect of management on DM yield and quality of perennial ryegrass. This research is also being used to develop the Grass Economic Index.

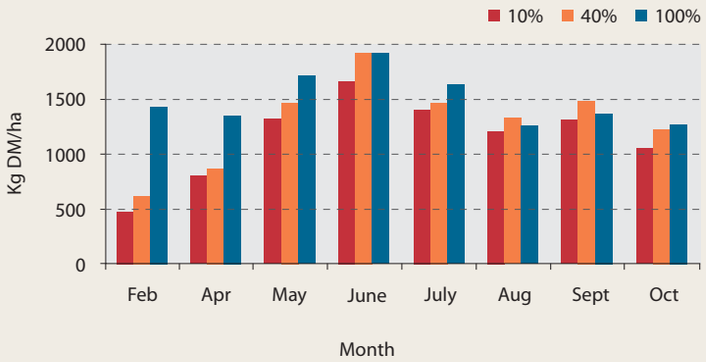

FIGURE 1: Dry matter distributions with 10% perennial ryegrass compared to 100% perennial ryegrass swards.

Irish ruminant production systems are predominantly pasture based with over 90% of the total agricultural area in Ireland in grassland. In recent years a rejuvenated interest in agricultural grazing systems has taken place in many temperate and subtropical regions of the world. This interest was stimulated by rising production costs and falling farm gate prices, as well as the perceived environmental and animal welfare concerns associated with intensive indoor production systems. These changes have induced a transformation of grassland management practices over the last decade. As a result, feeding strategies of spring-calving dairy cows have largely removed grass silage from the early lactation diet and replaced it with grazed grass. With future feed costs projected to increase, utilising more grass in the diet of ruminants is a major objective of Irish ruminant production systems. To achieve the optimum performance from a grass ley the most appropriate grass variety must be selected.

Why reseed pasture?

Reseeded pasture will:

- increase spring and autumn growth;
- increase response to nutrients; and,
- improve sward quality.

Older pastures can yield over 3t dry matter (DM)/year less than reseeded perennial ryegrass swards. Recent research completed at Moorepark has shown that a large proportion of the deficit in DM yield occurs in the spring period when increased growth is achieved in perennial ryegrass dominant swards.

Figure 1 indicates the difference in monthly DM yield between swards containing 10%, 40% and 100% perennial ryegrass. Research has shown the benefits of early turnout to pasture including increased milk yield and increased milk protein concentration; furthermore, as grass is the cheapest feed available, increasing the proportion of grazed grass in the diet will result in a reduction in total feed costs. Swards with lower proportions of perennial ryegrass can have up to 25% less of a response to applied nutrients such as fertilisers, thus increasing the level that must be applied to get the appropriate response in grass growth or, more importantly, increasing the cost of each kg of applied fertiliser as the potential response to nutrients is not being realised, while also resulting in increased loss of N to the environment.

Ryegrass swards, when managed correctly, tend to be leafy in the mid-season and less prone to deterioration in quality. Older swards with low perennial ryegrass content often tend to re-head regularly and result in a high proportion of stem material with a lower digestibility value in the mid-season period.

A three-year ongoing experiment, funded by the Department of Agriculture, Fisheries and Food Research Stimulus Fund, began in Moorepark in 2007 to investigate the effect of management on seasonal DM yields, total DM yield and sward quality. The objective was to identify the performance of varieties under different management systems and the suitability of varieties to different systems of management. Three concurrent management systems were imposed across 12 varieties:

i) simulated grazing system (10 simulated grazing defoliations);
ii) two-cut silage system (with one spring and two back-end simulated grazing defoliations); and,
iii) three-cut silage system (with two back-end simulated grazing defoliations).

Table 1 presents the results of the first two years of the study (year three is ongoing). Total DM yield was greatest for the two-cut and three-cut silage systems, which had a similar yield of 14.5t DM/ha and 15t DM/ha, respectively. The simulated grazing system yielded 11.5t DM/ha. It was found that management had a significant effect on variety DM yield. The results shown in Table 1 are relative to the mean DM yield (t DM/ha) for each variety under each management system. It is clear from the results that some varieties perform better under some protocols than others. In the simulated grazing system Bealey and Tyrella are the two highest yielding varieties. In the two- and three-cut silage systems, however, Bealey and Tyrella begin to be outperformed by other varieties and their position re-ranks in the table. Conversely, Malone performed poorly in the 10-defoliation grazing system but re-ranks as the number of silage cuts increased and was the highest yielding variety in the three-cut silage system. Quality data indicates that varieties also ranked differently in dry matter digestibility (DMD) between different protocols. Dunluce performed well across all protocols in DMD value. Bealey had

Plot trials in Moorepark are investigating the effect of management on variety performance.

Table 1: Effect of management system on ranking of grass varieties on total DM yield across two years (2007 and 2008).

	10-cut grazing system		Two-cut silage		Three-cut silage	
Rank	Variety	Relative to 11.5t	Variety	Relative to 14.5t	Variety	Relative to 15t
1	Bealey	1.08	Dunluce	1.05	Malone	1.10
2	Tyrella	1.05	Greengold	1.05	Portrush	1.05
3	Arrow	1.03	Arrow	1.04	Alto	1.03
4	Alto	1.01	Bealey	1.01	Navan	1.01
5	Dunluce	1.00	Malone	1.01	Lismore	1.00
6	Glencar	0.99	Glencar	1.00	Glencar	0.99
7	Navan	0.99	Lismore	1.00	Greengold	0.99
8	Dunloy	0.99	Navan	1.00	Bealey	0.98
9	Greengold	0.98	Alto	0.98	Dunloy	0.98
10	Malone	0.98	Tyrella	0.97	Arrow	0.97
11	Lismore	0.96	Portrush	0.95	Dunluce	0.95
12	Portrush	0.92	Dunloy	0.94	Tyrella	0.94

the highest DMD value in the 10-cut simulated grazing system but, as the number of silage cuts in the system increased, Bealey was outperformed by other varieties. The DMD was higher in the 10-cut simulated grazing protocol than the silage-based protocols. The performance of individual varieties is not important in this study but the change in performance rank between varieties with the differing management system should not be overlooked. These results highlight that certain varieties are suited to grazing only systems, while conversely other varieties are most suited to silage paddocks. This suggests that to accurately evaluate the appropriateness of a variety to its target use then both a simulated grazing and conservation protocol should be applied within its evaluation.

When to reseed

The majority of reseeding currently takes place in the autumn period and this can pose problems depending on weather conditions. Autumn 2007 and autumn 2008 were extremely wet and, as a result, it was difficult to do a post-emergence spray, resulting in problems with weeds such as docks on many reseeded pastures across the country. Targeting early to mid August for autumn reseeding is desirable to have the seed set and allow time for establishment of the crop before soil temperatures drop.

For these reasons a spring reseed may be preferable and this is possible with a 60-day turnaround time if correctly managed. This allows adequate time for successful crop establishment, a greater window of opportunity to post-emergence spray, with high quality reseed available to calves or milking cows in the early summer period to optimise performance.

Grass Economic Index

Ongoing research in Moorepark is working towards the development of an economic index for ranking grass varieties. This index will allow traits (DM yield, quality and persistency) to be assessed using a common currency (€). This index will be available at the end of 2009. The objective is to assign an economic weighting to a number of parameters that will allow varieties to be ranked on a total economic merit basis.

Economic values are derived for grass varieties based on:

- seasonal DM yield (spring, summer and autumn) – such values are derived from a frequent harvesting regime;
- first- and second-cut silage yields;
- mid-season quality (sward quality each month from April to September, inclusive); and,
- persistency – based on the sward depreciation over a 10-year period.

The Moorepark Dairy Systems Model is used to calculate the economic weighting of each parameter. Economic values are then derived by simulating a physical change for each trait of interest. This is conducted by changing each parameter individually and identifying what effect they have on profit per hectare. The effect of each individual trait will be quantified and will be used to rank varieties on a total economic index basis.

By applying economic values to these parameters the relative economic merit of different varieties can be identified. The development of a selection index from which the advantages and shortcomings of each recommended grass cultivar can be identified will put Irish grassland research to the forefront of grassland technology in the world. It will also provide clear direction to grass breeding as to the traits of importance to industry to breed for.

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Milk production systems for the BMW region

Dairy production systems in the Border Midlands West region can be on a par with those in the south of the country, according to the latest research from DONAL PATTON and BRENDAN HORAN.

The challenge for Irish dairy farmers is to increase the competitiveness of their business through innovation, productivity gain and increased operational scale in the years ahead. The economic superiority of Irish pasture-based dairy production systems based on lower production costs has already been well documented. The output and profitability of individual enterprises is dependent on the ability of dairy farmers to successfully grow and utilise large quantities of cheap high quality grass. Within a national context, 25% of all milk produced originates from the Border Midlands West (BMW) region, where the potential grazing season is shortened due to impeded land drainage, topography, and a reduced grass growing season (**Figure 1**).

Teagasc, in association with local milk processors and University College Dublin, has developed a farm systems research programme at Ballyhaise Agricultural College, Co Cavan, to increase the efficiency of milk production systems in the BMW region. The objective of this programme is to develop highly profitable and environmentally sustainable production systems suitable to the limitations of the region, with a specific focus on increasing grass growth and utilisation. The research programme is based on demonstrative grazing systems comparing high and low supplementation levels in terms of both biological and financial performance.

Grass growth in the BMW region

Detailed grass growth characteristics are an essential requirement when deriving rational systems experiments for a particular location. In systems designed from predominantly grazed pasture, high productivity is only realised where alignment is achieved between grass growth and herd feed demand (calving date and stocking rate). Over the last three years, the growth rates for Ballyhaise College have been identified and are compared to Teagasc Moorepark in **Figure 2**. In 2008, which was widely considered a poor growing season for wetter soils, Ballyhaise College produced 15.2 tonnes of grass dry matter (DM) per hectare in comparison to 16 tonnes at Moorepark. As evidenced by **Figure 2**, while mid-season growth is consistently higher at Ballyhaise, the differential in total annual growth in favour of Moorepark is explained by a comparatively increased growth rate before mid-April and beyond early September.

The extent to which new growth occurs is dependent on many factors such as soil fertility, climatic conditions (moisture, sunlight, soil temperature), sward characteristics (variety and leaf area) and management practices. Management practice in recent years has focused on increased grazing severity, reducing pre-grazing herbage yields and reduced grass supply to improve pasture quality and increase regrowth rates. On wetter soils, the ability to avoid pasture damage and

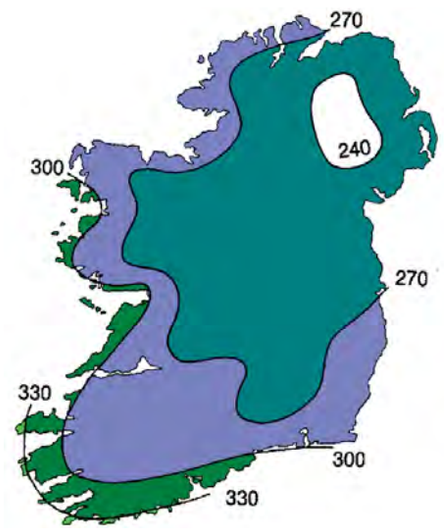

FIGURE 1: Regional variation in average grass growing season length (days).

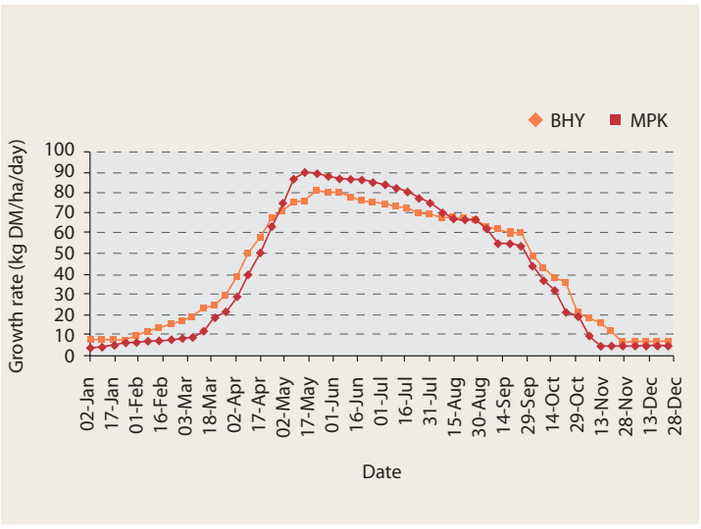

FIGURE 2: Grass growth characteristics for Ballyhaise (BHY) and Moorepark (MPK).

compromised regrowth requires additional investment in grazing infrastructure, including multiple access points to paddocks with good roadways and water infrastructure. As a consequence of these measures, in conjunction with reseeding of underperforming pastures, the overall growth of the Ballyhaise Research Farm is anticipated to be similar to Moorepark in future years.

Ongoing experimental design and results

During 2008, 2009 and 2010, the Ballyhaise College system experiment will compare two likely futuristic pasture-based production systems for the Northern regions. Both production systems are based on high milk solids (fat plus protein) production from within grass-based systems differing in stocking rate and feeding intensity. The systems compared are:

a) Low cost enclosed high grass system (HG): This is a low cost pasture-based system based on maximum grass production and conversion to milk with all winter feed requirements produced from within the grazing platform. In 2008, the stocking rate on this farmlet was 2.9 cows per grazing hectare, while this has increased to 3.1 cows per hectare in 2009. Concentrate supplementation is the minimum required over the season within this treatment.

b) High pasture utilisation high concentrate open system (HC): This is a high supplementation high output system based on a maximum grass conversion to milk from the grazing platform. In both 2008 and 2009, stocking rate on this farmlet was 4.5 cows per hectare, while the majority of the winter feed requirements will be imported from outside the grazing platform. Concentrates and conserved forages will be used to meet the nutritional requirements of this higher intensity system when grass growth is insufficient.

Each experimental group has its own farmlet, which received similar amounts of nitrogen fertiliser, while the herd mean calving date was March 4. The performance of each experimental group during 2008 is outlined in **Table 1**. In 2008, grazing season length was 265 days, which is below the 280-day experimental target due to poor grass growth during the wet autumn period, while concentrate and silage supplementation to milking cows was in excess of expectation. Average pre-grazing herbage mass was 1,394kg DM per hectare (10cm pre-grazing height) while post-grazing residual height was 4.1cm. The HC system produced more milk per cow, similar fat and protein composition, and higher milk solids (fat plus protein) production per hectare.

Table 1: Effect of system of production on animal productivity in 2008.

	System of production	
	HG	HC
Stocking rate (cows/ha)	2.9	4.5
Concentrate fed (kg/cow)	776	1,138
Silage fed to milking cows (kg DM/cow)	460	675
Milk yield (kg/cow)	5,169	5,668
Fat (%)	4.25	4.28
Protein (%)	3.46	3.47
Milk solids (kg/cow)	399	439
(kg/ha)	1,155	1,977

Average milk solids production on Irish dairy farms in 2008 was 360kg per cow, which equates to a current average stocking rate of 1.87 cows per hectare to 673kg of milk solids per hectare using a similar level of concentrate supplementation to that used in the above study. The current experiment demonstrates that with improved grassland management, in combination with increased stocking intensity, significant increases in milk production per hectare of farm land can be achieved with both HG and HC type systems. As part of the ongoing experiment, a complete financial appraisal of each production system will be prepared at the end of Year 3 of the study. Financial analysis will include sensitivities on milk prices, feed costs and land rental charges.

Conclusions to date

The preliminary results from this study indicate that comparable levels of pasture production and quality can be achieved on low cost grass-based dairy farms in the BMW region. The production results to date suggest that considerable potential exists to increase milk production from pasture within the region beyond historical levels, through improved grassland management practice. When this increase in sward productivity is matched with an appropriate stocking rate, the performance and profit potential per hectare of dairy farms in the region can increase significantly in a no milk quota scenario.

Weekly updates on all Moorepark research herds are available online at www.agresearch.teagasc.ie/moorepark.

Teagasc Moorepark wishes to acknowledge National Dairy Levy, National Development Plan and EU funding for this research. We thank the staff of Ballyhaise Agricultural College for their care of and attention to the experimental animals. In particular, we wish to thank the late Eugene Cahill for his technical assistance in the management of the dairy herd at Ballyhaise and express our deepest condolences to his family. Ar dheis Dé go raibh a anam dilis.

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The GM debate and the Irish pig meat sector

PEADAR LAWLOR and MARIA WALSH explore the viability of the Irish pig industry in the presence of a GM feed ban.

Over millennia plants and animals have undergone substantial genetic changes, as those individuals with the most desirable characteristics were selected by humans for breeding the next generation. These desirable characteristics are naturally occurring variations in the genetic make-up of individuals. Recently, it has become possible to modify the genetic material of living cells and organisms using techniques of modern gene technology. Organisms, such as plants and animals, whose genetic material (DNA) has been altered in such a way, are called genetically modified organisms (GMOs) (Europa, 2008). The World Health Organisation (WHO) defines GMOs as those organisms in which the DNA has been altered in a way that does not occur naturally (WHO, 2002). The technology is often called "modern biotechnology" or "gene technology", sometimes also "recombinant DNA technology" or "genetic engineering". It allows selected individual genes to be transferred from one organism into another and also between non-related species.

What is a GM food or feed?

The food and feed that contain or consist of such GMOs, or are produced from GMOs, are called genetically modified (GM) food or feed (Europa, 2008). Regulation (EC) 1829/2003 established 0.9% as base level for "presence of GMO". Therefore, in the EU, any food or feed containing more than 0.9% GMO is legally considered a GM food or feed.

Global picture

This year is the 14th year in which GM crops were grown commercially in the world. Worldwide, 125 million hectares of GM crops were planted in 2008. The unprecedented uptake of this technology is due to the substantial economic benefits to farmers worldwide (James, 2008).

Twenty-five countries grew GM crops (15 developing countries and 10 industrialised countries) in 2008. In order of largest area grown they were: the USA, Argentina, Brazil, India, Canada, China, Paraguay, South Africa, Uruguay, Bolivia, the Philippines, Australia, Mexico, Spain, Chile, Colombia, Honduras, Burkina Faso, the Czech Republic, Romania, Portugal, Germany, Poland, Slovakia and Egypt. The first eight of these countries grew more than one million hectares each. The USA is by far the largest grower of biotech crops, with 62.5 million hectares grown there in 2008 (James, 2008).

If more than one gene from another organism has been transferred to a particular crop, the created GMO has stacked genes (or stacked traits), and is called a gene stacked event. Many new GM varieties contain two or three 'stacked traits', which confer multiple benefits. For this reason, adoption growth can be more precisely measured when expressed as 'trait hectares', rather than hectares. In 2008, 166 million 'trait hectares' were grown globally (James, 2008). Stacked trait hybrids are likely to play a major role in the continued adoption of GM crops worldwide.

Ireland and GM crops

Currently, no genetically modified (GM) crops are cultivated in Ireland. However, Ireland relies more on imports of animal feed ingredients than any other country in the European Union (EU). We are 52% reliant on imports, while the UK is only 36%, France 19%, and Germany 26% dependent, respectively (Hughes, 2008). In particular, we do not have enough land to be self-sufficient in the protein supplements required for animal feeds. The high protein content in pig diets is achieved by using imported soybean and maize products (corn gluten feed, distillers dried grain), which are primarily sourced from the US, Brazil and Argentina. A large proportion of these are GM ingredients authorised for feeding in the EU. Between 2005 and 2007, over 3.4 million tonnes of GM feed ingredients were imported to offset the deficit in domestic feed supplies.

Cost of substituting imported GM feed with a non-GM equivalent

The idea of declaring Ireland a GM-free country has been raised by some as a mechanism to enhance the export potential of the Irish food industry. It is important to note that EU law prohibits the imposition of a national ban on GM crops/feed unless scientific research can support a ban based on health/environmental fears. The only way that Ireland could adopt a GM-free position would be to do so based on a voluntary decision by the Irish agricultural sector.

It is very difficult to accurately predict the financial impact of a GM-free Ireland on the Irish pig industry. Soybean and maize would be the ingredients of most concern in this regard. Pig diets are formulated on a least cost basis and if one ingredient becomes expensive the formulation is altered to incorporate a cheaper alternative. In addition to the GM situation, other factors such as weather, freight, currency, energy cost and funds activity will all impact on ingredient supply and price, thus influencing the ingredient composition of pig diets. Today the additional cost of formulating a GM-free pig diet would increase for the following reasons:

1. Cost of sourcing similar non-GM ingredients.
2. Cost of substituting GM ingredients with alternative protein and energy products.
3. While GM maize by-products are not used to a great extent in pig diets, the effect of using more wheat and barley as substitutes in ruminant diets would make such cereals scarcer, thus increasing their cost of inclusion in GM-free pig diets.

Table 1: Estimated cost for the Irish pig industry of substituting conventional for GM ingredients.

Assumptions		
Feed intake (inc. sow) per pig (kg)	285	(PIGSYS, 2008)
No. of sows in Republic	148,662	(Teagasc Pig Herd Survey, 2009)
No. of pigs produced/sow/year	23.4	(PIGSYS, 2008)
Total pig feed required (tonne)	991,427	

(a) Situation on September 11, 2009		Premium for non-GM ingredient (€/tonne)	Premium for non-GM diet (€/tonne)
Inclusion of GM ingredients	**(%)**		
Soya	20	35	7.00
Maize products	8	10	0.80
Soya oil	1	100	1.00
Additional cost/tonne diet (€)	**8.80**		
Total cost to pig industry (million €)	**8.7**		
Total cost per pig (€)	**2.51**		

(b) Situation on September 11, 2009, but with access to cheaper GM maize products		Premium for non-GM ingredient (€/tonne)	Premium for non-GM diet (€/tonne)
Inclusion of GM ingredients	**(%)**		
Soya	20	40	8.00
Maize products	8	60	4.80
Soya oil	1	100	1.00
Additional cost/tonne diet (€)	**13.80**		
Total cost to pig industry (million €)	**13.7**		
Total cost per pig (€)	**3.93**		

Table 1 contains an estimate of the cost of formulating a GM-free composite pig feed on September 11, 2009. At that time GM-free soya was available at a premium of €35/tonne. All the maize being imported at the time was GM-free with no premium over GM maize. However, there was a premium for non-GM maize gluten and maize distillers of €10 and €18, respectively. In Table 1, maize and maize products are not distinguished and a premium of €10 is assumed for non-GM over GM.

If we were to feed non-GM pig diets based on ingredient prices on September 11, 2009, the cost of feeding a pig would increase by €2.51 and the total cost to the pig industry would amount to in excess of €8.7m per annum (Table 1).

The EC Directorate-General for agriculture and rural development (2007) predicts that the additional cost of non-GM maize products could be as high as €60/tonne for some Member States, including Ireland. Even if alternative feed ingredients were used instead of maize or maize by-products to formulate a GM-free diet, these alternatives would similarly increase in price. Table 1 shows a scenario where the full €60/t premium for non-GM maize and maize by-products is absorbed. In this case the cost of feeding a pig would increase by €3.93 and the total cost to the pig industry would amount to in excess of €13.8m per annum (Table 1).

It is highly unlikely that the Irish pig industry could survive in a GM-free Ireland in the absence of a premium being paid for GM-free pig meat. The history of recovering such premiums from the marketplace has not been a positive one.

EU authorisation

As the area of GM crops increases year on year it becomes increasingly difficult and more expensive to access non-GM alternatives. In addition, it can take up to 33 months to get a GM feed ingredient authorised in the EU, which means that these crops are generally harvested before EU authorisation is received. The delay in the authorisation process results in a premium being paid by the industry for authorised GM alternatives or non-GM alternatives.

Summary

Genetic engineering is a tool employed by plant breeders, which allows faster genetic improvement than is achievable with traditional plant breeding technologies. It is mainly used to confer herbicide resistance or insect resistance or both to a crop. The Irish feed industry is highly reliant on imported feed ingredients, particularly soya and maize by-products, as a source of protein. If Ireland were to adopt a GM-free position, the resulting hikes in feed cost would make it difficult for the Irish pig meat sector to survive. As it is, Irish farmers pay a premium for authorised GM feed ingredients over world market prices because of the lengthy authorisation process currently in place in the EU.

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Life-cycle assessment of energy crops

JOANNE FITZGERALD, Teagasc Oak Park Crops Research Centre, is evaluating the environmental consequences of miscanthus cultivation using life-cycle assessment.

Currently, 12% of global greenhouse gas (GHG) emissions arise from agricultural production, with a further 10% from agriculturally-induced land use change. It is generally accepted that a global cut of 50% in GHG emissions is necessary by 2050. Timely moves to meet this target are vital if we are to retard the ongoing accumulation of GHGs in the atmosphere. The agricultural sector contributed almost 28% of Ireland's GHG emissions in 2005 (with the majority of this input coming from livestock production), while the Irish energy sector contributed 23% of Ireland's overall GHG emissions in the same period. The Kyoto protocol limits Ireland to a 13% rise in its GHG emissions over recorded 1990 levels by 2012, and the Irish Government has recognised that its energy policy must achieve a substantial reduction in GHG emissions. The Government's Energy White Paper of 2007 contains a target that biomass will contribute to 30% of energy input at peat electricity-generating stations by 2015, with a second target of 12% of heat generation to be reached by 2020. The use of bioenergy provides an opportunity to reduce GHG emissions originating from both the energy and agricultural sectors. However, the large-scale cultivation of bioenergy crops such as miscanthus requires landscape-scale changes, and the environmental and social consequences of such significant changes are not fully understood at present. In a global context, problems associated with both rapid population growth and climate change have led to questions being asked as to the wisdom of dedicating significant land resources to energy crops. However, Ireland is in a unique position, possessing a large agricultural area relative to its population size of just over 4.2 million people. Miscanthus has much to offer in this Irish context, being a renewable (and close to carbon-neutral) source of energy.

Because of reasons already outlined, it is advisable to quantify the environmental impacts of growing new crops in large quantities and to develop sound recommendations for their cultivation and utilisation.

Life-cycle assessment

This project uses life-cycle assessment (LCA) as a tool in the evaluation of the environmental impacts of large-scale miscanthus cultivation. LCA provides a robust method for the analysis and assessment of environmental impacts caused by product systems. According to the ISO 14000 standards, LCA is divided into four steps, which are: (1) goal and scope definition; (2) inventory analysis; (3) impact assessment; and, (4) interpretation. The life cycle of any production system consists of all the stages involved in its production, distribution, use and eventual disposal. For miscanthus production, the analysis includes all impacts related to the production of raw materials (such as minerals and fossil fuels) and farm inputs (such as fertilisers, herbicides, pesticides, machinery and rhizomes). By identifying where the main impacts lie within the miscanthus life cycle, the LCA method points clearly to where remedial action is needed.

Two distinct LCA approaches are taken in this work. The first is known as 'consequential' life-cycle assessment (CLCA), where the consequences of increased miscanthus production (and the potential displacement of other agricultural systems) are considered. This approach is useful with respect to evaluating the indirect local and global consequences of a specific course of action.

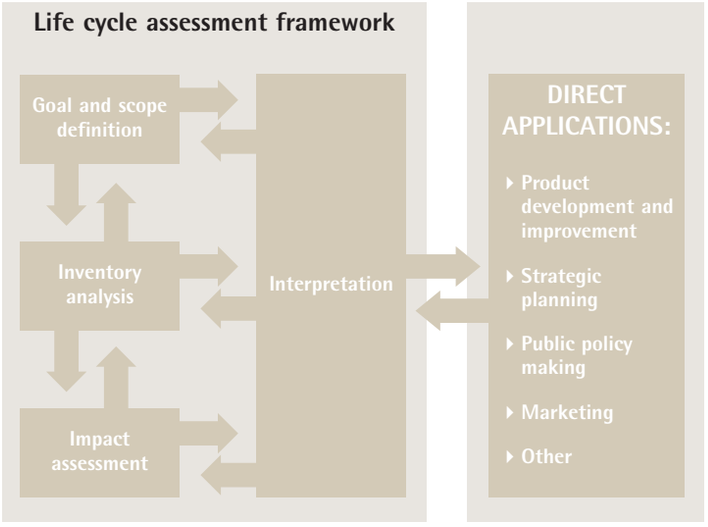

FIGURE 1: Phases of an LCA Study (ISO14040: 2006).

The increased cultivation of miscanthus in Ireland could occur at the expense of other agricultural systems. It is currently assumed that the demand for a displaced crop (or product) will be compensated for either by intensifying its production in Ireland, expanding the Irish land area involved in production, or by sourcing it from another country (which may involve that country also having to intensify production or expand land use). Intensification increases the yield of a given area by additional inputs (such as fertiliser). Expansion is defined as the transformation of a previously unused land type, (e.g., natural areas) into land for agricultural use. It is important to include the emissions related to land transformation in the LCA. As such, the geographical and system boundaries used in LCA are vital. For example, an LCA using the Irish border as its geographical boundary would exclude any increased production in a country overseas.

The CLCA focuses on the land use element of the system and the system boundaries can be described as 'cradle to farm-gate', i.e., the processing and end use of miscanthus is not considered at this stage. In order to meet the heat and co-firing targets, 90,000ha of miscanthus would need to be planted. This would displace existing agricultural systems, primarily grass-based beef production. The CLCA also contains a reference system, based on electricity, heat production and land use in 2005, as a means of comparison.

LCA may also be used to evaluate optimum supply chains and end uses of a product such as miscanthus from an environmental perspective by a method known as 'attributional' LCA (ALCA). ALCA differs from CLCA in that it does not

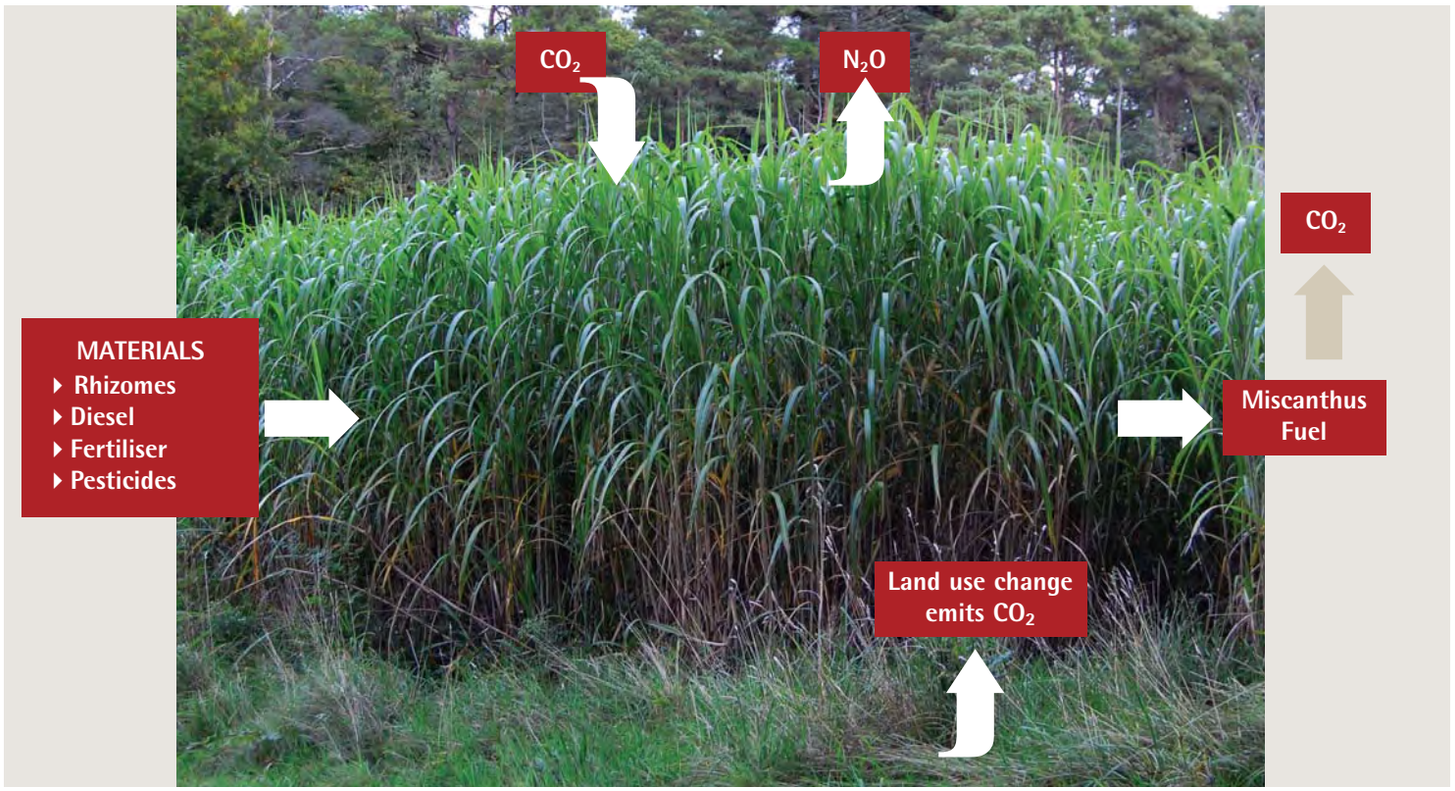

FIGURE 2: Some elements of the miscanthus life cycle.

consider indirect effects arising from changes in the output of a product or system. Several scenarios and end uses of miscanthus production are compared on the basis of a 'functional unit' in order to recommend optimum supply chains from environmental and sustainability perspectives. The functional unit is a quantified output that is used as a reference unit in LCA. All inputs and outputs of the life cycles are related to it. It is derived from the function of the product system, i.e., heat and energy production.

LCA is used in both cases to calculate the effects of meeting policy targets with miscanthus on several environmental receptors, namely energy use, GHG emissions, acidification, eutrophication, resource depletion, land use, and water quantity and quality. Over the time scale of this two-year project the combination of the CLCA and ALCA approaches will be able to answer some pertinent questions about miscanthus production in Ireland such as: to what extent are GHG emissions reduced?; and, does increased miscanthus uptake result in better sustainability over the production line?

Conclusions

Polices encouraging the uptake of biofuels, such as the Energy White Paper of 2007, require life cycle GHG reporting in order to ensure that biofuels achieve GHG reductions and improved sustainability relative to fossil fuels. This is necessary both in determining optimal land use and supply chains. Policy makers should be aware, when using LCAs to inform decision making, that the proponents/detractors of given scenarios often approach LCA (particularly CLCA) with a particular modelling framework that supports their world view. For example, proponents of biofuels may see a place for bioenergy within a more carefully stewarded use of land. They may point to land areas with low productivity, which offers room for higher yields.

On the other hand, detractors of bioenergy may emphasise how rising population and consumption is putting unnecessary pressure on the world's resources. Therefore, it is important to carefully examine the assumptions and boundaries of LCA. However, LCA is extremely effective in helping policymakers to make choices for the longer term, as it helps to avoid shifting environmental problems from one life cycle stage to another, from one environmental receptor to another, or from one geographical area to another. As such, it is an invaluable tool in the evaluation of the environmental impacts associated with large-scale energy crop cultivation.

This research is funded by the Department of Agriculture, Fisheries and Food Research Stimulus Fund.

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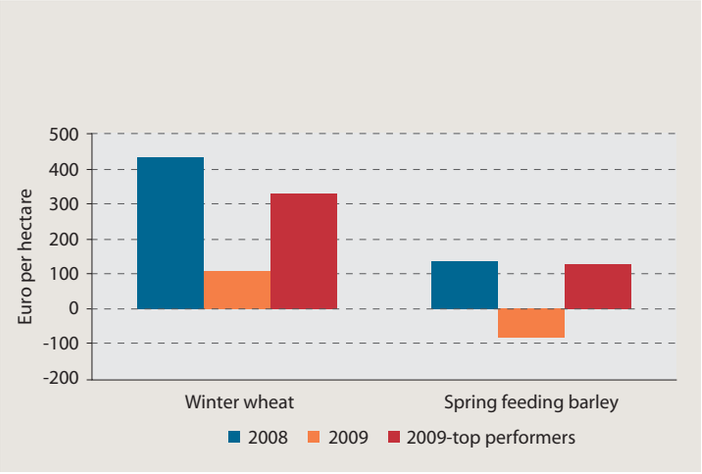

FIGURE 1: Gross margins on cereals farms.
Source: Derived from National Farm Survey and authors' estimates.

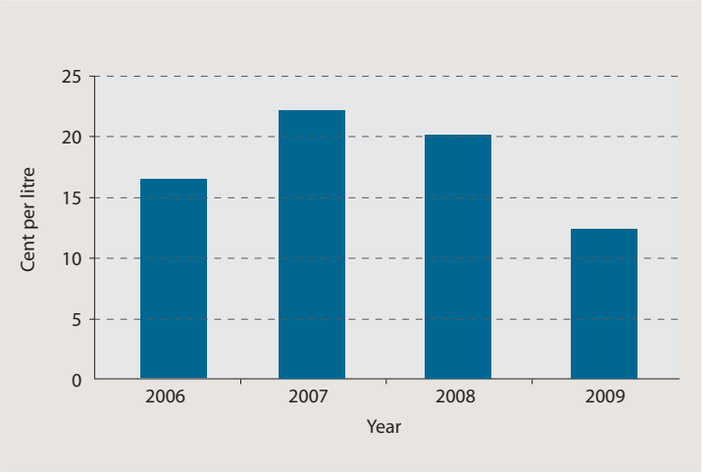

FIGURE 2: Gross margin per litre for Irish creamery milk producers 2006 to 2009.
Source: Derived from National Farm Survey and authors' estimates.

Situation and outlook in Irish agriculture: mid-year update 2009

Economists TREVOR DONNELLAN, KEVIN HANRAHAN and FIONA THORNE of RERC examine the likely outturn for 2009 across the main sectors of Irish agriculture.

While cost inflation was the main influence on farm margins in 2008, changes in output prices are the main factor behind the story for 2009. The recession has impacted on global food demand and has contributed to the decrease in commodity prices that has been observed over the last 12 months.

Input costs

On livestock farms feed, fertiliser and fuel prices will be down in 2009 by about 15-20%, while other costs will remain largely unchanged. Fertiliser expenditure has not fallen on cereal farms because purchases will have been made in advance of the fall in fertiliser prices.

Cereals

Due to a large global oversupply of cereals and carry over of global stock into the 2009 harvest year, on account prices in Ireland are in the region of €80-€90 per tonne for barley and €90-€95 per tonne for wheat.

Winter wheat and spring barley yields will be down in 2009 and, coupled with an estimated 20% reduction in cereal area, this means that total Irish cereal production in 2009 could be down by as much as 20% on the 2008 level.

Gross output values for the winter wheat and spring barley crops will be down by approximately 25% and 30%, respectively, in 2009 relative to 2008 (**Figure 1**). Direct input costs on crop farms have not moderated to the same extent on livestock farms. Direct cost inflation is estimated to be in the region of -1% to +2% depending on the crop examined. For farmers with average levels of technical efficiency, gross margins are estimated to be approximately €110 per hectare for winter wheat and minus €80 per hectare for spring barley. With overhead costs on specialist tillage farms estimated to be in the region of €480 per hectare in 2009, cereal farms will record negative net margins.

Dairy

A rapid decline in milk prices, coupled with only a slight moderation in costs, means that 2009 will be a very poor year for dairy farm margins.

The annual average milk price in 2008 was 32 cents per litre, down marginally on 2007. Producer milk prices in Ireland opened 2009 at about 28 cents per litre, but have dropped rapidly in the year to date and are now 22 cents per litre. At present the average producer milk price for 2009 is estimated to be just 23 cents per litre, a reduction in price of over 25% compared with 2008.

Gross output values will be down over 25% in 2009 (**Figure 2**). With a reduction in input costs of about 2 cents per litre, gross margins are likely to be just 12 cents per litre on average. This will mean that many Irish dairy farms will struggle to record a positive net margin in 2009.

Beef

Weak sterling rates have put downward pressure on Irish cattle prices in 2009. To date, finished cattle prices (R3 steer) are 8% lower than in 2008. The prices of weanlings and store animals in the first half of 2009 are between

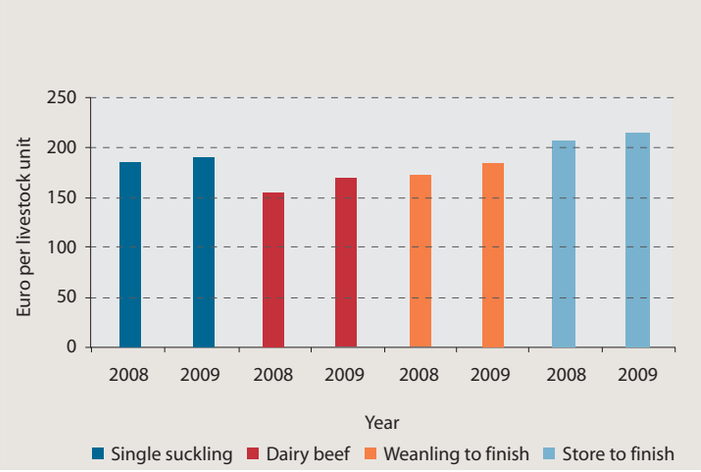

FIGURE 3: Cattle enterprise gross margins 2008 and estimates for 2009.
Source: Derived from National Farm Survey and authors' estimates.

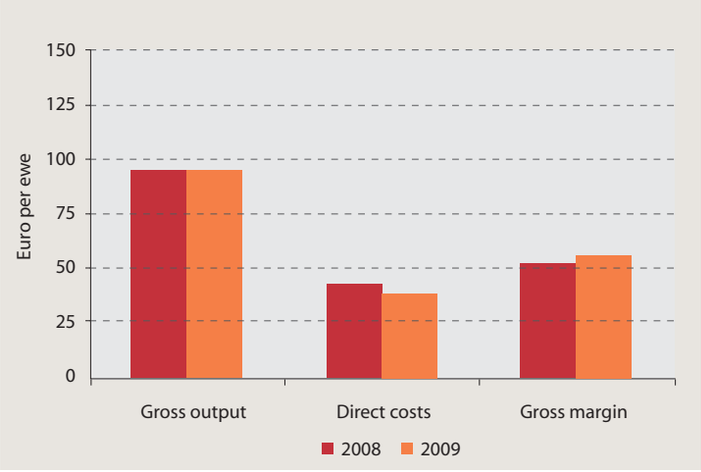

FIGURE 4: Gross output, direct costs and gross margin per ewe.
Source: Derived from National Farm Survey and authors' estimates.

11% and 12% lower than over the same period in 2008.

Gross output per livestock unit across the four different systems will decline by between 8% and 9% in 2009 relative to 2008. The reduction in the rate of the suckler cow welfare payment in 2009 is the basis for the largest reductions occurring in gross output from the single suckling enterprise. Smaller declines in gross output should occur on farms purchasing in weanling and store animals and bringing them to finish. If sterling weakens further, especially during the peak months for cattle slaughter in the final quarter of the year, gross output on all cattle systems could decline by more.

Direct costs will contract by between 16% and 18%. As shown in **Figure 3**, gross margins on Irish cattle enterprises are estimated to increase in 2009 by between 7% and 16%. The largest increases are estimated in the gross margins of weanling to finish and store to finish systems, where lower concentrate feed costs and the differential in the decline in finished cattle and weanling and store prices combine to bring a slightly greater reduction in costs. Margins on single suckling enterprises also improve, though the reduction in the value of the suckler cow welfare payments and lower cattle prices will largely offset the benefits of lower feed and fertiliser costs. Despite improved gross margins, average cattle enterprises will still return a negative net margin in 2009.

Sheep

The decline in cattle prices contrasts with the developments over the year so far on lamb markets, where prices are more or less equal to those in 2008. The marginally higher level of prices may not be maintained for the remainder of the year, but we expect that gross output per ewe and per hectare on mid-season lamb enterprises in 2009 should be largely equivalent to gross output in 2008. Importantly, the principal market for Irish lamb is France, where the euro–sterling exchange rate effect is largely absent.

As shown in **Figure 4**, a combination of lower direct costs and steady gross output will leave gross margins up by 7% on the level in 2008. Despite increased gross margins on the main lowland sheep enterprise, on average net margins on mid-season lamb enterprises (exclusive of decoupled payments) are still likely to be negative.

Fodder shortage

Due to the extremely wet weather experienced this summer, some livestock producers are likely to face a fodder shortage this winter. Where this occurs farmers will either reduce stock numbers or, where lengthening the grazing season is not possible, reduce forage consumption, while increasing concentrate usage. Given that straights and concentrate prices are expected to be considerably lower than last year, their purchase may provide better value than forages.

Conclusion

Dairy and cereal enterprises will experience considerable difficulties in 2009 because of substantial decreases in milk and grain prices relative to 2008. Reductions in input expenditure on dairy and cereal farms will be moderate and, as a consequence, very low gross margins and negative net margins will be widespread. By contrast, in 2009 output value will decline on beef and sheep enterprises due to falling prices, but margins may actually increase, as these output price reductions are more than offset by savings in input expenditure. Nevertheless, negative net margin will still arise on beef and sheep farms.

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T Events

NOVEMBER

November 8-15 *Nationwide*

SCIENCE WEEK –
Celebrating Creativity and Innovation

In this, the EU Year of Creativity and Innovation, Teagasc research centres at Ashtown, Athenry, Grange and Moorepark and Kildalton College will hold open days for local schools. Teagasc Oak Park Crops Research Centre will host BSc students from Carlow IT. Researchers from Ashtown will also give a public lecture at a local library. The Walsh Fellowships Seminar is on November 11 in the RDS. Ms Damini Kumar of NUI Maynooth and Ireland's ambassador for the "European Year of Creativity and Innovation" is guest speaker. The theme of this year's seminar is the scheme's contribution to innovation in the agri-food sector.

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November 12 *Hodson Bay Hotel, Athlone, Co. Westmeath*

Equine Conference

This conference will focus on the factors that impact on producing high performance sports horses that can compete on a global stage.

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November 18 (Mullingar, Co. Westmeath) and 19 (Killarney, Co. Kerry)

National Dairy Conferences

The Teagasc national dairy conference will feature two New Zealand dairy farmers, who will share their experiences. Managing Director of the Kerry Group, Stan McCarthy, is the keynote speaker at the conference in Killarney, and Teagasc speakers will focus on areas where technical performance can improve, such as increasing EBI and grass budgeting.

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November 26 *Johnstown Castle Environment Research Centre, Wexford*

Slurry Conference

The conference will be invitation only, and is aimed at DAFF, specialist advisors, farm organisations and researchers. It will provide a summary of the slurry research linked to Johnstown Castle (with Oak Park, Athenry, and UCD), and will also provide information on current and future research on the use of slurry nutrients.

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2010
JANUARY

January 15 *Heritage Hotel, Portlaoise*

Outlook 2010 – Economics of Agriculture

Full day conference by the Teagasc Rural Economy Research Centre.

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MARCH

March 9-11 *Silver Springs Moran Hotel and Conference Centre, Cork*

US/Ireland Functional Foods Conference:
Dietary Optimisation of Gut Function and the Microbiota

Functional foods are identified as one of the central pillars for the future development of the food industry internationally. In a recent foresight exercise undertaken by Teagasc, research in functional foods is seen as a priority to support the ambitions of Irish industry to compete in this market segment. In connection with this aim, Teagasc, University College Cork and the USDA have combined to organise US/Ireland Functional Foods Conference 2009, to bring together leading scientists whose research is important for the realisation of these ambitions.

This conference will focus on the science of gut function and response to diet and will address gut hormones and incretin release, gut microbiota for optimal gut function, diet and immune function, and biomarkers for enhanced health through diet. While the health effects are broad, they will naturally be those that are diet-related and that connect to gut responses linked to such conditions as obesity and the metabolic syndrome. The conference will focus on the sciences that the food industry will need to develop functional foods and bioactives with validated health claims.

Scientific programme: catherine.stanton@teagasc.ie;
Registration: louise@conferencepartners.ie www.corkff2010.com

APRIL

April 12-14 *Queen's University, Belfast*

Agricultural Research Forum and British Society for
Animal Science joint meeting

This joint meeting will have sessions on soils and the environment, crop science, grassland and agricultural economics in addition to regular sessions on animal science. A number of leading international scientists have been invited to present plenary papers on topics of current interest and importance across all of the above disciplines. The overall theme for the Conference is 'Food, Feed, Energy and Fibre from Land – A Vision for 2020'.

World food demand is predicted to double from present levels by 2050, driven by a projected 40% increase in population growth and changes in eating patterns. This will undoubtedly lead to greater demand for livestock products. However, our ability to increase food production is constrained by a number of factors, including competing demands for land use for energy production and recreational use, together with the impact of climate change on land availability and productivity. This conference will bring together a range of international research scientists to discuss future priorities for agricultural research and development and, in particular, to examine factors influencing the efficiency of food and energy production. Major themes for the conference will include: food production, energy from land; implications for land use; and knowledge and innovation transfer and interaction.

www.bsas.org.uk/Meetings_&_Workshops/