



TEAGASC

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The great debate on the battle to feed a changing planet

Food solutions for
weight management

Supporting rural
enterprise development

Wood energy potential
of farm forestry

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Teagasc is a proud sponsor of Dublin City of Science 2012

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Teagasc/RDS public lecture series

In conjunction with Dublin City of Science and the Euroscience Open Forum (ESOF) event in Dublin, Teagasc initiated a new series of science lectures on the 'Grand Challenges for Global Agriculture and Food', in association with the Royal Dublin Society (RDS). The series will explore key aspects of the complex challenge of producing sufficient food and ensuring fair access to that food, in the context of a growing world population and one that is (hopefully) more affluent, which will have consequent changes in the pattern of food consumption. The challenges are to do this while making more efficient use of scarce natural resources including agricultural land and energy, and adapting to and helping to mitigate the encroaching influence of climate change. This will require an integrated and effective approach, with public research playing a central role in advances in technology and adopting more sustainable production methods to allow more food to be produced from less.

As Irish agriculture grows over the next decade and participates more actively than ever in global food production and exports, we must understand the influences these grand challenges will have on our industry at both a global and national scale, and participate in the debate, again at a global and national scale. As the national body responsible for supporting the science and technology needs of the Irish agri-food industry, Teagasc is determined to play its part in developing this debate. This series of high profile lectures, presented by outstanding international scientists and policymakers, will contribute to heightening awareness of the scale of the problem and how all of us - governments, civil society, the private sector and individual consumers - have a role to play in addressing the challenges.

See page 14 for a report on the first lecture in the series, which was presented on behalf of Professor Sir John Beddington, Chief Scientific Adviser to the UK Government and Member of High-Level Stakeholder Group responsible for the 2011 UK Foresight Report on 'The Future of Food and Farming'.



Dr Frank O'Mara, Director of Research, Teagasc

Dr Lance O'Brien, Foresight & Strategy Manager, Teagasc
Teagasc Head Office, Oak Park, Carlow

Sraith léachtaí poiblí faoi scáth Teagasc/RDS

I gcomhar le Cathair Eolaíochta Bhaile Átha Cliath agus an Fóram Oscailte Eora-eolaíochta (ESOF) i mBaile Átha Cliath, tá sraith léachtaí eolaíochta tionscanta ag Teagasc i dtaobh 'Grand Challenges for Global Agriculture and Food', i gcomhar le Cumann Ríoga Bhaile Átha Cliath (RDS). Féachfaidh an tsraith ar ghnéithe tábhachtacha den dúshlán casta a ghabhann le dóthain bia a sholáthar agus teacht chothrom a thabhairt ar an mbia sin, i bhfianaise pobal domhanda atá ag dul i méid agus atá níos saibhre (tá súil againn), rud is cúis le hathrú ar phátrúin itheacháin bia. An dúshlán ná é sin a dhéanamh agus an úsáid is éifeachtaí is féidir a bhaint as acmhainní tearca nádúrtha lena n-áirítear talamh feirme agus fuinneamh, agus an tionchar méadaithe atá ag an athrú aeráide a chur san áireamh agus a mhaolú. Teastóidh iarracht chomhtháite éifeachtach chuige sin, agus beidh ról lárnach ag an taighde poiblí i dtaca le dul chun cinn sa teicneolaíocht agus modhanna táirgthe níos inbhuanaithe a ghlacadh ionas gur féidir tuilleadh bia a tháirgeadh as líon acmhainní níos lú.

De réir mar a fhásfaidh talmhaíocht an hÉireann sna deich mbliana romhainn agus go mbíonn sí níos rannpháirtí ná riamh i dtáirgeadh bia agus in onnmhairí domhanda, ní mór tuiscint a bheith againn ar an tionchar a bheidh ag an dúshlán mhóra sin ar thionscal na hÉireann ar leibhéal náisiúnta agus ar leibhéal domhanda araon, agus ní mór d'Éirinn bheith rannpháirteach sa díospóireacht, ar leibhéal náisiúnta agus ar leibhéal domhanda araon. Ós rud é gurb é Teagasc an foras náisiúnta a bhfuil sé de chúram air tacú le riachtanais eolaíochta agus teicneolaíochta thionscal agraibhia na hÉireann, tá sé meáite ar bheith lánpháirteach i bhforbairt na díospóireachta sin. Cabhróidh an tsraith léachtaí ardphróifíle seo, a chuirfear i láthair ag eolaithe agus ag déantóirí beartais idirnáisiúnta den scoth, chun feasacht a chothú ar scála na faidhbe agus ar an ról atá ag gach duine dinn - rialtais, an tsochaí shibhialta, an earnáil phríobháideach agus tomhaltóirí aonair - i dtaca le haghaidh a thabhairt ar na dúshláin seo.

Gheofar ar lch. 14 tuarascáil ar an gcéad léacht sa tsraith, a thug an tOllamh Sir John Beddington, Príomhchomhairleoir Eolaíochta Rialtas an RA agus Ball den Ghrúpa Geallsealbhóirí Ardleibhéil atá freagrach as Tuarascáil Réamhamhairc an RA 2011 ar 'Todhchaí an Bhia agus na Feirmeoireachta'.

An Dr Frank O'Mara, Stiúrthóir Taighde, Teagasc

An Dr Lance O'Brien, Bainisteoir an Tionscadail Réamhamhairc, Teagasc
Ceannáras Teagasc, Páirc Darach, Ceatharlach

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Dr Stephen Butler



Dr Stephen Butler is the leader of dairy cattle reproduction research in Teagasc Animal and Grassland Research & Innovation Centre Moorepark. He has comprehensive knowledge of dairy cattle reproduction and nutrition. After completing a Masters degree in University College Dublin in 1999, he carried out a PhD in Cornell University (New York) and graduated in 2004 with a major in Physiology of Reproduction and minors in Animal Nutrition and Nutritional Biochemistry. He was awarded the Maynard Award in 2003 by Cornell University faculty in recognition of his outstanding graduate student achievements. Since starting a Research Officer position with Teagasc in 2004, his main areas of research include exploring the genetic basis of sub-fertility, oestrous and ovulation synchronisation protocols to maximise submission rate for seasonal-calving systems, automated oestrus detection, and the role of micronutrients to impact the reproductive system. He is actively involved in improving dairy cow fertility through the design, implementation and reporting of research conducted at Moorepark and on commercial farms. He is also involved in strategic industry-wide initiatives led by both Teagasc and Animal Health Ireland to improve fertility. He has been the principal supervisor to completion of four PhD students and a Masters student in the last five years working on diverse areas of dairy cattle reproduction in pasture-based systems. He is heavily involved in teaching about dairy cow fertility to undergraduate students in Dairy Business and Animal Science degree programmes in UCD, and he has presented at many national and international conferences to scientists, veterinarians and dairy herdowners. In 2011, he successfully completed a part-time Masters degree in Bioinformatics and Systems Biology. In April 2012, he organised a conference on fertility for the Irish dairy industry and a dairy cow fertility workshop for veterinarians. He is a work package leader in the EU FP7 PROLIFIC project recently approved for funding.

Originally from Co Waterford, Stephen is currently living in Fermoy, Co Cork, and his personal interests include hiking, fishing, cooking, film and music.

TResearch reader survey

In order to improve the quality of TResearch, it is important that we hear from our readers and get your opinions regarding the current content.

With this in mind, we are undertaking a short online survey, which is being carried out on Survey Monkey, and we would appreciate it if you could take the time to offer your views and any suggestions you have for improvements.

We will be sending an e-mail to those recipients whose e-mail addresses we have on file or you can follow the link to the survey: https://www.surveymonkey.com/s/TResearch_Reader_Survey_2012

New Teagasc Animal Bioscience facility opened



At the opening of Teagasc's new Animal Bioscience Facility at Grange in Co. Meath are (from left): Dr Keelin O'Driscoll, Teagasc; Minister for Agriculture, Food and the Marine, Simon Coveney TD; Dr Sinead Waters, Teagasc; and Noel Cawley, Chairman, Teagasc Authority.

The Animal Bioscience Facility was developed as part of the Teagasc Vision Programme initiated in 2006 with the objective of establishing centres of excellence in the key sciences that underpin Irish agriculture. The new facilities include molecular biology laboratories, and laboratories for DNA/RNA preparation, immunology, biochemistry, microbiology, cell culture, and flow cytometry.

Animal Bioscience is a key component of Teagasc's Animal and Grassland, Research & Innovation Programme, which integrates applied and strategic research across the main livestock species in Ireland namely dairy cattle, beef cattle and sheep. The Teagasc Animal and Bioscience Department carries out research in the areas of animal breeding and genomics, animal health and welfare, infection and disease, computational and systems biology, fertility and reproduction, feed efficiency and product quality.

Tillage crop forum



Pictured at Teagasc's National Tillage Crop Forum are guest speakers and panel discussion members (from left): John Spink, Teagasc; Andy Doyle, *Irish Farmers Journal*; Gordon Rennick, Department of Agriculture, Food and the Marine; Pascal Hennessy, APHA/IASIS; Jim O'Mahony, Teagasc; Martin Bourke, Teagasc; Josephine Brennan, Department of Agriculture, Food and the Marine; James Nolan, RH Hall; Noel Delaney, IFA; and Pat Denn, Pat Denn Agri Ltd.

Dairy conference focuses on volatility

The volatility of milk prices and incomes in the dairy sector was the subject of a conference that took place at Cork Institute of Technology in September. The event was organised by CIT in conjunction with Teagasc and the Irish Cooperative Organisations Society.

Speakers at the event included Irish and US academics and financial experts. The keynote address was provided by Professor Andrew Novakovic of Cornell University, who described how the US dairy industry deals with the problem of volatility in dairy prices and farm incomes.

Other topics included: the particular difficulties that the dairy sector in Ireland faces in providing more stable dairy prices; the importance of the Single Farm Payment in acting as an income stabiliser on dairy farms' and the financial tools that are now becoming available in Europe to deal with price risk in the dairy sector.

Commenting at the event, Teagasc economist Trevor Donnellan, said: "The volatility issue is difficult enough to manage now, but after 2015 farmers will really need to create a more secure environment. This is where the financial instruments come in."

Unique opportunities for farm families

Over 100 people assembled in Macreddin Village, Co. Wicklow, recently to celebrate 2012 – UN Year of Cooperatives. The event – hosted by Teagasc in collaboration with Bord Bia's TASTE Council, ICOS and UCC's Centre for Cooperative Studies and sponsored by Cold Move – focused on cooperative models that assist farmers to pursue opportunities in high value-added differentiated food markets. At the event, Teagasc Director, Professor Gerry Boyle, referred to the market opportunities highlighted by *Food Harvest 2020* that are increasingly brand-centred and consumer focused.

Teagasc joins forces with Australian researchers

Researchers at Teagasc Food Research Centre, Moorepark, have received funding from the Gardiner Foundation Australia for a joint research project with Australian research agency CSIRO, Warrnambool Cheese & Butter Factory Company Holdings Ltd and Tatura Milk Industries Ltd. The project, 'Novel buttermilk ingredients – Unlocking buttermilk's potential for encapsulating bioactives', will focus on the feasibility of a higher value application for buttermilk and may offer dairy manufacturers a more profitable option for using this product stream.

Society of Dairy Technology conference



Sean Sherlock TD, Minister for Research and Innovation speaking at the Society of Dairy Technology Conference at UCC.

UK and Irish followers of the Society of Dairy Technology met recently for the Society's autumn conference, themed 'Towards a Sustainable Dairy Sector', which took place in UCC, Cork, in September.

The conference was officially opened by the Minister for Agriculture, Food and the Marine, Simon Coveney, TD, and Professor Gerry Boyle, Director of Teagasc, moderated the opening session on Sustainable Technologies and Ecology, during which Dr Rogier Schulte outlined Teagasc's position on 'Modelling choices and marginal cost predictions for sustainable Irish agriculture'. An Open Forum focused on 'Optimising process plant scale for expansion in milk production', while a technical tour to the Teagasc Animal and Grassland Research Innovation Centre, Moorepark, and the Teagasc Food Research Centre, Moorepark, was undertaken.

Dr Phil Kelly, Teagasc Food Research Programme, said: "While the market outlook is positive given the increasing global demand for naturally produced, nutritious milk products, continuing market volatility demands vigilance in manufacturing competitiveness. Consumer sentiment will also be uncompromising as regards environmental responsibility and attention to best-in-class sustainable technologies."

Improving farmer health

Teagasc, in association with the Health and Safety Authority and University College Dublin, held a National Seminar recently on improving occupational health among farmers in Ireland. The event took place in the Clanard Court Hotel, Athy, Co. Kildare, followed in the afternoon by a seminar on Positive Mental Health of Farmers. At the seminar, Aoife Osborne, Teagasc Walsh Fellow, revealed the findings of her four-year research study on farmer occupational health. Ms Osborne focused on musculoskeletal disorders, or diseases of the skeletal and muscular systems, which are increasingly a major source of disability and incapacitation among farmers in Ireland and worldwide. One international study, for instance, estimates that farmers are one of the main users of hip replacements with 20 per cent of farmers requiring one in their lifetime.

Organic crops forum

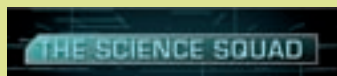
In organic farming the concept of sustainable land management is of primary importance and soil quality plays a large role in the production system. Dr Rachel Creamer - Teagasc Crops, Environment and Land Use Research Programme, Johnstown Castle, Wexford - discussed the soil management components of sustainable land management in the organic context at Teagasc's recent Organic Crops Forum. She also addressed the application of usefulness of indicators of soil quality outlining the European project Teagasc is involved in testing and developing indicators for soil biodiversity. Teagasc researchers presented results on soil quality and nutrition in the context of organic farming; research work on composting; the latest updates on clover research; and key findings on the phytochemical content of organic and conventional food crops.

Yale Environment Review

Researchers from Teagasc's Rural Economy and Development Programme have featured in a publication (*Yale Environment Review*) of the prestigious Yale University. The paper 'Finding beauty in the agricultural landscape: How the social and demographic uniqueness of a population relates to preferences for farmland practices' was written by Drs Peter Howley, Cathal O'Donoghue and Stephen Hynes (NUIG) and is available from: <http://environment.yale.edu/yer/article/finding-beauty-in-the-agricultural-landscape>

Science Squad

To view Teagasc's clips from The Science Squad television series, please log on to: <http://www.youtube.com/teagascmedia>



Sheep 2012



Niamh Kelly, from Kildare, at the recent Sheep 2012 'The Way Forward' at Teagasc, Mellows Campus, Athenry, Co. Galway

McEntee Addresses Future Entrepreneurs

Addressing participants recently who are commencing the Food Works Programme at the Guinness Enterprise Centre, Shane McEntee TD Minister of State at the Department of Agriculture, Food and the Marine said that "Ireland has great food strengths and food companies but in recent years too few of our high potential start-ups have been found in the food sector. Food Works aims to change this."

He concluded by congratulating the 29 participants for reaching Stage 4, in which they will carry out a robust feasibility analysis of their projects from a consumer, technical and commercial viability perspective. Food Works is a new, comprehensive training and development programme that sees Bord Bia, Enterprise Ireland and Teagasc combining their resources to design an in-depth process aimed at finding and fostering global food entrepreneurs.

SFI Principal Investigator award



Dr Paul Cotter from Teagasc's Food Research Centre Moorepark received funding for his project on 'Obesibiotics' via Science Foundation Ireland's (SFI) 'Principal Investigator' (PI) Programme. The project will be supported through to 2015. Paul is pictured with SFI Director Mark Ferguson.

ESOF2012



Pictured at the Teagasc stand at ESOF 2012 are (from left) Dr Stuart Green and Dr Ewen Mullins, Teagasc; Máire Geoghegan-Quinn, European Commissioner for Research, Innovation and Science; and Eric Donald, Head of Public Relations, Teagasc. See pages 10 and 12 for details on Teagasc's events at ESOF.

Leading microbiologist visits Grange



Researchers and students at the Animal & Bioscience Department in Grange were fortunate to have a visit recently from Professor Bob Hancock of the University of British Columbia, Vancouver, Canada (left). Professor Hancock is a very senior figure in the world of microbiology and immunity, having published over 500 papers. He has also founded Inimex Pharmaceuticals Inc. and The Centre for Drug Research and Development, which aims to bridge the gap between academic research and clinical application. He has received numerous awards including the Order of Canada and, in addition to his academic career, consults for a range of pharmaceutical companies.

Professor Hancock presented a very stimulating talk, titled 'Designing antimicrobial, anti-biofilm and immunomodulatory peptides for combating infections'. His presentation described how a bovine host defense peptide (a protein that is produced as part of the immune response) has been improved upon to produce synthetically-derived analogs, which can be used as peptide drugs to treat a range of infectious diseases in humans and animals. Professor Hancock's talk highlighted the route from strategic research to application, a theme that is very relevant to the Animal & Bioscience Department.

Teagasc/UCC research in *Nature*



Some of the authors of the *Nature* paper are pictured at UCC: Professor Ger Fitzgerald, Professor Fergus Shanahan and Professor Colin Hill (all UCC); Minister for Agriculture, Food and the Marine, Simon Coveney, TD; Professor Paul Ross (Teagasc); Dr Siobhan Cusack and Professor Paul O'Toole (both UCC).

New research published recently in the journal *Nature* shows that a relationship exists between diet, gut bacteria and the health of older Irish people. The findings provide exciting new opportunities for the food industry as there is now the scientific basis for developing foods to promote healthier ageing.

The discovery was made by a multidisciplinary team of scientists from University College Cork and Teagasc Food Research Centre, Moorepark. The team collected information on diet, physical activity, immune function, and cognitive function, and measured the faecal microbiota composition of 178 older persons living in different settings in the south of Ireland.

The study, which was funded by Department of Agriculture, Food and the Marine and the Health Research Board, found that the composition of the gut microbiota can positively and negatively impact the health of older people in our population.

Walsh Fellows overseas training awards

Recipients of the first Teagasc Walsh Fellows Programme overseas training awards are pictured (from left): Dr Lance O'Brien, Teagasc Walsh Fellowships Programme Director; Hilda Dooley; Tim Sheil; Professor Gerry Boyle, Director of Teagasc; Patrick Cashman; Natalie Heffernan; Dr Frank O'Mara, Director of Research, Teagasc; and Catherine Mulholland.



Teagasc is a major employer of postgraduate Walsh Fellowship students with some 180 pursuing PhD programmes at any one time. This year, Teagasc introduced a new Short-Term Overseas Training Awards scheme for fellows to spend short training periods (up to three months) in approved universities and research institutes outside of Ireland.

Rural suicide prevention

The findings of a major new study of men in rural Ireland was launched at University College Dublin by Ms Kathleen Lynch, TD, Minister for Mental Health, Disability and Older People. The study was a collaborative project between UCD and Teagasc. The study was undertaken in response to an increased risk of suicide in rural communities with males being at least three times more likely to complete suicide than women. The study found that background factors to suicidal action included mental illness, economic difficulties and marital separation. Low educational attainment, limited job opportunities, multiple job histories, marginal farming and dependency on social welfare payments characterised the biographies of the men interviewed.

Teagasc Health and Safety Officer John McNamara stated that Teagasc had supported the study to seek a better understanding of the issues involved in rural suicide with a view improving prevention strategies. Participants in the study were Dr Anne Cleary (School of Sociology, UCD); Ms Maria Feeney (PhD Student, Teagasc Walsh Fellow); and Dr Áine Macken-Walsh (Rural Economy and Development Programme, Teagasc).

For more information please log on to:
http://www.teagasc.ie/publications/2012/1333/Pain_and_Distress_in_Rural_Ireland_Report.pdf

Fulbright award

Applications are now open for the Fulbright Awards. The deadline for Fulbright scholarships is November 14, 2012. Teagasc sponsors the Fulbright-Teagasc Award in Agriculture, Food, and Forestry (student only). For more, please visit: www.fulbright.ie

Papers, presentations, and speeches delivered at Teagasc conferences, seminars, and open days can be viewed at:
<http://www.teagasc.ie/publications/>

International workshop to co-ordinate agricultural research in Africa

An International Workshop to build closer alignment between African national agricultural research organisations and the CGIAR (Consultative Group on International Agricultural Research) institutes took place recently at the Teagasc Food Research Centre, Ashtown, Co. Dublin. This workshop aims to address issues around building closer collaboration between the research providers.

The event brought together over 60 highly prestigious delegates from Africa, the US, Canada, Australia and the EU to identify strategies by which agricultural productivity in Africa can be enhanced through closer collaboration between the national and international agricultural research providers.

The gathering includes Dr Frank Rijsberman, the newly appointed Director of CGIAR, directors of national agricultural research institutes in Africa, representative of many national donor organisations, including USAID and the EU and the World Bank. With agriculture employing two-thirds of Africa's labour force and accounting for one-third of GDP, it is the main sector upon which the continent is relying to consolidate its recent gains on the macro-economic front and to free hundreds of millions of its people trapped in poverty and hunger. According to the World Bank's World Development Report for 2008, growth from agriculture is at least twice as effective in reducing poverty compared to growth generated by other sectors.

Opening the workshop, Professor Gerry Boyle, Director of Teagasc, said that the Teagasc model of innovation support, based on the integration of research, advisory services and education could provide an excellent blueprint for developing nations struggling with the challenge of enhancing their agricultural productivity. He said this is being increasingly recognised by the growing number of international visitors to Teagasc. In this regard, Teagasc is working with Irish Aid to send a team of experts to Tanzania to see how it could assist in building the Teagasc model of innovation in that country.

17th International Nitrogen Workshop



The importance of sustainable nitrogen use for global food security was highlighted at the recent International Nitrogen Workshop in Wexford, which was jointly organised by Teagasc and the Agri-Food and Biosciences Institute, Northern Ireland. Pictured are (from left): Dr Karl Richards; Dr Owen Fenton (both Teagasc); Dr John Sadler (USDA/OECD-CRP); Professor Mary Firestone (University of California); Professor

Christoph Muller (University of Geissen Germany); Dr Catherine Watson (Agri-Food and Biosciences Institute, Northern Ireland); and Mr Michael Hamell (DG Environment). Turn to page 28 for more on the event.

Agri-Food Graduate Development Programme



Pictured are: Dr Joanne Fearon (UCC); Professor Alan Kelly (UCC); Dr Lance O'Brien (Teagasc); Minister Simon Coveney (DAFM); Professor Michael Gibney (UCD); Professor Michael Murphy (President, UCC); and Julie Dowsett (UCD). Missing from picture is Dr John Finn, Teagasc.

A new Agri-Food Graduate Development Programme (AFGDP) has been launched. The programme was developed by UCC (Prof Alan Kelly), UCD (Prof Mike Gibney) and Teagasc (Dr John Finn). The AFGDP aims to provide specialised skills training for postgraduate students in agriculture, forestry, horticulture, food and nutrition. The training is provided in the form of three-day intensive modules that are delivered by national and international experts.

For more information on the range and schedule of modules, see www.foodpostgrad.ie. Postgraduates who wish to be included in the database for notification of future modules can email admin@foodpostgrad.ie. The AFGDP is funded by Department of Agriculture, Food and the Marine and the National Development Plan 2007-2013.

Opportunities for the food industry

Teagasc's Technology Transfer Office details Teagasc expertise in whey processing and spray drying, applicable to the food and food ingredients industry, and welcomes enquiries for partnering in these areas.

Whey processing

Background

Whey protein is a mixture of proteins with unique nutritional, functional, physiological and nutraceutical properties that are not fully exploited in whey protein concentrates and isolates. Hence, there is considerable value in characterising the individual whey proteins for their potential use in consumer foods, nutraceuticals and therapeutics. Teagasc has the expertise to isolate and fractionate individual components of whey.

Benefits to industry

Assistance to manufacturers of whey products and users of whey protein as an ingredient in formulated foods - such as infant formula, sports and other beverage applications - through expertise in development, scale-up, optimisation and technology transfer of whey protein separation processes can be provided. A range of solutions from technical services, contract production of whey fractions for market evaluation, consultancy and project management, to partnering in collaborative research in the area of whey processing is available.

Areas of expertise

- Separation of whey protein fractions at laboratory and pilot scale and scale up of processes
- Optimisation/modification of existing whey protein separation processes
- Analytical and engineering, rheology, microscopy and heat stability capabilities

Facilities/equipment

- Pilot plant facilities of MTL Ltd.
- Cross-flow membrane filtration technology and centrifugal technology
- Electro-dialysis plant 2500 L/hr whey

Of interest to

- Manufacturers of dairy ingredients and nutritional beverages, infant formula, medical and sports applications
- Users of whey protein as an ingredient, from consumer foods to nutraceuticals and therapeutic applications

How to proceed

For further information, please contact Dr Mark Fenelon.
Tel: +353 25 42355; mark.fenelon@teagasc.ie

Ingredients development using spray drying

Background

Ongoing adaptation of the spray drying process is extending beyond milk to the wider food ingredient sector. Through extensive research, the know-how and facilities available at Teagasc, most client demands in spray drying for the purpose of ingredients development can be addressed. This extends from powders for food service applications to nutritional formulations and tailored ingredients.

Benefits to industry

Through engaging with Teagasc, access to state-of-the-art facilities and expertise in ingredient evaluation and development is available to offer a range of innovative processing solutions, extending from powders for food service applications, nutritional formulations and tailored ingredients.

Areas of expertise

Powders for food service applications

- Coffee-stable powders, imitation creamers

Powders for nutritional applications

- Evaluation of ingredient behaviour on end-product stability
- Intermediate ingredient pre-mixes with defined performance
- Stabilised mineral fortified powders
- High protein ingredients for sports nutrition use
- Protein hydrolysates

Business-to-business tailored ingredients

- High fat and microencapsulated fat-containing powders.
- Powders for chocolate applications
- Yoghurt and other fermented powders
- Powders customised to client needs

Facilities/equipment

- Pilot processing and analytical facilities
- Moorepark Technology Ltd.
- Tall-form spray drying-Niro TFD-20 pilot scale drier to industrial specifications
- Reconstruction processor, separation processor, evaporator and heating systems

Range of solutions

Teagasc can provide a range of solutions including

- Evaluation of scale-up considerations during drying of new ingredients
- Provision of innovative milk powder ingredients for evaluation
- Evaluation and diagnosis of ingredient performances in spray dried formulations
- Optimisation of pre-processing treatments
- Analysis of powders
- Advice on quality and food safety issues

For further information

Contact Dr Phil Kelly. Tel: +353 25 42212; phil.kelly@teagasc.ie

This research was supported by the National Development Plan and Department of Agriculture Food and the Marine.
For more information on these and other offers see: www.teagasc.ie/research/collaboration or contact techtransfer@teagasc.ie

The Great Debate on the battle to feed a changing planet

‘Will we starve or will we burn?’ This was the central question of the ‘Great Debate on the Battle to Feed a Changing Planet’, organised jointly by Teagasc and the FACCE-JPI at the EuroScience Open Forum 2012 in Dublin. The Great Debate brought together five top scientists and a diverse audience to debate how global agriculture can ‘feed the world’ while at the same time reduce its greenhouse gas emissions.

Carbon tax, carbon labelling, waste less food, more research funding, binding international agreements, better distribution of food, farming more efficiently, use less land, more extensive farming, buy local food, more biofuel, less biofuel, eat less meat, produce more Irish beef – popular opinion is not short of ‘solutions’ to the food security/climate change dilemma. But which of these solutions stand up to scrutiny? We put this question to five eminent scientists from around the globe.

Will we starve or will we burn?

The first question was easy to answer: we cannot afford to ‘starve’ nor ‘burn’. Already, 1bn people go to bed hungry each night, and this number is projected to increase as the world population is projected to increase by a further 2bn citizens over the next 40 years. At the same time, climate change is already affecting large parts of the globe, particularly developing nations, and efforts to limit the global temperature rise to 2°C now require critical urgency. Therefore, there is a need to both increase food production and reduce global greenhouse gas emissions from agriculture, i.e., methane emissions from livestock and rice production, nitrous oxide emissions from fertilizer and manure applications, and carbon dioxide emissions from energy consumption. This means that the debate leaves no room for single-dimensional approaches such as ‘leave agriculture alone when it comes to greenhouse gases’, nor: ‘agricultural production should be curtailed to prevent climate change’.

The consensus from the Great Debate was that

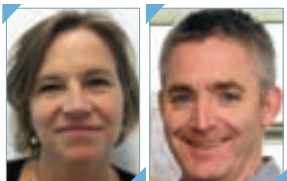
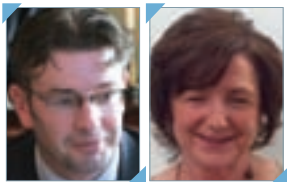
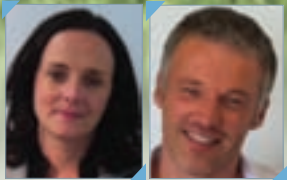
there is no ‘silver bullet’ to solve this dilemma. Simply increasing food production will not meet the challenge on its own, and neither will efforts to reduce food waste, nor will a global redistribution of food solve all problems overnight. At a global level, we need to strive towards a mosaic of simultaneous solutions.

No room for romanticism

Central to this mosaic is the increased recognition that each food product should be grown intensively where this can be done efficiently. For example, the Irish climate allows for highly efficient milk production (with the lowest carbon-footprint in the EU), while rice should be grown intensively in Asia. This represents a major shift in thinking, away from the old adage that food should be grown ‘locally, using traditional methods’, to avoid greenhouse gas emissions from the transportation of food. In reality, these transport emissions are very small, compared to the emissions arising from inefficient production, i.e., growing products in unsuitable climates or locations. Therefore, each country should maximise the production of crops that it can produce best. Professor Louise Fresco, University of Amsterdam, warned passionately that “this leaves no room for romanticism about small-scale local production.” “We know from an ecological point of view, food has to be produced where it can best be produced, under the most favourable circumstances. Maintaining low productivity in poor countries almost always means low yields and an environmental disaster,” said Professor Fresco.

Lateral thinking

In addition, we need to open our eyes and minds to the myriad of simple solutions that lie just outside the agricultural sciences. Professor Rajendra K. Pachauri (Nobel Laureate - Chairman, Intergovernmental Panel on Climate Change) provided an example where the provision of electricity – and hence refrigeration – in local communities allowed for storage of food and reduced food waste, resulting in food security. He said: “There are 1.4bn people in this world who have no access to electricity. A large number of them live in rural areas so there is no such thing as refrigeration in a large part of the developing world. So farmers who produce vegetables or fruits really have no choice:



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 Dr Rogier Schulte, Teagasc
 Trevor Donnellan, Teagasc
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What you said... three questions, many answers

Throughout the Great Debate, the audience had their say through Twitter and through instant voting on some of the most burning questions of the Debate:

1. How would you eradicate hunger and reduce climate change?
2. Rank the effectiveness of policy 'tools' to reduce agricultural emissions
3. Do you think agriculture is reducing its greenhouse gas emissions effectively?

Up to 350 people participated in the instant voting. Whilst not a scientific poll, the answers revealed some interesting insights:

Opinions were divided on the first two questions. 'Waste less food', 'Reduce our dependency on meat', 'Assist developing countries in increasing their yields' and 'Invest in technologies for sustainable intensification' (Question 1) all received similar number of votes – reflecting the diversity of opinions and solutions.

Question 2 yielded a similar variety of answers, as 'Global agreement on agricultural emissions', 'Carbon-tax on food', 'Carbon labelling of food' and 'More research funding' received similar shares of the vote. The only unpopular option was: 'No policy tools needed'.

On Question 3, approximately half of the audience voted that 'agriculture is sitting on the fence' when it comes to reducing greenhouse gas emissions, while the other half voted either that 'agriculture is becoming more carbon efficient' or that 'emission reductions should come from other sectors'. The votes showed an interesting geographical divide: a higher proportion of Irish audience members were of the opinion that agriculture is becoming more carbon efficient, whilst the majority of international members (mostly European) voted that 'agriculture is sitting on the fence'. In addition, opinions on this question tended to change as a result of the Debate – by the end of the Debate, more people were convinced that 'agriculture is becoming more carbon efficient'.

either they are direct victims of the changes that take place in the market, or a lot of their produce actually perishes. We need to use renewable sources of energy to improve the lot of farmers across the world.”

Too much of a good thing

This includes studies on consumer behaviour – after all, it is consumer preferences that drives the food industry to source their produce from efficient, low-carbon production systems. Professor Lynn Frewer, Newcastle University, explained that consumer studies can contribute to the food security/climate change debate by ensuring that public opinion translates into sustainable consumer choices. “In developed countries we know that between 30-40% of food that's taken into the household is wasted. If you look at the impact of that over the developed world that's an enormous loss of calories,” she explained. She also argued how over-nutrition in developing and emerging economies leads to an inequitable distribution of food and calories, which is adding to the disease burden globally.

Adapting to climate change

This leaves a strong role for research, not only research on the mitigation of greenhouse gases, but also on adaptation. Professor Pamela Ronald, University of California, Davis, exemplified how her genetics research groups has produced rice varieties that are resilient to flooding caused by climate change – and how this variety is now increasingly popular in Asia. “We have genomes from many different varieties of plants. So, geneticists can now go into those genomes and fish out genes that have not been used before to try to develop plants that can adapt to climate change,” said Professor Ronald.

How FACCE-JPI is helping

Finally, Dr Marion Guillou, President & CEO, INRA and Chair of the FACCE-JPI Governing Board, explained how the FACCE-JPI has been initiated to coordinate and integrate these research efforts across 21 EU member states (see panel): “We have solutions now and we have solutions to prepare for the future. The JPI is very important in this, as we all need to join our research efforts so that we move quicker and more efficiently in research, innovation and communication.”

Acknowledgments

The committee acknowledges the contribution of the speakers and the expert moderation by broadcaster Leo Enright.

What is FACCE-JPI?

The Great Debate was organised by the FACCE-JPI, which is the EU Joint Programming Initiative on Agriculture, Food Security and Climate Change. The FACCE-JPI brings together 21 European countries and aims to 'increase the value of national and EU R&D funding on agriculture, food security and climate change, by concerted and joint planning, implementation and evaluation of national research programmes'.

Ireland (Teagasc and the Department of Agriculture, Food and the Marine) are active members of the FACCE-JPI, and Teagasc is responsible for the coordination of the JPI's activities with other international initiatives.

For more see: <http://www.faccejpi.com>

Missed the Great Debate?

Over 3,000 viewers watched the Great Debate live online, and over a further 7,200 viewers have watched the recording since. To see clips from the debate see: <http://www.youtube.com/user/teagascmedia>

The clips include students from Gorey Educate Together National School and the video of Edward Ouko, a farmer from Kenya (courtesy of CCAFS Climate Change, Agriculture and Food Security Programme of CGIAR), who explains what climate change means to him.

The Great Debate continues on Twitter: @thegr8deb8

Teagasc @ESOF2012

The Euroscience Open Forum is the biennial pan-European meeting dedicated to scientific research and innovation, with more than 5,000 attendees. Teagasc was involved in four scientific sessions at ESOF2012 in Dublin, as well as participating in the exhibition.

A Harvest of Irish Food

'A Harvest of Irish Food' was a day-long event held the day before the start of the ESOF scientific programme and was organised by Teagasc in partnership with Bord Bia, University College Dublin, and the Dublin Institute of Technology, to celebrate Dublin City of Science 2012. The event showcased the unique combination of Irish food culture and tradition with the best of our food science and technology and reflected the central importance of the food industry to the Irish economy and the role of these organisations in supporting the sustainable development of the sector.

A Harvest of Irish Food was directed at visiting researchers, media, ESOF delegates, students and food industry personnel.

The tour began in Teagasc Food Research Centre,

Ashtown, with an Irish summer breakfast sponsored by Bord Bia. At the breakfast, Aidan Cotter, CEO, Bord Bia, discussed the sustainability credentials of Irish food production and Professor Gerry Boyle, Director of Teagasc, outlined the role of science-based innovation in developing the Irish food sector. This was followed by a series of on-site demonstrations hosted by Teagasc Food researchers, under the research theme 'science for food innovation from Ireland's high quality natural resources', as demanded by today's consumer.

The delegates then visited University College Dublin, where research at 'the intersection of food and health' was demonstrated. Delegates also experienced a walk-through exhibition and talks on the 'past, present and future of food' at Dublin Institute of Technology, Cathal Brugha Street. The day ended in Trinity College Dublin with an Irish evening dining experience where delegates got a taste of the best of Irish seasonal products from Bord Bia Quality Assured suppliers, Irish hospitality and culture, culminating in a performance by the Anúna singers. The dinner was attended by Minister of Agriculture, Food and the Marine, Mr Simon Coveney, TD, and the Chairman of the Dublin City of Science/ESOF 2012, Professor Patrick Cunningham, in addition to representatives of various State organisations. "This unique opportunity allowed delegates to experience the breadth and depth of food research taking place in Ireland, as well as the quality of sustainable Irish food being produced throughout Ireland," said Declan Troy, Assistant Director of Research and Head of Technology Transfer at Teagasc.

"It is anticipated that new potential projects, initiatives or collaborations will be inspired by the tour and interaction with our researchers and food industry experts," he added.

Milk: Nature's perfect food?

The Teagasc Food Programme participated in two scientific sessions at ESOF. Professor Paul Ross hosted a session entitled 'Milk: Nature's Perfect Food?' to a packed audience which included international food scientists, dairy industry representatives and journalists. This event was designed to deliver some of the excitement that currently exists around the latest research on the technology and health aspects of milk, which is particularly relevant given the impending expansion of the Irish dairy industry.

The session opened with a very entertaining lecture from Professor Bruce German from University of Davis, California, on how milk has evolved over millennia to improve the health of the young. In particular, he gave a fascinating account of how milk contains an elaborate array of complex sugars



that can promote the growth of specific health-promoting bacteria (*Bifidobacterium infantis*) in the human colon. In addition, Bruce went on to dispel much of the myth surrounding the association of dairy consumption with human ill health such as cardiac disease – showing some compelling epidemiological evidence to the contrary.

Dr Catherine Stanton (Teagasc) then followed with a talk entitled ‘Milk Intelligence’, which chartered the array of health-promoting substances in milk that can positively affect our health. One particular example was the healthy fatty acid CLA (conjugated linoleic acid) which is abundant in the milk from pasture-fed animals and hence Irish milk in particular. CLA has a wide array of health properties associated with it including positive effects on the immune system and on cancer cells. She also showed that it is possible to supplement animal fed with oils to increase it even more in milk or in products such as cheese.

The session closed, with an enthusiastic account from Dr Mark Fenelon (Teagasc) on the potential to develop new value-added dried ingredients from milk with added ‘smart’ properties. These included improvements in functionality and biological activity of dairy powders including infant formula. He also spoke about the huge potential to export such ingredients to counties such as India and China.

Probiotics

In the second session on the food theme, scientists from the APC (Alimentary Pharmabiotic Centre) - including Professors Fergus Shanahan, Colin Hill, Paul Ross and Ted Dinan - hosted a session entitled ‘Probiotics: alternative medicine or evidence-based alternative?’. This session gave a very upbeat account of the latest scientific evidence to support the health-promoting properties of probiotics and gut microbiota in general. This session also included a talk from Professor Michiel Kleerebezem from the NIZO in Holland on the positive effects of probiotic ingestion on metabolic processes in the body. Between the two sessions, a very positive scientific message was delivered on the benefits of dairy and probiotics for the future of consumer health.

Genomic tools for healthier livestock

Dr Donagh Berry spoke at a session on ‘Can we use genomic tools to select healthier livestock’. Animal health is one of the most neglected suites of traits in most livestock species. This is primarily due to a lack of routine access to animal health records on which to make informed breeding decisions.

“Traditional genetic evaluations exploit large databases of animal records, coupled with knowledge on the genealogy of each animal, to estimate the genetic merit of each animal. The success of exploiting genomic information in national breeding strategies for any trait, including animal health, is dictated by the genomic architecture of the trait, or in other words if the trait is influenced by few or many DNA mutations. Such phenomena also influence the ability of animal research to detect these contributing DNA mutations, but also the ability of the pathogen to itself alter (i.e., mutate) its DNA to overcome the developed host defences,” explained Dr Berry.

There are many examples where genomic information has been used in breeding programmes for animal health. Susceptibility to transmissible spongiform encephalopathy in sheep, commonly referred to as scrapie, appears to be influenced by a single gene and therefore eradication of susceptibility is theoretically possible. However, many different variants of scrapie exist with different host DNA mutations conferring resistance to different strains. Mutation of pathogenic DNA is also possible in the future and host variation attributable to only a small number of mutations is, in general, more susceptible to being overcome. In direct contrast, susceptibility to worm infestation in sheep or mastitis in livestock is likely to be very polygenic (i.e., influenced by a large number of DNA mutations) and, therefore, individual DNA mutations are unlikely to have a large impact on resistance to infection.

“Animal breeding can be a useful tool, as part of an overall strategy to improve animal health,” concluded Dr Berry.

The Great Debate

For a full report on the auditorium session ‘The Great Debate on the Battle to Feed a Changing Planet’ see feature on p10.



Speakers at the ‘Milk: Nature’s perfect food?’ seminar (from left): Professor Bruce German, University of California Davis, USA; Dr Catherine Stanton; Dr Mark Fenelon; and Professor Paul Ross, Head of Food Research, (session chair), all Teagasc Food Research Centre, Moorepark.



Teagasc lecture series kicks off with The Perfect Storm

The inaugural lecture in Teagasc/RDS series on Grand Challenges for Global Agriculture and Food was presented on behalf of Professor Sir John Beddington, Chief Scientific Adviser to the UK Government. Drs Frank O'Mara and Lance O'Brien summarise the main points of the lecture 'Navigating the Perfect Storm: The International Challenge of Food, Water and Energy Security'.

There are several important factors that will influence the production and demand for food over the coming decades. Of critical importance are population growth, increasing urbanisation, climate change and rising prosperity with associated rise in the middle classes. The trends in these factors can be altered in the medium to long-term, but regardless of actions taken immediately, the trends are such that significant changes are inevitable in global food demand to 2025/30 and how that food is produced.



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Population

Global population exceeded 7 billion for the first time in 2011. It is expected to rise to 8 billion in 2025, and projections are that it will approach 10 billion by the end of the century. Higher or lower rates of female fertility than anticipated will increase or decrease these projections, but the rise projected by 2025 (8 billion) is virtually inevitable at this stage. In the longer term, prosperity, education and the availability of family planning are the key factors that could influence female fertility and the rate of growth in global population.

Urbanisation

Most of the growth in population will occur in urban centres. For the first time in history, the number of people living in urban areas exceeded 50%

of global population in 2010. This is set to continue. The extra 1 billion people inhabiting the planet by 2025 are expected to be roughly equally divided between Africa and Asia. In Africa, there will be 1,000 new cities with a population of 500,000, while in Asia, it is expected that there will be 500 new cities with populations of 1 million.

Climate change

Evidence of climate change was presented. The five lowest December extents of Arctic sea ice in the satellite record have occurred in the past six years. Summer temperature and rainfall in Texas in the summer of 2011 were dramatically outside normal ranges (indicating climate change is not just an issue for developing countries). Insurance company, Munich Re, has charted a strong trend of increased natural catastrophes loosely associated with weather (meteorological, hydrological and climatological-related events). There is uncertainty over the extent of climate change over the next century, but in the shorter term to 2025, some degree of climate change will occur regardless of what we do now. There is a huge range in outcomes thereafter, depending on whether we make progress in tackling greenhouse gas emissions or not.

Prosperity

Rising prosperity will increase the number of people in the middle classes globally. As people's living standards rise, they consume more food, energy and consumer goods.

The trends in these factors combine to produce a perfect storm for the world's food supply system. We have already seen impacts such as the reversal in the long-term decline in real food prices and the food price spike on 2008. This was sparked by significant weather events (e.g., drought in Russia and Ukraine reduced grains yields and caused those countries to cease grain exports). The recent volatility in food prices has put 44 million more people into extreme poverty, and has been linked to social unrest and political instability.

Challenges for food security

To date, the world's food production system has coped reasonably well with rising food demand. There are significant regional differences in how this has happened. For example, in the 40 years from 1961 to 2001, cereal production in Africa and Asia rose by 241% and 282%, respectively. In Africa, this was mainly due to an increase in the land area under cultivation, whereas in Asia, it was mainly due to increased yields. The scope for continued increase in the land under cultivation in Africa is very limited, which is significant as this is one of the regions where population will experience strong growth. So, land availability will be a significant challenge to future food security. There are a number of other significant challenges:

- Currently, agriculture consumes 70% of total global water withdrawals from rivers and aquifers, many of which are overexploited. For instance in India, aquifer water currently being used is hundreds of years old, indicating these aquifers are not being given sufficient opportunity to replenish. Having sufficient water for irrigation for increased food production will be a significant challenge in the future, with a gap of 40% between supply and demand predicted by 2030.
- There is evidence of flattening of the growth in crop yields. Long-term wheat yield measurements at Rothamsted research station in the UK show significant growth from 1940 due to 'scientific' breeding and agronomy, but yields have been flat over the last decade or more. We will need to increase the rate of yield increase but without major increases in fertilizer or pesticide use.
- Agriculture currently emits 10-12% of global greenhouse gas emissions and increasing food production using current technologies will inevitably increase these emissions. Production systems will need to be developed that produce less greenhouse gas emissions.
- Two per cent of all fossil-fuel energy produced is used for nitrogen fixation in fertilizer production, and there is a strong link between energy and fertilizer prices. This will challenge crop production systems to be more nitrogen efficient.

Global solutions

These challenges point to the need for a transition to sustainable agriculture which is: productive and generates income; is more resilient and resource efficient (including land); protects the environment, and maintains ecosystem services; but, at the same time, adapts to climate change and reduces GHG emissions.

There is a need for greater co-ordination globally to boost productivity while reducing GHG emissions. Important approaches suggested were:

- Improved varieties or breeds of crops, livestock and aquatic organisms.
- Improved diversity of agricultural systems (e.g., agroforestry).
- Improved quality of feed for livestock and aquaculture.
- Soil management to sequester carbon.
- Complementary biological and ecosystem services supporting agriculture (e.g., forest protection).
- Resource (water, fertilizer) efficient practices for crops (e.g., rice).

Tackling food waste

Another area that science needs to tackle is waste in our production systems. It is estimated that 30% of food produced is



Panel of speakers at the inaugural Teagasc RDS lecture series (from left): Laura Burke, Director General at Environmental Protection Agency; Tom Arnold, Chief Executive Officer of Concern Worldwide; Professor John Sweeney, NUI Maynooth and Matt Dempsey, Editor, *Irish Farmers Journal*.

never consumed. In developing countries, this is mostly on-farm or during transport and processing, whereas in developed countries, it is mainly lost after consumer purchase. Losses due to pests and diseases of major food crops are estimated to be greater than 40% worldwide. This is an area where science and technology can help, and all technologies, including genetic modification, should be considered in these efforts.

In summary, the world food security faces major challenges from population growth, urbanisation, prosperity (through increased use of resources) and climate change. We need to increase food production through an agricultural system that, as well as being productive and profitable, is resource efficient, resilient, adapts to climate change, and reduces greenhouse gas emissions. There is a huge role for technological advances in meeting these challenges.

Acknowledgments

The contribution of the panel to the discussion and of journalist and broadcaster Leo Enright, who chaired the lecture, is greatly appreciated.

Upcoming lectures in the Teagasc/RDS lecture series

Lecture 2:

Will we Run out of Natural Resources Needed for Food Production?
November 27, 2012

Lecture 3:

Will Science and Technology Solve the Food Security Challenge?
March 2013

Lecture 4:

How can we Change Food Consumption Patterns?
November 2013

Lecture 5:

Is Better Global Governance of the Food System the Answer?
March 2014

Lecture 6:

Ireland's Response to Global Grand Challenges
November 2014



Food solutions for weight management - satiety enhancing bioactives



Teagasc researchers, as part of the Food for Health Ireland consortium, have been screening for milk-derived proteins, which increase satiety, as possible functional food ingredients for weight management.



Obesity is a global health concern that has reached epidemic proportions. In Europe alone, the prevalence of obesity has tripled in the last two decades and, coupled with obesity-related illnesses, is now responsible for over 1 million deaths in Europe each year. It is predicted that by 2015 almost 1.5 billion consumers worldwide will be overweight or obese. The diet and weight management market is, therefore, expected to be worth over €13.9 billion. An increase in portion size has been identified as a contributing factor to the obesity epidemic. Portion sizes began to grow in the 1970s, followed by a sharp increase in the 1980s. Since then, portion sizes have increased in parallel with increases in body weight. Several of the drug-based therapies currently on the market to treat obesity either lack efficacy or have adverse side-effects. There is, therefore, an opportunity to develop food-based alternatives to regulate appetite and to aid in weight management. Teagasc runs an active research programme to identify food solutions for weight management. One of the areas of interest to Teagasc is to develop food ingredients that can target appetite.

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Satiety

Research into the area of appetite control and weight management is primarily focused on promoting satiety. Satiety is the feeling of fullness which prevents further food intake in the period between meals. Primarily, satiety is associated with gastric distension, reduction of gastric emptying and increases in the secretion of pancreatic and gastric digestive enzymes. The presence of ingested nutrients in the gut causes secretion of several satiety hormones with multiple actions. These hormones stimulate the vagus nerve, which leads to activation of the hypothalamus of the brain. Depending on the signal, orexigenic (appetite-promoting) or anorexigenic (appetite-suppressing) peptides will be released, which then regulate satiety and control energy intake. The development of food formulations that increase the production and secretion of satiety hormones could have the potential to provide functional ingredients for weight management and appetite control to avoid the onset of overweight and obesity.

Milk proteins and satiety

Protein is generally regarded as the most potent stimulus of satiety. Research into foods that can promote satiety has been focused largely on bioactive peptides from dietary protein sources. Usually, bioactive peptides are inactive within the unhydrolysed parent protein sequence. However, they can be released by several methods including



enzymatic hydrolysis using proteolytic enzymes, or microbial fermentation using microbes with proteolytic capabilities. Bovine milk protein-derived hydrolysates are of particular interest and several studies have correlated increased milk and dairy consumption with positive effects on body weight, metabolic control and glycaemia. The main bovine milk proteins are caseins (α , β and κ casein) and whey proteins (α -lactalbumin and β -lactoglobulin).

Food for Health Ireland

As part of Teagasc's programme on food solutions for weight management, Teagasc is an active member of Food for Health Ireland (FHI). This consortium comprises researchers from Teagasc, University College Cork, University College Dublin and University of Limerick, and industry partners Carbery, Kerrygold, Glanbia and Dairygold, and is supported by Enterprise Ireland. FHI is focused on developing novel milk protein-based food ingredients with positive health benefits. The consortium is divided into several health pillars, one of which is focused on weight management and metabolic health. To date, FHI has produced over 1,000 milk protein hydrolysates and bacterial fermentates. Part of the team that forms the weight management health pillar is located in Teagasc Food Research Centre, Moorepark. Ongoing work at Teagasc is focused on screening the hydrolysates and fermentates for positive effects on gastrointestinal satiety signalling using a mammalian cell culture model, supported by *in vivo* trials (in mice and pig models) in conjunction with the FHI team (lead by Professors Ted Dinan and John Cryan) located at the Biosciences Institute at University College Cork and with the Pig Development Unit in Moorepark.

Screening milk fractions for satiety

The gastrointestinal tract is sparsely populated by a population of cells known as enteroendocrine cells. These cells function to produce and secrete hormones involved in gastric motility, blood flow and the regulation of food intake. The principle hormones involved in satiety and appetite control are peptide YY (PYY), cholecystokinin (CCK) and glucagon-like peptide 1 (GLP-1). These hormones are released by enteroendocrine cells after nutrient ingestion via increases in intracellular Ca^{2+} or cyclic adenosine monophosphate (cAMP).

The murine, epithelial gastrointestinal STC-1 cell line is used as our *in vitro* high-throughput screening platform. Milk-derived hydrolysates and bacterial fermentates, produced by FHI, are screened for effects on STC-1 intracellular levels of Ca^{2+} and cAMP. Samples that significantly increase Ca^{2+} or cAMP are then screened for their effects on the production and secretion of the specific satiety signals: CCK, PYY and GLP-1 in a low-throughput assay. Once a potential hit has been identified *in vitro*, an in-house scale-up team (led by Dr Phil Kelly) focus on the economic potential of pre-commercial scale-up of the sample. This information can then be transferred to our industry partners. Potential hits are also screened for *in vivo* effects on feed intake and satiety hormonal signalling. Initial food intake studies are performed in mice models following intra-peritoneal injection. Follow-up, and arguably more accurate, studies are then performed in pigs. This work is performed in conjunction with Dr Peadar Lawlor in the Pig Development Unit. Test foods are fed to pigs and blood samples taken every 15 mins over a two-hour period, in order to measure levels of satiety and metabolic signals in the blood.

To date, researchers at Moorepark have identified 15 samples which induce satiety hormones *in vitro*. Out of these 15 samples, two front runners have demonstrated a reduction in food intake in animal models. Although researchers at Teagasc have, thus far, focussed on screening milk fractions, the screening assays developed are applicable to screen any food fraction for satiety.

Benefits to consumers

Teagasc is striving to deliver functional foods that enhance satiety. Ingestion of such foods may reduce portion size and/or frequency leading to a reduction in food intake and body weight over time. Food-based alternatives to medical weight management approaches can be more easily adapted into daily eating episodes. This allows consumers to control their own caloric intake and to manage their eating patterns. This could also help to reduce the negative psychological connotations of dieting, which ultimately leads to non-compliance and prevents continued weight loss.

This research was supported by Enterprise Ireland under Grant Number CC20080001.

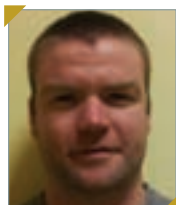
Seaweed: an alternative protein source



Teagasc researchers are looking to seaweed for proteins with health benefits for use as functional foods.



Historically, edible seaweeds were consumed by coastal communities across the world and today seaweed is a habitual diet in many countries, particularly in Asia and in countries where Asian populations have had an influence on local dietary habits, such as Hawaii and Brazil (Brownlee *et al.*, 2012). The popularity of seaweed is growing in Western cultures and seaweed compounds, particularly viscous polysaccharides, are already used in an increasing number of food products to improve product shelf life and acceptability. Seaweeds are classified according to their colour as red (*Rhodophyta*), brown (*Phaeophyta*) or green (*Chlorophyta*). Seaweeds are rich in minerals and trace elements and these positive health attributes may impact negatively on sensory characteristics if these seaweeds are incorporated into food products.



However, whole seaweeds have been successfully added to foods including meat and cereal products in recent times. For example, the brown seaweed *Ascophyllum nodosum*, commonly known as egg wrack, was incorporated into sausage products successfully without affecting flavour (Brownlee *et al.*, 2012). *A. nodosum* has also been incorporated into pizza bases, cheese and frozen meat products. Furthermore, the incorporation of whole seaweeds into foods has been shown to have a preservative effect and is known to inhibit Gram-negative bacteria in particular. More recently, the seaweed species *Undaria pinnatifida* and *Himanthalia elongate* (sea spaghetti) were successfully incorporated into frankfurter type gel/emulsion meat systems (Brownlee *et al.*, 2012).

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Marine functional foods

The Marine Functional Foods Research Initiative, also known as the NutraMara programme, was established by the Department of Agriculture, Food and Marine (DAFM) and the Marine Institute (MI) under the Sea Change Strategy. NutraMara aims to drive the development of the marine sector and assist food companies through the identification of novel, functional foods and bioactive ingredients from sustainable Irish marine resources. These resources include seaweeds, microalgae, marine processing co-products and aquaculture materials. Researchers have shown that protein rich red seaweeds such as *Palmaria palmata* (common name Dulse) and *Porphyra* (common name Sleabhac or Laver) species may potentially be used in the development of low-cost, highly nutritive diets as an alternative to current protein crop sources such as soya bean. For example, the protein content of Dulse varies from between 9-25% depending on the season of collection and harvesting. The highest percentage protein per gram of dried whole seaweed is normally found in *P. palmata* collected during the winter season (October – January) (Lourenco *et al.*, 2002). Valuable amino acids such as leucine, valine and methionine are well represented in Dulse. In *Porphyra* species, the amino acid profile is similar to those reported for leguminous plants such as peas or beans.

Role in preventing cardiovascular disease

Following World War II, the incidence of cardiovascular diseases (CVD) quickly replaced infection as the primary cause of death in the Western world. Today, cardiovascular disease (CVD) accounts for more than 4.3 million deaths each year (Fitzgerald *et al.*, 2012). High blood pressure is a main cause of CVD.

Functional foods are foods that impart health benefits to the consumer and these health benefits extend beyond those of basic human nutrition. Bioactive peptides are food-derived peptides that exert



a physiological, 'hormone-like', beneficial health effect. Proteins and peptides from food sources such as dairy, eggs, meat and fish are well documented as agents capable of reducing high blood pressure and are thought to be able to prevent CVD.

Food-derived peptides may act as inhibitors of important enzymes such as Angiotensin I converting enzyme (ACE-I) and renin. Indeed, food products such as Calpis® and Ameal-S® are commercial products available in Japan and Finland, known for their abilities to reduce high blood pressure through inhibition of ACE-I. ACE-I and renin cause blood vessels to constrict and therefore increase blood pressure within the renin angiotensin aldosterone system (RAAS) [Fitzgerald *et al.*, 2012]. RAAS is the primary system in the human body that controls blood pressure and salt water balance.

Although ACE-I inhibitory peptides are widely reported in the literature, peptidic renin inhibitors are less well known. Within the

RAAS, inhibition of renin may reduce high blood pressure. Inhibition of renin has several advantages over ACE-I inhibition in the prevention of high blood pressure. Renin is the only known enzyme that converts angiotensinogen to angiotensin I. Renin inhibition eliminates angiotensin I from the blood stream preventing the formation of angiotensin II. Another advantage of renin inhibition over ACE-I inhibition is that renin inhibitors do not affect kinin metabolism and therefore are not thought to cause side effects such as dry cough or angioneurotic oedema associated with ACE-I inhibition.

Renin inhibitory peptides from seaweeds

Ciaran Fitzgerald, a Teagasc Walsh Fellow based within the Teagasc Food BioSciences Department in Dublin and his supervisors Dr Maria Hayes and Dr Eimear Gallagher recently generated protein isolates and peptides from seaweeds using food-friendly methods. Subsequently, renin inhibitory peptides were identified from *P. palmata* (Dulse) supplied by trained phycologists at National University of Ireland, Galway. Renin inhibitory peptides have not been identified from seaweed species before. These renin inhibitory peptides are currently being assessed in bread products for human consumption. Research work at Teagasc will also assess the effects of the *P. palmata* protein hydrolysates on the sensory attributes of bakery products, in particular bread. Currently, proximate analysis of a *P. palmata* bread product is underway and the effects of the hydrolysate on the moisture content, ash, crude fat, fibre and protein content have been assessed. The effects of the seaweed protein on the colour and texture profile of the bread are also being carried out.

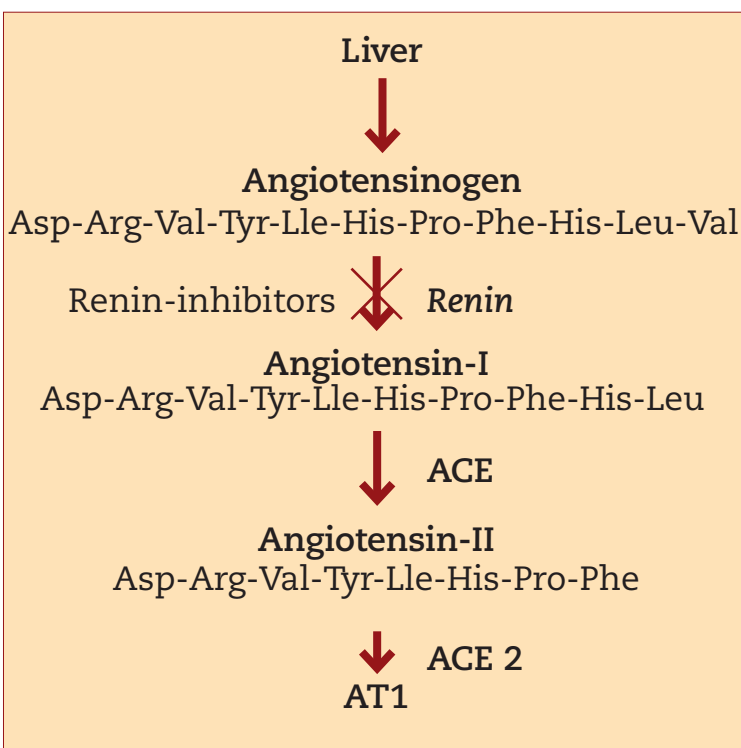
Reduced fat products

It is possible also that protein isolated from *P. palmata* as part of this study could be used for technical purposes in food manufacture, for example in the manufacture of reduced fat products. Microalgal proteins have recently been isolated by the American company Renewable Algal Energy (RAE) and RAE are one of several companies promising to bring novel algal derived ingredients to the food and supplements market in 2012, along with the French company Solazyme-Roquette Nutritionals. The microalgal protein isolate is not currently available but will be available to food manufacturers in October 2012. The strain source of this product is not currently known.

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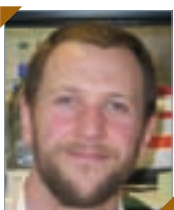
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Breeding tomorrow's potato varieties

Teagasc researchers develop one to two varieties of potato each year, which are marketed by Irish Potato Marketing. Here, they explain how recent advances are speeding up the breeding process.



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Prospects for potato

The future for the potato is bright. Although consumption is declining in the western hemisphere, potato is undergoing a resurgence globally due to its extremely efficient use of limited resources to produce highly nutritious food. Potato produces more food per unit of water, area and time than any other crop, and is currently the third most important food crop after wheat and rice. The Food and Agriculture Organization (FAO) is promoting the use of potato as a hunger-busting crop to support food security in developing countries. In light of the current global population growth, there will be increased demand for new potato varieties in the future. However, potato is susceptible to a large range of diseases and improved resistance is necessary to contribute to sustainable food production.

Teagasc potato breeding

Teagasc has been breeding new potato varieties since 1962. Originally, the programme focused exclusively on breeding for the Irish market but during the 1970s a partnership was formed with Irish Potato Marketing (IPM), which continues to this day, and expanded the scope of the programme to

breed for export markets. Thirty-nine varieties have been released in the intervening period, with over 25 of these still being marketed commercially by IPM. Rooster is by far the best known of these varieties in Ireland and now accounts for 56% of the total potato area grown in Ireland (approximately 9,000 ha in 2011). Cara was the first successful variety released and is still popular in the UK, Northern Africa and Mediterranean regions. However, varieties such as Banba, Burren, Shannon, Slaney and Rooster are currently the most widely marketed and seed produced in North Western Europe is exported to over 40 markets - mainly in Europe, North Africa and the Middle East. Teagasc-bred varieties are being grown as far afield as Australia and Brazil. The breeding programme at Oak Park releases one to two varieties per year with 14 released in the last ten years (see Table 1). These new varieties are becoming established in both traditional and new markets. For instance, Setanta and Infinity are showing promise in the crisping industry, while Nectar, Cristina and Electra are suitable for pre-pack markets. The potato breeding programme in Oak Park is fully funded from income based on all the commercial varieties including Rooster. The relationship with IPM has been an excellent example of public-private partnership.

History

The potato crop (*Solanum tuberosum* L.) is indigenous to South America and was introduced to Europe in the 1600s. This new crop was widely adopted by the 1800s due to its productivity and relative freedom from diseases. Over time many new potato

diseases migrated through the potato growing world, the most famous of these being potato blight (*Phytophthora infestans*), which arrived in Ireland in 1845. However, there have been many more disease introductions such as potato cyst nematode or *Globodera rostochiensis* (first discovered in Europe in 1913). There were very few subsequent introductions of potato after the 1600s until the early 1900s, which lead to a narrow genetic base for the crop. Many widely grown varieties can trace their ancestry back to these early potato introductions. As a result of this restricted gene pool, there was relatively little disease resistance available to breeders and consequently potato varieties were susceptible to many diseases and still rely heavily on fungicide and insecticide inputs. There is a huge wealth of genetic diversity available to breeders in related wild species from South America. Success has been achieved for many diseases such as the H1 gene which confers resistance to *Globodera rostochiensis*: Cara was one of the first varieties to possess this resistance, which is now commonplace. Breeding for other diseases, such as blight, has proved more elusive. A challenge for conventional breeders in the future is to harness the potential in these wild relatives to aid sustainable food production.

The breeding process

Cultivated potato is tetraploid (four sets of chromosomes), which complicates the breeding process compared to other food crops. Over 50 different traits are evaluated in each new variety produced. In addition to disease resistance, the main target traits include: eating quality, suitability for processing (crisps, French fries), yield and adaptation to different climates. Due to the complicated trait inheritance pattern and need to combine so many traits, traditional breeding programmes have focused on producing very large numbers of seedlings and selecting out the best ones. Breeders select potato varieties or genotypes with complementary traits for use as parents. One parent is emasculated by removing the anthers of an immature flower to prevent self pollination, when this flower matures it is fertilized with pollen from the selected male parent. A berry forms which contains up to two hundred seeds known as true



potato seed. Each seed is a sibling to the other seeds in a berry but genetically different and each seed is a potential new variety. Up to 100,000 seedlings from 200 different parental crosses (families) are grown in the glasshouse in Oak Park each year. One tuber from each seedling is selected and these are maintained in their family groups. The tubers are planted in the field and the produce of each plant or seedling visually selected at the end of the first field season for commercial traits such as tuber number, size, yield, etc. A maximum of 3,000 are advanced for further evaluation. Seedlings are tested for a further eight years in field trials under increasingly rigorous selection criteria. The numbers are reduced each year as more traits are scored, beginning with foliage maturity in year four and culminating with disease resistance screening, cooking and quality evaluation. Seedlings from the sixth generation of selection are tested at a number of trial sites in Spanish territories, North Africa, the UK and Ireland, to test the agronomic performance across a number of geographically diverse sites representing climates where the variety might eventually be grown. After approximately 10 years of evaluation, only one or two seedlings remain, which are entered for national list trials to determine if they are suitable for variety status and a grant of plant breeders’ rights.

Future prospects – new technology

Introgressing new disease resistance traits (such as blight resistance) from wild species can take a long time. This is due to the number of rounds of crossing required to dilute deleterious traits from the wild species and also the length of time necessary between rounds of crossing to identify the high performing resistant genotypes for the next round of crossing. Any method that would speed up the time between rounds would dramatically improve the efficiency of the breeding process.

Teagasc has been a leader in the deployment of marker assisted selection (MAS) in potato breeding. Markers (unique DNA sequences that are easily detected in the laboratory) associated with a trait of interest from the parents allow breeders to identify progeny seedlings with these traits at a very early stage and this can speed up the breeding process. Using suitable markers it is now possible, in theory, to produce conventional varieties with new traits from wild species in as little as 15 years from the initial cross. In practice, this period may be considerably shorter as many wild species donors have already undergone several rounds of crossing by traditional methods.

In the past, development of markers was a limiting factor and a major research effort was required to define each new trait and marker combination. The recent publication of the potato genome sequence (which Teagasc was a partner in) will dramatically speed up the development of new markers for a range of traits. This will improve the efficiency of producing new, more disease resistant, conventional varieties.

Variety	Release Year	Variety	Release Year	Variety	Release Year	Variety	Release Year
Cara	1972	Balmoral	1989	Shannon	1995	Carnaval	2005
Clada	1972	Rooster	1990	Orla	1997	Nectar	2005
Mizen	1978	Slaney	1990	Banba	2000	Savanna	2005
Tuskar	1978	Ambo	1991	Emma	2000	Electra	2007
Red Cara	1981	Anna	1991	Malin	2000	Romeo	2007
Amber	1982	Barna	1991	Camelot	2003	Cristina	2009
Avondale	1983	Colleen	1991	Galactica	2003	Infinity	2009
Cultra	1986	Tulla	1991	Habibi	2003	Torino	2011
Afton	1987	Burren	1993	Kikko	2003	Bikini	2012
Glenroe	1987	Druid	1993	Setanta	2003		

Table 1: List of Teagasc potato varieties and year of release.



The Carbon Navigator

The Carbon Navigator is an online decision-support system to assist farmers in assessing their current performance in relation to greenhouse gas mitigation and to chart a path to help lower their emissions. Pat Murphy explains how it works.



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Reducing agricultural greenhouse gases (GHGs) is the biggest challenge facing Irish agriculture in the foreseeable future. GHG research has been the most rapidly growing component of the Teagasc research programme in the last five years. It is not just an issue for the environment programme but is important for all Teagasc research programmes. Considerable advances have been made in our understanding of the sources of agricultural GHGs, of the potential mitigation strategies and of the cost effectiveness of those strategies. However, if farmers are to adopt these strategies, it is vital that we integrate GHG mitigation as a core element of the Knowledge Transfer and Education programmes and develop tools and decision-support systems to support this. To this end, Teagasc and Bord Bia are working in partnership to develop the Carbon Navigator suite of programmes.

Ireland scores well for carbon efficiency

Recent work by the EU commission (Leip *et al.*, 2010) shows that Irish food products are carbon efficient when compared to our EU counterparts. Our milk is the most carbon efficient and our beef is the fifth most efficient in the EU and, because of our temperate grass-based production systems, Irish products also compare favourably on a worldwide basis (FAO, 2010). There are, however, huge challenges ahead. Ireland is committed to a 20% reduction in GHG emissions from the non-traded sectors, which include agriculture. Agricultural emissions account for almost 30% of Ireland's non-traded emissions. 'Food Harvest 2020' (Department of Agriculture, Fisheries and Food, 2010) sets out ambitious growth targets for the agri-food sector, particularly after the abolition of milk quotas in 2015. One of the biggest challenges will be to meet these growth targets, while at the same time, reducing Ireland's agricultural carbon footprint in the context of emerging national and international policy and regulations.

International demands for reduced carbon footprint

International purchasers of Irish food are also putting pressure on the processing industry to ensure that the food that they source for their customers is produced sustainably; a key measure of this relates

to its carbon footprint. Over the last 12 months, processors have been responding to this challenge by initiating projects to measure the carbon footprint of our food products and to examine ways in which it could be reduced, particularly at farm level. Demonstrably improving the carbon efficiency of our food products will be essential if Ireland is to maintain and enhance its green image and capitalise on the potential for improving returns from the marketplace.

Mitigation from agriculture

Agricultural GHGs are particularly difficult to mitigate, particularly in Ireland with its predominantly ruminant-based agriculture. In 2012, Teagasc produced 'A Marginal Abatement Cost Curve for Irish Agriculture' (Schulte *et al.*, 2012) setting out the potential mitigation actions available to Irish agriculture and assessing the cost associated with them. The clear outcome of this study was that the most cost-effective mitigation strategies are those that focus on increasing the technical efficiency of our farm enterprises. It was clear from the study that the efforts to mitigate agricultural GHGs should be aligned with the technical messages which already form part of current Teagasc Knowledge Transfer Programmes delivered through discussion groups, individual advice and quality assurance schemes.

The Carbon Navigator

The Carbon Navigator is being developed as a joint venture between Teagasc and Bord Bia. It is a tool with a simple objective and *modus operandi*. It is designed to assess the level of adoption of technologies that have been proven to reduce GHG emissions on farms, to communicate with the farmer how he/she is performing and to give clear targets for improvement. The Carbon Navigator does not provide an overall count of GHG emissions on the farm as to do that would make it too cumbersome and bureaucratic to be an effective tool at farm level. Instead, it focuses on 'distance to target' by assessing current performance, comparing that performance with average and best performing farmers and setting practice adoption and efficiency targets to be achieved over a three-year period.

The Carbon Navigator will be delivered in conjunction with Bord Bia Quality Assurance Schemes. The Beef Quality Assurance Scheme has been in existence for a number of years and it involves data gathering by QA inspectors and links to other data sources, such as the Department of Agriculture, Food and the Marine and the Irish Cattle Breeding Federation. This database provides an efficient and effective platform for the navigator given that most of the data required to deliver the outputs of the model are already in the database. A relatively small amount of data entry by farmers, or their advisers, will allow the model to be run.

How it works

The first Carbon Navigator will be for beef farmers and this will be quickly followed by a version for dairy farmers. The model will focus on six technologies at farm level. It does not cover all potential mitigating technologies but focuses on ones that meet the following criteria:

- There is a body of science to support and quantify the mitigation capability of the technology
- It is relatively easy to implement at farm level
- It has a significant impact on GHG emissions
- It is cost-effective

The design of the programme will allow additional measures to be included at a later stage if they satisfy these criteria.

The Carbon Navigator assesses the farmers' current performance with respect to six technologies. These are:

- **Grazing season length** – Longer grazing season reduces rumen methane production and reduces storage period and losses associated with manure application
- **Calving rate** – Higher output per cow and hence more produce for the same amount of greenhouse gas
- **Age at first calving** – Shorter, unproductive time thereby lowering emissions
- **Liveweight gain** – Higher output and/or faster finishing times and hence more meat for the same amount of greenhouse gas
- **Nitrogen usage** – Lowering of nitrogen usage per kg output
- **Slurry application** – Lowering GHG losses through timing of applications and application method.

Each technology is assessed and a common approach is used to present the information to the farmer. The objective of the output is to let the farmer see that by improving performance or adopting a technology he/she can both reduce GHGs and also increase the profitability of the enterprise.

The system outputs are graphic rather than textual and include:

- Details on current performance
- A rating of the current performance compared to average and top 10% performance in the farmer's own region/soil
- The target for future performance
- The financial impact of achieving the targets
- An explanation of how the performance improvement reduces GHG emissions.

Implications for industry

The system brings together information from each of the technologies and gives a graphical representation of the farm's current and targeted performance. A summary page brings the outputs of the component technologies together in a single output.

The Beef Carbon Navigator was launched at the National Ploughing Championships in 2012 and will be followed early in 2013 by the Dairy Carbon Navigator. The programme will be particularly useful in working with farmers in Dairy Expansion Programme (DEP) and Beef Technology Adoption Programme (BTAP) groups, but will be available to all farmers who are members of the Bord Bia Quality Assurance Schemes.

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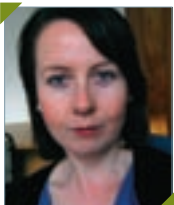
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This project is funded by the Teagasc core fund.

Wood energy potential of farm forestry

Researchers in Teagasc’s Forestry Development Department have found that farm forestry offers significant potential towards meeting renewable energy targets.

The Renewable Energy Directive (2009/28/EC) has set ambitious targets for Ireland – that by 2020 at least 16% of all energy consumed in the state is from renewable sources. Every available renewable energy resource in Ireland needs to be evaluated for its potential in meeting these targets. The target for thermal energy in particular will be difficult to meet, and forestry has an important role to play in achieving it. Much of Ireland’s private forest estate of about 270,000 ha has been planted since 1989. Significant potential exists to leverage some of the biomass from forestry thinnings, as a significant area is now at, or close to, first thinning stage. Good forestry practice achieved through thinning forest crops at an appropriate age would allow an increased supply of biomass. The SUPPLYCHIP project is aimed at examining what potential distinct geographical concentrations of forestry have to address the shortfall in biomass supply. The project quantified the wood energy potential of forest plantations, based on their anticipated thinning potential and harvest output. While foresters would like to thin every forest plantation to increase the overall quality of a forest stand, not every forest plantation is suitable for thinning, due to a variety of considerations such as windthrow risk, low output, excessive roading requirements, and costs of harvesting due to the small and fragmented nature of farm forestry in Ireland. The location of forests and their proximity to the public road network is also a major factor limiting the supply of forest thinnings to the market. The SUPPLYCHIP project examined the realistic potential of the private forest resource to supply raw material to the heat sector, given the various productive, logistical and roading constraints that exist.



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Study area

Previous work undertaken by Teagasc (Farrelly *et al.*, 2008) classified private forests in Ireland into 16 distinct geographical concentrations referred to as ‘forest clusters’. These clusters are situated close to potential major wood energy end users. To build on this research, one of these forest clusters in the North West and centred around Ballaghaderreen,

Co. Roscommon, was chosen for a detailed analysis of its potential for wood energy supply. It was anticipated that considerable demand for raw material would exist at a local level, (i.e., in the towns of Ballaghaderreen, Castlerea and Kiltimagh) and at an industrial level (i.e., Lanesboro Power Station).

The assessment of forest resources

A detailed classification of forest plantations using geographic information system (GIS) and remote sensing methods, succeeded in classifying 3,276 privately owned forest plantations occupying approximately 11,500 ha. Of this area 8,459 ha was classified as productive forest. As no data on growth potential existed, forest growth was simulated using a GIS forest growth model (Farrelly *et al.*, 2011). This model uses wind speed, soils and land quality to predict the yield of any plantation in Ireland. A thinning rotation classification was assigned to each plantation based on the plantation area, ground conditions and proximity to the public road network. This provided new information on the extent of forest area suitable for thinning. Results of this analysis concluded that 5,666 ha were suitable for conventional thinning practice (five thinning operations and clearfell). A further 2,153 ha, or 25% of the area, was found to be suitable for a reduced thinning rotation (two thinnings and then clearfell). A total of 640 ha were found to be unsuitable for thinning.

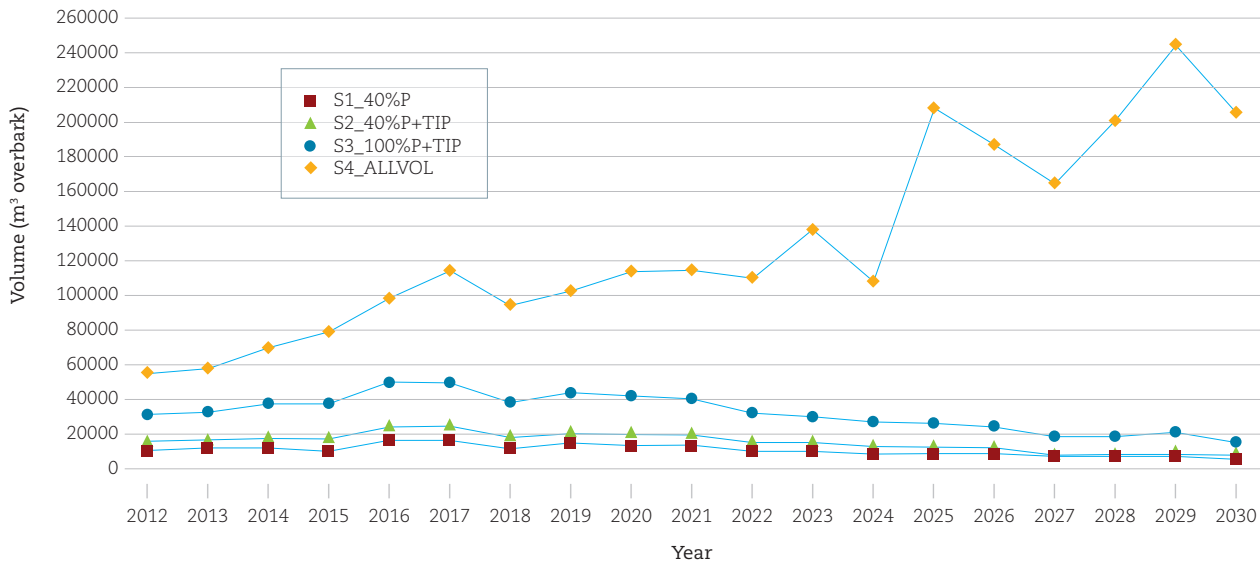
Quantification of wood energy potential

The forest growth model predicted the age and yield of first thinning. Conventional forest product assortment tables were used to derive the total



Figure1:
Forest clusters
and potential
locations of
industrial wood
energy using
facilities

Figure 2: Potential volumes available for wood energy using four scenarios, S1, S2, S3 and S4.



volume output and volume assortments (pulp, pallet, sawlog) in the cluster. Total annual harvest output is forecasted to reach over 100,000m³ in 2016, of which pulpwood (7 - 13 cm diameter) and tree tops (1 - 6 cm diameter), make up over 50% of the output (51,000m³). Much of the palletwood and sawlog material is unlikely to be available for the wood energy market. In addition, the proportion of pulpwood that may be available for wood energy can be unpredictable and is largely determined by the market conditions at time of harvest. To evaluate the wood energy potential, we utilised four scenarios:

- Scenario S1: 40% of the pulpwood went to wood energy
- Scenario S2: 40% of the pulpwood and all tree tops went for wood energy
- Scenario S3: 100% of pulpwood and all tree tops
- Scenario S4: 100% of harvest output

The potential wood energy volume available under the four scenarios is shown in Figure 2. Under scenario 1, wood energy potential is forecast to reach a maximum of 18,000m³ in 2017. Under scenario 2, the provision of additional material from the tree top assortment increases supply to 24,000m³ by 2017. If all pulpwood goes for wood energy (S3), potential supply could reach 51,000m³ by 2017. The forecasted wood energy output 2012 - 2020 has been mapped and indicates local concentrations around major towns in Mayo and Roscommon (Figure 3). A decline in potential output is evident from 2017 to 2030 due to the increase in maturity of forest plantations, and resulting decline in pulpwood output, which depends on planting levels being maintained into the future. Total annual volume output (including sawlog, palletwood, etc.) is forecast to exceed 100,000m³ by 2020, and 200,000m³ by 2028.

Conclusion

To place this study in context, the amount of solid volume required to run a 12 MW steam boiler to dry milk in a major dairy plant year-round is approximately 35,000-40,000m³ of round wood at 55% moisture content. Under scenario (S1), about 30% of wood energy requirement could be met, increasing to 40% under scenario 2 (S2). Much of the demand for a 12 MW boiler could be met up to 2020, under the S3 scenario. For larger co-firing facilities (e.g., Lanesborough), it may be necessary to include some of palletwood

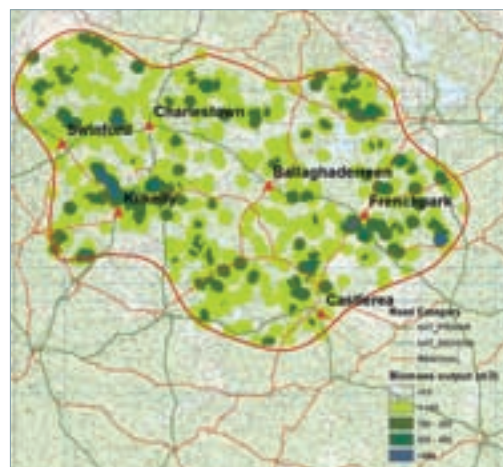


Figure 3: Location of forest biomass around towns in Co. Mayo and Co. Roscommon.

and sawlog assortment to reach large-scale continuity of supply. Results indicate that increased recovery of pulpwood and forest residues can increase the availability of wood energy from farm forests. In the long term, however, the supply of wood energy is highly dependent on the ongoing availability of first thinnings,

which is highly dependent on the maintenance of current planting levels. This research has succeeded in providing a framework for the evaluation of wood energy potential from farm forests. Considering this cluster represents about 5% of the private forest resource, it can be concluded that farm forestry is an important renewable energy resource and offers significant potential towards meeting the renewable energy targets.

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This research was funded by CoFoRD (Competitive fund for Forest Research and Development).



Figure 1. Dry bubble disease in a mushroom crop.

Detecting bubble trouble in mushrooms



Researchers compare traditional culture with molecular detection for the diagnosis of dry bubble disease in mushrooms.



One of the most ubiquitous and persistent diseases affecting commercial production worldwide is caused by the microscopic fungus *Lecanicillium fungicola*, which is responsible for the disease known throughout the industry as ‘dry bubble’. The pathogen causes the mushroom to produce misshapen masses of tissue rather than mushrooms and it can also cause the mushroom stalk to split or result in grey-brown spots developing on the mushroom cap (Figure 1). This has a serious effect on both mushroom quality and marketable yields, and severe outbreaks can reduce already tight profit margins to unsustainable levels. Therefore, the industry is always keen to keep the disease well under control.



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Invisible threats

The dry bubble fungus produces large numbers of microscopic spores, which are held in sticky mucilage. These are very easily spread around the mushroom farm via water-splash (when the crop is watered) or by sticking to whatever they come in contact with, such as mushroom flies, farm personnel and equipment. The spores can survive for seven to 12 months in soil and dust, which makes *L. fungicola* persistent on farms and difficult to eliminate. Outbreaks of the disease occur when cleaning and disinfection of the farm is not done thoroughly, or when weather conditions result in contaminated

dust and debris blowing around the farm onto freshly cleaned machinery, equipment or new crops. In addition, warm summer weather and temperature-controlled growing rooms favour the development of mushroom fly populations - major vectors of disease spread - which can cause major outbreaks of the disease to occur in summertime.

The microscopic nature of the dry bubble spores means it is difficult for the growers to perceive when there is a potential threat or when “clean” surfaces are contaminated. Information about potential sources of *L. fungicola* on mushroom farms can be obtained using a selective medium to test samples for the presence of the pathogen but, although it is quite a simple technology, it can be quite time consuming. Since 2007, Teagasc has been searching for improved methods to detect *L. fungicola* on mushroom farms in order to provide mushroom growers with a means to identify potential sources of this costly disease. Both molecular and microbiological detection methods have been investigated and good progress has been achieved both in terms of detection methods and identifying sources of the pathogen on farms.

Better detection

By modifying both the concentrations and ingredients in an existing selective medium we were able to develop a more effective medium, which enhanced the detection of the dry bubble fungus in farm samples. Growth of the fungus on the new medium was much stronger compared with the existing one, where the fungal growth was very weak (Figure 2). This means that the selective medium method of detection is now more reliable than it had

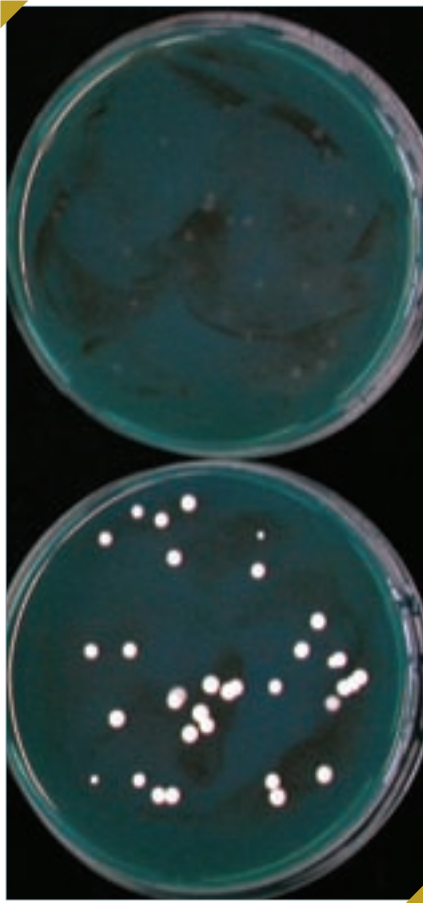


Figure 2: Enhanced growth of *L. fungicola* on improved selective medium (bottom).

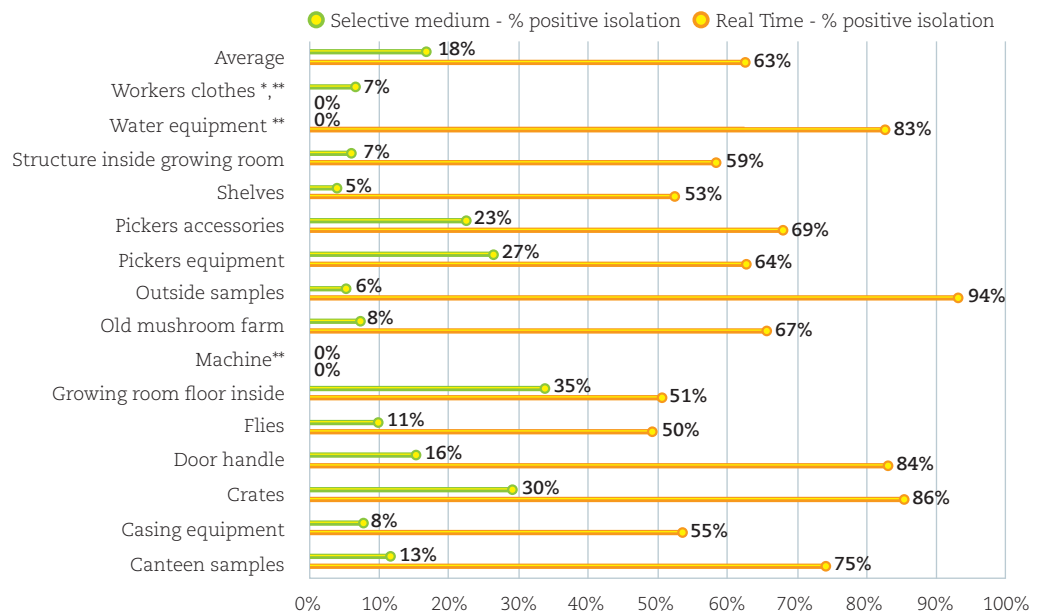


Figure 3. Detection of *L. fungicola* in mushroom farm samples.
 * Only selective medium tested,
 ** not enough samples for comparison.

been and the chance of recording false negative results due to poor growth is much reduced.

With the advance of the genomic sciences, we have been keen to explore the possibility of using a more rapid, molecular-based method (Real Time PCR) for the detection of *L. fungicola* on mushroom farms. Researchers in the Netherlands (Zijlstra *et al.*, 2008) have developed a TaqMan PCR test using a FAM-labelled MGB probe specific for *L. fungicola*. We evaluated this detection method in conjunction with on-farm survey work between 2008 and 2010. In all, 438 samples were collected during 18 visits to nine mushroom farms that were experiencing different levels of dry bubble disease. Samples were collected from different stages of the crop cycle, as well as from other locations on the farm and they were tested for the presence of *L. fungicola* using both molecular (Real Time PCR) and classical (selective medium) methods.

Molecular vs. classical detection

The Real Time PCR method generally gave significantly more positive results for the presence of *L. fungicola* compared with the selective media (63% versus 18%), see Figure 3. Although this initially looked promising, the positive results often did not tie in with incidence of the disease on farms. This high detection rate of *L. fungicola* by the Real Time PCR method may reflect the detection of dead spores and/or mycelium of *L. fungicola*, which can persist after disinfection and cleaning of the growing rooms, equipment and other locations. There is a high likelihood that dead propagules of the pathogen are present on most farms; especially if there have been serious outbreaks of the disease in the past, which is invariably the case. Samples containing high levels of organic matter, such as those from growing-room floors and picking platforms, where mushroom compost and peat accumulate, often gave more positive results on selective media and lower Real Time PCR results, compared to other samples. Organic matter is known

to contain polymerase inhibitors, which reduce the effectiveness of PCR reactions so this is to be expected. Similarly, samples that had no organic matter, and which therefore did not contain polymerase inhibitors (door handles, water equipment, crates, etc.) gave more positive results with Real Time PCR compared with selective media, further suggesting that the positive Real Time PCR result may be associated with dead material rather than living material – since many of the relatively ‘clean’ samples that were positive by PCR, resulted in no living cultures growing on the selective media.

Benefits to industry

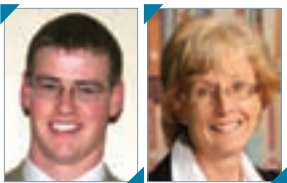
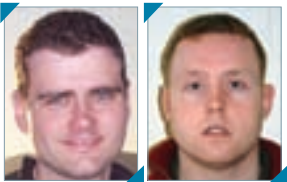
Our results suggest that selective medium may be a more reliable method for routine detection of *L. fungicola* on mushroom farms. It is not an expensive method for detection, but it requires at least a week before a result is obtained. The advantage is that it detects only viable material, such as spores and mycelium, so that a positive result identifies a very real disease risk for a farm. Real Time PCR is a fast but expensive method for detection of *L. fungicola* from mushroom farm samples; however, in these experiments, detection levels were very high, suggesting that non-viable background levels of *L. fungicola* were also being detected. We would therefore be of the opinion that in order for Real Time PCR to be more useful for *L. fungicola* detection on mushroom farms it needs to be more specific for living material.

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This work was supported by the Teagasc Walsh Fellowship Programme.

Sustainable nitrogen use and global food security



The importance of sustainable nitrogen use for global food security was highlighted at the recent 17th International Nitrogen Workshop in Wexford, organised jointly by Teagasc and the Agri-Food and Biosciences Institute, Northern Ireland. Over the three-day conference 300 delegates from 34 countries around the world discussed and debated the role of nitrogen in meeting the demands of 2050. The results of an audience poll, used to gauge participants opinions during the workshop, are included.

Global food demand

The global population is predicted to increase from 6.9 to 9 billion by 2050 and such an increase may lead up to a 70% increase in demand for agricultural products. In addition, the consumption of livestock products is predicted to increase considerably due to increasing affluence; such as in China, which has seen a 30% increase in animal product consumption over recent years. The effects of climate change are likely to alter global agricultural production patterns and per hectare crop yields are predicted to decrease globally. Action is required throughout the food system before food price rises increase to levels that could result in political and economic problems.

The increased demand for agricultural products in the coming decades can be met through a range of options including:

- Increase food production per unit area
- Increase agricultural land area
- Moderate consumer food demand and product selection
- Reduce food waste

Role of nitrogen in food security

Nitrogen fertilization is important for meeting the increased demand for food. However, it has implications for environmental quality through water,

air and soil pollution and contributes to biodiversity decline. A range of national, European Union (EU) and other international policies are in place to reduce nitrogen emissions to the environment and to protect environmental quality. As a result, there is a greater need to integrate food production targets and environmental sustainability. The total environmental cost of nitrogen for the EU27 is estimated to be from €70 to €320 billion, with 40% originating from agricultural sources, and the remainder being associated with energy, transport and industry. Although some reductions in environmental nitrogen emissions have been observed over the last decade, there is still a great need to reduce reactive nitrogen loss. Sixty-two per cent of participants felt that society can meet global food demands while protecting environmental quality (Figure 1).

There is a need to increase food production per unit area due to the limited availability of new land that can be converted for agricultural use. Nitrogen science can contribute to food security through increasing agricultural production per unit nitrogen applied, and this is best achieved via sustainable intensification. In terms of crop production, the yield gap can in part be addressed through land-use planning, improved nutrient and water management, developments in crop selection/breeding and use of new technologies. When conference participants were asked if sustainable intensification was achievable, 53% said yes and 30% said maybe.

Nitrogen accounting

Research has improved the understanding of the fate and rates of nitrogen processes within agricultural systems. However, nitrogen balances rarely account for 100% due to limited quantification of many nitrogen processes. When asked, 73% of conference participants estimated that we could account for less than 60% of terrestrial nitrogen. New tools such as labelled nitrogen tracing and molecular biology can now help to provide greater insight into agricultural nitrogen cycling. These tools are often under-utilised due to cost, limited availability and expertise. Further multidisciplinary research can help to address these limitations and help to complete nitrogen balances. There are currently a lot of tools available

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to farmers to maximise nitrogen utilisation and reduce losses. There is no ‘silver bullet’ for increasing nitrogen utilisation and reducing environmental emissions. Combining mitigation measures often provides synergistic effects, greatly improving their efficacy. Meteorology often drives environmental emissions, reducing the efficiency of nitrogen utilisation. New tools that utilise medium-range weather forecasting could provide additional strategies to improve nitrogen use.

Putting research into practice

A gap often exists between research producers and implementers of research. Strikingly, 68% of conference participants felt there was a conflict between research drivers (scientific papers and funding) and knowledge transfer to stakeholders (Figure 2). Scientists should consider dissemination to farmers and other research users to be just as important as the generation of scientific papers, 72% of participants felt that researchers should be limited to less than two papers per year. Dissemination can be greatly improved through farmer/researcher partnerships leading to ownership of results and recognition of roles.

The nitrogen footprint associated with livestock is considerably higher than plant-based products. Within livestock production, there are also substantial differences in nitrogen use efficiency between cattle and pork/poultry protein sources. Dietary choices result in consumers having a personal responsibility for their nitrogen footprint. When participants were asked if changing human protein consumption patterns is the key to reducing total reactive N losses to the environment, 78% of conference delegates agreed or strongly agreed (Figure 3). When changing population demand was considered, 62% of delegates believed it was not possible to change consumption patterns.

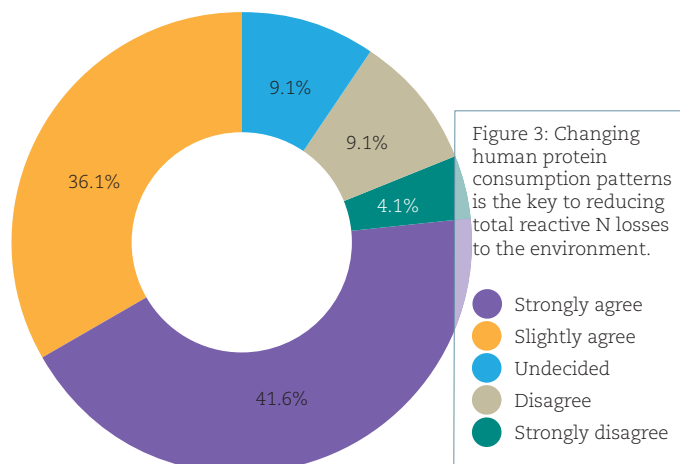
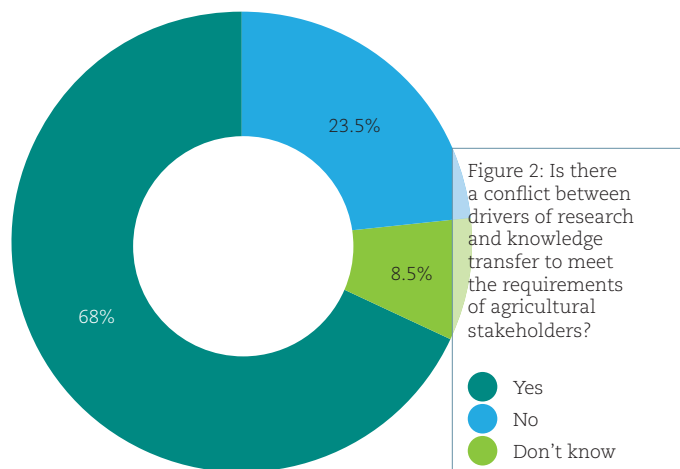
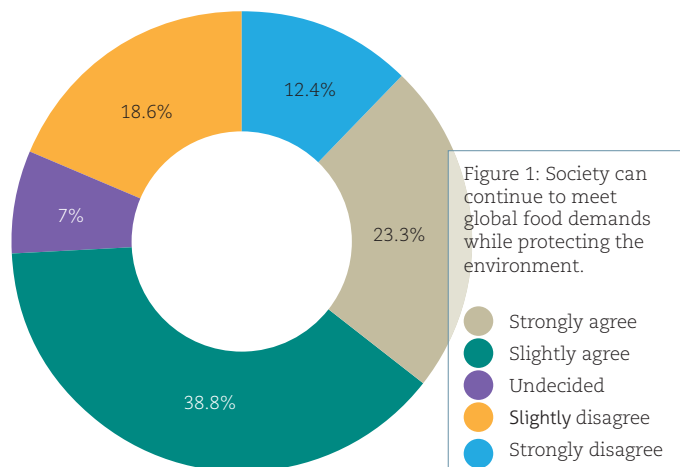
Nitrogen science can contribute to growth in the agricultural sector to meet the rising global demand for food. Constraining the demand for food and dietary selection must form part of food security. Waste of food must be reduced from the current 30% level. The use of nitrogen and carbon foot-printing can be used to benchmark the sustainability of agricultural production globally and highlight the effect of consumer choice. There is a need for new tools for farmers to optimise nitrogen use within their production systems. There is a greater need for research to be translated and implemented on farms through effective knowledge transfer.

Summary

Increasing demand for food products and, in particular, animal proteins, represents a major opportunity for the agricultural sector in Ireland to expand and develop. Nitrogen fertilization will be a key ingredient to this development. The challenge for the sector will be to achieve this growth in output in a way that uses nitrogen resources efficiently. Research continues to improve the understanding and rates of nitrogen processes in agricultural systems. New tools, such as isotope tracing and molecular biology, can further add to this understanding, thereby enabling scientists to develop new tools for optimising nitrogen utilisation. Globally food security is increasingly important and nitrogen has a critical role in meeting the food demands of 2050. Scientists must improve the dissemination and impact of their research at farm level through effective knowledge transfer. Changing human protein consumption patterns is the key to reducing N losses to the environment and, therefore, there needs to be greater public awareness of the impact of dietary choices by consumers on their nitrogen footprint.

Acknowledgements

This event was financially supported by the OECD Co-operative Research Programme; Teagasc; Agri-Food and Biosciences Institute, Northern Ireland; Department of Agriculture, Food and the Marine; Department of Agriculture and Rural Development, Northern Ireland; Irish Fertiliser Manufacturers Association; the Environmental Protection Agency; Koch Fertilizers; and Fáilte Ireland.



Reduced salt ready meals

Consumer perceptions of reduced salt ready meals means that food manufacturers will need to address a number of issues when designing new products.

Teagasc research findings suggest that consumers of ready meals do not know their recommended daily allowance (RDA) for salt. This finding, along with consumers' perception that reducing salt content negatively affects the taste of ready meals, has implications for food manufacturers seeking to develop new products to support the goal of reducing the average salt intake from 10g to 6g a day.

Regular consumers of ready meals gave their opinions on salt and ready meals in a series of six focus groups conducted by Teagasc. Participants included young males, aged between 18 and 20, who are among the most frequent consumers of ready meals. Young females in similar age groups were also selected, as well as housewives with teenage children. Given the changing profile of ready meal consumers and the emergence of the high-end quality category, an over-sixties group of males, currently using prescribed medication for hypertension, were also included in the focus groups.

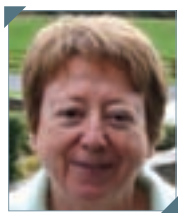
It doesn't apply to me

Given that two out of five deaths in Ireland are caused by cardiovascular disease, and that blood pressure is one of the major factors in developing cardiovascular heart disease, it was not surprising that consumers were aware that high dietary salt

intake is an important causal factor in the rise of blood pressure.

While Irish adults are advised to consume no more than 6g of salt per day, the average Irish adult consumes approximately 10g. Most focus group participants did not know the RDA of salt but they were aware that ready meals and processed foods in general have a high salt content. Across all the focus groups, consumers had a good knowledge of the function of salt in food; they knew it acted as a preservative and flavour enhancer and contributed to the "tastiness" of the meal. They also considered it a necessary mineral for optimum body function. Thus, they are conscious that if salt is removed from a product, it needs to be replaced by something else.

The term sodium caused confusion among consumers with some consumers believing that salt and sodium were interchangeable terms. Some housewives believed that food manufacturers deliberately tried to mislead consumers by using the term sodium rather than salt. While all consumers understood the health risks associated with high salt consumption, younger consumers believed that this risk was a concern for the over sixties and those who had a diagnosed health problem rather than themselves. Middle-aged housewives believed themselves to be at a greater risk of cancer than hypertension and many of them did not see the need to have their blood pressure measured. They formed this view mainly because of their first-hand experience of having friends or acquaintances with cancer. For many, hypertension was a less serious condition than cancer and could be treated with medication and diet.



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Image courtesy of Bord Bia

Reduce salt but don't change the taste

As is generally the case with many foods, consumers want a tasty product when they buy a ready meal so while consumers cautiously welcomed a reduced-salt variant they were not prepared to trade-off taste for reduced salt. Worryingly, some consumers would like a reduced or possibly a no-salt variant so that they could add salt at the table, negating the benefits of a reduced-salt strategy. Some consumers wanted permission to add salt at the table and it was felt a no-salt product would give them this permission!

Consumers were concerned that salt, which was perceived as a natural product, could be replaced by less desirable ingredients such as “chemicals”. This was particularly worrying for mothers, and many pointed to the use of aspartame (sugar substitute) in diet drinks, an ingredient which generated much debate and controversy. If salt is to be reduced in ready meals, consumers want only natural replacements used. Replacing salt with herbs and spices in consumers' current favourite ready meals was seen as a change too far as this was assumed to make a significant change to the overall flavour and result in a different product. Consumers do not want to trade the flavour of their favourite ready meal for a reduced salt reformulation. However, new products that included herbs and spices were welcomed.

Salt won't make you fat

Focus group participants thought that it was not technologically possible to replicate the preservative properties of salt without compromising the shelf-life of ready-meals. For some younger, price-sensitive males, reformulating the salt content of ready meals translated into unwelcome higher prices. For many the 'reduced' or 'low' tag on foods equated to a price premium. Younger females were generally concerned about the fat rather than the salt content of ready-meals with a particular interest in how fat increased the calorie-count of the meal. One young woman summed up the priorities of her group by expressing her view that “salt won't make you fat” and salt was, therefore, deemed a somewhat acceptable ingredient for young women.

Reformulate foods – but don't tell consumers

Some consumers expressed a view that government should regulate the salt levels used by food processors. Reducing costs in the health service was the main motivation behind this suggestion. However, some people were cynical of government policy-making and expressed lack of confidence in their ability to implement such a policy. Some members of the focus groups thought that it may be useful to reduce salt levels gradually without telling consumers and felt this would prevent consumers developing any preconceived biases against reduced-salt products. However, many consumers felt they should be given the choice between reduced-salt and regular salt variants.

Implications for the food industry and policy makers

Consumers appear to understand the risks associated with high levels of dietary salt intake but many are under the impression that these risks only apply to those with a diagnosed health condition or other age cohorts, i.e., consumers have no clear demand for reduced-salt ready meals. Furthermore, they are not willing to trade-off taste for reduced salt and are demanding in terms of what is viewed as acceptable in terms of a salt-substitute. Thus, reformulating ready meals to reduce salt levels presents a number of risks to manufacturers. Retaining value-pricing, taste and shelf-life are key priorities for manufacturers and are reflected in the choice motives of consumers in these focus groups but will be challenging to achieve. Thus, overall, reducing salt in ready meals is a significant marketing, as well as technological, task for food manufacturers.

In terms of nutritional policy, this research suggests that some consumers are suspicious of the motivations of both food manufacturers and government; therefore, it is important that such policy be evidence-based and transparent. The fact that consumers have no clear demand for reduced-salt ready meals may be the reason why they are suspicious of current initiatives. However, on the positive side, they do cautiously welcome reduced-salt variants to their favourite recipes if taste is not compromised, it does not incur a price premium and natural alternatives are used.

This research was funded by the Food Institutional Research Measure of the Department of Agriculture, Food and the Marine.

Farm Partnerships in Ireland

Farm Partnerships are becoming increasingly popular in Ireland with 650 formally registered Milk Production Partnerships currently in existence.

Farm Partnerships are associated with wide-ranging economic and social benefits and are identified by Teagasc and the Department of Agriculture, Food and the Marine (DAFM) as critically important to the future development of agriculture. As relatively new organisational structures in the Irish context, however, little information has been available to date on Irish farmers' experiences of Farm Partnerships or the factors that influence farmers' establishment of partnerships.

A recent Teagasc project explored Irish farmers' experiences of partnerships, focusing specifically on Milk Production Partnerships (MPPs), which are the prevalent type of formalised partnerships currently in operation on Irish farms. The project examined the experiences of two case-study groups of Irish farmers: those who established a MPP; and those who actively considered but, for various reasons, chose not to establish a MPP. The case-studies represented the diversity of Irish farmers who are involved in or are considering Farm Partnerships. One of the aims of the project was to identify, from farmers' perspectives, the incentives and disincentives to establishing partnerships and the advantages and disadvantages associated with operating partnerships. The findings of the project have led to a deeper and more comprehensive understanding of the factors influencing Irish farmers' establishment of Farm Partnerships and are intended to inform the design of effective extension processes. Thus far, the range of benefits associated with Irish MPPs identified by the project has informed a recent national promotional campaign of collaborative farming ventures undertaken by Teagasc.



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Farm Partnerships

A Farm Partnership is where two or more farmers join resources and efforts in order to acquire various benefits. The benefits associated with partnerships are diverse, including economic benefits, social benefits and occupational health, well-being and safety benefits (Turner and Hambly, 2005). Various joint farming ventures are prevalent in New Zealand, Canada, Portugal, Denmark, Norway, the Netherlands, France, and in the UK. The model most closely related to formalised Farm Partnerships in Ireland is the French *Groupements d'Exploitation en Commun* (GAEC) model.

The context in which Farm Partnerships have emerged and become prevalent is that they are acknowledged to provide a solution to a common challenge experienced by farmers. Farmers who do not have the manpower or finances to improve the financial performance of their farms, yet wish to improve the economic viability of their farms, can use a Farm Partnership to access the manpower and resources they require (Barthez, 2000). Farm Partnerships, while facilitating farms to increase their scale and manpower, also allow family farms to continue as family-run and owned entities, which is an important incentivising factor for farmers (Almas, 2010). The first Milk Production Partnership in Ireland was registered in 2002 and the number currently operating is 650 (August 2012 figure). There has been strategic inter-agency collaboration to support the establishment of Farm Partnerships in Ireland, involving primarily Teagasc, DAFM, the Revenue Commissioners and the Law Society. Obstacles to the establishment of Farm Partnerships have gradually been removed and incentives have been put in place.

Irish case studies

The Irish case-studies undertaken for this research identified a range of benefits associated with Farm Partnerships (see panel), which correspond with the



types of benefits experienced by farmers in France, Norway and the UK. Issues relating to compatibility of the farmers involved: work-sharing; and relationships between wider members of farm families were identified as significant determinants of the establishment and operation of farm partnerships, which could be potentially problematic (see Macken-Walsh and Roche, 2012). However, of the first 708 Farm Partnerships registered (January 2012 figure), just nine were deregistered as a result of such issues between the parties. Of the total 117 deregistered Farm Partnerships, 75 were due to the retirement or death of one of the partners. Farm Partnerships, as reflected in these figures, can be used as a strategy for farm succession and gradual retirement. The remaining relatively small number of deregistered partnerships were due to: non-compliance with MPP regulations (e.g., the non-renewal of annual certificate of registration; farmers exceeding off-farm income limit; partners disposing of lands; partners emigrating); sale of quota or farm; change of legal status to limited company; disease issues; and personal health and financial issues (see Macken-Walsh and Roche, 2012 for more detail).

The low rate of deregistrations due to problems between the parties involved in Farm Partnerships reflect formally registered MPPs, which are underpinned by written legal agreements (they do not reflect cases where farmers work together informally). These partnerships have been assisted by a comprehensive and meticulous approach to preparing a detailed written partnership agreement. When Farm Partnerships are formalised with written legal agreements, they offer a regulatory and protective function to the parties involved. Such written legal agreements manage not only the terms of farmers working together, but also include provisions for dissolving the Farm Partnership. Significant investment is required to produce a workable and comprehensive Farm Partnership agreement that is customised to the partners' circumstances.

Facilitating farmers' establishment of Farm Partnerships

Customised planning processes particular to the individuals establishing Farm Partnerships are necessary. However, a group-based extension method (such as a discussion group), addressing a comprehensive range of issues and considerations relevant to partnerships in general, has the potential to serve as an important preparatory and time-efficient process for farmers considering Farm Partnerships. Group-based extension processes can facilitate farmers to consider critical issues in preparation for individualised planning supports; and can operate as a forum for learning about established, workable partnerships by incorporating farm visits and sharing the experiences of successful farm partnerships.

Effective facilitation of group-based extension methods is sensitive to the financial, social and cultural factors motivating farmers. In this regard, research on Irish farmers' experiences of farm partnerships can be used to provide guiding information to communicate and encourage exploitation of the potential benefits of farm partnerships and to address potentially problematic factors, thus enhancing the effectiveness of the extension process and its relevance to farmers. A template for achieving this is set out in Macken-Walsh and Roche (2012). A national extension strategy to promote uptake of Farm Partnerships as part of a suite of collaborative farming ventures is due to be initiated by Teagasc with the support of DAFM later in 2012.

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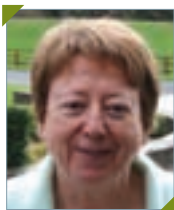
Benefits of Milk Production Partnerships: Ireland

- Farm Partnerships were used as a strategy to develop larger farm enterprises/increase scale by managing two previously independent enterprises together
- Farm Partnerships were formed to access increased milk quota
- Farm Partnerships were formed to increase efficiency by consolidating land and facilities and by developing new management strategies and business plans
- Farm Partnerships assisted farmers to share their work-loads to cope with the extra work involved in up-scaling and applying new technologies on the farm
- Farm Partnerships introduced new skills, specialisations and occupational preferences to enhance the operation of the farm
- Farm Partnerships fostered new diversification activities on the farm by bringing in new expertise and business interests
- Farm Partnerships facilitated off-farm work Farm Partnerships were used to share decision-making power between members of farm families (spouses, heirs, for example)
- Farm Partnerships reduced isolation in farmers' working lives and improved farm safety
- Farm Partnerships facilitated family circumstances and needs where, for example, farmers had childcare responsibilities
- Farm Partnerships allowed farmers time-off to pursue other interests and take holidays, improving their quality of life



Supporting rural enterprise development

Two *Économusées* recently opened in Ireland, a first step in the development of a network of 'living museums'.



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Small and micro enterprises are critical for the economic viability of rural areas. Teagasc, together with organisations from Sweden, Iceland, Greenland, Norway, Northern Ireland, the Faroe Islands and Canada, is implementing an innovative rural enterprise support initiative to determine its potential to generate additional income and employment for small and micro enterprises. Funded by the EU Northern Periphery Programme (NPP), the project named 'Craft International', which runs from late 2011 to the end of 2013, seeks to support rural artisan producers to develop a cultural tourism aspect to their business. To do so, the project provides business advice, mentoring and funding for promotional and interpretive material to artisan producers who wish to diversify in this way and join an expanding national and international network of similar businesses. Membership of the network helps expand sales and sustain employment. From a policy perspective, the approach and activities of Craft International present a proven model to help small and micro rural enterprises that could be mainstreamed by other organisations in Ireland.

Économusée

The project is based on a successful model developed in Québec, Canada, over twenty years ago where rural artisan businesses that are supported to develop a cultural tourism dimension to their

operations are called '*Économusée*'. The closest English translation of this French term is 'living' or 'working' museum. As of January 2012, there were 68 *Économusées* internationally; 51 in Canada and 17 in Europe. On one level, the concept is simple: the *Économusées* form a tourism-based network, or trail, which, by bringing people to the premises, assists the businesses expand sales and sustain employment. On another level, the concept is very sophisticated as it attempts to help artisan producers develop their capabilities and infrastructure to tap into the burgeoning number of tourists who wish to 'experience' local culture and produce. To date, two *Économusées* have been created in Ireland; The Connemara Smokehouse in Ballyconneely, Co Galway and Celtic Roots Studio in Ballinahown, Co Westmeath. Two *Économusées*, a jeweller and a hurley maker, have also been created in Northern Ireland. The remainder of this article presents a brief overview of the project, the process rural artisans have to go through to join the network, the impact of the project to date and a look at future project activities.

Project overview

The NPP, which is part of the European Commission's Territorial Cooperation Objective, is one of 13 INTERREG programmes aimed at encouraging and supporting transnational co-operation between the regions of Europe. The NPP's target area is the northern margins of Europe. Researchers and specialists in Teagasc's Rural Economy and Development Programme (REDP) with expertise in industrial economics, SME marketing and rural tourism have been involved in several NPP-funded

projects since 2007. Most recently the Économusée Northern Europe (ENE) 2009-2011 project introduced and adapted the Canadian Économusée concept to Europe. It was during this project that The Connemara Smokehouse and Celtic Roots Studio joined the network. In the present project, Craft International (2011-2013), the aim is to expand the Économusée network in Ireland by creating two more Économusées and adding value to their operations through developing their internet sales and tourism promotion capabilities.

How does a business become an Économusée?

The term Économusée is copyright protected. An Économusée is an artisan business that develops a tourism dimension to their operations based on the local knowledge, skills and networks used in production. Therefore, being eligible to be called an Économusée is to be awarded a cultural tourism quality mark. To become an Économusée, an artisan producer has to go through a four-stage process. First, the artisan has to fulfil certain fundamental selection criteria in terms of authenticity of the product, turnover and length of time in existence. Second, the artisan must undertake a feasibility study. The emphasis in the feasibility study is on the ability of the artisan to convert to, and function as, an Économusée. Third, if the feasibility study outcome is positive, the artisan engages in the development phase which involves putting in place any required infrastructural changes identified in the feasibility study, installing interpretive panels, modifying premises layout, receiving new brochures and availing of training from the Économusée Network. As no capital funding is available within the project, partnerships with local LEADER companies are developed from the outset so



that candidate artisans might apply to them for capital funding. Finally, there is usually a relatively high profile launch of the new Économusée. The Canadian Ambassador to Ireland launched the Celtic Roots Économusée in March 2011.

What is the impact of the project so far?

All the available evidence suggests that becoming an Économusée has benefited Canadian artisans. During the period 2000-2010, Canadian Économusées at worst equalled, and at best outperformed, Canadian SMEs in terms of revenue and employment growth (Heanue, 2011). The Canadian experience suggests that turnover increases three years after the Économusée is established. In Europe, comparable data is not yet available as the Économusées are only recently established. Nevertheless, we know that 35 new jobs were created in six different countries. In addition, project activities leveraged nearly €1 million in extra support for the participating businesses.

What does the future hold?

Project activities for the period 2012 to the end of 2013 will concentrate on three main areas. First, by hiring an e-commerce expert, the project will provide integrated web sales support for the participating artisans to improve their on-line marketing and sales, and help attract visitors to the individual Économusées. Second, the project will seek to embed the Économusée concept and the network in the regional and national tourism strategies and event marketing of the relevant national agencies. Third, increase on-site sales for each artisan from visiting tourists by transferring best-practice from the Canadian partners who have over two decades experience with this. To help guide the project, an Advisory Group comprising Fáilte Ireland, Bord Bia and The Crafts Council is being formed. The overall vision for the project is to establish a network of Économusées within Ireland, throughout Northern Europe and on both sides of the Atlantic by 2014.

By the end of the project, a further 22 artisans throughout Europe will have converted to being an Économusée, with at least another 20 jobs created in the process. Based on past experience, additional funding for the artisans will also be leveraged due to the project's activities. An exit strategy for the project will also be developed that will focus on the establishment of a viable and durable organisational structure to support the Économusées and continue the development of the network post-2013.

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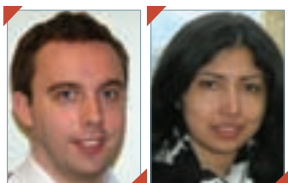
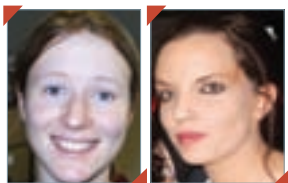
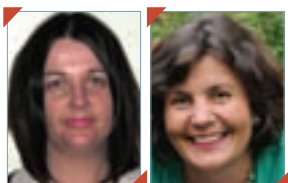
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This project is funded by the EU Northern Periphery Programme and by Teagasc.

For more details on the NPP see <http://www.northernperiphery.net/>
For more details on ENE see <http://www.economusee.no/>

Overcoming lameness in Irish sows

There is widespread under-appreciation of the extent of the problem of lameness in pigs of all ages and of its impact, not alone on welfare, but also on productivity and farm finances. In this article we discuss ways of addressing the problem in sows to protect welfare, longevity and performance when the national herd changes to group housing in 2013.



Owing to its high prevalence, and the fact that it is associated with pain, lameness is one of the most serious welfare concerns of a number of farm animal species. Lameness a sow is particularly worrying as often the only 'treatment' is to cull her and this is often delayed until she has farrowed and weaned her piglets. This means that lame sows may suffer prolonged periods of pain and distress. From farm records, lameness accounts for at least 11% of all sow removals, but this is probably underestimated because sows that are culled for reproductive failure are often lame too. The highest economic losses occur when culling for lameness mainly because young sows are particularly at risk. There is worrying evidence that lameness is set to increase once the national sow herd switches to group housing.

Group housing

Under SI 311 of 2010, European Communities (Welfare of Farmed Animals) Regulations, sows must be kept in groups from 28 days post-service from January 2013. Financial constraints mean that producers are opting for systems featuring minimal 'shared' space for sows, competitive feeding systems and fully slatted flooring with no bedding. These are major risk factors for lameness in sows.

Housing system

We recorded claw lesions and lameness in sows in the Moorepark herd. Forty-two sows were housed in gestation stalls on concrete and 43 sows were housed loose in a single group on unbedded part-solid floors and fed by an electronic sow feeder during pregnancy. The sows' walking ability was scored on their way to



Heel erosion

the farrowing house with non-lame sows receiving scores of 0 (normal), or 1 (slight abnormality), and lame sows receiving scores of 2, 3, 4 and 5, according to severity. While sows were lying in the farrowing crate prior to farrowing, their hind claws were also inspected for a number of claw lesions, which were also scored according to severity. The findings revealed that all sows inspected had at least one type of claw lesion and the majority had two or more types. Furthermore, while loose sows had more severe heel erosion and stall-housed sows had more severe white line damage and dew claw injuries, the severity of wall cracks and heel/sole cracks was similar between the two groups. Nevertheless, the loose-housed sows were 2.37 times more likely to be lame on transfer to the farrowing house than the stall-housed sows. These findings support work done elsewhere, which shows that even though both stall- and loose-housed sows have similar problems with claw lesions, these lesions are much more likely to cause lameness in sows that are group-housed. These findings were confirmed by survey work conducted on farms that

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Wider slats offer better support to the hoof structure and reduce injury.

have already changed to group housing. Of 305 animals inspected on 21 different sites, almost 50% were clinically lame, i.e., they received scores of 2 or greater for their walking ability. In contrast, of a similar number of sows kept in stalls on about 30 farms, 30% were clinically lame: this is still a high percentage.

Flooring

Concrete is an uncomfortable and cold surface for any animal to live on. However, the potential for injuries caused by slatted flooring is much higher in pigs and particularly sows, because aggression features strongly in their behavioural repertoire. Our preliminary survey on farms with group systems indicate that, while slats narrower than required under S.I. 311 (i.e. <80mm) were associated with high levels of lameness (73.3% of sows), only 38.2% of sows were affected when slats were wider than required by legislation (i.e. >80mm). Wider slats offer better support to the hoof structure and are therefore less injurious. Ideally, slats for use in group systems should be a minimum of 120mm wide to minimise lameness.

We also conducted a longitudinal study on a large commercial farm whereby 160 gilts were monitored through two pregnancies on either rubber or concrete slatted flooring. Animals on rubber had a much lower risk of being lame, had less severe swellings and wounds on their limbs and culling for lameness was reduced. Fewer sows that were kept on rubber during pregnancy crushed ≥ 1 piglet(s) in the farrowing crate (Parity 1: 9.4% rubber vs. 13.2% concrete; and, Parity 2: 5.2% rubber vs. 16.4% concrete). Even more importantly, animals kept on rubber gave birth to an extra 0.3 piglets - potentially worth an extra €10,000 p.a. to a 500-sow herd. Hence, rubber flooring could play a major role, not only in reducing lameness, but also in improving productivity of sows in group systems.

Replacement gilts

One of the critical factors determining the success of group-housed sows, from the point of view of lameness and longevity, is the way in which the replacement gilts are reared. For example, research from The Netherlands shows that a space allowance for gilts that is considerably higher than required by EU legislation is a critical factor to success in group housing. On some units, gilts are still 'hardened



Injured dew claw caused by slatted floor.

off' in the mistaken belief that it stimulates good performance. The practice is all too often used as an excuse to overstock gilts and/or keep them in poor accommodation and one that we need to urgently address as the industry moves towards group housing.

Feeding gilts a diet specifically formulated to meet their requirements as future breeding sows is another potential way of reducing lameness and thereby improve sow longevity. The majority of producers who 'home produce' their own replacement gilts feed diets formulated for finisher pigs until selection, which is often very late in the development of the animal (i.e., 100kg). Such diets are often too low in calcium and phosphorous, which are necessary for good bone formation. Thereafter, the animals are generally switched to a diet formulated for gestating sows. In Moorepark we selected gilts at 60kg and fed them a 'developer' diet specifically formulated for their needs. We have seen better locomotion in gilts fed such diets compared to gilts fed diets formulated for finisher pigs. Early indications are that differences in the severity of osteochondrosis - a disease of the growth cartilage, which might be linked to fast growth rates of gilts on finisher diets - is responsible for the locomotion differences. However, bone density scans using dual X-ray absorptiometry have also revealed important differences between the diets, which could help to explain lameness and poor longevity in replacement gilts reared on finisher diets.

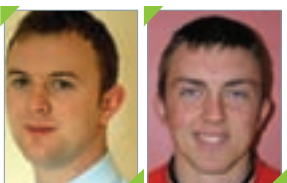
Implications for industry

The original intention of the legislation, which comes into force next year, was to improve sow welfare. However, because of severe financial constraints, many of the group systems being chosen by pig producers potentially offer much poorer welfare for sows than stalls. Because of this, lameness could exacerbate unplanned removal and mortality rates and threaten profitability. Improving conditions underfoot for sows in groups, combined with paying better attention to the way we house and feed replacement gilts, will help to ameliorate some of the negative aspects of housing sows in groups.

This research is funded by EasyFix™ Rubber Products, Enterprise Ireland and Teagasc core funding.



Rumen function in grazing dairy cows



The study of rumen function is important as the rumen is the ‘fermentation vat’ of the cow – where the ingested feed is broken down and converted to the basic ingredients for milk production. Abnormal rumen function, such as low rumen pH, can result in milk fat depression, lameness and laminitis, and reduced intake and digestibility of feed.

Dairy cow rumen function – the science bit!

A dairy cow is a ruminant with four stomachs, the largest of which is the rumen, which acts like a fermentation vat. In the rumen, the feed taken in by the cow is broken down by the resident bacteria, fungi and protozoa (microorganisms). Different microorganisms have different jobs. Some microorganisms digest cellulose and hemicellulose and are referred to as fibre-digesters. Other microorganisms digest starch and are referred to as starch-digesters. The microorganism population of the rumen changes depending on the type of feed offered to the cow. The microorganisms break down the feed ingested by the cow to yield VFA and ammonia. These are absorbed through the rumen wall into the blood stream. They are the main source of energy and protein for the cow. They also act as precursors for the manufacture of milk.

When there is an accumulation of acids in the rumen, the rumen pH decreases. If the rumen pH falls too low, then the negative consequences mentioned above may be seen, i.e., milk fat depression, lameness and laminitis and impaired absorption of nutrients. This is often referred to as sub-acute ruminal acidosis (SARA). Broadly-speaking, SARA is said to be present when the rumen pH is below 5.5 to 5.8. Traditionally, most of the work on rumen pH and SARA took place using high producing dairy cows offered high concentrate diets. Recent work carried out in Ireland (at Teagasc, Animal and Grassland Research &

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Farmers are striving to increase the proportion of high quality grazed pasture in dairy cow diets, as this is strongly linked to improved milk protein content and increased profitability. However, grazing high quality pasture may lead to low rumen pH and altered rumen volatile fatty acid (VFA) profiles, which can be detrimental to the cow, resulting in milk fat depression and reduced fibre degradation, nutrient absorption and overall health and welfare. Reseeding pastures using high quality perennial ryegrass cultivars and clover, along with excellent grassland management, will result in very high quality pastures. A series of studies were conducted at Teagasc, Animal and Grassland Research & Innovation Centre, Moorepark, to determine if these high quality pastures would negatively impact on dairy cow rumen function.



Innovation Centre, Moorepark) indicated that rumen pH in pasture-based systems was low, but did not give rise to dairy cow production performance and health and welfare problems. However, due to its importance, the research in this area continues, with a particular focus on those scenarios most likely to give rise to rumen function problems, namely high digestibility grass cultivars and grass clover pastures.

High digestibility grass cultivars

Differences exist between grass cultivars in terms of fermentation characteristics, which could give rise to differences in rumen function. In spring 2011, the rumen function of cows grazing four grass cultivars differing in sward structure was measured. Across 48 hours, the average rumen pH did not differ between cultivars. The two cultivars with the highest digestibility were the cultivars that gave the highest milk yield and milk solids yield. The average rumen pH was numerically lower on these cultivars than on the other two cultivars. Although average rumen pH was low (5.67 to 5.86), milk fat depression was not exhibited. The average milk fat concentration ranged from 4.29% to 4.60%.

A similar study was run in late spring/early summer 2010. Cows grazing the highest digestibility cultivar, which also had the highest leaf proportion, spent some time at low rumen pH (<5.2). Cows on the other cultivars spent no time at this rumen pH level. Cows produced the lowest milk protein concentration from the cultivar that was predicted to be the least digestible and that had the lowest leaf proportion. These cows tended to spend more time at a high rumen pH (>6.2) than cows on the other cultivars.

Finally, the study was again run in late summer 2010. Once again,

cows offered the lowest digestibility cultivar tended to spend more time at a high rumen pH (>pH6.0) than cows on the other cultivars. This was reflected in them tending to spend a greater proportion of their time ruminating and performing more ruminating mastications than cows on the other cultivars. These cows also produced the lowest milk and milk protein yield.

This study demonstrated that higher digestibility grass cultivars gave rise to longer periods at lower rumen pH than lower digestibility cultivars. Despite low average rumen pH values, the cows did not exhibit milk fat depression. This shows that high digestibility grass cultivars are an excellent source of nutrition for dairy cows, providing high production performance without rumen function problems.

Grass clover pastures

There is great interest in introducing clover into Irish pastures in order to reduce nitrogen fertilizer costs and increase pasture quality. However, the inclusion of clover to increase pasture quality may result in lower rumen pH. In early summer 2011, the rumen pH and grazing behaviour of cows grazing grass only and grass clover pastures were compared. Over a 48-hour period, the average rumen pH was 5.91 and did not differ between the two treatments. However, there was a difference between treatments in the diurnal rumen pH pattern. In the afternoon, the rumen pH of the grass clover cows was lower than that of the grass-only cows. Milk fat concentration was also slightly lower on the grass clover treatment, but neither treatment exhibited milk fat depression (grass clover 3.74%, grass only 3.88%). Milk yield from grass clover cows was higher than from grass only cows.

The study was repeated later in the summer. Over a 48-hour period, the average rumen pH of grass-only cows was lower than grass clover cows, which was associated with more time spent grazing by the grass-only cows. There were no production differences between the treatments.

This study demonstrated that highly digestible grass clover pasture did not give rise to rumen function problems. However, the pastures gave rise to grazing behaviour differences and diurnal rumen pH pattern differences depending on the season. These differences should be explored further, for example, by analysing the interaction between diet selection and pasture structure and chemical composition.

Implications for industry and future work

Methane is produced in the rumen by the normal digestive processes. There are important associations between methane production and the rumen pH, VFA and microorganisms. Hence, the analysis of these parameters is also important in understanding and manipulating methane production by grazing dairy cows.

The study of rumen pH is important in order to avoid dairy cow production performance and health and welfare problems. Research in this area will continue with a particular focus on the rate and extent of grass and clover degradation in the rumen.

This research was funded by Teagasc core funding, the Teagasc Walsh Fellowship Scheme, the Dairy Levy Research Fund, the EU's Seventh Framework Programme for Research and the Department of Agriculture, Food and the Marine Research Stimulus Fund.

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.

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.

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@teagasc.ie

11 October

Tullamore Court Hotel, Tullamore, Co. Offaly

Teagasc/ICBF 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. It will also focus on latest developments in Irish beef breeding indexes, especially new economic values and maternal traits, and the potential payback to the breeder/farmer from selecting animals based on genetic indexes. Contact: sinead.caffrey@teagasc.ie

16 October

Johnstown House Hotel and Spa, Enfield, Co. Meath

National Rural Development Conference 2012

The conference is being held in association with the Irish Local Development Network, Macra na Feirme and the Western Development Commission. A range of national and international speakers including Scott Daugherty, North Carolina's Small Business Commissioner, will address the theme of 'Maximising the Use of Rural Resources' in the morning, followed by a panel discussion. Afternoon workshops will provide an opportunity for those attending the conference to discuss specific topics related to the theme. Contact Helen.McNulty@teagasc.ie or Paula.Briody@lit.ie For further information and registration: <http://nationalruraldevelopmentconference2012.eventbrite.com/>

18 – 19 October

RDS/UCD, Dublin

AESI Annual Conference and Early Career Researcher Seminar

The AESI conference will include contributed papers on themes such as agriculture, the environment, rural development, food marketing, supply chain management, land use and development economics. 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

19 October

Galway Bay Hotel, Salthill, Galway

5th Annual Glycoscience Ireland meeting

GlycoScience Ireland is an academic organisation that aims to build support and promote Glycosciences research in Ireland and to provide visibility and collaborative opportunities for Irish glycoscientists with international academic and industrial communities. The 2012 meeting will focus on Next Generation Glycotechnologies and their relevance to BioPharma and the growing Natural Food sector in Ireland. This is a free event sponsored by the Alimentary Glycoscience Research Cluster, AGRC. Speakers include Dr Jens Bleiel, FHI, and Devon Kavanaugh, Teagasc. For more information contact: Prof Lokesh Joshi or Dr Marian Kane at agrc@nuigalway.ie To register visit: <http://www.conference.ie/Conferences/AddRegistration.asp?Conference=187>

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: 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: www.scienceweek.ie Contact: catriona.boyle@teagasc.ie

22 November

RDS, Dublin

Walsh Fellowships Seminar

Presentations by Postgraduate students awarded fellowships under the Teagasc Walsh Fellowship Scheme. Contact: lance.obrien@teagasc.ie

27 November

RDS, Dublin

Teagasc Lecture Series: Will we Run out of Natural Resources Needed for Food Production?

Dominique van der Mensbrugge, Head of the Global Perspectives Unit in the FAO gives the second lecture of the Teagasc Lecture Series. He is Head of the Team responsible for the production of the FAO's reports on 'How to Feed the World in 2050', 'World Agriculture Towards 2030/2050', 'The State of Land and Water Resources (SOLAW)' and many other ground-breaking reports on global food requirements, including the resources needed to produce food. Further details of the second lecture to follow. <http://www.teagasc.ie/events/rds-lecture-series/index.asp>

29 November

Teagasc Ashtown Food Research Centre, Dublin 15

Food Packaging Exhibition & Seminar for SMEs

This event will be of interest to those involved in product development from start-up and Artisan enterprises to SMEs developing new or additional product lines. In addition, those responsible for regulatory, compliance or quality functions and in particular packaging or labelling decisions should attend. It may also be of interest to marketing and purchasing personnel. Further details: <http://www.teagasc.ie/food/research/events/20121129.asp>