TEAGASC

Research

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Science supporting Ireland's agri-food industry

Teagasc @ ESOF2012

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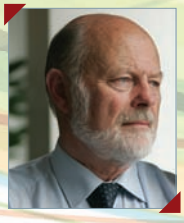
Science supporting agri-food

Teagasc, and its predecessor in science, An Foras Talúntais, have a proud record of over 50 years of service to our agriculture and food industries. Their work has both led and supported the waves of change and adaptation that have been necessary for Ireland to stay competitive in a changing world. And Teagasc itself has had to change. The expanding frontiers of knowledge continuously open new possibilities. We need scientists capable of seizing these opportunities and building on them.

A good example is the way in which Moorepark researchers have pioneered the use of genomic selection in dairy cows to give Irish farmers the benefits of genetic improvement in production and fertility ahead of their competitors in other countries. The ProSafeBeef programme in Ashtown is enhancing the value of our meat output. The Oak Park work on cereals has enabled Irish wheat producers to lead the world in yield per hectare.

Apart from these, and many other practical benefits to our agriculture and food industry, Teagasc research has one other major mission, and that is for Ireland's reputation. As a country that exports 80% of what our land produces, we are more dependent than others on how we are seen abroad. We take the quality, safety and ethical production methods of Irish agriculture and food for granted. However, in foreign markets, where we face tough competition, reputation is everything. Quality and wholesomeness are underpinned by sound science. We must be seen as not just meeting world standards, but as helping to create them.

The successful bid to host the Euroscience Open Forum in Dublin in 2012 is recognition of our new standing in the world of science. Ireland is now becoming known as a country that is serious about science, and we need to capitalise on this. The work that Teagasc researchers do was never more critical.



Professor Patrick Cunningham
Chief Scientific Adviser to the Government
Chairman, ESOF 2012

Eolaíocht ag tacú leis an ngnó agraibhia

Tá cuntas teiste a bhfuil bród acu as ag Teagasc, agus a réamhtheachtaí in Eolaíocht, An Foras Talúntais, de os cionn 50 bliain seirbhíse dár dtionscail talmhaíochta agus bhia. Thug a gcuid oibre tacaíocht don athrú agus don choigeartú a bhí riachtanach in Éirinn d'fhonn a bheith iomaíoch i saol atá ag athrú. Ní mór go n-athródh Teagasc fosta. Oscaíltear na féidearthachtaí úra fairsingíocha trí na raonta eolais i gcónaí. Tá eolaithe de dhíth orainn a bhfuil sé ar a gcumas acu na deiseanna seo a ghlacadh agus forbairt a dhéanamh orthu. Is sampla maith é an dóigh a raibh taighdeoirí Moorepark ina gceannródaithe maidir leis an roghnúchán géanómaíochta i mba bainne d'fhonn tairbhí a thabhairt d'fheirmeoirí Éireannacha maidir le feabhas géiniteach i dtáirgiúlacht agus torthúlacht roimh a n-iomaitheoirí i dtíortha eile. Tá an clár ProSafeBeef i mBaile an Ásaigh ag feabhsú luach ár n-aschuir fheola. Trí obair Pháirc na Darach ar ghránaigh tá sé ar chumas táirgeoirí cruinneachta Éireannacha a bheith ina gceannairí ar thoradh in aghaidh an heicteáir.

Le taobh an méid sin, agus a lán tairbhí praicticiúla eile maidir lenár dtionscal talmhaíochta agus bia, tá mórmhisean eile ag baint le taighde Teagasc, agus is é sin cáil na hÉireann. Mar thír a easpórtálann 80% den mhéid a dtáirgtear inár dtír, braithimid níos mó ná tíortha eile ar an dóigh a bhfeictear muid thar lear. Níl an meas ceart againn ar cháilíocht, sábháilteacht agus modhanna táirgthe eiticiúla thalmhaíocht agus bhia na hÉireann. I margaí coigríche, áfach, áit a bhfuil iomaíocht láidir os ár gcomhair, tá cáil an-tábhachtach ar fad. Tá eolaíocht shlán mar bhun taca le cáilíocht agus folláine. Ní mór go bhfeictear, ní hamháin go bhfuilimid ag comhlíonadh caighdeán domhanda, ach go bhfuilimid ag cuidiú lena gcruthú chomh maith.

Tá an tairiscint rathúil maidir le Fóram Oscailte Euroscience a óstáil i mBaile Átha Cliath in 2012 ina aitheantas dár seasamh úr i saol na heolaíochta. Tá Éire á haithint anois mar thír atá dáiríre faoi eolaíocht, agus ní mór dúinn an leas is fearr a bhaint as seo. Ní raibh an obair a dhéanann taighdeoirí Teagasc riamh chomh tábhachtach.

An tOllamh Pádraig O Cuínneagáin
Príomhchomhairleoir Eolaíochta don Rialtas
Cathaoirleach, ESOF 2012

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Developing Ireland's agri-food sector

Simon Coveney, T.D.,
Minister for Agriculture,
Food and the Marine

I was delighted to hear that Dublin was chosen as the host city for the Euroscience Open Forum (ESOF) following in the footsteps of such cities as Stockholm, Munich and Turin. I would like to congratulate Professor Patrick Cunningham for his tireless efforts in bringing this major international scientific conference to our capital city and the wonderful surroundings of the Dublin Convention Centre.

The ESOF conference is the marquee event of a year-long celebration of Dublin being the 2012 City of Science. This is a wonderful opportunity for Ireland to showcase its talents at all levels to an international audience from all over Europe. I would like to take this opportunity to give a warm welcome to all the international delegates who will participate in the ESOF conference over the coming days and I trust you will enjoy all that Dublin has to offer as a vibrant European capital city.

I wish to pay tribute to Teagasc for their continued efforts to develop the agri-food sector in Ireland. Teagasc is a unique organisation in Europe; combining research, extension and education under the one umbrella organisation and I know other Member States look enviously at this structure. Teagasc researchers continue to make a valuable contribution in their fields of research, creating knowledge that is then widely disseminated by the Teagasc extension team to our farming community and wider industry. I know that Teagasc, in conjunction with the EU Joint Programming Initiative on Agriculture, Food Security and Climate Change, has been heavily involved in organising 'The Great Debate on the Battle to Feed a Changing Planet' that is scheduled to take place this week as part of ESOF. This debate is very timely and I look forward to hearing the outcomes of the deliberations. I would like to acknowledge the continued commitment of Professor Gerry Boyle as Director of the organisation and wish him and all his staff every success in the years ahead.

The Government remains committed to Science, Technology and Innovation and understands the necessity to commit significant financial resources to underpin the growth and development of the Irish economy. It is, however, important that the available funding is targeted to ensure optimal value for money is delivered. In view of this, my Ministerial colleague Mr Richard Bruton has overseen a process that resulted in the publication of the National Research Prioritisation Exercise earlier this year. This Government publication identifies 14 priority areas where the majority of exchequer funding of research will be targeted over the coming years. As Minister for Agriculture, Food and the Marine, I was delighted to learn that Sustainable Food Production and Processing and indeed Food for Health were selected as two of the 14 priorities.

My Department has committed significant financial resources to research in these fields through both core grant-in-aid to Teagasc and the Department's three competitive research funding programmes, FIRM (Food Institutional Research Measure), RSF (Research Stimulus Fund) and CoFoRD (Programme of Competitive Forest Research for Development). This research funding has contributed to building a significant research capability in the agri-food sector. I would like to take this opportunity to encourage the research community in Teagasc and other Research Performing Organisations to continue to compete strongly for non-exchequer sources of funding such as the EU Framework Programme. The Commission is about to embark on a new funding programme, Horizon 2020, and this will present real opportunities for Irish-based researchers.

Finally, I would like to wish everyone involved with ESOF every success for the days ahead. I have absolutely no doubt that Dublin will deliver an impressive event and will leave a lasting impression on all involved.

Teagasc – at the cutting edge of agri-food research

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Director of Teagasc
Dr Frank O'Mara,
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Food security will be one of this century's key global challenges. The FAO of the United Nations projections envisage that global food demand will rise by around 50% by 2030, driven by a global population set to reach around 8.3 billion, accompanied by increased per capita consumption. Moreover, consumption patterns are changing as incomes grow around the world. The trend towards more 'western style' diets in emerging economies, with higher levels of meat, fish and dairy consumption, will significantly increase the pressures on land and water resources, as will the demand for bioenergy. These trends will create new market opportunities for countries, such as Ireland, capable of producing surpluses of animal-related products.

In realising these opportunities, Ireland will need to face up to the growing environmental challenges and pressures and respond to the strengthening consumer demands for healthier, safer and more sustainably-produced food. Farmers will need to adapt and innovate to deal with climate changes, water quality and availability issues, biodiversity action plans and farming regulations. Food manufacturers, processors, distributors and retailers will need to be more resource-efficient and tackle waste throughout the food system, and further reduce food safety hazards and risks. In addition, Irish food processors will need to move as far up the value chain as possible by producing value-added products that consumers want.

Developing and deploying new technologies, processes and knowledge that make the Irish food system sustainable and efficient will be critical in meeting future needs. Future technology and innovation must transcend the objective of merely increasing yields, and adjust to meeting the challenges of increasing resource scarcity and the structural transformation of the economic and social role of agriculture. Such a transformation will enhance the multifunctional role of agriculture and acknowledge the complexity of agricultural systems within specific contexts. New technologies (ICT, nanotechnologies, biotechnology, etc.) will become increasingly important. New approaches to international competitiveness will be required that place a much greater emphasis on innovation, flexible responses to rapidly changing market demands, and producing a wide range of food and non-food products and services.

Teagasc is to the forefront in developing and deploying new technologies for sustainable and competitive production. Our strategy embraces a cross-disciplinary approach, combining new disciplines of molecular biology and genomics along with traditional subjects such as animal science, agronomy, plant physiology, plant pathology and soil science. While across Europe, there is a growing shortage of expertise in universities and research centres in these traditional subjects, Teagasc has maintained those skills, as well as a strong emphasis on systems research. In particular, given the major challenges facing livestock production, Teagasc is very much to the forefront of knowledge in pasture-based systems of production that are inherently more sustainable than intensive feedlot systems. Moreover, the organisation is widely recognised as a leading national and international player in the strategic functional foods sector.

The Teagasc model of innovation support recognises the importance of integrating the critical functions of research, knowledge transfer and knowledge absorption (education) in order to ensure impact for its stakeholders. Indeed, Teagasc is unique in European terms in having these three elements embedded within a single organisation. No single element is sufficient of itself to ensure that knowledge capital translates into a form of knowledge that is usable for the benefit of stakeholders. Continued investment in R&D and translation into innovation are crucial for the long-term production of sustainable and safe food and meeting food security globally. Teagasc is in a strong position to ensure that it will remain at the forefront in terms of meeting the scientific and technological needs of Ireland's growing agri-food sector and, in association with its university partners and other national support agencies, helping to position the country as a global leader in the development of environmentally sustainable, safe and innovative pastoral production systems and products.

BSAS honour Tim Keady

Dr Tim Keady, a Principal Research Officer at the Teagasc Animal and Grassland Research & Innovation Centre, was awarded the Sir John Hammond Award at the British Society of Animal Science's annual conference at the University of Nottingham in April.
Presented to those who make a significant impact on the science or development of animal production, the award was given to Dr Keady for his work in nutritional management of cattle and sheep.
Among some of his many contributions to the livestock industries, Dr Keady has studied the impact of silage fermentation on beef cattle's digestion and performance and investigated ways to improve dairy cow performance from silage-based diets.

Teagasc features in TV series

Teagasc researchers are featured in The Science Squad, a new television series on RTÉ 1. Dr Mark Auty, Teagasc Food Research Centre, Moorepark featured in an episode on food structure imaging and Dr Donagh Berry, Teagasc, Animal and Grassland Research & Innovation Centre, featured in an episode on genomic selection, both in June. Other researchers featured include Dr Vivian Gee and Walsh Fellow Eoin Murphy. Dr Dan Milbourne will appear in an episode on July 12 at 8.30pm, where he will be talking about the potato genome.

Opportunities and challenges in reducing GHG emissions

A range of technologies can reduce the carbon footprint of Irish agriculture, but achieving reductions in total greenhouse gas (GHG) emissions in the sector will not be easy, according to a report produced by Teagasc and submitted to the Government in May.
The report, prepared by the Teagasc greenhouse gas working group, identifies a number of cost-effective approaches to reducing GHG emissions from the agriculture sector, but notes that the growth in Irish agriculture as set out in *Food Harvest 2020*, is likely to leave overall sectoral emissions close to current levels.
The study represents the Teagasc submission to the public consultation on national climate policy and legislation.
It indicates that if current farming practices remain unchanged, GHG emissions from agriculture could rise as the growth targets for the dairy and meat sectors set out in *Food Harvest 2020* materialise.
The report also details how Teagasc research has identified changes in farming practices that, if adopted, could allow the sector to grow until 2020 without increasing its GHG emissions.
The measures identified can improve the production efficiency of Irish farming, while reducing the carbon footprint of agricultural produce. Commenting on the submission, Teagasc Director of Research, Dr Frank O'Mara, said: "Irish agriculture could increase its contribution to the economy by about one third in the period to 2020. Given that Irish agriculture is already among the most carbon efficient globally, further steep reductions in emissions from the sector present a huge challenge in the short to medium term."
The Teagasc submission is available to download at www.teagasc.ie/publications/submissions.asp

Sheep technical updates

Pictured at the launch of Teagasc publication 'Technical Updates on Sheep Production' are (from left): Michael McHugh, co-editor; Shane McEntee, Minister of State at the Department of Agriculture, Food and the Marine; Professor Gerry Boyle, Teagasc Director; and, Michael Diskin, co-editor.

NutraMara conference

Functional foods, which are expected to reach a global value of almost €140 billion next year, coupled with seafood, should be seen as a key area for Ireland's economic growth, speakers said at the Teagasc hosted NutraMara international conference in April.
Declan Troy, Director of NutraMara and Assistant Director of Research in Teagasc said: "The global market for functional foods is expected to reach $176 billion [€139 billion] by 2013 – this demand for functional foods is a driver for research into novel ingredients with demonstrated health benefits. The research carried out by NutraMara's scientists will help Irish companies to secure a share of this global market".
According to Dr Peter Heffernan, CEO, Marine Institute: "Ireland's seafood sector already contributes over €700 million to the economy and supports 11,000 jobs and the potential to grow this is significant. Ireland is well positioned to excel in this area with our 220 million acre marine resource supporting a variety of habitats and species and an internationally recognised research capability in marine sciences and food research. Research in the areas of 'Food for Health' and 'Sustainable Food Production and Processing' were recently highlighted as targets for public investment in the Government's Research Prioritisation Report, as a result of our demonstrated expertise in these areas and because of the real potential for these sectors to deliver jobs," said Dr Heffernan.

The President of Ireland Michael D. Higgins (right) is welcomed to the NutraMara conference by Dr Noel Cawley, Chairperson, Teagasc (left) and Declan Troy, Assistant Director of Research, Teagasc

Probiotic bacteria may influence brain fatty acid composition

Designer probiotic bacteria have the potential to alter brain fatty acid composition, according to new research published in the prestigious *American Journal of Clinical Nutrition*.

The research, carried out by Dr Rebecca Wall, Dr Catherine Stanton and their colleagues at the Alimentary Pharmabiotic Centre in Teagasc Food Research Centre, Moorepark, and University College Cork, demonstrated that mice fed with *Bifidobacterium breve* NCIMB 702258 and *Bifidobacterium breve* DPC6330 had altered brain fatty acids and gut microbiota.

"The finding that bacteria in our gut influence brain fatty acid composition opens up new possibilities for the use of probiotic foods in the promotion of human health and mental well being," said Dr Stanton, senior author on the publication and Principal Investigator at the Science Foundation Ireland-funded Alimentary Pharmabiotic Centre, Teagasc.

The researchers showed that mice fed with the conjugated linoleic acid (CLA)-producing bacterium *B. breve* NCIMB 702258 had increased levels of two fatty acids, ARA and DHA, which play important roles in neurogenesis, neurotransmission and protection against oxidative stress and whose levels in the brain influence cognition. The researchers also showed that feeding with the CLA-producing *B. breve* strains is strain dependent on both the fatty acid composition of the mouse brain and on the microbial community in the gut. These findings could lead to designer probiotics for improved cognition and brain function.

Appointment of Paul Ross as Research Professor in University College Cork

Paul Ross, Head of the Food Research Programme in Teagasc, has been appointed to the position of Research Professor in University College Cork, in the Alimentary Pharmabiotic Centre (APC). Professor Ross will continue in his current position in Teagasc. This is the first such appointment in UCC and it comes following the establishment of the Alliance in Food Research between UCC and Teagasc in 2010. Professor Ross has made a significant contribution to the success of APC where he engages in research, postgraduate supervision and other academic activities.

Chinese technical team visits Ireland

In June, a full technical visit was made to Ireland by Chinese authorities, where they examined beef production controls. During this visit, the team visited a number of plants in the country, as well as meeting with high-level Irish Government officials. This is seen as an important step towards Ireland gaining access to the Chinese beef market. This happened just weeks after Minister for Agriculture, Food and the Marine, Simon Coveney, hosted a visit from Vice Minister Gao Hongbin, from the Chinese Agriculture Ministry, where Vice Minister Gao first announced the technical team's trip. Minister Goa visited the Teagasc Animal and Grassland and Food Research Centres in Moorepark, Fermoy, where he was given an overview of the Teagasc Animal and Grassland Research & Innovation programme and was shown the extensive research facilities in Moorepark during his visit to Ireland in May. This visit, in turn, followed on from Minister Coveney's trade mission in April, where Dr Frank O'Mara, Director of Research at Teagasc, outlined the role of science in developing and improving our food production and processing systems. He also emphasised the strengths of Irish research in grassland science, animal breeding and genetics, soils, environmental sustainability, food research, and rural economics.

Dr Frank O'Mara speaking as part of an Irish trade delegation to China, led by the Minister of Agriculture, Food and the Marine, Simon Coveney.

Rural Communities: Fighting for a Sustainable Future

Irish Rural Link held its 21st Anniversary Conference recently at the Connemara West Campus in Letterfrack, Co. Galway, in May. The conference, entitled 'Rural Communities: Fighting for a Sustainable Future' was addressed by the President of Ireland, Michael D. Higgins. Teagasc economist Dr Kevin Heanue gave the keynote address to the conference. In a wide-ranging presentation entitled 'Development in Rural Areas: Exit or Voice?' Dr Heanue outlined the changes in key indicators such as population, employment, disposable income and poverty rates in rural Ireland since 2006. Based on analysis carried out in Teagasc's Rural Economy and Development programme, he said: "A long term pattern of population decline persists in many rural areas; most of the employment gained during the 'Celtic Tiger' era has been lost and many of those areas, which experienced most growth during the boom times, are now experiencing relatively lower disposable income and higher poverty rates." Identifying a vacuum in terms of rural policy since the NESC report and White Paper in the late 1990s, Dr Heanue suggested: "Rural communities need to proactively engage to challenge conventional wisdom about development options and to drive the formulation of a new rural policy framework."

Dr Kevin Heanue is also Chairman of Connemara West Plc, the Letterfrack-based rural community development organisation that hosted the Irish Rural Link conference. His presentation to the Irish Rural Link conference included analysis by Teagasc colleagues Dr David Meredith, Dr Cathal O'Donoghue, Dr Jason Loughrey and Dr John Lennon.

Irish Rural Link was founded in Letterfrack to represent the interests of rural communities who are affected by disadvantage or marginalisation by highlighting the problems, advocating appropriate responses and sharing best practice.

Grass book launched at Flora and Fauna seminar

The Grasses of Ireland by John Feehan, Helen Sheridan and Damian Egan, produced by Teagasc in association with the School of Agriculture and Food Science, University College Dublin, was launched during the Teagasc Farmland Flora and Fauna seminar in Birr in June.

This book is intended for farmers, agriculturalists, horticulturalists, botanists, green-keepers, teachers, students and anyone who wishes to know more about our unique suite of Irish grasses. This book is available to purchase from Teagasc, Oak Park.

There were a wide range of presentations at this year's Farmland Flora and Fauna event, with speakers from the National Biodiversity Data Centre, UCD, BirdWatch Ireland, Bat Conservation Ireland, and the MISE project discussed grasses, flowering plants, trees, bees, butterflies, birds, bats and other small mammals.

Commenting on the importance of the event, Catherine Keena, Teagasc Countryside Management Specialist, explained that raising awareness of our native farmland wildlife is a key objective: "It is important that we understand our farmland flora and fauna so that we can look for appropriate, well funded agri-environment measures that will maintain our flora and fauna."

Best presentation at annual UCC Food Research Conference

Teagasc Walsh Fellow Ian O'Loughlin received first prize for the best overall presentation at the 41st Annual UCC Food Research Conference, the longest-running and largest annual post-graduate event in Food Science and Research in Ireland for his contribution, 'Enzymatic hydrolysis of heat-induced aggregates of whey protein isolate'.

Pictured at the European Meeting of the International Microsimulation Association, hosted by Teagasc at Ashtown May 17-19 are (from left): Dr Cathal O'Donoghue, Head Rural Economy and Development Programme, Teagasc, and President, International Microsimulation Association; Richard Blundell, Professor of Economics, University College London; Hilmer Schneider, Head of Labour Policy IZA (German Labour Economics Institute); and, Professor Gerry Boyle, Director, Teagasc.

Using microsimulation to improve public policy

In May, Teagasc hosted an international conference focused on policy modelling as part of the European City of Science 2012 in Dublin at Teagasc's Ashtown Conference facility. The conference was the European Meeting of the International Microsimulation Association and brought together researchers from all over the world presenting 116 scientific papers.

One of the objectives of the conference was to bring together researchers in parallel disciplines that utilise computer-based simulation models to simulate the impact of public policy and/or economic and social change on micro units such as households, firms and farms. Depending upon the policy area, the discipline has different names. However methodologically, there is much in common and much that can be learned from the different fields' methodologically.

The aim of the conference was to focus on the modelling; allowing scientists the space to discuss the detail of their models and analysis and to progress their fields. Plenary presentations were given by Prof Richard Blundell, University College London, and Professor Raj Chetty, Harvard University. The conference also afforded a number of Teagasc PhD Walsh fellows an opportunity to present and get feedback in an international forum.

Ag Research Forum

The Agricultural Research Forum is a two-day event, featuring all the latest agricultural research from the major research institutes on the island of Ireland each year. More than 200 delegates from southern and Northern Irish universities, institutes and government departments, as well as Teagasc, attended the event this March in Tullamore.

"This is an exciting time for Irish agriculture with buoyant product prices, rapid increase in exports and strong world demand for food products," said Michael Diskin, Chair of the Organising Committee. "Most of the studies reported on at the forum are focussed on issues that are highly relevant to the agriculture and food industry in Ireland," he explained.

Pictured at the Agricultural Research Forum in March are: Professor Alex Evans, UCD; Dr Karl Richards, Teagasc, Crops, Environment and Land Use Research Centre; Professor Mark Crowe, UCD; and Dr John Bailey, AFBI.

At the launch of the Teagasc National Farm Survey Results for 2011 are: Drs Anne Kinsella, Thia Hennessy and Cathal O'Donoghue, Teagasc, Rural Economy and Development Programme.

Farm incomes increase, as debts fall

Family farm income increased by 32% in 2011, bringing the average income figure for the farming sector to €24,861, while farm debts reduced by 20% compared to 2010's figures, according to a preliminary estimate of the Teagasc National Farm Survey results in May.

Income increases were entirely driven by output gains, as production costs increased and the value of direct payments declined marginally, and debt reductions were seen as a result of incomes rising.

Speaking at the launch of the Teagasc National Farm Survey results, Dr Anne Kinsella said: "Farmers used the favourable market conditions experienced in 2011 to repay debt and the sector debt figure of €1.8 billion represents a reduction of 20% on the previous year".

Research in Teagasc

Dr Frank O'Mara,
Director of Research,
Teagasc

Research is very important to the agri-food industry, and has been instrumental in helping the industry to increase food production, productivity and efficiency, while also improving animal welfare, food safety and quality and delivering social, environmental and policy impacts. Examples of this are contributions to food security, the long-term decline in relative food prices, and the contribution to regional economic development because of its locally-dispersed nature. The research Teagasc has carried out for over 50 years has been pivotal to the development of Ireland's agri-food industry, and is highly valued by government and farmer and industry stakeholders.

The pay off to publicly funded agriculture/food research has been extensively studied by Irish, UK and US researchers, and the results are very positive. For instance, the estimated average internal rate of return from seven Irish case studies was 55%, which compares very favourably with most other public sector investment projects.

The recent UK Government Foresight (*Global Food and Farming Futures*) concluded that the consequences of the decrease in public investment in agriculture R&D, and the increasing focus of the reduced expenditure on environmental concerns over recent decades, are now starting to emerge as a reduction in the growth of productivity. For example, the study refers to the relative rates of yield increase for major grain crops, which were around 2 to 3% per annum in the 1980s, but are now significantly less (typically 1 to 1.5% per annum), and there is evidence of crop yields not increasing at all in some locations.

There are many challenges and opportunities facing us that need research. There is the opportunity to increase food production - particularly in the dairy sector but also in other sectors – but to sustain our industry in competitive global markets we need constant improvements in efficiency and productivity. At the same time, we will have to reduce greenhouse gas emissions, ensure the quality of our waters, protect biodiversity, use less pesticides and increase efficiency of resource use. We have a reputation for high environmental standards, but we need the evidence to prove this to international customers for our food. Our food industry has a global reputation for quality and food safety and we must enhance both, and take advantage of the opportunity that comes with increased demand for high value foods with functional properties, particularly related to health and wellness.

Teagasc has an excellent track record of delivering high quality research that makes an impact on the industry. We engage closely with industry and other stakeholders in setting priorities for our research. We are fortunate to have an integrated research-advisory-education organisation which helps in getting the results of research to the end user, and in setting research priorities. We partner with many other research providers, particularly Irish Universities in conducting our research, and work closely with many industry organisations, such as the Irish Cattle Breeding Federation, Bord Bia, Animal Health Ireland, Enterprise Ireland and The Marine Institute in delivering on shared priorities.

We have organised our research into four programmes: Food; Animal and Grassland; Crops, Environment and Land-Use; and Rural Economy and Development. In the following pages, we outline some of the key activities and achievements of these programmes in recent years.

Animal and Grassland Research & Innovation Programme

Dr Pat Dillon,
Head of Animal and Grassland Research & Innovation Programme, Teagasc, Moorepark.
Correspondence: pat.dillon@teagasc.ie

The aim of the Teagasc Animal and Grassland Research & Innovation Programme is to increase the profitability, competitiveness and sustainability of Irish livestock production through research and innovation. In this short article we outline some of the key highlights of the programme in recent years.

Role of Genomic Technology
Dr Donagh Berry

Genomic selection involves the direct inclusion of information on the DNA of an animal to supplement genealogical information in identifying the genetically elite animals to become parents of the next generation. Ireland was the second country in the world to implement genomic selection in its national genetic evaluations for dairy cattle in spring 2009. Implementation of genomic selection in beef cattle is currently being researched. Simulation studies suggest that genomic selection is expected to increase national genetic gain by at least 50% and the past three year's experience have seen this materialise. The increased genetic gain is mainly a function of greater intensity of selection (i.e., more candidate animals can be screened at a low cost; approximately 0.3% of the cost of previous progeny testing) and being able to apply selection at a very young age (i.e., about five weeks of age with genomic selection compared to about five years of age with progeny testing). Genomic selection in Ireland, based on current breeding schemes is worth €8 million annually which is cumulative and permanent; the research cost for implementation was €0.4 million. The level of usage of semen from genomically-tested dairy bulls in Ireland was approximately 47% in 2011. Optimising the national breeding scheme to fully exploit genomic selection can increase gains further.

Beef Carcass Quality Payment System
Dr Mark McGee and Dr Eddie O'Riordan

Beef carcass prices should reflect meat yield and market value, just as milk payment systems reflect constituent yield. For many years, the Irish beef carcass pricing system was criticised for not sending a proper signal to farmers as to the type of cattle the market wanted and for not adequately reflecting the value of higher quality, good conformation cattle. Research at Teagasc Grange, led by Dr Michael Drennan, established the effects of a change in cattle carcass conformation and fat score on carcass value. In the research, carcasses of over 500 steers, 115 young bulls and 40 heifers representing the various sections of the carcass classification grid for conformation and fatness were completely dissected and proportions of meat, including individual meat cuts, fat and bone were determined. Carcass wholesale value

was established. Regression analysis was used to ascertain the relationships between carcass value and conformation and fat scores. This research provided the scientific base underpinning the new beef carcass quality payment scheme that was introduced in Ireland. This payment scheme now rewards farmers for producing cattle with better conformation and appropriate fat cover with carcass grades based on a more differentiated 15-point scale instead of the old 5-point scale.

Deciphering the mechanisms responsible for poor cow fertility
Dr Stephen Butler

A novel Holstein cow genetic model of fertility has been generated at Teagasc, Moorepark. Holstein cows with similar genetic merit for milk production traits, but with divergent genetic merit for fertility traits were identified from the national herd. These animals were representative of the top quartile of the Irish national herd in genetic merit for milk production, but had either good genetic merit for fertility traits (Fert+) or poor genetic merit for fertility traits (Fert-).

Fert+ cows had improved reproductive performance during the breeding season, maintained greater body condition score (i.e., more body reserves) and had greater circulating concentrations the key metabolic hormones insulin and insulin-like growth factor-I during lactation compared with Fert- cows. After ovulation, Fert+ cows developed a larger corpus luteum and had greater blood concentrations of progesterone compared with Fert- cows. Interestingly, more Fert- cows ovulated without showing any behavioural signs of heat compared with Fert+ cows, and more Fert- cows failed to ovulate after displaying signs of behavioural heat compared with Fert+ cows. It is likely that these differences represent key mechanisms responsible for subfertility in the Fert- cows.

Grass Selection Index
Dr Michael O'Donovan and Dr Mary McEvoy

An economic index has been developed to ranked grass cultivars based on their total economic merit within a grass-based production system. The index applies economic values to traits of economic importance. The traits selected are expressed on an annual profit (€)/ha: spring, mid-season and autumn grass dry matter (DM) yield (€/kg DM), grass quality (€/unit DMD), first and second cut silage yield (€/kg DM) and sward persistency (€/% change in persistency). The Moorepark Dairy Systems Model was used to estimate the economic value of the traits identified. The effect of a unit change in each trait was calculated by simulating a unit change in the trait of interest while holding all other traits constant. The base scenario had fixed cow numbers and fixed land area (40 ha) and assumed an annual DM yield of 13 t DM/ha. The economic values generated on a per ha per year were: €0.152/kg DM spring, €0.030/kg DM mid-season, €0.103/kg DM autumn, the quality value was €0.001, €0.008, €0.010, €0.009, €0.008 and €0.006 per unit change in DMD for the months of April, May, June, July, August and September, respectively; €0.033/kg DM 1st cut silage, €0.023/kg DM 2nd cut silage and -€4.96 per one per cent decrease in persistency. The Department of Agriculture, Food and Marine are working closely on this project with the view of applying the economic values to their generated recommended list.

Crossbreeding the dairy herd
Dr Frank Buckley

The ideal cow for Ireland is one that efficiently delivers high milk solids from grazed grass and continues to go back in calf year on year. Teagasc has evaluated the merits of crossbreeding our national Holstein-Friesian cow population with breeds such as Montbeliarde, Normande, Norwegian Red and Jersey. The Jersey and Norwegian Red (crossbreds) have proven to be most compatible in an Irish seasonal grass-based production environment. A large on-farm study, involving 46 commercial dairy herds over three years confirmed the advantages of crossbreeding with Norwegian Red. This study demonstrated substantial improvements to reproductive efficiency (e.g., six week in-calf rate +15%) and udder health (-25,000 SCC/ml) with Norwegian Red×Holstein-Friesian compared to pure Holstein-Friesian, without compromising production potential. Concurrently, research at Ballydague highlighted that crossbreeding with Jersey will give a significant improvement to milk composition (+0.7% fat and +0.3% protein), annual milk solids output (+13kg) and feed/production efficiency (+10%). Reproductive efficiency was also markedly superior with the Jersey crossbred cows (e.g., six week in-calf rate +16%). Economic analysis indicated superior profit (per lactation) for both Norwegian Red × Holstein-Friesian and Jersey × Holstein-Friesian compared to the pure Holstein cows, equating to approximately +€13,000 annually on a 40 ha unit. These results suggest that crossbreeding with high genetic merit Norwegian Red or Jersey sires can increase the profit/sustainability on Irish Holstein-Friesian herd.

Animal transport
Dr Bernadette Earley

There is strong public interest and scientific endeavour aimed at ensuring that the welfare of transported animals is optimal. Teagasc conducted a series of studies to evaluate effects of: 1) stocking density, journey duration, on the welfare of cattle transported within Ireland, and 2) transport by land and sea journeys (roll-on roll-off ferry and walk-on walk-off ferry) of (i) weanling heifers from Ireland to Spain; (ii) weanling bulls from Ireland to Italy; and (iii) bulls from Ireland to the Lebanon. Physiological, haematological and immunological parameters were used to determine the welfare status of animals, before, during and after the respective transport journeys. It was concluded that there was no evidence to suggest, under the conditions applicable to the transport studies, that transport adversely affected the performance of animals post-transport. There was no welfare advantage in transporting bulls at 1.27m^2 versus the standard stocking density of 0.85m^2 for a 250 kg animal on a 12-hour road journey. Within the conditions of the transport studies, and based on the measurements that were made in assessing the welfare of control and transported animals, transport had no adverse effect on animal welfare. Teagasc research findings on animal transport has contributed directly to regulations on animal transport; e.g., on 5 January 2007 a new EU rule (Council Regulation (EC) 1 of 2005 on the protection of animals during transport and related operations) on the protection of animals during transport came into operation. The Council Regulation was given legal effect in Ireland by the European Communities Regulations 2006 (S.I. No. 675 of 2006).

Researchers at Teagasc were part of the international Potato Genome Sequencing Consortium, whose findings were published in *Nature*.

Crops, Environment and Land Use Programme

Paddy Browne
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The aim of the Teagasc Crops, Environment and Land Use Programme is to develop and transfer cost-effective crop production systems, along with evidence-based knowledge to support and underpin the development of an environmentally sustainable, competitive and profitable agri-food sector. In this short article we outline some of the key activities of the programme.

Monitoring plant pathogen populations

Dr Steven Kildea

Sitting on the north western edge of Europe Ireland enjoys a mild maritime climate. These climatic conditions are a major factor in ensuring Irish cereal yields are consistently amongst the highest globally. Unfortunately, it is these same conditions that provide the ideal conditions for the spread and development of cereal pathogens. Currently, routine fungicide applications are required to prevent yield losses associated with cereal diseases. With such reliance upon fungicides the emergence of resistance to them amongst their target pathogens represents a serious problem to the economic viability of cereal production in Ireland. To address this issue a fungicide sensitivity monitoring programme targeting the major pathogens has been ongoing within the Crops, Environment & Land Use Programme since 2002, using high throughput microtitre plate assays coupled with molecular identification. In early 2009, a new strain of *Septoria tritici* was detected with increased insensitivity to two of the most commonly used triazoles. Its early detection allowed revised fungicide strategies to be developed to delay its spread, whilst maintaining high levels of disease control in the field.

David Ryan, Agricultural Catchments Team, flow gauging in Castledockerrell, Co. Wexford.

Sequencing the potato genome

Dr Dan Milbourne

Diseases such as late blight are the biggest constraint on potato production, and world-wide, cost billions of Euro in control measures and crop losses, so breeding potatoes with natural resistance to multiple diseases is important. Potato breeding involves crossing parents with complementary traits and evaluating the progeny for fifty characteristics over a ten-year period, gradually throwing away those not deemed suitable. After a decade, from several hundred thousand progeny seedlings from crosses between different pairs of parents, one or two varieties are selected. A major limitation of this is that we're only able to combine resistance to two or three diseases every ten year cycle of selection, making resistance breeding difficult. Disease resistance is encoded by a specific class of genes, called R-genes. We have recently helped to sequence the potato genome and now know where almost all of the approximately five hundred R-genes in potato are. We use this information to develop DNA-based genetic markers for the genes, allowing us to select resistant seedlings earlier and more accurately. We're using these markers to develop strategies that can combine resistance to different diseases in three-year cycles rather than ten. Multi-resistant varieties produced in this way will save millions of Euro, reduce inputs of pesticides and fungicides, and secure the future supply of the third most important crop species in the world

Genomic studies aid understanding of a new mushroom virus

Dr Helen Grogan

Two genomic technologies (Next Generation Sequencing and whole genome microarrays) are being employed to fully characterise the double-stranded RNA (ds-RNA) viruses associated with the disease known as Mushroom Virus X (MVX) and to understand the host responses and mechanism of symptom development. Diagnostic quantitative-PCR tests have shown that viral transcript level increases approximately 100-fold in the compost during the 17-day period before cropping. Microarray analyses have identified transcripts differentially expressed in MVX infected and non-infected samples. In addition, *Agaricus* mycelium growing in compost had 18.7% of its genes showing increased levels of expression and 19.1% with reduced expression during MVX infection while surprisingly small numbers of genes showed increased or reduced levels of expression in mushroom fruitbodies (<1%). This suggests an interaction between the viral elements and different mushroom tissue types. We know that MVX-infected mushrooms sometimes exhibit symptoms of brown colouration, however, the transcriptomic data reveals that the activity of two tyrosinase genes, which are normally associated with mushroom browning, were massively reduced in MVX-infected fruitbodies. Thus the mechanism of browning in MVX-infected mushrooms is different to that due to other pathogens. As a result of this work more sensitive diagnostic tests are being developed to enhance MVX detection in mushroom compost, aiding the detection and control of costly MVX outbreaks.

Broadleaf silviculture research

Dr Ian Short

Broadleaf silviculture research carried out by Teagasc and funded by COFORD (Council for Forest Research and Development) has been used to formulate tending and thinning protocols for use in forest management. They have also been used to inform Forest Service grant aid. Published by Teagasc as the "Silvicultural Guidelines for the Tending and Thinning of Broadleaves" (Short and Radford, 2008) they have been well received by industry. The guidelines have been downloaded from the Teagasc Forestry website more than 20,000 times since the beginning of 2010. Research continues to inform guidance. Teagasc Forestry Advisors receive the latest available information from broadleaf silviculture research conducted by Dr Ian Short. Together they have provided training to forest owners and other forestry professionals via numerous demonstration days and workshops around the country. Additional guidance materials are also available on the Teagasc Forestry website for download. Broadleaf silviculture research is a long-term process which can result in long-term impacts to broadleaf forests and farm-forest incomes. The close association of the Teagasc Forestry researchers and advisors ensures that the best practices available are transferred to industry in appropriate ways to maximise their uptake.

Agricultural Catchments Programme

Dr Ger Shortle

The Agriculture Catchments Programme, an integrated research/advisory project, evaluates Ireland's Nitrates Action Programme (NAP) and supports environmentally and economically sustainable farming. With farmers' support and co-operation it operates in six catchments, which represent important farming/nutrient-loss-risk scenarios.

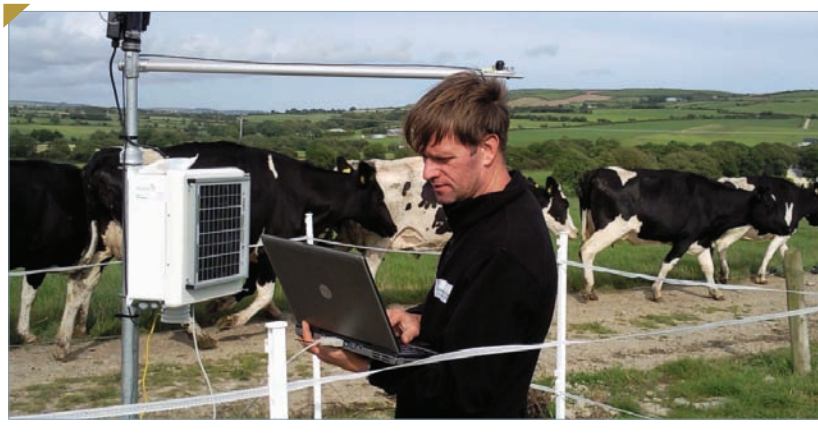
The same experiment is implemented in each catchment based on the concept of a continuum from nitrogen and phosphorus sources to potential mobilisation via pathways and delivery to water bodies where an impact may or may not occur. Understanding this continuum and the socio-economic background on catchment farms is the key to revealing the processes governing the fate of the nutrients.

Phase 1 results indicate that intensive farming can, potentially, deliver good water quality; however, we can expect substantial lag times between farm practice changes and reduced risk to water quality. In the meantime rigorous implementation of the current NAP measures is critical to the attainment of production and environmental goals.

Phase 2 of the programme (2012-2015) builds on Phase 1, delving deeper into the nutrient continuum, demonstrating sustainable farming and how it can be improved. Using the Programme's platform of high resolution data and collaboration within and outside Teagasc, Phase 2 aims to maximise the benefits to Irish farming and catchment science worldwide.

A climate for change

Mark Gibson and Dr Rogier Schulte



Dr Per-Erik Mellander, Teagasc Researcher, downloading weather data in Timoleague, Co Cork.

The climate change narrative in Ireland has moved rapidly from why each sector of the economy should reduce their carbon footprint to how, and at what cost. There is now a consensus that measures must be put in place to reduce greenhouse gas (GHG) emissions from the sector.

Recently, Teagasc published an in-depth analysis of a number of proven measures to reduce GHGs on Irish farms. The outcome of this process was an assessment of the impact and cost of each measure; thereby enabling policy makers to make important decisions on how the agri-food sector can respond to the climate change challenge.

At a farm level, efficiency is key to reducing GHG emissions. Teagasc has developed a web-based tool called the 'Carbon Navigator'. This practical tool offers farmers a novel way of benchmarking their farms against others. It provides a list of carbon friendly measures that farmers can implement. The 'Carbon Navigator' will be an important advisory support tool for the industry.

Teagasc and the EU Joint Programming Initiative on Agriculture, Food Security and Climate Change are jointly hosting the'Great Debate on the Battle to Feed a Changing Planet' at the Euroscience Open Forum 2012 (see p 18).

Food Research Programme

The Teagasc Food Programme is located across two centres at Ashtown, Dublin and Moorepark, Cork, and is a highly applied research programme which has earned an international reputation based on its quality and scientific output. The programme produces over 150 peer review publications and interacts with 300 companies per annum. It has a seamless relationship with University College Cork, which has recently been formalised as the UCC/ Teagasc Alliance or Food Innovation Alliance Ireland as it is now called. The following is a brief outline of some of the recent achievements of the food programme.

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Meat

In meat, Teagasc has developed a research capability that spans from animal genetics and breeding to meat quality and meat tenderisation. Meat quality is primarily affected by post-mortem factors. Research has focused on chilling regimes, hanging methods, hot-boning and muscle restraint technologies, electrical stimulation and their interactions. A palatability grading model developed by Meat Standards Australia, for predicting consumer scores from pre- and post-mortem factors was tested on Irish beef and Irish consumers. Results show it fits sufficiently well for the Irish industry as a means to guarantee the eating quality of Irish beef. In collaboration with University College Dublin, an imaging method was developed for predicting the eating quality of steaks and even better results have been achieved using hyperspectral imaging. Applications of genomic (microarray, high-throughput SNP analysis), proteomic (2DE, DIGE, MS) and metabolomic (NMR) platforms in meat quality studies have greatly augmented our knowledge and appreciation of molecular pathways and processes underpinning quality traits. Using these platforms, insights have been gained into the molecular mechanisms behind fat deposition, glycolytic potential and tenderness development. More than 200 novel DNA polymorphisms have been characterised in candidate genes and over 100 tested for association with Irish beef and pork quality. New associations have been identified with tenderness, intramuscular fat and drip loss traits in pork and beef, and additional published associations have been validated.

Dairy

Cheese research covers the development of new cheese varieties, development of improved ingredient cheeses and improvement in process efficiency. Total cheese production in Ireland was worth more than €500m in 2010, where Cheese accounted for 30% of whole milk utilisation. Research at Teagasc includes capability in physico-chemical, rheology, techno-functionality and microstructure characterisation, cheese flavour-mapping and sensory analysis, cheese microbiology and biochemistry during manufacture and ripening. Teagasc has developed a new cheese technology platform-based manufacturing process from concentrated reassembled milks prepared using novel dairy proteins. With respect to cheese microbiology, Teagasc has now amassed a culture collection of over 8,000 bacteria which include a large variety of starter and flavour-enhancing bacteria. One

example of the latter is *Lactobacillus helveticus* DPC4571, an organism originally isolated from Swiss cheese. In a landmark study (Callanan *et al*., 2008), Teagasc researchers completely sequenced the entire genome of this organism which suggested how the organism had evolved in the milk environment through a process of selective gene loss and insertional sequence acquisition. Development of a range of new and enhanced dried dairy ingredients has been identified by the industry as a key challenge to be overcome if Ireland is to fully exploit new and emerging markets, many of the more dynamic of which are in Asia. Much of the research at Teagasc is devoted to the development of 'smart' ingredients, i.e., dried ingredients which when reconstituted have some added functionality. Primarily, these are ingredients in which the innate protein chemistry has been modified to deliver new or improved powder reconstitution properties. These base ingredients can have unique functional properties for use in cheese and/or nutritional beverages or be supplemented. An example of the latter is the development of dried yoghurt powders containing up 5 x 10^8 probiotic bacteria per gram (Kearney *et al*., 2009). Coupled with ingredient research, Teagasc expertise in dairy process technologies are among the major factors which have led to the development of a unique research programme on infant formula.

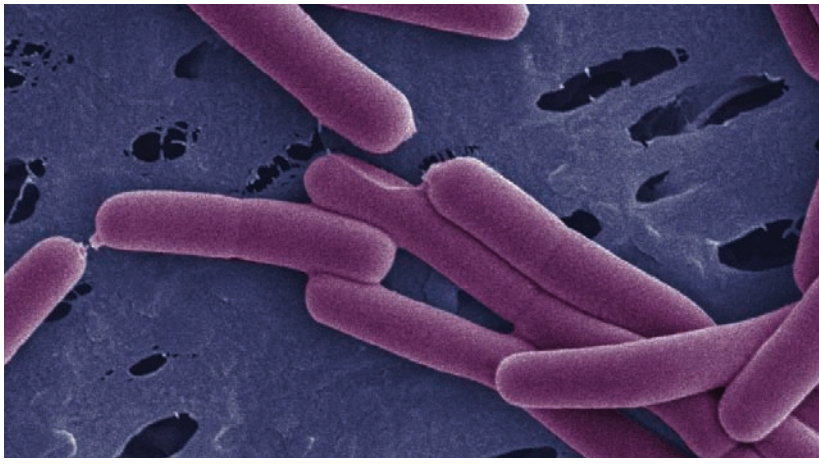
Cereals

In cereals, research is targeted at the development and transfer of enabling science and technology to support the bakery industry's needs. Research currently concentrates on wheat and wheat-free products for new 'healthy' formulations, micro-structural elucidation of novel functional extruded snacks, baked products, staling kinetics, mechanical properties of cereal-based goods, and chemical/*in vitro* characterisation of new formulations.

Food Safety

The food safety research programme addresses microbial and chemical contaminants along the farm to fork chain. A major focus of the microbial research programme is on Verocytotoxigenic *E. coli* (VTEC), a pathogen that is particularly virulent with potential to cause bloody diarrhoea, kidney failure or death in infected individuals. While *E. coli* O157 is the most notorious VTEC, more recently other serogroups (*E. coli* O26, O103, O111 and 0145) have also been linked to human illness. Recent research by the group has focused on detection, transmission and virulence of emergent VTEC in the meat and dairy chain. They have developed capability in real time PCR detection of emergent VTEC, genetic fingerprinting, virulotyping and gene expression. The group has also developed novel bio-control strategies against VTEC in the beef chain including the use of bacteriophage (Rivas *et al*., 2010), essential oil extracts (Carvacrol), and Shellac (a hide bacterial immobilisation agent). This knowledge is supporting risk management of the pathogen at national and international level and the group have contributed to national and international working groups on VTEC at the European Food Safety Authority, WHO/FAO, Health Canada and USDA–FSIS.

In the area of chemical contaminants, recent research has focused on the important area of anti-parasitic drug residues. Anti-parasitic agents are commonly administered during animal production but there has been a gap in monitoring these agents in foods due to a lack of suitable methodology. As part of EU Framework project ProSafeBeef, co-ordinated by Teagasc, the food safety team has developed a novel mass spectroscopy-based method (LCMS/MS) to simultaneously detect 38 different anthelmintic residues in food. The method has been validated according to international standards (2002/657/EC), and use of this assay has also led to the setting of a new European regulation for maximum permitted levels (MRL) of these particular drug residues in milk in Europe in 2010.



Electron micrograph of *Lactobacillus helveticus* DPC4571

Food for Health

Teagasc is involved in a number of collaborative programmes in Food and Health including the Alimentary Pharmabiotic Centre (APC), Food for Health Ireland (FHI) NUTRAMARA, ELDERMET and INFANTMET. The mission of the APC is to explore the role of the gut microbiota in human health and how it is programmed by food. Notably, APC is a seamless collaboration with University College Cork and was recently ranked second in the world in probiotic research by Thomson Reuters. Probiotics are live bacteria, which when ingested into the body have associated health benefits in humans. An example of research from the APC is the demonstration in animal models that an ingested probiotic bifidobacteria can act on dietary fatty acids in the gut, and lead to changes in the lipid composition of organs such as the liver, adipose tissue and even the brain. These changes include increases in CLA and omega-3 fatty acids in the liver and brain, respectively (Wall *et al*., 2012). Thus, the effects of probiotics can be seen in other tissues of the body beyond the gut. Another example from APC research is the discovery and exploitation of a number of new antimicrobials or biopreservatives. Two examples are lacticin 3147 and thuricin CD (Rea *et al*., 2010) – both of which are highly unusual peptides with potent antimicrobial activity against a variety of pathogenic bacteria.

The examples outlined in this manuscript serve to highlight the role of the Teagasc Food Programme to serve as a pipeline of innovation and discovery which will aid economic success in our agri-food industry as it enters a period of rapid expansion in the coming decade.

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Rural Economy and Development Programme

The aim of the Teagasc Rural Economy and Development Programme is to help decision making by stakeholders of Teagasc through research and knowledge transfer activities. In this short article we outline some of the key activities of the programme.

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Teagasc National Farm Survey

Underpinning much of the analysis and modelling of the programme, is the Teagasc National Farm Survey (NFS) which has been collected annually since 1972. It is a random, nationally representative sample of approximately 1,000 farms and collects detailed financial and farm management data. It is the Irish component of the EU Farm Accountancy Data Network, which is harmonised across Europe, facilitating an international comparison of the performance of agriculture. As the official statistical source on the economic performance of farms, the data collected by the NFS have been used extensively over the years for many purposes. Economists in Teagasc and other institutions have used the data to chart the performance of farms, measuring productivity, efficiency, farm investment and the adoption of technology. NFS data has also been used for policy analysis, and the capability to demonstrate the impact of a policy reform on the full population of farms has been critical in informing debate. Recent methodological improvements have improved the efficiency of delivery and management of the data and have allowed for linkages to administrative, geographic and environmental data.

FAPRI-Ireland partnership

The FAPRI-Ireland partnership was established in the mid-1990s between Teagasc and the University of Missouri Food and Agricultural Policy Research Institute (FAPRI) to develop economic models to quantify the effect of policy reform on agricultural markets and farm income in Ireland. Teagasc developed the FAPRI-Ireland aggregate and farm-level models. Given the strong export orientation of Irish agriculture, these models are linked to the FAPRI models of international commodity markets. The aggregate model is a model of the Irish agricultural sector and can consistently assess the effect of a policy reform on global, European and Irish markets. The model is used to produce projections of commodity prices, input costs and outputs, which are then applied to NFS data using the farm level models to assess the effect of policy reform on farm income and employment. They have been used to examine numerous policy questions including the decoupling of direct payments, WTO trade agreements, expansion of the EU milk quota, national strategy planning such as the Department of Agriculture Food and the Marine's *Food Harvest 2020* and, more recently, environmental policy. The FAPRI-Ireland models play a central role in the policy formation process by providing timely, evidence-based information.

The Teagasc eProfit Monitor

The Teagasc eProfit Monitor (ePM) is a farm business financial analysis system and decision-support tool. It allows for whole farm and individual enterprise analysis of output, costs and profit using standard measures presented in a standard format. This allows farmers and their Teagasc adviser to identify strengths and weaknesses in farm business performance and allows benchmarking of key financial measures. The ePM is available via the web, with data held centrally with secure access. Regular updates are carried out and include increasing the database and data processing capacity, increasing to almost 5,000 in 2012. Demand for the system is high due to the emphasis placed on farm financial analysis in *Food Harvest 2020* and is a key requirement for participants in the Dairy Efficiency Programme and the Beef Technology and Adoption Programme. The ePM allows users to link with data from other sources such as the Irish Cattle Breeding Federation (ICBF).

Innovation studies

Developing capabilities and use of best practices and technologies is critical to increasing employment, income, and profitability. Through national and EU funding, Teagasc examines innovation at farm and firm level. At farm level, it focuses on the agricultural knowledge and innovation system (AKIS) and seeks to understand the innovation systems that support farmers' capability building and their technology adoption, as well as the extension mechanisms and activities through which Teagasc interacts with its clients. At firm level, the focus is more on technology transfer and understanding barriers to interaction between researchers and industry, and on understanding how companies organise themselves to support innovation. Research is ongoing, in an EU project, NetGrow, to understand how networking by firms influences their innovation performance. Overall, the outputs of this research are practical tools for farmers, firms, extension agents, and support agencies, as well as policy recommendations. Achievement of sectoral strategic goals is dependent on improving strategic marketing performance. Food market and consumer research is conducted using qualitative and quantitative research techniques to support new product development and market orientation by food companies and the design of food sector support services and policy measures by public bodies. Furthermore, much of this research is fundamental to the Teagasc food research programme ensuring such research is market-oriented and providing a foundation for research commercialisation.

Spatial analysis

Spatial analysis research, comprising Geographic Information Systems (GIS), earth observing (EO) and remote sensing (RS) technologies, provides a powerful platform for the comprehensive analysis of all land–based activities at the interface between the agri-food sector, economy and the environment. A key strength of GIS/EO is the potential for integrated analysis across all scales from the field to farm right up to national level. New methods of analysis and the collection, archiving and distribution of spatial data on issues affecting the agri-food industry and the rural economy are being developed and applied. Current research using RS technologies in space and on board aircraft is seeking to integrate real measurements of farm performance and output into Teagasc farm models, to map areas of high biodiversity and to make 3D-derived measurements of biomass contained in hedgerows and woodlands. Spatial analysis seeks to equip stakeholders with the knowledge to achieve high farm output and excellent agri-environmental quality while providing evidence-based knowledge to support policymakers in designing, implementing and evaluating programmes.

Rural Development research

Rural Development research is concerned with improving our understanding of economic development in rural Ireland. It primarily focuses on changes affecting farm enterprises and farm households and exploring their implications for the broader rural economy. It applies spatial analysis and microsimulation methods to capture the interconnections between farms, farm households and whole sectors of agriculture in the context of societal process of change operating at local, regional and global levels in order to simulate the impact of socio-economic and policy changes at the local level. Recently completed studies identified the geography of rural economies and explored changes in off-farm employment arising from the downturn in Ireland's economy. Current research is exploring the local impact of the Agri-Food sector in Ireland using the Simulation Model of the Irish Local Economy (SMILE) and farm operator's attitudes and capacity for diversification. This research has been developed in partnership with Local Development Companies, with funding from national and European sources.

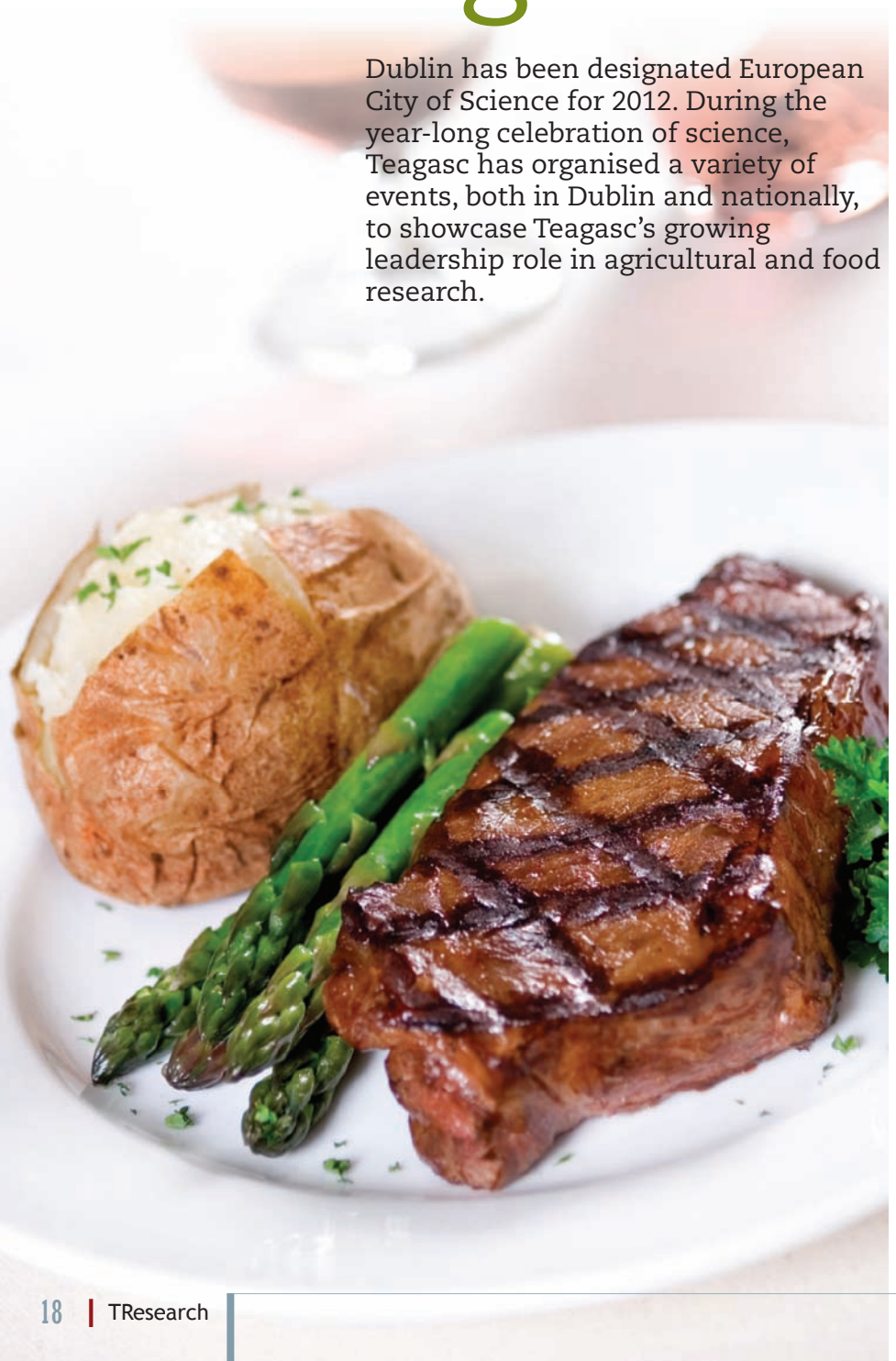
Teagasc Options Programme

With around 40% of Irish farmers classified as economically vulnerable, a key goal is to encourage the development of alternative income sources. The Teagasc Farm Options Programme aims to facilitate farm households to exploit the full potential of their farm resources by focusing on the financial position of their farm and exploring on and off-farm opportunities. The programme is implemented through a series of nationwide "Farm Options" courses, which allow participants to examine their household situation and provides them with new thinking and ideas on a variety of diversification ideas. About 600 people annually participate in 13 courses held throughout the country. The courses are run by Teagasc specialist advisors, local advisors and successful farmers/entrepreneurs with farm diversification ideas. Local development companies provide important possible funding and development support for participants. Teagasc has developed a "Decision Tree" decision-support tool which aids farmers in exploring these issues in an interactive way and helps them to focus on improving farm household planning.

The author acknowledges the contribution of many colleagues in the programme to this overview.

Teagasc @ESOF2012

Dublin has been designated European City of Science for 2012. During the year-long celebration of science, Teagasc has organised a variety of events, both in Dublin and nationally, to showcase Teagasc's growing leadership role in agricultural and food research.



The designation of Dublin as European City of Science for 2012 is a commendation of Ireland's continued investment in science. As Ireland's leading agri-food research organisation, Teagasc is proud to sponsor Dublin City of Science 2012 and is organising a major programme of scientific events during the year in support of the City of Science programme.

The highlight of the year will be the Euroscience Open Forum (ESOF 2012), which will be held in The Convention Centre, Dublin, between July 11–15. This event will bring together 6,000 scientists, business leaders, government officials and members of the international media to discuss the best of European science and to address all of the major global challenges, including energy, climate change, food and health.

The City of Science year will also see a programme of other science-related events all around the country. This programme will embrace a wide range of events designed to encourage the public to engage with science. Teagasc is contributing to this programme by way of a series of conferences, workshops, exhibitions, schools visits, etc. These events will be branded with the City of Science logo and will be promoted through Teagasc's City of Science web page.

A Harvest of Irish Food

In the run-up to ESOF 2012, Teagasc in partnership with University College Dublin (UCD), Dublin Institute of Technology (DIT), Trinity College Dublin (TCD), Bord Bia, Enterprise Ireland and the Irish food industry will host 'A Harvest of Irish Food' on July 10. This day-long event will showcase the unique combination of Irish food culture and tradition with the best underlying food science and technology.

Attendees will start the day with an early morning Irish summer breakfast at Teagasc Ashtown, where Aidan Cotter, CEO of Bord Bia (the Food Board), will present on the sustainable attributes of Irish food production and Professor Gerry Boyle, Director of Teagasc, will outline the role of science-based innovation in developing the Irish food sector.

This will be followed by a series of research demonstrations, showing how Ireland's high quality raw materials are converted into food and food products.

After breakfast, delegates will visit UCD to hear about aspects of the 'science of personalised nutrition', with presentations outlining research at UCD in the area of targeted nutrition and the development of food products based on this research. Interactive workshops will outline the practical applications of the research. A buffet lunch will be provided during the UCD programme, which will showcase Irish food at its freshest and best. Following on from UCD, attendees will learn about, the 'past, present and future of food' at DIT. This will include: a talk on the history of Irish food production; an interactive showcase and tasting of current Irish food products; and, a presentation on research and development of food products in areas such as molecular gastronomy and nutraceuticals.

The day will conclude with an Irish dinner in Trinity College Dublin's famous dining hall. Hosted by Bord Bia, the menu will showcase the best of Irish produce sourced from sustainable and quality assured farms and artisan producers.

Milk: Nature's Perfect Food

On July 12, as part of the ESOF 2012 Science programme, Teagasc has organised a scientific session on the subject 'Milk: Nature's Perfect Food' at The Convention Centre, Dublin (10.45am-12.15pm). The event will include a series of presentations that will report on the extensive health benefits associated with milk consumption, as well as demonstrating how modern processing technologies can be exploited to maximise these benefits. The event will seek to convince the consumer as to the scientific validity of these claims.

Milk is a complete food that has evolved with each mammalian species to reflect the particular environmental conditions and evolutionary demands of the young of that species. Humans have exploited this valuable resource since the dawn of the agricultural revolution, developing technology to preserve it and an array of milk-based foods now common in the diets of most human cultures. In addition to milk's base nutritional composition, research is revealing that there are a multitude of additional benefits of milk, undoubtedly many of which remain to be discovered. Foremost in the public mind is the fact that milk is an excellent source of dietary calcium, while milk proteins are an excellent source of essential amino acids for human nutrition. In addition, milk proteins and their encrypted peptides have been associated with a range of unique biological functions, such as improved absorption and tissue delivery, gut health, optimum growth and maturation of intestinal cells, suppression of deleterious and pathogenic bacteria, elimination of bacterial and viral toxins and development of the immune system. Milk carbohydrates support the growth of beneficial gut flora and have been associated with a range of other positive health attributes.

The Great Debate on the Battle to Feed a Changing Planet

On July 13, Teagasc, in association with the EU Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE – JPI), have organised 'The Great Debate on the Battle to Feed a Changing Planet' at The Convention Centre Dublin (13.30pm-15.00pm). An international panel of high-profile speakers - including Professor Rajendra K. Pachauri (Nobel Laureate), Chairman, Intergovernmental Panel on Climate Change; and Mrs Marion Guillou President & CEO, INRA - Chair of FACCE-JPI GB - and moderated by broadcaster Leo Enright, will engage and raise awareness among not only a live audience, but also media and the public outside the auditorium, on one of the most challenging scientific topics of the 21st century: how to simultaneously achieve global food security while also combating the effects of food production on climate change. With food demand expected to increase by 70% by 2050 and calls to reduce greenhouse gas emissions by 50% at the same time, many hard decisions will be required from interested parties, including policy makers, producers and consumers.

The debate will maximise its impact potential through modern media, encouraging interactive audience participation from both inside and outside the auditorium through its Twitter account (@thegr8deb8). Delegates will hear from African farmers, who will discuss what food security and climate change mean to them every day.

The international panel of high-profile speakers will tease out some of the leading topics on food production this decade:

- 'Will we starve or will we burn?' Can the world grow food at affordable prices and deal with climate change?
- 'Cool Food?' Can consumer choices make a difference?
- 'Plough our own furrow?' Can Europe go it alone on climate change if others won't follow?

Dublin's year as European City of Science 2012 is a great opportunity, not only for Dublin, but, for the country as a whole to demonstrate the ongoing research and development in science. With agriculture and food playing such a vital role in Ireland's economy today, Teagasc is proud to demonstrate to a national and international audience of scientific peers, as well as consumers, the continuing efforts and advances of the industry.

Web Links

To register for ESOF 2012 events: http://esof2012.org/
More on Dublin's City of Science: www.dublinscience2012.ie/
Teagasc's City of Science and ESOF 2012 event details: www.teagasc.ie/events/cityofscience/


dublin city of science2012
THE UNIVERSITY OF CALIFORNIA
DAVIS
ESOF2012
DUBLIN
The Convention Centre Dublin
Wicklow Meeting Room 2
July 12, 2012 at 10.45am
MILK
Nature's perfect food?
Debate on the science behind milk and dairy products and their effect on human health
Nutrition: see how milk has evolved over millennia to provide complete nourishment for the young
Health: enter a lively debate on the health aspects of milk: everything from infant milk formula to traditional butter
Milk intelligence: discover the hidden secrets of milk bioactive constituents
Ireland's Great White Hope – 2020 will see us produce 50% more milk but what will we do with it?
Registration
http://esof2012.org/programme/esof-2012-registration/
eagasc
Agriculture and Food Development Authority

'THE GREAT DEBATE'

ON THE BATTLE TO FEED A CHANGING PLANET

THE CONVENTION CENTRE DUBLIN
[Great Auditorium]
13 JULY 2012
AT 13.15

Can we beat hunger and climate change? How can we curb greenhouse gas emissions from food production and at the same time provide access to affordable food for everyone? Achieving both goals simultaneously will require hard and controversial choices. How can we be sure we make the right ones?

...food production will need to increase by 70% by 2050.

...emissions must be reduced by more than 50% by 2050 to avoid irreversible climate change.

HEAR

An international panel of high-profile speakers will debate the hot topics of this decade:

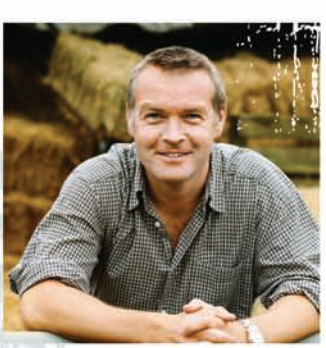
- **'Will we starve or will we burn?'**
  Can the world grow food at affordable prices and deal with climate change?
- **'Cool Food?'**
  Can consumer choices make a difference?
- **'Plough our own furrow?'**
  Can Europe go it alone on climate change if others won't follow?

SEE

Farmers from Africa feeding in live from their farm, explaining what food security and climate change mean to them every day.

JOIN IN

Join the debate from the audience, by Twitter, by email, or by text, or follow us live online.



CONTACT

TheGreatDebate@teagasc.ie

Organised by the Joint Programme Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) and Teagasc.

http://www.faccejpi.com/FACCE-JPI-Home/FACCE-JPI-News/The-Great-Debate

Twitter: @thegr8deb8

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Agriculture and Food Development Authority

FACCEJPI

ESOF2012

Ireland's food and drink industry

The Irish food and drink industry is playing a large role in Ireland's economic recovery and will continue to do so if given the support to innovate, says Paul Kelly, Director, Food and Drink Industry Ireland.

Paul Kelly,
Director, Food and Drink Industry Ireland, Irish Business and Employers Confederation.
Correspondence: paul.kelly@ibec.ie

Ireland's food and drink industry and our economic recovery are tightly intertwined. The sector is embedded in Ireland's economic and social fabric and, indeed, every household in the state like no other. When it does well, Ireland does well.

For example, food companies supply the majority of Ireland's €14bn domestic grocery and food service market and, last year, they generated almost €9bn in exports to over 120 countries - with a higher percentage of export earnings retained in our economy than from any other sector. In doing so, these companies provided or supported over 230,000 people working in the wider agri-food sector; about 1 in 8 of those at work today in Ireland.

In short, Irish food and drink companies have significant ambitions to capitalise on the sustained increase in demand for food arising from a growing global population. Innovation will be the key enabler for companies seeking to meet this demand. The vision of the Department of Agriculture, Food and the Marine's *Food Harvest 2020* strategy – smart, green growth – depends on companies placing innovation - in sustainable production, in processing and product development, in logistics and in marketing - as a central part of their businesses.

The *Food Harvest 2020* strategy is being driven by strong industry input - a positive innovation in policy-making in itself. Driving export growth is the central element of the strategy because every extra euro of food exported has a greater positive impact than other sectors in the economy. This is because food companies spend the equivalent of 59% of sales in the domestic economy. This compares with 19% for the rest of manufacturing.

Export market

Ireland's small domestic market has meant that Irish food companies have always sought to export. Historically, most exports went to the large UK market on our doorstep. However, a greater emphasis on value-added food products has led to growing market diversification into other EU markets and third countries.

The scale and success of Ireland's exporters are demonstrated by the following facts:

- Largest net exporter of dairy ingredients, beef and lamb in Europe
- Largest exporter in Europe of powdered infant formula
- Ireland is the UK's largest supplier of food and drink
- Over 80% of dairy and beef production is exported
- Irish beef is stocked by more than 70 retail chains across Europe
- Over half the pigmeat produced is exported – to over 60 countries around the world

To drive the innovation envisaged within the 'smart' element of *Food Harvest 2020*, food companies have developed industry-led strategic research agendas. These seek to combine the market focus of industry with the scientific capability of research institutions. In addition, they harness the perspective of the regulatory authorities and consumers' insights to create a demand-driven innovation map. The Department of Agriculture, Food and the Marine's industry-led Food Research Expert Advisory Group has overseen these important developments.

Strategic research objectives

This is a model that is also driving industry innovation across Europe. 'Food for Life', the industry-led European Technology Platform has successfully met the EU objectives of driving innovation in the sector by uniting stakeholder communities to reach strategic research objectives.

This industry-led approach has also ensured that agri-food innovation has successfully informed national innovation policy. The Irish government's recent National Research Prioritisation exercise puts forward a business case for fourteen research areas to be prioritised over the next five years. Two of the areas are food related (Food for Health and Sustainable Food Production and Processing) and a further two (Manufacturing Competitiveness and Processing Technologies and Novel Materials) are horizontal areas with a high degree of applicability to the food and drink sector.

Innovation

The food and drink sector faces many challenges in achieving the required levels of innovation at this time. Consumer sentiment is weak at home and in European export markets. This is driving down consumer spending with absolute food expenditure down by 8% since 2009. This makes cost recovery difficult in the marketplace, squeezing margins and inhibiting the ability of companies to reinvest in innovation and new product development.

To facilitate food companies, the government must continue to address our cost competitiveness. Wage costs remain above the EU average and energy costs are rising again. The harsh reality of a globalised industry is that Irish industry suffers from lack of scale at processing level compared with larger European competitors. Irish producers selling on world markets find themselves competing against much lower cost economies – Brazil, for example. Convincing food companies to continue investing in innovation is the key to growth. The potential for volatility associated with world commodity prices - and with 65% of exports going to non-Eurozone countries - is also a strong driver for value-add through innovation to minimise the risks. The government has a role to ensure that companies have the confidence and the cost base to innovate and add value.

As food companies move up the value chain, meeting and surpassing consumer trends is key to survival, placing innovation front and centre for companies. Today's consumer cares about sustainability and the safety of the food chain and these have become factors in the purchase decision. This is reflected in the strategy for smart development, which aims to increase integration across the sector, increase adoption of new technologies at primary production level and increase investment in innovation and development. Feeding into the 'sustainability' concern, *Food Harvest 2020* aims to capitalise on Ireland's reputation for grass-based natural production systems. With substantiation of these green credentials and the implementation of world class environmental practices at all levels of the agri-food industry, Irish exports will have a product differentiator that will allow companies to capture new markets.

Future direction of food

It's not just how the consumer thinks that will dictate the future direction of the food industry. With rising obesity rates and an ageing population, the interplay of consumer lifestyles with nutrition and health are shaping the future of food and driving innovation in the sector. The broad regulatory framework is now in place to address nutrition and health claims, novel foods and consumer information. The industry has spent billions in reformulating and fortifying products, new product development and consumer information, and recognises the role it can and should play in reducing obesity. Yet, it still is scapegoated and faces penalising measures including discriminatory taxation in some countries. Governments would better serve their populations by engaging with food companies in a whole of society effort that encourages innovation in partnership with research institutions and is supplemented by targeted public health interventions at at-risk groups.

Ireland's food and drink industry will continue to grow and this will be a central element of our economic recovery. The joint innovation potential of our companies and research institutions will be a key component in this growth and in continuing to deliver high quality nutritious food to consumers in Ireland and overseas.

Team work

Aidan Cotter,
Chief Executive, Bord Bia
Irish Food Board.

Aidan Cotter, Chief Executive, Bord Bia - Irish Food Board, outlines the importance of collaboration between relevant organisations, the food industry, and research bodies and institutes.

Success in the marketplace comes through having high quality, safe food, which has to be underpinned by science; and also by being able to take differentiated positions in the marketplace, which again can be facilitated through science and R&D. Our role in that space is to be the eyes, ears and voice of the Irish industry in the marketplace and, in particular, our contribution to innovation is through the consumer and market insights we deliver: it is an area we have been continually reinforcing over recent years (see panel below on consumer trends).

In addition, the *Pathways for Growth* report clearly highlighted that in order to be a successful food industry in the international marketplace we have to drive innovation, and innovation comes through entrepreneurial efforts. Food Works is an example of a programme that addresses this. We have worked alongside Teagasc and Enterprise Ireland to ensure that this programme utilises all the competencies of the three organisations, to make them available to those who want to start up a food business that has the scale to become a significant player and contribute to growth in exports.

It is important that all agencies work closely together. All the relevant agencies and organisations are very complementary in terms of what they do within the food industry. We have excellent working relationships with all agencies, including Teagasc, Enterprise Ireland and Bord Iascaigh Mhara (BIM – the Irish Sea Fisheries Board).

Sustainable food production

One of the most significant projects we have undertaken in recent years is in the area of sustainability, and the science that Teagasc brings to this area is critical. Teagasc has a very high reputation for their understanding of the science behind sustainability and that is something we have been able to exploit by working with the organisation in introducing our carbon footprint calculation programme. Bord Bia worked with Teagasc, and the Carbon Trust in UK to develop a carbon footprint calculation model, which has been accredited to the PAS 2050 standard, and has been rolled out across our routine Beef Quality Assurance audits for the last 12 months - in effect, over that period we have measured the carbon footprint of over 20,000 farms, and we continue to do so at rate of 500 every week.

Crucially, the feedback we can offer farmers in terms of their carbon footprint score and the subsequent advice we can offer to help improve efficiency and profitability is key. We have also worked with Teagasc and with Glanbia in developing a similar initiative for the dairy sector, and we now we have a dairy calculation model also accredited to the PAS 2050 standard, which is available to roll out across the 18,000 dairy farms in sector. Similar farm level programmes are planned across the entire range of primary production sectors.

Our vision is that every farmer and food business would sign up to a sustainable charter, across all sectors. Retailers are looking for suppliers that can align with their commercial strategies and offer them a point of difference. Our research has highlighted the significant opportunities that exist if the Irish food and drink sector can express its committment to delivering continuous improvement. It is about being able to demonstrate to the marketplace that we have a comprehensive approach to sustainability,

Pictured at the Pathways for Growth Food and Drink Leadership Summit are Aidan Cotter, CEO, Bord Bia; Simon Coveney, T.D., Minister for Agriculture, Food and the Marine; and Michael Carey, Chairman, Bord Bia.

which is covering the supply chain from the primary sector into processing - not just looking at the carbon footprint but also looking at issues such as water, biodiversity, waste management, animal welfare, etc. This will be implemented on a scale that no other country has so far contemplated. Participants of this programme (which was launched in June) submit independently verified progress reports and successful members will be entitled to use the 'Origin Green' logo as part of their trade marketing, communications and customer relations. In turn, Bord Bia will promote, communicate and develop trade awareness of the 'Origin Green' programme among buyers, international media and relevant stakeholders in export markets. This will help Ireland become a world leader in sustainably produced food and drink. It is intended that a target of 75% of Irish food and drink exports will be sourced from signed up members to the programme before the end of 2014.

Dairy expansion

Dairy ingredients, and high value foods are key to growing Ireland's exports. Ireland has a very strong position in the dairy sector and it is a significant player in infant formula, and much of that is thanks to Teagasc and its Moorepark Research Centre, which has an outstanding international reputation. From its inception in 1958, it has ensured our dairy industry at farm and food processing level is able to compete with the best in the world.

There is real growth in production expected post-2015 within the dairy sector and I am confident that the markets will be in place to facilitate this. The growth in world markets is underpinned by the increase in population and in the middle classes. The world's population is growing by some 75 million people a year, but the middle classes are expanding by twice that level, at about 150 million a year. So, there is more buying power coming into the marketplace and, with that, a switch to more protein-based foods and dairy products.

Clearly, everybody is conscious that a lot has to be done to ensure we remain competitive in the marketplace and at farm and processing level and that the necessary investment is enabled so that the expansion occurs and it occurs in a way that is sustainable economically.

Consumer insight

Latest research unveiled by Bord Bia as part of its Consumer Lifestyle Programme, aims to arm businesses with the knowledge to prepare for their consumers' future needs.

Fluid Lives

Life is still hectic and many consumers still find it difficult to fit everything they want into their routines. Therefore, solutions that save time or remove complexity continue to resonate strongly - convenience is still important, but it must come at the right price.

Simple pleasures

The economic crisis has resulted in changed consumer priorities. Greater value is placed on spending quality time with others and trying new things, even on a tighter budget. Indulging in small rewards and savouring moments of fun in the simple pleasures of life are increasingly important.

Responsible living

Social and environmental concerns remain high importance issues for people, even as the economic climate has become harsher. But high priority does not always mean the top priority. Affordable choices resonate with people wanting to live more responsibly – the expectation is rising that companies progress on these issues without passing on the extra cost to the consumer.

Quest for health and wellness

Health and wellness is progressively moving to the fore in consumer's food choices, as people have begun to adopt a more balanced approach to life and their diets. Consumers are also keen to maintain a level of convenience without compromising on healthy options.

Consumers in control

The financial crisis has fundamentally changed consumer attitudes, and they are smarter and savvier with their money than ever before. Food and drink continues to make up a substantial portion of people's spend, particularly as prices have continued to rise. Therefore, budgeting is now the norm for many, who wish to keep their spending in check.

Keeping it real

At the peak of the recession, brands that had stood the test of time and remained true to their values were considered points of stability in the turmoil. But as life has settled into new routines consumers expect more than a product with a strong history. Consumers are attracted by a sense of tradition but tangible benefits that have relevance in their modern lifestyles is important. Words such as 'seasonal' and 'local' becoming synonymous for quality and trustworthiness.

(Source: Bord Bia)

Driving innovation in food

Michael Cantwell,
Manager, Food Division,
Enterprise Ireland

Michael Cantwell, Manager of Enterprise Ireland's Food Division, discusses the supports in place for Irish agri-food companies, which help to promote and encourage R&D and innovation within the food industry.

Growing companies internationally is our primary target because increased exports means more jobs in Ireland. A key part of achieving this goal is stimulating research and development (R&D) within the agri-food industry and supporting innovation across the different sectors.

In order to meet the targets set out in *Food Harvest 2020*, we need to increase exports by 50%. Stimulating innovation and investing in research and development is crucial towards this goal. On average, Irish food companies do not invest as much in R&D compared to other European countries, so we are trying to bring this investment level up to international standards.

Enterprise Ireland innovation supports

Enterprise Ireland has a suite of programmes in place to ensure that this is achieved, providing supports for both companies and researchers in Higher Education Institutes, and agencies such as Teagasc, to develop new technologies and processes that will lead to job creation and boost exports. These supports include Innovation Vouchers, which offer funding of up to €5,000 for small/medium companies to engage research and development centres in Ireland and will undertake work on the company's behalf.

Enterprise Ireland also has a significant R&D Fund, which provides in-house funding for both large and small companies. Between 2009 and 2012 the amount approved for food companies in the R&D Fund was approximately €15 million. Another product is the Innovation Partnerships programme which encourages companies and higher level institutes to work together and up to €250,000 can be awarded in this scheme: over the past three years a total value of €2 million has been granted. This is a very flexible programme, allowing companies to have access to a 'dream team' from the academic community to complete market-led projects. It's a really powerful instrument in terms of being able to respond to companies in a quick and effective way.

The Enterprise Ireland Advocate programme assists companies in understanding how R&D is relevant to their business. Sector experts within the field of R&D

go out to individual companies to encourage them to incorporate research initiatives into their business activity. Applied Research Enhancement Centres are located around the country, supporting regional innovation needs and also ensuring that they can avail of the national network of research expertise across a range of disciplines.

Technology centres

One of the most significant types of industry/academic collaboration Enterprise Ireland supports are technology centres. This is where a group of companies (both indigenous and multinational) within a particular sector come together and identify a research challenge or innovation-based opportunity that they would like to explore. We work with that industry group to refine that challenge and then go out to the research community and partner with them to identify solutions. A typical investment here would be approximately €5-6 million. Food for Health Ireland (FHI) is one of the largest of these, which is dairy focused. FHI is a unique partnership between four Irish public research organisations, including Teagasc, and four major dairy processing companies. The objective is to determine how milk ingredients can be extracted and used to deliver health benefits for consumers in the areas of obesity control, immunity, infant development and healthy ageing.

Dairy is a sector well known for its innovative strides, specifically in the area of infant nutrition, functional dairy ingredients and nutritionals. It is vital that the meat industry is also committed to developing innovative solutions for the customer and consumer and we would like to replicate what we are doing with the dairy industry, through FHI, with the meat industry. The need to add value and remain competitive into the future requires significant investment in meat and Irish companies are responding accordingly. Enterprise Ireland sees potential for research into waste streams – to develop market opportunities for the 'fifth quarter' – and we believe there is significant potential to add value here.

Sourcing technologies

Companies looking for a technical solution or a new technology can also avail of our services within this area. The Enterprise Europe Network is an information source on internationally available new technologies. EEN comprises over 500 partner organisations in more than 45 countries in Europe and beyond. The Network has a total reach of 25 million SMEs. Enterprise Ireland co-ordinates the Enterprise Europe Network in Ireland in partnership with the Chambers in Dublin, Cork, Galway, Sligo and Waterford. The EEN can offer assistance in:

- identifying licensable technologies for your company;
- providing information regarding how to license out your own proprietary technology; and,
- advice on best practice for IP licensing

The technology transfer team also advise companies on protecting their interests when licensing technologies and managing intellectual property.

FP7

It is also important to highlight that Ireland is the leading European nation in terms of SME participation within the Seventh EU Framework Programme (FP7). Enterprise Ireland has a team of national contact points who work directly with companies to find suitable research partners and funding and provide financial support to put together proposals for funding within this Programme. We have been very successful as a country in drawing down EU funds, and we want to see increased level of engagement from the food industry in particular here, particularly in the marine sector, for example, and within food processing.

Overall, collaboration between the State organisations and the food industry is crucial towards supporting the agri-food industry and achieving the goals set out in *Food Harvest 2020*, and we have an excellent working relationship with Teagasc, BIM and Bord Bia. Food Works, for example, is one of the most exciting things we have done in a number of years within the area of food start-ups and it has involved bringing the expertise and services of three State organisations together – Teagasc, Bord Bia and Enterprise Ireland. We are working collaboratively to facilitate the establishment of new start-up companies in the food industry. In the past 10 years, the food industry has a history of establishing roughly three to five start-ups per annum and we expect that the Food Works initiative will increase this number significantly.

Technology services for the food processing sector

Pat Daly explains how Teagasc's Food Programme is helping Irish companies to grow and innovate

Pat Daly,
Head of the Food Industry Development Department, Teagasc Food Research Centre Ashtown, Dublin.
E mail pat.daly@teagasc.ie

Food processing is a mature but a very dynamic sector in the Irish economy. The sector consists of about 600 processing companies, employing approximately 50,000 people directly and a multiple of this indirectly at producer, catering and retail enterprises. The processing sector comprises a small number of international operators and a large number of small to medium sized food businesses (SMEs). There are also a significant number of entrants or start-up food businesses. SMEs make up a large majority of manufacturing companies in Ireland, which is similar to many other European countries. Food processing companies in general, and SMEs in particular, are located in every county in Ireland and contribute enormously to the local and regional economy in terms of employment and as a key customer and supplier link in the indigenous food supply chain. In order to maintain and expand the business and to create employment, it is essential that food businesses focus on new and export markets, be efficient, innovative and create new, improved, better value products to win the purchaser spend.

Innovation

The ability to produce a stream of new products to meet international consumer demands is often recognised as a critical success factor for Irish food companies. There has been substantial investment at national level for many years into food research and development programmes and company development initiatives. More technically advanced companies with dedicated research and development capabilities can adopt and apply food research knowledge and technologies. However, there remains significant challenges for many food companies, in particular for SMEs and start ups who often lack in-house technology/R&D capability to develop new products, understand market place requirements and, in particular, how to access new knowledge to their competitive advantage.

Teagasc recognises the challenges facing food businesses and has an applied food research programme in place and a specific SME technology-support service to help these companies innovate. Teagasc also participates in many development initiatives with other development agencies providing an integrated national support infrastructure for the food sector. Food Works is a major, recent initiative supporting early stage and start-up food businesses in conjunction with Enterprise Ireland and Bord Bia. This initiative, which was launched in March 2012, provides a cohesive support programme in food entrepreneurship, incorporating the combined supports and expertise of the three food development agencies. See www.foodworksireland.ie for details of the programme.

Food research programme

Teagasc Food Research Programme has two decades of experience in providing specialist technical development support for the food processing sector. This technology support programme is underpinned by an applied food research programme. The core research areas are in Food Biosciences, Chemistry and Technology and Food Safety. The Food Research Programme provides public good research, industry contract research and technical services, and is carried out by teams of scientists and technologists from two well-resourced research centres at Ashtown, Co Dublin and Moorepark, Fermoy, Co Cork. The latter includes a unique joint venture between Teagasc and the food industry, Moorepark Technology Ltd. Through their work, research scientists have extensive linkages with many international food research institutes.

A staff of some 180 scientists, technologists and support staff deliver the programme. Annually, Teagasc engages with about 300 client businesses, along with a wide range of research institutes, on its food research programme. A new technology transfer strategy is in place to ensure industry has effective access to research outputs and expertise.

Industry development support

The Teagasc industry development support programme is unique in that the service is provided by a team of highly qualified and experienced researchers, trainers, consultants and product development specialists working from within an applied food research environment. The core industry technology development supports are: research, training courses and scientific seminars, product development, consultancy and information services. Contract research for industry is carried out at our research centres in Dublin and Cork for a wide range of the leading food manufacturers. Trainers act as technical consultants to industry and are actively involved in the development of national food standards and policy documents on training and skills development. This gives trainers very practical experience of food standards, production practices and policy developments in the food industry. A range of specialist technical training courses are provided in food safety, food quality, technology and product development (www.teagasc.ie/food/research/training/index.asp). External expertise is availed of where necessary such as from Leatherhead Food International or Campden & Chorleywood Food Research Association. Both of these organisations are UK membership-based organisations with a deep knowledge of UK and international markets and technologies and provide a very beneficial insight into UK and international markets for Irish food exporters. A technical information service is also available to provide immediate response to enquiries from industry. All work for clients is carried out on a confidential basis.

The majority of training courses are aimed at management level and are typically attended by technical and production managers. Courses are typically of short duration (one to three days) and are developed to address a particular knowledge or skills gap such as, for example, interpretation of emerging legislation and commercial technical standards requirements. Courses are delivered at Teagasc or other centres or, in many cases, in-company.

Training initiatives

A variety of training courses have been carried out over many years to address specific industry needs, usually in conjunction with national or regional agencies such as Government departments, and the food development agencies (Bord Bia, Enterprise Ireland and the Food Safety Authority of Ireland). Examples are: regulatory inspector training, food safety trainer training, course conversion to European languages, understanding food retailer technical requirements and food safety HACCP training for industry. A number of courses are certified through FETAC (the National Qualifications Authority of Ireland qualifications framework). A number of scientific seminars are delivered each year based on outputs from the food research programme. Additionally, technology events are delivered in conjunction with industry on ingredients, packaging and equipment technologies.

Food consultancy

While training is excellent for skills development and knowledge transfer, often businesses need individual customised assistance to apply knowledge or skills to their particular situation. Teagasc scientists and technologists provide a consultancy service covering a wide range of product manufacturing technologies, food assurance and regulatory requirements.

Teagasc has a wide range of well-equipped modern food production facilities, which are regulatory approved, at our Dublin and Cork research centres for use by industry. A range of processing plant and equipment is available for all the key sectors such as dairy, meat, bakery, horticulture and prepared food products. Facilities also include food preparation kitchens. Well-equipped testing laboratories are available for new product development testing for microbiological (shelf life), chemical (nutritional) and sensory testing and trained sensory panels are available.

This facility can be used for an agreed timescale by those at start-up stage for product validation purposes, moving to a more permanent production facility when the business is more established. The facility is also very suitable for established businesses requiring access to production facilities for product development and production trial purposes.

Further information on any of the above and how to access services and expertise see: http://www.teagasc.ie/food/research/fid/index.asp

Dr Maria Hayes, Teagasc Food Research Centre, Ashtown, discusses marine functional foods with Minister for Agriculture, Food and the Marine, Simon Coveney T.D. (left) and Professor Gerry Boyle, Director, Teagasc, at Teagasc's Food Innovation Gateways exhibition.

Gateways to technology transfer

Declan Troy, Assistant Director of Research and Head of Technology Transfer.
E-mail: declan.troy@teagasc.ie
Dr Miriam Walsh, Head of Intellectual Property

Teagasc's Technology Transfer Office supports, facilitates and enhances the transfer of research outputs including intellectual property, capabilities and related information between Teagasc and the business community and other stakeholders. Most recently, Teagasc launched its Food Technology/Knowledge Transfer Strategy, promoting almost 40 Teagasc technologies applicable to the food industry.

The recent Teagasc 'Food Innovation Gateways' event targeted at the Irish food industry, served to launch its Food Technology/Knowledge Transfer Strategy and to showcase its Food Technology Portfolio, promoting close to 40 Teagasc technologies applicable to the food industry and accessible through various means. This portfolio includes a comprehensive resource of technologies in various forms, for uptake by industry, promoted through five gateways - or opportunities - for engagement. These include a range of expertises, services and intellectual property emanating from its food research programme, as well as key outputs from recently completed projects and profiles of key Teagasc scientists as other means to engage.

While Teagasc already engages with approximately 300 industry clients annually, Teagasc used this event, attended by CEOs and researchers of over 100 companies, to further push its message of being open for business, to all food companies, both as clients to access services, and as partners for collaborative and licensing arrangements. This event is one of the first major initiatives resulting from implementation of its new strategy, whereby fostering relations with industry and encouragement of proactive and systematic engagement with the food sector is key. "We want to ensure our technologies are fully utilised and capabilities are easily accessible by industry," is the message from Declan Troy, Head of Food Technology Transfer.

Strategic planning

With substantial public investment in food research in Ireland over the past two decades, particularly within Teagasc's Food Programme, and considering the primary function of Teagasc is to support science-based innovation in the agri-food sector, the innovative technologies and related expertise and infrastructure it has developed, have been and will continue to be critical in supporting the relevant industries to this end. According to the Director of Teagasc, Professor Gerry Boyle: "The results of state investment must now be more readily translated into helping food companies to realise the ambitious growth targets set in *Food Harvest 2020* (Department of Agriculture, Food and the Marine's strategy). Teagasc, as the national agriculture and food development authority, has the responsibility of supporting agri-food companies in this drive, and achieving these targets depends on enhanced partnership between industry and public research."

Furthermore, as part of the Irish Government's National Innovation Taskforce recommendations, a document 'Putting Public Research to Work in Ireland',

Food Technology Portfolio

Following mapping of Teagasc technologies, a branded Food Technology Portfolio was developed using five distinct 'Gateways' in order to provide accessible and understandable information to potential partners/clients including: live technologies, expertise/capabilities, services, project key findings and key personnel. This tool, which will be continually updated, is the basis for initial communication with potential partners and aims to enable the target audience to understand the breadth and depth of our research and development capabilities and technologies.

- Technology Offers –"Live" technologies based on Intellectual Property of Teagasc (and partners), requiring partnering with industry for validation and/or licensing for commercialisation, e.g., enhanced derivatives of Nisin, with food bio-preservation applications.
- Technology Expertise –Areas of expertise, based on researcher's expertise, know-how and specialist infrastructure, are central to partnering with industry, e.g., cheese and whey processing technologies.
- Technology Services- Technical and specialist services offered to clients, including testing for agrichemical residues and flavour profiling of foods and beverages.
- Technology Updates- Outline of key findings from state funded research projects, and potential implications for key stakeholders.
- Technology Profiles- Staff profiles detailing their areas of expertise and highlighting their role in providing solutions and/or opportunities for engagement.

For more information or to engage with Teagasc's Technology Transfer Office see: www.teagasc.ie/research/collaboration/

including Ireland's national policy on commercialisation of results arising from public sector research, is soon to be launched.

This will set out the Government's policies to encourage industry to benefit from this research. In response, Teagasc invested in developing a 'Food Technology/Knowledge Transfer Strategy', which was launched at the recent Gateways event, and is putting in place resources to facilitate the efficient and effective transfer of knowledge and technologies to industry, so these companies can realise the opportunities existing in the global market place.

Strategy

As innovation is one of the key drivers of economic growth and recovery, this strategy aims at enabling industry and Teagasc to engage with each other in systematic ways, in order to support the companies' own food innovation strategies. This plan takes into account different mechanisms of Technology Transfer by which companies can engage with Teagasc, depending on their specific needs and absorptive capacity. As proactive and systematic engagement with the sector is at the core of the strategy, central to implementation is excellent relationships based around trust, credibility, transparency, consistency, and confidentiality.

The objectives and related actions in the strategy have the common goal of developing an environment of effective Technology Transfer within Teagasc. Some key achievements to date include establishment of a Technology Transfer Office and development of a Food Technology Portfolio. Such commitment and buy-in at all levels, contributed to the success of the Gateways event in providing an effective forum for interaction between food companies and Teagasc's R&D teams.

While much still needs to be done, Teagasc is committed to implementing this strategy over the period 2011 to 2013, through commitment of resources to ensure best practice and up-skilling and incentivising its staff to encourage proactive involvement. To achieve its objective, to: "Implement a systematic, effective and flexible technology transfer process which supports science-based innovation, thereby turning knowledge into commercial products and processes", Teagasc recognises the importance of a culture of technology transfer, through sustained commitment from management, entrepreneurial and leadership skills of its motivated researchers and an effective and fully supportive Technology Transfer Office.

Technology Transfer Office

The Teagasc Technology Transfer Office (TTO), led by Declan Troy, Assistant Director of Research, aims to be a major conduit for Technology Transfer by Teagasc to industry. Its mission is to support, facilitate and enhance the transfer of research outputs including intellectual property, capabilities and related information between Teagasc and the business community and other stakeholders, in order to promote exploitation of our research with benefits of economic and social importance. As well as facilitating collaborative and licensing arrangements, it also facilitates commercial and research services to clients. While the core team engage in a professional manner with industry, in order to enhance its ability to manage relationships with companies, Teagasc is also training customer relationship managers, who will have close linkages to the TTO.

Key to an effective TTO are transparent, consistent and equitable policies and procedures for management of IP and Technology Transfer, in line with best practice and agreed metrics for Technology Transfer performance. As well as close links with partner academic institutions and industry and commitment to National IP policy, best practice is ensured through Continuing Professional Development of its staff and researchers, and involvement in organisations for TTOs such as ASTP (Association of Science Technology Transfer Professional), Proton Europe and LES Ireland. We are also a member of EU TTO Circle Network, consisting of TTOs of major public research organisations across Europe whose aim is to develop synergies at European level in the field of Intellectual Property (IP) and Technology Transfer management.

Teagasc success in competitive funding

Dr Raymond Kelly outlines some of Teagasc's recent successes in obtaining competitive research funding.

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Teagasc's research programme is funded by a mixture of grant-in-aid from the Department of Agriculture, Food and the Marine (DAFM), external funding from competitive Irish and European public funding schemes, industry contributions or levies and funding from industry for collaborative research. In recent years Teagasc has put in place resources and structures to improve our success in external funding competitions, and this has yielded significant dividends. Funding from the European Union's 7th Framework Programme for Research (FP7) has more than trebled, from an average of €1 million (value of new awards) in 2008 and 2009, to €3.6 million in 2011, while national funding awards have increased from €1.4 million in 2010 to €5.7 million in 2011.

Success in competing for European funding allows Teagasc to work with our European peers to address grand challenges such as food security and climate change, which cannot be adequately addressed at a national level. Having successfully partnered with other institutions on FP7 projects for a number of years, we have recently coordinated four successful FP7 proposals. This is an important trend as it shows that Teagasc is taking a leadership role in European research.

As an applied research organisation, Teagasc research is focused on the needs of the Irish agriculture and food industry. Recently, we have noted an increase in the number of projects that involve direct industry collaboration and funding. In particular, two of the recent FP7 coordinated proposals were to the Research for SME Associations scheme. This funding scheme brings together SME associations across Europe and encourages them to define specific research needs for their industry. Those needs are then met by research providers such as Teagasc. We have also noted a significant increase the value of 'Innovation Partnerships' undertaken by Teagasc. Jointly funded by Enterprise Ireland and Irish-based companies, Innovation Partnerships are collaborative projects between Teagasc and those companies, with the aim of developing new and improved products, processes and services, thereby improving the companies' competitiveness.

The increased collaboration with industry and success in European funding is all underpinned by continued funding from Irish funding agencies, principally DAFM, but also Science Foundation Ireland (SFI), Enterprise Ireland, the Environmental Protection Agency (EPA), the Irish Research Council and the Marine Institute. This funding allows Teagasc to recruit excellent researchers, to build expertise and to improve infrastructure. All of these are vital in delivering research-based innovation to Irish industry and in competing for research funding at the highest level in Europe. We include, below, a selection of recent funding successes.

GrassMargins

Coordinated by Dr Susanne Barth of Teagasc's Crops Research Department, this FP7-funded project aims to enhance biomass production from marginal lands using perennial grasses. Marginal land is defined as land of poor quality for agriculture and which yields poor returns for the farmer. The aim of this project is to identify, characterise and develop novel varieties of grasses that show high and stable productivity, and require the minimum of additional inputs when grown on different forms of marginal land. The consortium assembled to achieve these outputs

consists of a mix of academic and SME partners from eight European countries, Russia and China.

MushTV

Funded under the FP7 'Research for the benefit of SME associations' programme, MushTV aims to identify new strategies to prevent and/or control outbreaks of two serious mushroom pathogens, *Trichoderma aggressivum* and Mushroom Virus X. This need was highlighted by mushroom industry SME associations across Europe and arose partly from the withdrawal of key pesticides and disinfectants in recent years, as well as the ability of these pathogens to exploit weaknesses in modern technologically-advanced growing systems. Coordinated by Dr Helen Grogan, a mushroom researcher in Teagasc's Horticulture Development Department, this project brings research groups from Ireland, the UK, Belgium and the Netherlands together with six SME associations.

FibeBiotics

The goal of this FP7-funded project is to support the development of functional food ingredients and products that are beneficial for the human gut and immune system and therefore of crucial importance for quality of life.

The project will study the effects of specific non-digestible polysaccharides in terms of enhancing immune defence against pathogens, the reduction of infectious diseases like common cold and influenza of the elderly. Coordinated by Food & Biobased Research, based in Wageningen, the Netherlands, this project brings together researchers from universities, research institutes and partner SMEs. Teagasc involvement is led by Dr Catherine Stanton of the Food Biosciences Department.

Dairy beef programme

This project, led by Dr Padraig French of Teagasc's Livestock Systems Research Department, aims to increase the quality and quantity of animals produced for the 'Hereford Prime' and 'Certified Angus' schemes. This will be achieved by generating and transferring the knowledge required by all of the stakeholders involved, to increase their profitability and sustainability. The key stakeholders are the pedigree beef breeders, the dairy farmers, the beef calf rearers, the meat processor and marketer. This project is jointly funded by Teagasc, ABP Food Group, the Hereford society, Hereford Prime, the Angus Society and Certified Angus.

National Cheese Research Programme 2015

Funded by DAFM under the Food Institutional Research Measure (FIRM), this project supports immediate work on the development of reduced fat, low salt cheese variants to address growing health concerns, as well as addressing longer term cheese diversification opportunities. Led by Dr Phil Kelly of the Food Chemistry and Technology Department, this project involves researchers from Teagasc, UCC, UL and UCD as well as the Agri-Food and Biosciences Institute Northern Ireland (AFBI). This collaboration is particularly targeted at the Irish dairy industry's forecast for substantial expansion in cheese production over the next 10 years.

Volatility and risk in Irish agriculture

This DAFM-funded project, led by Trevor Donnellan of Teagasc's Agricultural Economic and Farm Surveys Department will analyse the impact of volatility in Irish agricultural input and output prices on agricultural production and incomes at the farm and aggregate sector levels. This is particularly important at the moment, as CAP reform and ongoing multilateral and bilateral international trade negotiations will likely increase the exposure of Irish and EU agriculture markets to world market price volatility. As well as analysis of the impact of volatility, possible market-based and public policy mechanisms for dealing with volatility and risk in Irish agriculture will be examined.

Interleukin 8 and cow health

Variation in immune genes and their association with differences in disease susceptibility has been conclusively demonstrated in human studies. The Interleukin 8 (IL-8) protein is key to mediating successful immunity and functions by attracting cells and activating them to kill bacteria. Led by Dr Kieran Meade of the Animal & Bioscience Research Department in Teagasc, this SFI-funded project will build on the previous discovery of two different IL-8 gene versions in cattle and will characterise the relationship between gene version and cattle health. Exploiting these genetic differences will allow the breeding of animals with better immunity, thus reducing infectious disease on farms, antibiotic use and contamination of the food chain.

Moving from physical measures of water quality to user values

The aim of this EPA-funded study is to firstly derive a water benefit index and relate it to river water quality. This study will also link physical measures of river water quality with a number of spatial datasets in order to determine the major economic influences on the ecological quality of rivers. Led by Dr Cathal O'Donoghue, Head of the Rural Economy and Development Programme, the results of this project will be used to help Ireland meet water quality targets and also to shape policy in order to tailor resources at areas that would generate the greatest market return or welfare gain.

Strategic alliances demonstrates commitment to agri-food development

Teagasc has formalised alliances in recent years with University College Cork and University College Dublin, building on both universities' expertise and capabilities in food and agriculture, respectively.

Over the last number of years, Teagasc has worked together with a number of educational institutions to encourage innovation and growth in the Irish agri-food sector.

These projects include the Strategic Alliance in Food Research with University College Cork (UCC), launched in 2010, and The National Agricultural Research, Education and Innovation Partnership with University College Dublin, which was officially signed late last year.

With a long-standing relationship with both institutions, after significant investment in dozens of projects in both universities, these collaborations reinforce Teagasc's commitment to the promotion of research in the areas of food and agriculture.

Strategic Alliance in Food Research

Teagasc and UCC launched this partnership in May 2010. It was designed as a step towards creating a single food research programme in Ireland, supporting innovation and development in the food industry. It also provides one base where Irish food companies can access international-quality research and innovation. Over the past 10 years, UCC and Teagasc have collaborated on more than 80 research projects worth in the region of €50 million, resulting in over 250 joint peer-reviewed publications.

Through this alliance, the food research programme consults with industry and government agencies, strengthens collaborative research, including postgraduate training across a range of topics and improves Ireland's reputation as a centre for excellence in food research.

The formation of the alliance will create a critical mass of expertise (more than 200 researchers/postdoctorates/postgraduates) across food science, technology, nutrition, health, consumer and business; will allow for the sharing of very considerable physical resources (equipment, analytical capability and pilot scale production facilities) and will be the driver for streamlined and more effective engagement with the food industry. The alliance will involve the development of a single point of contact for industry in accessing the combined resources of UCC and Teagasc and will create a 'Food Hub', which will further mark Ireland as a world centre for fundamental and applied food research, which will be focused on excellence, innovation, development of

human capital and technology transfer to industry.

The alliance focuses on three main areas: food and health; food science and technology; and, food and the consumer. The alliance will bring an already vibrant interaction between Teagasc and UCC to a new and higher level with:

- joint strategic planning for food research;
- joint education, training and skills enhancement programmes;
- a common approach to supporting key stakeholders (the consumer and the Irish food industry);
- joint staffing appointments;
- co-development and sharing of technology platforms which will avoid any duplication in terms of personnel, equipment or facilities; and,
- a common approach to meeting the funding for the joint Food Research Programme.

At the time of the launch, the then Minister for Agriculture, Fisheries and Food, Brendan Smith pointed to the indication that the food industry will be a 'major driver' for the Irish economy, and this alliance will extend the scientific capability of the organisation to food companies, which will lead to more products, processes and jobs being injected into the economy.

Director of Teagasc, Professor Gerry Boyle, echoed these sentiments: "Teagasc and UCC both recognise that we benefit from significant public funding and that this has to be deployed to the greatest possible extent for the benefit of Irish industry. The enhanced capability will permit both UCC and Teagasc to accomplish goals together that they could not achieve separately. It is anticipated that a deeper relationship will bring new and additional resources to both partners through new programmes, efficiencies and resource-use optimisation, which will enhance the flow of new information to the Irish food industry and benefit consumers and taxpayers and be of international significance."

President of UCC, Dr Michael Murphy, said: "The creation of this alliance fits perfectly with UCC's strategy of forming partnerships with other like-minded institutions, partnerships which are based on strong foundations and highly ambitious in scope and intent."

Chairman of the UCC/Teagasc Strategic Alliance Steering Committee, Professor Michael Dowling, said: "With an important input from industry into the direction of the food research programme, the alliance can play a critical role in contributing to the expansion of the food industry, and to the future economic growth of the country."

The National Agricultural Research, Education and Innovation Partnership

In November last year, the memorandum of agreement to establish this partnership was signed by UCD President Dr Hugh Brady and Director of Teagasc Professor Gerry Boyle.

This came after a working party, chaired by former IFA Chief Executive Officer, Michael Berkery, met over six months to agree how to formally acknowledge the long-standing relationship between the two institutions, while strengthening it in the process.

Like the UCC Alliance, this partnership is designed for both organisations to achieve greater efficiencies and effectiveness with State resources, while ensuring the investment in agricultural R&D provides good returns for the tax payer and the agricultural sector.

Professor Maurice Boland, Principal of the UCD College of Agriculture, Food Science, & Veterinary Medicine is the Director of the partnership. The partnership is designed to enhance the scientific and technical leadership of UCD and Teagasc in order to underpin the international competitiveness, growth and sustainable development of the agricultural sector. It will provide world-class education for agricultural students and deliver excellent basic and applied research programmes in key areas of relevance to the development of Irish agriculture. The partnership's core strategy will focus on the establishment, in close collaboration with industry, of a National Agricultural Research, Education and Innovation Programme linked to the strategies of both organisations. At the core of the National programme will be an agreed programme of agricultural research; a shared strategy for post-graduate training, including a provision for greater involvement by Teagasc personnel in undergraduate and post-graduate teaching, while also enabling more substantial engagement by UCD personnel in Teagasc research programmes and technology transfer activities.

In November, Dr Brady said: "The enhanced capabilities that the partnership will provide will permit both organisations to accomplish goals together that they could not achieve separately. It is anticipated that this partnership will bring new and additional resources to both organisations that will enhance the flow of new information and technologies to the Irish agriculture and food sector."

Professor Gerry Boyle said: "increasing the co-operative and collaborative links between UCD and Teagasc will enhance the scientific and technical competence and breadth of the two institutions, while making better use of respective facilities and enabling faculty and staff to work together to develop stronger programmes of mutual interest and benefit."

Michael Berkery, who has been appointed as Chairman of the Board of Management of the Partnership, welcomed the commitment of researchers and academics in UCD and Teagasc to "engage directly with farming and the food industry in developing joint programmes and to prioritising the development and transfer of new technologies and knowledge that will enable the sector deliver on ambitious growth targets. The state will also benefit from greater integration, efficiency, cost effectiveness and commercial benefits for public funds invested in agricultural research and education."

Role of research in education

Paddy Browne, former Head of Education, explains the role of research in developing Teagasc's education programme.

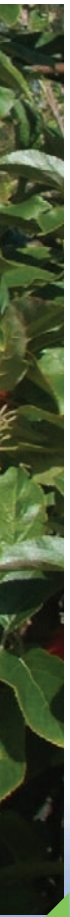
Paddy Browne
is currently Head of Teagasc Crops, Environment and Land Use Programme, Teagasc, Oak Park, Carlow. Correspondence: paddy.browne@teagasc.ie

Teagasc aims to ensure that its education and training programmes are learner-centred, based on a platform of innovation and excellence and respond to the need for competitiveness in existing sectors and opportunities in the wider bio-economy.

The information revolution that is driving changes throughout the economy, including advances in science and technology, are transforming agriculture and horticulture into a more knowledge-intensive industry. This shift affects all producers, large and small, and the capacity to succeed depends on more than just the scale of operation. As the industry becomes more knowledge-intensive, the range of skills and competencies required by producers, become critical for success. Continuous professional development through focused full-time and short courses will give producers the capacity to respond to a rapidly changing environment, while improving the performance of individual producers and the industry as a whole. It is education that will produce the leading farmers and producers of the future. Teagasc is the primary education provider for the overall land-based sector and is a significant education provider to the food sector. It also provides specialised and customised training to the agri-service sector as required. Teagasc works in partnership with many other education stakeholders including FETAC, universities, Institutes of Technology and others to deliver quality-driven, applied education and training programmes. Teagasc education programmes are provided through its network of colleges and regional education centres with full-time, part-time and distance learning courses offered as appropriate. Lifelong learning is now an essential requirement in the farming sector and Teagasc advisory and education services are committed to expanding the organisation's role in this area.

Participation rates in agricultural education

Enrolments at Teagasc Colleges have doubled in the last six years, with 1,322 enrolees in the current academic year. Courses at Teagasc Colleges are generally of two to three years duration and, as a consequence, total numbers attending colleges amounts to 2,426. A further 1,114 part-time farmers attend courses at local centres or on-line bringing the total number participating in programmes for future farmers to 3,540. In addition, Teagasc delivers a comprehensive suite of short courses each year for adult farmers in areas such as Technology and Business, Health and Safety, Environment, Farm Diversification and ICT. Annual participation rates in these programmes amounts to 10,000.



Unique Teagasc structure

Teagasc is unique in having, in the one organisation, three separate functions, i.e., research, advisory (extension) and agricultural education. These functions are becoming increasingly integrated and provide Teagasc with a unique opportunity to leverage the new and emerging technologies generated by the research function and embed them into our education programme. This can be done earlier in the knowledge generation/adoption curve because of the integrated nature of the organisation. In addition, the tools and educational/advisory methodologies being developed and deployed by the specialist advisory service (who take messages from research and other areas and mould this into information for advisers and farmers) can be immediately adapted for use in young farmer education programmes. The following are some examples of the adaptation of Teagasc's research and knowledge transfer technologies and methodologies for the benefit of participants in education and training programmes:

Discussion Groups and Benchmarking Farms

The classroom has been brought out onto the farm by the introduction of the discussion group methodology in recent years. Second year students now participate in a discussion group on Benchmarking Farms. These are leading edge farmers who co-facilitate the groups with the teacher or adviser. The groups meet throughout the year and track progress on the farms and are given access to the technical and financial data on the farms. This in turn enables the students to complete a major project relating to their home farm, usually the Irish Cattle Breeding Federation's Herd-plus programme. In this way they can 'benchmark' the performance on their own farm to that of the host benchmark farmer. The project also encourages students to become more involved in their family farm.

Financial management training

There is major emphasis now on financial management training to reflect the fact that farming must increasingly be run as a business. All the recognised Teagasc tools are employed with students required to complete an e-Profit Monitor and a six-year computerised farm plan. Students also receive training in cost benefit analysis, investment appraisal as well as all types of taxation.

Grassland technology

Another good example is the grassland technology developed at Moorepark. Students, especially those on advanced specialised courses, are fully exposed to measurement of grass covers and grass budgeting. Students are also required to complete a wide range of projects relating to their home farms including fertiliser plans, risk assessments and ration formulations.

Professional Dairy Farm Managers Programme

The dairy implementation group of the *Food Harvest 2020* committee (Department of Agriculture, Food and the Marine) recognised that the ambitious targets for expansion in milk production could not be met without a cadre of well trained and highly motivated dairy farm managers. A working group comprising the Curriculum Development and Standards Unit along with dairy research and knowledge transfer staff were brought together and have developed a two-year professional post-graduate diploma programme for graduates of Teagasc's Level 6 programmes. The programme is validated by UCD at Level 7 and will comprise two years of on-farm professional work experience along with modules in farm management, dairy technology and enterprise development, delivered jointly by college and research/knowledge transfer staff.

UCD/Teagasc Dairy Business Degree

This programme is another example of a collaborative initiative between Teagasc's education and research staff and UCD. The need for such a programme was first mooted by Teagasc's dairy stakeholder group and has resulted in a specific stream within UCD's Agricultural Science offering. The students undertake a pre-placement orientation programme at Teagasc Kildalton College and after placement (usually in New Zealand) they complete a full semester at Moorepark where they are exposed to the latest technology from the programme there presented by the Research and Knowledge Transfer staff.

Ballyhaise Dairy Research Programme

A need has been identified to adapt pasture-based dairy production systems for use on heavier soils in the Northern part of the country. As a consequence a systems-based research project has been established at Teagasc Ballyhaise Agricultural College, Co Cavan, with the aim of increasing grass utilisation using grazing technologies to overcome the limitations on wetter soils in the region. The project also serves as a focal point for the transfer of a range of dairy technologies from research onto dairy farms in the region. The students at Ballyhaise, particularly the Advanced Dairy students, are benefiting from being fully exposed to the research programme and the expertise of the research staff involved in the programme.

Soils Research/Education Collaboration

Dr Rachel Creamer, a soils researcher at Teagasc Crops Environment and Land Use Research Centre, Johnstown Castle and Veronica Nyhan, a soils teacher at Teagasc Kildalton College, have identified a gap in the appreciation of soil science among second level students in this country. They have conducted a survey of second-level Agricultural Science teachers in an attempt to ascertain why students, who are generally very well disposed towards agricultural science, have an antipathy towards soil science. While the results are not yet analysed, some of the problems relate to the fact that many Agricultural Science teachers are not Agricultural Science graduates and may not fully relate soil science to actual farm practice.

Effective innovation support

Teagasc's Director of Knowledge Transfer explains how Teagasc's unique structure and innovative approach to programme development enables the delivery of programmes that are relevant to the changing needs of the agri-food sector.

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Keeping Teagasc's programmes relevant

Teagasc is a unique organisation incorporating Research, Advisory and Education in a single organisation to support the Irish agriculture and food industry. Teagasc has a broad base of 40,000 paying clients, 3,500 students, 300 food industry clients, Joint Industry Programmes and relationships with many public and private agencies and organisations. Teagasc has come a long way from the model where programmes are conceived, formulated and directed centrally. Our programmes respond to issues and problems raised by the Department of Agriculture, Food and the Marine (DAFM), our staff, clients and industry stakeholders.

The client and stakeholder interaction is formalised through a central process of stakeholder engagement at producer and processor level. Within the EU countries and further afield, huge resources are allocated to research, advisory and education programmes with little formal stakeholder involvement or ownership of the programmes. There are a multitude of potential stakeholders who would like to influence the direction of innovation support programmes. However, it is important to have a defined group of people who are interested in influencing the prioritisation process. Clearly, end users, farmers, growers, processors and consumers are keen to identify the problems that affect them most - financial, technical, social and market-related. Other service providers and non-governmental organisations may have issues related to health and environment; all are capable of providing valued direction in terms of what can be done to address the problems and where action should be prioritised. Big ticket issues are highlighted in these fora, such as fertility in dairy cattle, disease resistance in cereals, soil fertility, farm structures, farmer indebtedness, etc. These are balanced by more short-term issues where campaigns and specific actions are needed, e.g., poor weather, disease outbreaks, etc.

The prioritised issues and actions from 16 Stakeholder Groups feed into the annual business planning process where specific objectives, actions, key performance indicators and outcomes are refined into programmes and projects. Teagasc implements a performance management process that links business plans activities and targets with individual staff members roles and competencies. The Teagasc Authority and Senior Management review performance on a six monthly basis.

The input of stakeholder groups to Teagasc is highly valued for making programmes more relevant and improving organisation effectiveness.

Effective and efficient Knowledge Transfer

Information applied and used correctly is vital to sustainable wealth creation. In providing effective and efficient Knowledge Transfer it is important to understand the difference between information provision and practice adoption. This realisation is driving the emphasis on what influences practice adoption. In the past, literature viewed Knowledge Transfer as a linear process with information flowing from research to early adoption farms to other farms over time, aided by the various media outlets, advisers/teachers, technical events, etc. A more multi-dimensional theory (Leeuwis and Van den Ban, 2004), where variables such as performance expectancy and performance effort are modelled - showing that for different technologies adoption variability is a reality. Vanclay (2004) further explored the social influences that impact on effective Knowledge Transfer. This study highlights the danger of 'one-size-fits-all' solutions and supports the role of trusted extension

Recent research has shown that adoption of key practices were higher on Teagasc's dairy discussion group participant farms. Sandra Hayes, Teagasc, Thurles, Co Tipperary, with discussion group.

Teagasc Programme Development and Implementation Process

staff in changing farm practices.

Teagasc advisers have maintained a role in the administration of development and income support schemes. This is often a source of criticism of the service by those who see its role as developmental and strictly Knowledge Transfer, however these activities have helped Teagasc maintain a broad base of over 40,000 clients. Teagasc has withdrawn from certain services that are widely and competitively available to farmers from the private sector.

The effectiveness of the adviser is hugely influenced by the relationship that builds up between the farmer and adviser. The important aspects of this are independence, trust and support for the farmer's best interest. The dynamic of this relationship is well recognised in the one-to-one situation, with very high satisfaction ratings of clients with their advisers. This dynamic changes as more farmers participate in groups; farmers are challenged to come up with more of the solutions to problems within their group.

The key measure of the success of advisory services is the influence it has on best practice; not just the high-performing farms, but all farms. This influence is not confined to new practices, but to influence the ongoing implementation of best practice.

Group advice: better decisions and more profit

The availability of information in a useable format is a huge help to farmers who are faced with profit influencing decisions every day. The process of interpretation of information and adoption of best practice on farms is an ongoing series of events and communications. Farmers, when faced with decisions, are most likely to go with whatever worked last year - unless this is challenged. Recent research has shown that adoption of key practices were higher on Teagasc's dairy discussion group participant farms (Kelly, 2011). What is interesting is that many of the practices were not new practices but continued to require the influence of the adviser and discussion group to support high adoption rates. The benefit of discussion group participation was quantified as a 2 c/L increase in profit worth about €40m per annum to the Irish dairy industry (Hennessy and Newman, 2010).

Factors influencing profitability of farmers are often outside the control of the farmer such as price of product, weather and cost of inputs; it is important to keep the focus on things within farmer control, e.g., quality, performance and efficiency. These are difficult to manage in the absence of good physical and financial benchmarking showing year-to-year and farm-to-farm variation.

Financial indicators motivate technology adoption, e.g., herd Economic Breeding Index, cost/litre, etc. The Teagasc e-Profit monitor measures financial progress on farms against targets set by the discussion group or individually with the adviser. Farmers need to know the profit implications of various actions and inactions. The decision not to take action is often the default and, while it might be easy to justify this to oneself, it can be more difficult to justify this to the adviser or the other farmer peers in the discussion group. The one-to-one advisory model has risks; the individual adviser can become the de-facto farm manager by creating a dependency relationship. This might suit a farm consultancy; it does not suit an advisory model that aims to help farmers make better decisions themselves. The discussion group also has a risk; 'groupthink' where members fail to challenge the dominant or traditional views/solutions. The role of an adviser in facilitating a group is to ensure that members of the group are able to challenge each others views and, where necessary, agree to differ. The facilitator's role is made easier by the sharing of the technical knowledge and experience; however, the facilitator needs to link farm decisions back to a common financial objective. The Teagasc e-Profit Monitor is invaluable in ensuring that the group compares favourably to the national database, thus creating objective criteria for best practice.

References and further reading

Hennessy, T. and Newman, C. (2010) 'The Benefits of the Membership of a Dairy Farm Discussion Group: Evidence from the Irish National Farm Survey'. In: Proceedings of Teagasc National Dairy Conference 2010 "Dairying: Entering a Decade of Opportunity".

Kelly, T.G. (2011) 'Teagasc Influence on Best Practice and Technology Adoption on Irish Dairy Farms'. BSAS Best Practice Knowledge Transfer Workshop, "Knowledge Exchange Between Providers of KT to Farmers".

Leeuwis, C. and Van den Ban, A. (2004) *Communication for Rural Innovation; Rethinking Agricultural Extension* Wiley, 3rd Edition.

Vanclay, F. (2004) 'Social Principles for Agricultural Extension to Assist in the Promotion of Natural Resource Management'. *Australian Journal of Experimental Agriculture*, 44: 213-222.

Dublin City of Science

Dublin has been designated as European City of Science for 2012. During the year, a large number of scientific events will be organised in Dublin and nationally in order to showcase Ireland's growing capacity in science.

The highlight of the year will be the Euroscience Open Forum (ESOF 2012), which will be held in the new Conference Centre, Dublin, on July 11-15, 2012. This event will bring together 6,000 scientists, business leaders, government officials and international media to discuss the best of European science and to address all of the major global challenges, including energy, climate change, food and health.
The City of Science year will also see a programme of other science-related events all round the country. This programme will embrace a wide range of events designed to encourage the public to engage with science. Teagasc is contributing to this programme by way of a series of conferences, workshops, exhibitions, schools visits, etc. These events will be branded with the City of Science logo and will be promoted through the City of Science website.

http://www.teagasc.ie/events/cityofscience/

JULY

12 July RDS, Dublin

Teagasc & RDS Public Lecture Series 2012-2014 RDS

A new series of science lectures on the growing challenges of sustainably meeting the food security needs of the world will be hosted by Teagasc in association with the RDS. The inaugural lecture will be delivered by Prof. Sir John Beddington, Chief Scientific Adviser to the UK Government. Prof. Beddington's lecture on the challenges of food security will be delivered on July 12, at 5pm at the Concert Hall, RDS, Dublin. Email: lectureseries@teagasc.ie

10 July Dublin

A Harvest of Irish Food

A public event jointly organised by Teagasc, UCD, DIT, TCD, Bord Bia, Enterprise Ireland and the Irish food industry to promote Irish food and its underlying science.
Further details at: www.teagasc.ie or email harvestofirishfood@teagasc.ie

12 July *Convention Centre, Dublin*

Milk: Nature's Perfect Food

Scientific session organised by Teagasc as part of the ESOF 2012 Scientific Programme, aimed at scientists, policy makers , media, industry students and general public.
Contact Professor Paul Ross: paul.ross@teagasc.ie

13 July *Convention Centre, Dublin*

The Great Debate on the Battle to Feed a Changing Planet

Scientific session organised by Teagasc and the EU Joint Programme Initiative on Agriculture, Food Security and Climate Change (FACCEJPI) as part of the ESOF 2012 Scientific Programme. Aimed at scientists, policy makers, media, industry students and general public. Email: thegreatdebate@teagasc.ie

23 July *Teagasc, Grange Research Centre*

Designing antimicrobial, anti-biofilm and immunomodulatory peptides for combating infections

Professor R.E.W. (Bob) Hancock from the Centre for Microbial Diseases and Immunity Research, University British Columbia, will give a talk in Teagasc, Grange Research Centre, on July 23 at 2pm in the Animal Bioscience conference room. For further information contact David Lynn: david.lynn@teagasc.ie
For more information on the speaker, visit: www.cmdr.ubc.ca/bobh/bob.html

SEPTEMBER

5 – 8 September *UCC, Cork*

Society of Dairy Technology Conference

Addresses the opportunities and challenges of expansion; the business challenges of meeting diverse nutritional demands; and rapidly evolving environmental management targets.
For further information, contact Mr Michael Hickey, Hon. Sec. S. Ireland Section SDT: mfhickey@oceanfree.net

4 September

Suckler Cow Breeding Conference

This conference will provide an overview, both national and international, of current published information pertaining to suckler cow types and traits of importance, as well as providing a forum to discuss the most efficient way to proceed with the new genetic indexes. Contact Mark Mcgee: mark.mcgee@teagasc.ie

OCTOBER

5 October *Teagasc Animal & Bioscience Centre, Trim, Co. Meath*

AVTRW (Irish Branch) 46th Annual Scientific Meeting

Current trends and new developments in animal health and immunology both in veterinary diagnostic laboratories and research institutes across Ireland will be reflected at this meeting. It aims to strengthen existing collaborative relationship between institutes and enable the establishment of new linkages between the investigators in both basic and applied science. Contact Kieran Meade: kieran.meade@teagasc.ie

18 – 19 October *RDS/UCD, Dublin*

Annual Conference and Early Career Researcher Seminar (AESI)

The AESI will include contributed papers on themes such as agriculture, the environment, rural development, food marketing, supply chain management, land use and development economics. Please note, the AESI conference will be held in the RDS, Dublin on 18 October and the Early Career Researcher Seminar will be held on 19 October in UCD.
For more information visit: www.aesi.ie

23 – 25 October *The Crowne Plaza Hotel, Blanchardstown, Dublin.*

Global Food Safety: Solutions for Today and Tomorrow conference

This three-day conference is a joint initiative between Teagasc, The Institute for Food Science and Technology of Ireland (IFSTI), the International Union of Food Science and Technology (IUFoST), the Food Safety Authority of Ireland (FSAI) and University College Dublin. It will host a number of world-renowned experts in the area of food safety presenting the latest findings at primary production level and during processing and distribution. For further information visit: www.globalfoodsafetyconference.com

NOVEMBER

1 November *Aviva Stadium, Dublin*

Teagasc Knowledge Transfer Conference

This conference will highlight the evolution of advisory (extension) support services to farmers and the current best practice in advisory methods and services with a view to achieving efficient and effective support for agriculture. Contact Dr Tom Kelly: Tom.kelly@teagasc.ie

11th – 18th November *Teagasc research centres*

Science Week 2012

The Forfás Discover Science and Engineering Science Week initiative aims to promote the relevance of science, engineering and technology in our everyday lives. Teagasc supports Science Week by holding a series of events each year.
During Science Week, Teagasc research centres invites students from local secondary level schools and third level colleges to see practical examples of the use of science in agri-food production. For more information: http://www.scienceweek.ie/index.asp Contact Catriona Boyle: catriona.boyle@teagasc.ie

22 November

Walsh Postgraduate Fellowships Seminar RDS, Dublin

Presentations by Postgraduate students awarded fellowships under the Teagasc Walsh Fellowship Scheme. For more information, contact Dr Lance O'Brien: Lance.obrien@teagasc.ie