

TEAGASC

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Social media: can it connect science and society?



Novel bacteria potentially associated with pneumonia Kildalton Open Source Sustainable Development Farm Kefir - molecular insights into a fermented food

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Teagasc | Oak Park | Carlow



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Teagasc external research funding doubles

Teagasc research is funded by a mixture of grant-in-aid from the Department of Agriculture, Food and the Marine (DAFM) and external, competitively-won funding. The value of new research contracts signed by Teagasc in 2016 was more than €21 million, which is more than double the value of new contracts signed in 2015. This increase is primarily due to the return of the DAFM's competitive Research Stimulus Fund; Food Institutional Research Measure; and Competitive Forest Research for Development programmes. In December, the Minister for Agriculture, Food and the Marine, Michael Creed, TD, announced awards of over €28 million for new research and innovation projects that respond to the needs identified by industry-led stakeholder advisory groups. This investment is very welcome and will provide the basis for science-based innovation in the agri-food industry over the next five to 10 years.

A second significant investment in research and innovation is from Enterprise Ireland (EI) and a group of Irish meat companies that have funded a Meat Technology Centre to be led by Teagasc. The Centre will be a 'one-stop shop' for meat processing research and technology, serving as a hub to coordinate all beef and sheepmeat processing research needs. This investment by EI and the meat industry highlights the importance of Teagasc research and innovation to industry and our focus on building a knowledge-based bioeconomy.

In recent years, the European Commission has pioneered a new type of project in the agri-food area, known as 'Thematic Networks'. These networks take the results of recent research projects and collate and disseminate them in a usable format for farmers across Europe. In 2016, five thematic networks were funded by the European Commission, and Teagasc is a partner in all five funded networks. This is particularly heartening as the concept of turning excellent research results into innovation on Irish farms is central to Teagasc's mission. This also aligns closely with the Irish Government's Innovation 2020 strategy, which aims to make Ireland a global innovation leader.

Successes at a European level is only possible due to the continued investment of DAFM, EI and other Irish funding agencies, including Science Foundation Ireland, the Irish Research Council and the Environmental Protection Agency, which allows Teagasc to recruit the best students and early-career researchers, thereby building the human capital on which we depend to serve our stakeholders.



Raymond Kelly
Head of Research Support, Teagasc

Tá méadú faoi dhó tagtha ar mhaoiniú seachtrach do thaighde Teagasc

Tá taighde Teagasc á mhaoiniú ag deontas i gcabhair a fhaightear ón Roinn Talmhaíochta, Bia agus Mara agus ag maoiniú seachtrach a fhaightear ó chomórtas a bhuachan. B'ionann agus breis agus €21 mhilliún luach na gconarthaí nua taighde a shínigh Teagasc sa bhliain 2016. Bhí an tsuim sin breis agus a dhá oiread níos mó ná luach na gconarthaí nua a síníodh sa bhliain 2015. Ba as tabhairt ar ais an Chiste Spreagtha Taighde iomaíoch, an Bhirt Taighde Institiúidigh Bia agus an Chláir Iomaíoch um Thaighde agus Forbairt Foraoise de chuid na Roinne Talmhaíochta, Bia agus Mara a tháinig an méadú sin go príomha. I mí na Nollag, d'fhógair an tUas. Michael Creed TD, an tAire Talmhaíochta, Bia agus Mara, go ndámhfaí breis agus €28 milliún do thionscadail nua taighde agus nuálaíochta a fhreagraíonn do na riachtanais arna sainaitheint ag grúpaí comhairleacha geallsealbhóirí atá treoraithe ag an earnáil tionsclaíochta. Fáiltítear go mór roimh an infheistíocht seo, a bheidh ar an mbonn le nuálaíocht eolaíocht bhunaithe sa tionscal agraibhia sa tréimhse cúig bliana go deich mbliana romhainn.

Fuarthas an dara hinfheistíocht an-suntasach i dtaighde agus nuálaíocht ó Fhiontraíocht Éireann agus grúpa cuideachtaí Éireannacha feola a chuir maoiniú ar fáil d'Ionad Teicneolaíochta Feola, a mbeidh Teagasc ina bhun. Beidh an tIonad ina 'ionad ilfhreastail' le haghaidh taighde agus teicneolaíocht próiseála feola. Beidh sé ina mhol óna gcomhordófar gach riachtanas taighde próiseála feola agus caoireola. Leis an infheistíocht a rinne Fiontraíocht Éireann agus an tionscal feola, leagtar béim ar a thábhachtaí atá taighde agus nuálaíocht Teagasc don tionscal agus ar ár ndíriú ar bhithghéilleagar eolasbhunaithe a fhorbairt.

Le blianta beaga anuas, tá an Coimisiún Eorpach ag déanamh ceannrúdaíocht ar chineál nua tionscadail i réimse an agraibhia. Tugtar "Líonraí Téamacha" ar an gcineál nua tionscadail sin. Tógann na líonraí sin na torthaí ar thionscadail taighde a rinneadh le déanaí agus déanann siad iad a chóimheas agus a scaipeadh i bhformáid inúsáidte ar fheirmeoirí ar fud na hEorpa. Mar gheall ar an ngairm a reáchtáladh sa bhliain 2016, beidh cúig líonra téamacha á maoiniú ag an gCoimisiún Eorpach. Tá Teagasc ina chomhpháirtí i ngach ceann de na cúig líonra mhaoinithe. Is ábhar dóchais é sin mar gur cuid dhílis de mhisean Teagasc é an coincheap um thorthaí sármhaithe taighde a thiontú ina nuálaíocht ar fheirmeacha Éireannacha. Ina theannta sin, tagann sé go mór le straitéis Nuálaíocht 2020 ó Rialtas na hÉireann, ar straitéis í a bhfuil mar aidhm aici ceannaire nuálaíochta domhanda a dhéanamh d'Éirinn. Ní bheifí in ann an rath sin ar leibhéal Eorpach a bhaint amach in éagmais na hinfheistíochta leantaí a dhéanann an Roinn Talmhaíochta, Bia agus Mara, Fiontraíocht Éireann agus gníomhaireachtaí maoinithe Éireannacha eile, lena n-áirítear Fondúireacht Eolaíochta Éireann, an Chomhairle um Thaighde in Éirinn agus an Ghníomhaireacht um Chaomhnú Comhshaoil. Cuireann an infheistíocht sin ar chumas Teagasc na mic léinn agus na taighdeoirí luathghairme is fearr a earcú, rud a fhorbraíonn an caipiteal daonna a mbímid ag brath air chun freastal ar ár gcuid geallsealbhóirí.

Raymond Kelly
Ceann Tacaíocht Taighde, Teagasc

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Paul Cormican



Paul Cormican is a Research Officer in the Animal and Bioscience Department at Animal & Grassland Research and Innovation Centre, Grange, Co Meath. He has an Honours BSc degree in Pharmacology from University College Dublin (UCD), an MSc in Bioinformatics from University of Ulster, Coleraine, and a PhD in Comparative Genomics from the School of Biochemistry and Immunology, Trinity College Dublin (TCD). Following his PhD, he worked as a Research Fellow in Neuropsychiatric Genetics in the School of Medicine, TCD. During this time, he helped in the establishment of Ireland's first next generation sequencing facility and was a member of numerous genetic analysis teams within the large international Psychiatric Genomics Consortium (PGC).

Paul joined Teagasc as a Computational Biologist in 2013. The past decade has seen the initial development and rapid evolution of high-throughput genomic technologies. Parallel with these developments, computational biologists have had to deal with the increased volumes of data generated. The role of the computational biologist has come to encompass several disciplines including bioinformatician, data analyst, data curator, statistician and ontologist. Paul's research in Teagasc has seen him apply these skills to a number of diverse projects across a range of Teagasc priority areas, including animal health, fertility and reproduction, feed efficiency, bioreactors and crop genomics. Working closely with the information and communications technology department, Paul also runs the Teagasc High Performance Computing Cluster – a valuable resource available to all Teagasc researchers. Paul is currently a mentor and/or supervisor to 10 Walsh Fellow PhD candidates using computational biology techniques as part of their research programmes. He has contributed as an author to over 60 scientific publications, as well as acting as a referee for several high-impact journals. Paul also has lectured extensively at both undergraduate and postgraduate levels in TCD and Dublin City University.

Originally from Galway, Paul now lives in Kildare where his interests include amateur astronomy, hiking and reading.

Commercialisation awards winners

Teagasc, University College Cork (UCC) and Cork Institute of Technology (CIT) recently celebrated successful innovations at the UCC commercialisation awards. Hosted by UCC, the Teagasc invention of the year award was won by Paul Cotter and Nidhi Gopal, Teagasc Moorepark Food Research Centre, for a novel system for simultaneous detection of food-poisoning *Bacillus cereus* toxin genes. An invention led by Brijesh Tiwari and Carlos Alvarez, Teagasc Ashtown Food Research Centre, involving a novel protein recovery process, was also shortlisted. The contribution of Teagasc researchers, comprising Phil Kelly and Tim Guinee, Teagasc Moorepark Food Research Centre, in licensing the intellectual property of start-up company Dairy Concepts Ireland Ltd., was also acknowledged.



Pictured at the commercialisation awards are (from left): Sharon Sheahan, Teagasc Technology Transfer Office; Phil Kelly, Teagasc; Mark Fenelon, Teagasc; Paul Cotter, Teagasc; and Sarah Henneberry, Dairy Concepts Ireland Ltd.

Knowledge Transfer Ireland

A Knowledge Transfer Ireland (KTI) networking event, Innovation through Collaboration – advancing business through collaborative research, was held recently to encourage networking between public research organisations and businesses. Speakers included a panel from industry and technology transfer offices (TTOs) from higher education institutes, sharing their experiences on what makes a successful collaboration. Acknowledgement was also given to experienced TTO professionals who obtained the internationally recognised registered technology transfer professional (RTTP) accreditation in 2016. Miriam Walsh, head of intellectual property of Teagasc TTO was one such recipient.



The 2016 RTTP accredited technology transfer professionals from Irish research performing organisations with Minister of State for Training and Skills John Halligan, TD (centre) and Alison Campbell, KTI Director (far right).

BTYSTE winners visit Moorepark

The winners of the Teagasc special award at the BT Young Scientist and Technology Exhibition (BTYSTE) 2017 were Asa Curran, Tiarnan Collins and Jack Ryan-Purcell from Schull Community College, Co Cork. They were also highly commended in their category, putting them in the top 15% of entries. Their project investigated the relatively new land use, agroforestry, and its potential to offset carbon emissions from other agricultural sources. The winners recently visited Teagasc Moorepark where they received a private tour of the facilities, met with a number of researchers at the centre and were given the opportunity to present their project. The theme of Teagasc's stand at BTYSTE was 'The Future of Farming and Food', based on the five research prioritisation areas identified in Teagasc's Technology Foresight 2035 exercise: plant and animal genomics; human, animal and soil microbiota; digital technologies; new technologies for food processing; and, transformation in the food value chain. Visitors to the stand used the interactive display to give their ideas on technologies for the future.



Teagasc staff and volunteers at BTYSTE 2017 in the RDS.



The Teagasc prize winners from the BT Young Scientist & Technology Exhibition Tiarnan Collins, Jack Ryan-Purcell and Asa Curran, Schull Community College are pictured with John Casey, Teagasc on a visit to the Teagasc/Dairygold research farm in Kilworth, Co Cork.

Teagasc researcher wins CommBeBiz photo competition

Dheeraj Singh Rathore of Teagasc Crops, Environment and Land Use Programme, Oak Park, Carlow, won the CommBeBiz photo competition with his entry, 'One to many: *in vitro* regeneration of multiple potato shoots from callus'. His photograph is an example of a potato cultivar, Desiree, showing multiple juvenile shoot regenerations and root formation as it grew on agar gel. "I am extremely honoured to be the overall winner of the CommBeBiz photo competition 2017 and would like to thank the organisers and judges of the competition. As an early-career researcher, winning is a wonderful achievement and a great addition to my CV. I have presented my work in the form of posters and oral presentations at several conferences in my field, but taking part in the CommBeBiz photo competition is a perfect platform to show science to a diverse audience. I sincerely thank my supervisor Ewen Mullins at Teagasc for encouraging me."

This is a European-wide competition. The criteria against which the judges scored the entries were relevance to the bioeconomy, ability to effectively engage both expert and lay audiences in the science shown, creativity of the shot, and the overall quality of the image, considering aspects such as resolution, exposure, composition, colour, and technique.



Addressing climate change



The impact of climate change on dairy production



Details of a *safefood*-sponsored research project, which surveyed Irish dairy industry stakeholders to determine their level of awareness of the potential impacts of climate change, were discussed at a special industry conference at Teagasc, Ashtown. This is the first survey of its kind. Trevor Donnellan, Teagasc, who was a research collaborator on the project, said: "The study confirmed that climate change presents both an opportunity and a threat for the Irish dairy sector. The threats identified in the survey include: extreme weather events, the emergence of new diseases and pests. By contrast, the development of unfavourable climate conditions in some of the world's key milk producing countries could offer an advantage to the Irish dairy sector, since the Irish climate is likely to be less adversely affected. One of the major recommendations of this research was that more planning is required to consider how to deal with extreme weather events." The conference heard that there was a general view that science and technology can play a major role in mitigating climate change, but that there are obstacles to getting technology from the lab to the farm. Stakeholders felt technologies being developed to address greenhouse gas emissions should be discussed with farmers in the development stage to establish their practicality.

Breastfeeding C-section babies

Cork scientists found that breastfeeding is particularly important for babies born by Caesarean section, and especially those born early (<35 weeks), as it helps develop a more 'normal' gut microbiota.

An in-depth study at the APC Microbiome Institute, led by Catherine Stanton at Teagasc and Anthony Ryan at University College Cork and Cork University Maternity Hospital, compared development of the gut microbiota of 199 infants from one to 24 weeks of age. Infants were initially breastfed following vaginal or C-section delivery and included both full-term and pre-term (<35 weeks' gestation) births.

"This study clearly shows that mode of delivery and gestational age at birth are the strong influencers of early gut microbiota populations following birth," said Catherine. "We have shown that infants that were naturally delivered through the birth canal have a much more established and mature microbiota at just one week of age, which remains relatively stable over the first six months compared to infants born by C-section, whose initial microbiota is very different to naturally delivered."

GMIT/Teagasc strategic partnership

Nuala Ni Fhlatharta, Head of the Teagasc Forestry Development Department, and Dermot O'Donovan, Galway-Mayo IT (GMIT), Letterfrack, Co Galway, will lead the implementation of a memorandum of understanding (MOU) between Teagasc and GMIT. The MOU focuses on areas of broadleaf forestry and hardwood timber utilisation and also allows for the development of a range of collaborative activities in other areas. Commenting on the MOU, Nuala said such initiatives are crucial to ensure that forest owners with broadleaves (which account for 164,000 hectares or 26% of forest area) are supported in adding value to their forest crops thereby accessing new markets and providing raw material for local development opportunities in rural areas.

Malting barley seminar

Demand for malting barley continues to grow, with the distilling sector on an upward trajectory. Teagasc's *Malting Barley Seminar* focused on the technical aspects of producing malting barley for brewing and distilling. Liz Glynn, Teagasc, provided an in-depth review of fungicide trials and the best strategies to implement in 2017. "Trials are consistently showing that a lower rate of a combined fungicide product will give good disease control and the best return for money. Spending roughly equal amounts on fungicides at each timing has shown to be the best strategy," Liz explained.

The growing distilling market is driving demand for low-protein barley, however the low protein can be difficult to achieve. Richie Hackett, Teagasc, outlined research in this area. "There is no guarantee every well-managed field will achieve distilling quality. Site selection, based on previous low proteins, combined with excellent agronomic management and with low nitrogen inputs, give the best possibility of producing low-protein barleys," he said.

The importance of getting the foundations of the crop correct was addressed by Ciaran Hickey, Teagasc advisor. Areas such as a good seed bed, base fertilizer and a targeted seed rate for the conditions are of critical importance to achieve high yield.



Teagasc speakers Liz Glynn, Michael Hennessy and Richie Hackett at the Malting Barley Seminar.

Trust me...I'm a Doctor

Teagasc's Paul Cotter and Aaron Walsh, Teagasc Moorepark Food Research Centre, recently contributed to an episode of BBC Two's *Trust Me I'm a Doctor*. The episode related to how we can improve our health by eating foods that modify the mix of bacteria living in our digestive systems. The programme set up trials in which groups of volunteers were given kefir milk, a commercial yoghurt drink and prebiotic inulin, a soluble dietary fibre found in foods such as Jerusalem artichokes, to see whether the substances promoted the growth of 'good' gut bacteria. The researchers studied the results, which showed that the commercial drink had the least impact on gut health, while the kefir milk had the greatest impact. The study found that taking these probiotic and prebiotic foods can help some people to modify their general health, by improving gut health.



Grass10 campaign

The Teagasc Grass10 Campaign was launched by the Minister for Agriculture, Food and the Marine, Michael Creed, TD at the Teagasc Animal and Grassland Research and Innovation Centre, Moorepark. Grass10 is a four-year campaign to promote sustainable grassland excellence for Irish livestock. It aims to increase grass utilisation on Irish livestock farms. Its objective is to increase the number of grazings per paddock to 10 and the amount of grass utilised to 10 tonnes grass dry matter per hectare.

The campaign is supported by AIB, FBD Trust, Grassland Agro the Department of Agriculture, Food and the Marine and the *Irish Farmers Journal*.

Teagasc Director, Gerry Boyle said: "There are four important pillars to the Grass10 campaign namely, soil fertility, sward composition and reseeding, grassland management and grazing infrastructure. Livestock

farmers who want to get the most from grassland will have to address all four areas and this campaign aims to provide the technical knowledge and required skills to all farmers to achieve that. The roll-out of the new PastureBase Ireland website is a key component of this campaign as it will allow our advisors to provide improved advice and decision making support to livestock farmers."



Launching the Teagasc Grass10 campaign in Moorepark, were (from left): Michael Creed, Minister for Agriculture, Food and the Marine; Noreen Lacey, AIB; Gerry Boyle, Teagasc Director; Liam Woulfe, Grassland Agro; Hugh Ryan, FBD.

ReValueProtein

A one-day workshop on Meat Co-products, organised by the ReValueProtein project team, was recently held at Teagasc Ashtown. At the workshop, ideas, knowledge and skills in the areas of animal (non-dairy) protein extraction, for the development of high value products and applications were shared among attendees.

ReValueProtein is a nationally funded research project bringing together a multidisciplinary team to support innovation in the Irish meat industry. The partners in the project are Teagasc, UCC, UCD, NUIG, IT Tralee/Shannon Applied Biotechnology Centre and the Department of Agriculture, Food and the Marine. Coordinator of the ReValueProtein project, Anne Maria Mullen, Teagasc Ashtown Food Research Centre, said: "This event looked at recovering value for the meat sector, providing a perspective on current activities and opportunities. It updated participants on the major national and international developments in the area, and highlighted current trends." A full article on the event will appear in the next issue of *TResearch*.

Teagasc presents food research to Chinese businesses

Teagasc outlined its dairy and nutrition research to Chinese food companies at seminars organised by Enterprise Ireland in Shanghai recently. Teagasc Director, Gerry Boyle, outlined some of Teagasc's innovation in dairy technologies in its food research programme regarding clover rations in dairy cows and the sensory characteristics and functionality of milk. He spoke about the superior quality of dairy products produced from Ireland's pasture-based system and recent developments in dairy processing technologies. The integrated research, advisory and education functions of Teagasc were highlighted, along with the benefits of having the animal and grassland, research and innovation programme integrated with its food research programme. Several Chinese food researchers and PhD students work in Moorepark and Teagasc is collaborating with similar research institutions in China. Teagasc has recently established a joint research lab with the University of Fujian to extend its research collaborations in support of Ireland's dairy industry. John Hunter, Chief Executive of Moorepark Technology Limited (MTL), also demonstrated the capacity of the pilot plant facilities at MTL. Catherine Stanton from the APC Microbiome Institute and Teagasc spoke about how intestinal microbiota influence health and disease and outlined some of the latest findings from the Institute's research programme.

Sheep conference

The Teagasc National Sheep Conference highlighted the importance of technical performance in terms of ewe productivity, grassland management, stocking rate and flock health in driving on-farm profitability. Frank Campion, Teagasc, advised farmers that managing the ewe's nutrition in late pregnancy, six to eight weeks pre-lambing, will influence lamb viability and vigour and the overall performance of the flock at lambing. He said planning and management decisions from mating will influence the performance of the flock at lambing and particular care is needed to ensure that ewes are lambing down in correct body condition and receive adequate high-quality protein in the weeks prior to lambing.

Michael Gottstein, Head of Teagasc Sheep Knowledge Transfer Department, outlined strategies for coping with the extra lambs produced in highly prolific flocks. He spoke about some of the practical labour-saving strategies for managing surplus lambs. To maximise profitability, he suggested flock owners should aim to wean more than 1.7 lambs per ewe.

Tillage conference

Speaking at the Teagasc National Tillage Conference, Teagasc Crops Researcher, Dermot Forristal, demonstrated the rotational benefits of break crops, increased profitability from rotation and identified potential market expansion for both oilseed rape and beans. He also emphasised the need for an industry-wide approach to developing these markets. Steven Kildea, a plant pathologist with Teagasc, outlined the current situation regarding fungicide resistance across the main cereal diseases and what can be done to slow the development of resistance.

Liz Glynn, Teagasc Crops Science Department, Oak Park, demonstrated that using the correct timings for fungicide sprays can reduce product rates, presenting significant cost-saving opportunities for growers. Ongoing work at Teagasc's Crops, Environment and Land Use Programme, Oak Park, to develop varieties with improved resistance to *Septoria* was presented by Ewen Mullins and Ger Hehir, and Ronan Byrne, a Teagasc Walsh Fellow jointly funded by the Irish Seed Trade Association, described work on herbicide resistance in grass weeds and his discovery of resistance to the 'fop' and 'dim' class of herbicides in wild oats.



Teagasc and 'One Health'

'One Health' initiatives refer to the collaborative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals and our environment.

The importance of improving animal health

To meet these challenges, sustainable expansion of the agri-food sector in a welfare-friendly manner is a top priority. Some 60% of all known infectious agents are zoonotic, so we may infer that improved animal health is key to improving human health. As well as being a public health problem, zoonotic diseases prevent efficient production at farm and processor levels and create obstacles to international trade.

The future for 'One Health'

Teagasc recently launched the *Teagasc Technology Foresight 2035* report that highlights how advances in technology can be used to address some of the critical challenges facing agriculture into the future. Research partnerships with leading academics in national and international universities are also exploring new avenues to tackle infections at source. In conjunction with enhanced biosecurity and improved on-farm management practices, selective therapies can be used to reduce the demand for antibiotics. A new national farm animal health strategy will also be launched shortly, which will seek to emphasise 'prevention rather than cure' in relation to disease control.

Interestingly, in Denmark, all non-therapeutic use of antibiotics was banned in 1999, which revolutionised livestock management and led to a significant decrease in antibiotic-resistant microbes. One of the most striking aspects is that Denmark's transformation had little negative impact on industry. From 1992 to 2008, antibiotic use per kg of pig dropped by more than 50%; yet, overall productivity increased.

Successful 'One Health' approaches will unite human and veterinary medicine to find common solutions to shared problems that will ultimately support sustainable agriculture, protect the food chain and safeguard human health.

Reference

Van Boeckel *et al.* (2015) 'Global Trends in Antimicrobial Use in Food Animals', *PNAS*, 112(18): 5649-5654.



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The first antibiotic, penicillin, was discovered by Alexander Fleming in 1928 and hailed such a medical revolution, it was naively claimed in the 1970s, that: 'We can now close the book on infectious diseases.' However, fast forward 50 years and infectious diseases remain the largest cause of death in mankind.

Antibiotic misuse and resistance represent the "greatest challenge in infectious diseases today", according to the World Health Organization (WHO). In addition, some microbes can transfer between humans and animals, causing 'zoonotic' diseases.

Therefore, the WHO, the Food and Agriculture Organisation of the United Nations (FAO) and the World Organisation for Animal Health (OIE) now advocate a 'One Health' approach to promote best practices to avoid the emergence and spread of antibacterial resistance.

Did you know?

- The global human population is expected to increase to approximately 9.2 billion by 2050 and an increased demand for 50% more food is expected by 2030, posing enormous challenges for food production.
- The current world cattle population is about 1.3 billion, with approximately one billion pigs, two billion small ruminants and >50 billion poultry reared annually for food production.
- Globally, the usage of antimicrobials is expected to increase by 67% by 2030 (Van Boeckel *et al.*, 2015).

Teagasc ConnectEd

Teagasc recently launched ConnectEd – a new knowledge network for the agri-food industry.



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Innovation has always played a crucial role in the way the Irish agri-food industry has responded to new challenges. As we discover more about the processes involved in developing long-lasting solutions, there is increasing acknowledgement of the value that stakeholder networks have to offer.

In 2016, the Standing Committee on Agricultural Research (SCAR) Strategic Working Group on Agricultural Knowledge Innovation Systems, published a paper titled *Agricultural Knowledge Innovation Systems Towards the Future*. The paper emphasised the need for greater mobilisation of existing knowledge and a more interactive or participatory approach to innovation. The paper also supported the greater use of a transdisciplinary approach to innovation.

In Teagasc, we are acutely aware of the power of collaboration and the need to develop meaningful and productive connections with our stakeholders. The dissemination and, importantly, the application of knowledge at all levels within the agri-food sector will be crucial if we are to achieve the targets set out in the Food Wise 2025 strategy. This strategy also points to the need for greater support for what is becoming an even more knowledge-intensive agri-food sector.

During a strategic review of its activities, Teagasc identified the need for greater engagement with professionals and businesses that provide services to the agri-food sector through education, skills development and knowledge exchange. To better understand the knowledge requirements of the industry, Teagasc carried out detailed market research with the sector. Stakeholders regularly articulated the

need to have better access to the latest information affecting their business and their clients. Effective business tools for farm financial management and soil fertility management were also identified as key components of any future programme.

In 2016, Teagasc announced the launch of the ConnectEd Programme, an innovative professional knowledge network. The programme has been developed to meet the growing appetite among rural professionals and businesses in Ireland for the latest agri-food research and knowledge outputs. The programme provides structured access to the extensive knowledge base available within Teagasc.

ConnectEd is delivered through high-quality professional education programmes, member briefings and events, as well as print and digital communications.

The programme operates through an annual membership fee. A number of plan options are available depending on the members' needs. Fees begin at €195/year.

The ConnectEd Programme is now Ireland's fastest growing agri-food knowledge base providing services to all leading agri-food businesses across the country.

Teagasc is offering a 50% discount on ConnectEd Pro membership to all new members for 2017. For full details, visit: www.teagasc.ie/connected; email: connected@teagasc.ie or call 076 111 3510.

Key benefits:

- Teagasc regular publications by post;
- access to professional education courses;
- invitations to Teagasc events;
- specialist reports on crops, dairy and beef;
- special ConnectEd Networking events; and
- access to online tools including Nutrient Management Plan (NMP) Online and eProfit Monitor.

Feature



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Major Meat Science Conference ICoMST 2017

Teagasc will host the 63rd International Congress of Meat Science and Technology in Cork this August.

Teagasc will host the 63rd International Congress of Meat Science and Technology (ICoMST), in collaboration with University College Cork this August in Cork. This prestigious global Congress will be held in the Rochestown Park Hotel in Cork, from August 13-18, 2017. ICoMST reconvenes in Ireland after an 11-year absence.

The theme of the Congress is 'nurturing locally, growing globally'. In addressing this, we will consider how science can offer the meat production and processing sector solutions to enable it to nurture sustainably at local level while offering opportunities to grow globally. This will be discussed through several session themes such as the science of meat sustainability, genomics, animal welfare, meat safety, emerging technologies in meat processing, consumer marketing and perspectives, meat biochemistry, and advancements in meat packaging. The Congress will end with a discussion on the role of meat in the diet. In light of Brexit, new technologies that will extend the shelf-life of meat products in response to overseas market requirements will be a particular focal point. In addition, 'hot topic' sessions will be held to encourage dialogue between researchers from academia and industry, which will continue throughout and beyond this meeting. It promises to be a most rewarding

experience with an effective exchange of information and ideas on important topics in the world of meat science and technology.

The Congress will have over 400 participants including food scientists, engineers, food industry professionals, thought-leaders, decision-makers, regulatory authorities and students from over 55 countries. Declan Troy, Teagasc (Congress Chair) explains: "Delegates will present, discuss, exchange, showcase and network at a global level over five packed days through technical presentations, plenary sessions, posters, exhibits and one-to-one discussions." The Congress will provide a dynamic interface between academic research and innovative applications, and represents an important opportunity for everyone in the field of meat science.

"Registration and the call for papers are now open and we welcome you to visit our website to learn more about the key dates, scientific and social programmes, our carefully selected venue and the exceptional keynote speakers," says Declan. The extended deadline for submission of short papers is April 7, while the deadline for early bird registration is May 31. Companies wishing to showcase the capabilities of their products and brands at this high calibre, innovation-driven international forum, will find on the website the many sponsorship opportunities that are available, either as packages or as tailored, individual offerings.

Visit the website at: www.icomst2017.com or contact us at: icomst2017@teagasc.ie.

RESEARCH INTEGRITY NATIONAL FORUM

Fostering research integrity in Ireland



The National Forum on Research Integrity was established in June 2015 and recently hosted its inaugural seminar 'Responsible research and innovation' at the Royal Irish Academy in Dublin.

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Research integrity relates to performing research to the highest standards of professionalism and rigour, and to the accuracy and integrity of the research record in publications and elsewhere. Maintenance of research integrity underpins the role of science as a reliable process of investigation, and protects the reputations of individuals, research institutions and funding agencies. Commitment to research integrity ensures that scarce research resources and funds are allocated where they are most needed, and supports public confidence in science. Fabrication, falsification and plagiarism (FFP) are examples of serious breaches of research integrity, and generate considerable attention when they occur. Globally, there is now a strong response to support responsible conduct in research.

Teagasc is a member of Ireland's National Forum on Research Integrity, which recently hosted its inaugural conference on research integrity. The event consisted of seminars from leading experts on research integrity, a number of reflections on 'integrity dilemmas' from researchers (e.g., authorship, P-hacking, proportional responses to incidents, design of training events), as well as engaging discussions.

Some discussion points from the event included:

- External speakers complimented Ireland on its strong commitment to research integrity, and the National Forum for Research Integrity for supporting the implementation of research integrity policies and processes in a harmonised manner across various research institutions.
- There was widespread agreement that training is a crucial component in underpinning an effective awareness and practice of research integrity. The National Forum on Research Integrity will help guide the development and roll-out of research integrity training programmes for researchers (staff and students).
- Reflecting on the measurement of research integrity, Nick Steneck (University of Michigan), stated that there needs to be improved definition and quantification of 'research integrity'. If research practice is to demonstrate that it is adhering to the highest standards of professionalism, then these standards need to be quantifiable and reportable. For example, there is an urgent need for an assessment of the effectiveness of training interventions on research integrity.
- Although instances of serious research misconduct (FFP) are relatively rare, they tend to attract considerable attention. Individual instances of poor practice in research may be less serious but are far more frequent, and the aggregate impact on research integrity is considerable. These poor practices may include inappropriate research design, bad data management and storage, claiming undeserved authorship and inadequate mentoring of research students. Participants heard that there needs to be a continued focus on the active promotion of research integrity so that the behaviour of researchers is driven by a commitment to strong principles that support research integrity, and help to eliminate both 'sloppy science' and serious misconduct.
- Participants reflected on the use of regulation to enforce research integrity. Enhanced regulation runs the risk of being treated as a box-ticking exercise. In practice, what is more important is the fostering of a wider climate that pursues excellence in scholarship, and clearly recognises the role of research integrity in attaining such excellence.

Further information

John Finn represents Teagasc on the National Forum on Research Integrity. For more on the Forum and the 'National Policy Statement on Ensuring Research Integrity in Ireland' see: <http://www.iua.ie/research-innovation/research-integrity/>

Impact of Teagasc research publications

Research-performing organisations, such as Teagasc, need to evaluate their research output to justify investment, guide decisions on the direction of future research and understand how their performance compares to similar organisations. Funding bodies require data to show return on investment and researchers like to know how their peers rate their outputs. Teagasc is monitoring its research impact and compiling that data for stakeholders.

The main way that scientists communicate their research results to the wider community is by publishing articles in scientific journals. These peer-reviewed publications are a very important, accepted metric for measuring the quality, productivity and impact of research, and for giving a measure of quality control to the research published. In Teagasc, we track how our publications are performing by compiling a bibliometric analysis each year. We examine a number of metrics for a rolling five-year period to track our progress, as well as comparing Teagasc performance to other relevant research organisations.



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Bibliometrics

Bibliometrics is the application of quantitative analysis and statistics to journal articles and their citation (references in other publications) counts. There are many different metrics, all of which represent different ways to compare and evaluate the impact of journal articles and, by implication, the research behind them. Significant bibliometric change for an organisation is achieved gradually, as the process is dependent on publications gathering citations. Accumulating citations takes time and papers that have just been published will naturally have fewer citations than older ones. Bibliometric analysis is only one way to evaluate research outputs, but it is one that is increasingly used by both research-funding and research-performing bodies.

Tools

There are a number of tools and resources available to provide both the basic citation counts and a variety of metrics. One such resource, which we use in Teagasc, is the *Web of Science* and its accompanying research evaluation tool *InCites*. *Web of Science* is an online subscription-based scientific citation indexing service, which allows for in-depth exploration of the scientific literature. It also provides a count of citations to each article it indexes. *InCites* is a customised research evaluation tool that allows an organisation to analyse institutional productivity and benchmark output against peers worldwide.

Trends

Our reports show that the number of publications by Teagasc authors has been increasing for each five-year period, as has the total number of citations (see Table 1).

Table 1. Number of publications by Teagasc authors (measured over five-year periods).

Five-year period	Number of publications	Number of citations*
2011 to 2015	2,216	16,642
2010 to 2014	2,099	14,379
2009 to 2013	1,938	10,738

* The citation counts above are as recorded on the date of preparation of the report each year. It should be noted that not all journals in which Teagasc authors publish are indexed in *Web of Science* and, therefore, no citation counts/metrics are available for these articles. They are, however, counted in the number of publications listed in the table above. Non-inclusion does not indicate that articles in such journals are in any way inferior.

In order to maximise the impact of our research, Teagasc actively collaborates with research organisations across the world. Their willingness to collaborate with Teagasc is a measure of our reputation. The trend towards an increasing amount of collaboration is illustrated by Figure 1.

As citation patterns can vary considerably across different subject areas, it's useful to look at the performance of our publications broken down by subject. For example, Figure 2 shows the increasing trend of our category normalised citation impact (NCI) in the area of agriculture, dairy and animal science for a 10-year period to 2015.

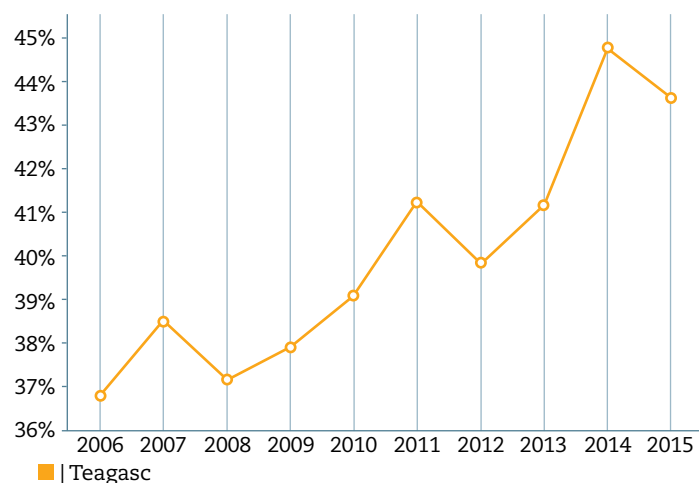


Figure 1. Teagasc publications with at least one international collaborator 2006 to 2015.

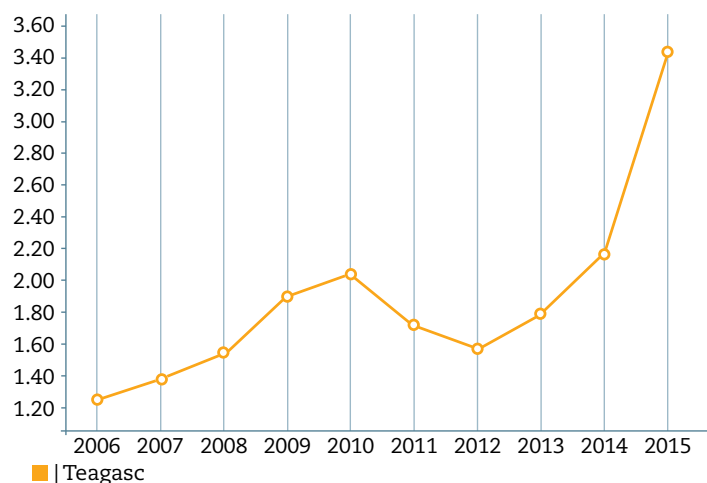


Figure 2. Teagasc publications in the agriculture, dairy and animal science category normalised citation impact 2006 to 2015.

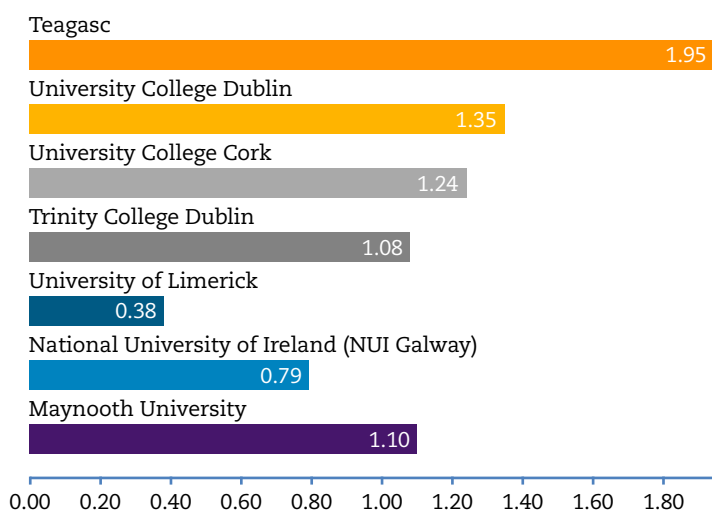


Figure 3. Teagasc and Irish universities, agriculture, dairy and animal science category normalised citation impact, 2011 to 2016.

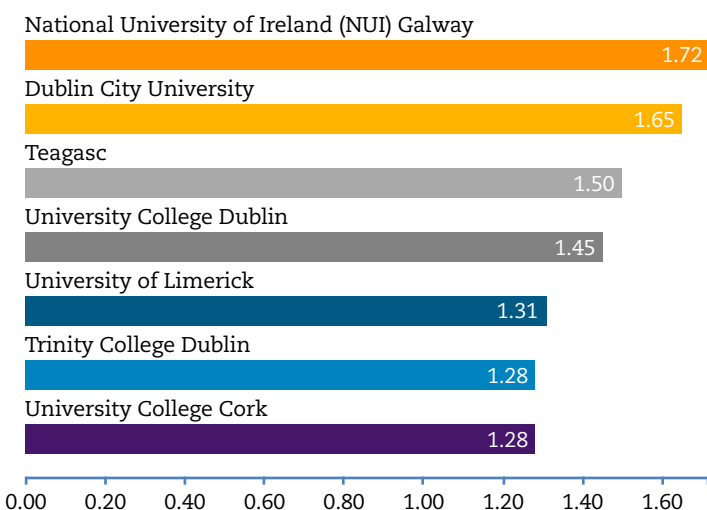


Figure 4. Teagasc and Irish universities, food science and technology category normalised citation impact, 2011-2016.

The NCI is calculated by dividing the actual count of citing items by the expected citation rate (baseline) for publications with the same document type, year of publication and subject area. It is used for comparative purposes to correct the way that citation rates vary across subjects, as citations grow over time, and vary with publication types.

Comparison with other research performing organisations

It is important to understand how our performance ranks against other research bodies. Comparisons within (subject) categories are the most meaningful. Two categories of relevance to Teagasc are (a) agriculture, dairy and animal sciences and (b) food science and technology. To place our performance in a national context, we can compare Teagasc performance with that of the Irish universities within these subject categories.

Figure 3 shows how Teagasc performs when our NCI is compared with that of the Irish universities in subject category (a) above. A value of one represents average performance for that category; values above one are above average. This chart shows that our

performance in this category for the years 2011 to 2016 is well above average and we are ranked first in Ireland.

Figure 4 illustrates the same metric for our publications in category (b) above. Here we see that our performance is also well above average and we are ranked third in Ireland.

Of course, all bibliometric analysis must be placed in context and the impact of our research must be evaluated in other ways, to give an overall assessment. Even Thomson Reuters, who publish *Web of Science*, recognised this in their publication *Impact Measures and How to Use Them* (2016): 'Measures that are firmly grounded in consistent, quantitative analysis, along with newer analytics, must be combined and balanced with the oldest evaluative tool of all: sober, clear-eyed human judgment'.

Acknowledgements

Data reproduced from *InCites* produced by Clarivate Analytics. Thanks to Jane Kavanagh and Frank O'Mara for their contribution to this article.

Johne's disease and bovine tuberculosis testing



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Aideen Kennedy won the RDS medal for the best oral presentation at the recent Teagasc Walsh Fellowships seminar for her work on Johne's disease.

Johne's disease (JD) is an incurable disease of ruminants caused by infection with *Mycobacterium avium* subspecies *paratuberculosis* (MAP). Infection with MAP normally occurs in calves through ingestion of contaminated faeces, colostrum or milk. Clinical signs of the disease include weight loss, diarrhoea, emaciation and eventual death. These clinical signs usually do not appear until adulthood (Garcia *et al.*, 2015).

As a result of concerns regarding the hypothesised zoonotic link between MAP and Crohn's disease in humans, JD-associated economic losses, and animal health and welfare issues, a number of JD control programmes have been established internationally. These programmes aim to break the cycle of disease transmission through the identification and removal of infected animals and optimal calf management.

Due to the slowly progressive and prolonged nature of the disease, JD is notoriously difficult to diagnose. None of the commonly used tests (enzyme-linked immuno-sorbent assay [ELISA], polymerase chain reaction [PCR] or microbial culture) report acceptable test sensitivity or specificity and, therefore,

Figure 1. The bTB CST involves taking repeat skin thickness measurements 72 hours post-PPD administration.

occasionally yield false-positive and false-negative results (Garcia *et al.*, 2015). A further complicating issue in the Republic of Ireland is that the current bovine tuberculosis testing (bTB) regimen has been reported to interfere with JD ELISA diagnostics.

Comparative skin test

The comparative skin test (CST) is used to test for bTB and involves intradermal injection of avian and bovine purified protein derivative (PPD). An animal is classified a bTB 'reactor' if the animal records an increase in skin thickness ($\geq 4\text{mm}$), 72 hours post-PPD administration at the bovine PPD injection site compared to the avian PPD site (de la Rua-Domenech *et al.*, 2006), see Figure 1. It has been suggested the bTB CST can aid identification of animals previously exposed to MAP; however, further research is necessary to improve the value of this diagnostic option (OIE, 2016).

The aim of this particular study was to examine the impact of bTB CST on both serum and milk MAP ELISA test results to provide appropriate advice on the optimal timing of JD ELISA testing in Irish dairy herds (Study 1). A further study was subsequently conducted to investigate if animals recording skin thickness increases on bTB CST had associated increases in MAP ELISA response (Study 2). We proposed that combining bTB CST and MAP ELISA responses in individual cows may aid identification of sub-clinical JD, as similar strategies have been used to improve bTB ELISA test sensitivity.

Materials and methods

A 139-cow herd was recruited for both studies. Milk and blood samples were collected pre-administration of the CST and multiple times post-administration. An IDVet indirect MAP ELISA was used to test all samples. Results were interpreted according to the manufacturer's instructions and categorised as positive or negative. Apparent herd prevalence was calculated as the number of positive cows over total number of cows tested. Skin thickness measurements were taken (mm) pre-CST and 72 hours post-CST and categorised as follows:

- Category 1 – skin thickness increases at both the PPD avian and PPD bovine sites post-CST;
- Category 2 – skin thickness increases at one PPD site only; or
- Category 3 – no skin thickness increases at either site.

Generalised estimating equations were used to investigate differences between pre- and post-CST MAP ELISA responses and between post-CST categorical skin thickness response and MAP ELISA results. Independent variables included in the models were: sampling time point, breed (Friesian, Jersey), parity and date of calving.

Results

No bTB reactors were identified throughout either study. Prior to the administration of the CST, less than 10% of the study herd tested MAP-positive using either blood or milk samples. There was a significant ($P<0.01$) increase in the apparent prevalence of positive cows, peaking at 39% on day 14 post-CST (Figure 1). Statistically significant differences between pre- and post-CST apparent prevalence of MAP-positive cows were recorded until 43 days post-CST using milk samples. Serum samples recorded elevated results for a further 28 days post-CST.

A total of 50 cows were classified as category 3 (no skin thickness response) post-CST and 35 cows responded at both PPD avian and PPD bovine administration sites (category 1). The remaining cows recorded skin thickness increases at the PPD avian site only (category 2). Results from generalised estimating equations highlighted that category 1 cows were almost four times more likely to test MAP ELISA-positive than category 3 animals ($P=0.004$). No significant difference was recorded between category 2 and category 3 animals.

Implications

We aimed to provide farmers and veterinarians with advice on the optimal timing of JD ELISA testing in the Irish dairy herd. The results of our study have shown that blood sampling for MAP ELISA testing should be avoided for at least 71 days post-administration of a bTB test. If test results are required sooner we advise using milk samples to establish herd MAP status. Milk samples, however, should not be collected with 43 days of the bTB test.

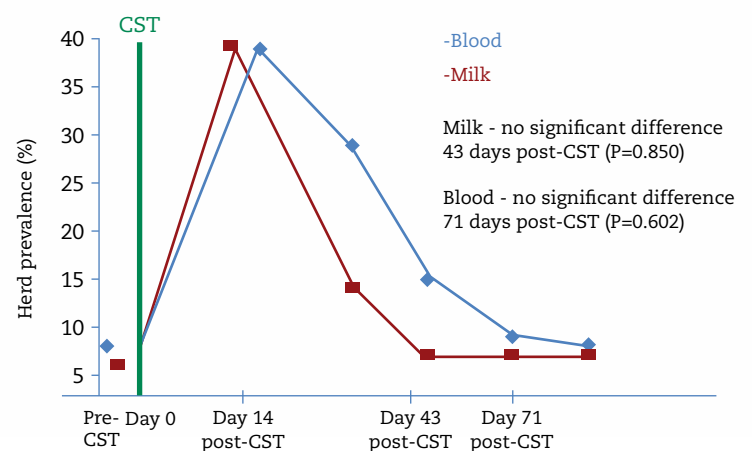


Figure 2. Graph showing increase in the herd prevalence of MAP ELISA positive animals post-administration of the bTB CST.

The identification of an association between the skin thickness increases and MAP antibody response post-CST may suggest increased MAP ELISA sensitivity. From this study alone, however, we cannot rule out the possibility of reduced MAP ELISA specificity (i.e., increase in false-positive results) and, therefore, further research is required to determine if a combination of these tests could identify sub-clinical JD.

Overall, these studies contribute to more accurate interpretation of MAP ELISA results and highlight the complex interactions between bTB and MAP diagnostics.

Acknowledgments

This work was conducted under the Walsh Fellowship Programme. The authors wish to acknowledge the assistance of the farm staff.

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Infant formula: α -lactalbumin and its effect on stability during processing



Aoife Buggy was the winner of the best food research presentation and the Food Science and Technology Ireland medal at the recent Teagasc Walsh Fellowships seminar for her work on infant formula.



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Ireland is viewed internationally as one of the world leaders in infant formula manufacturing. Irish infant formula exports are estimated to be worth €1.5 billion to the Irish economy, which equates to about 35% of total Irish dairy global exports, according to Bord Bia's Annual Report 2015. Continual growth has led to an increased interest in research on the nutrient profile of ingredients used in infant formula and their interactions during manufacture. A key objective when producing a first-stage infant formula is to mimic the nutrient profile of human breast milk as closely as possible. As part of achieving this goal, a mixture of skimmed milk and whey protein is commonly used to more closely match the protein composition of mothers milk, providing a targeted amino acid (sub units of protein) level for the infant.

Two main protein fractions exist in both human and bovine milk: casein and whey protein, with ratios of 40:60 and 80:20, respectively. Within the whey fraction of bovine milk, the primary proteins present are β -lactoglobulin and α -lactalbumin. In human milk, when compared to bovine milk, the total whey protein content is higher and β -lactoglobulin is not present. Therefore, increasing the level of α -lactalbumin can improve the amino acid profile of an infant formula by more closely matching that of human milk. This study analysed three model infant formulae with increasing amounts (12%, 30% or 48% of total protein) of α -lactalbumin within the protein fraction. These formulations were split into two; the first batch receiving heat treatment and then

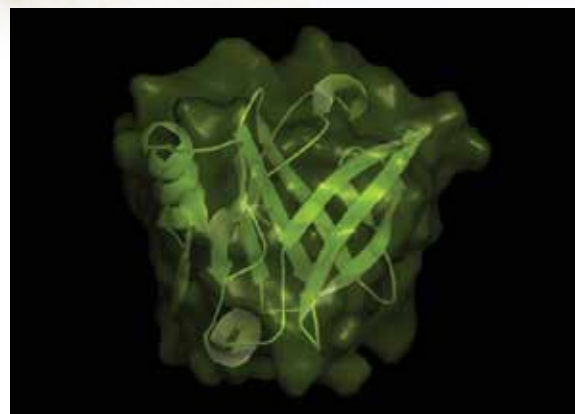


Figure 1. 3D structural image of β -lactoglobulin.

homogenisation, whereas the second batch was heat treated after homogenisation. The stability of each formulation (six in total) was analysed by measuring the size of fat droplets formed after homogenisation using laser light diffraction and the viscosity of each formulation. The results showed that heating after homogenisation reduced the stability of formulations containing 12% α -lactalbumin during processing, as evident by an increase in fat globule size distribution. However, increasing the α -lactalbumin concentration from 12% to 48% prevented this from happening. The formulations containing the higher α -lactalbumin concentration had a lower viscosity when concentrated, regardless of processing conditions used. The use of α -lactalbumin in infant formula can therefore facilitate the design of new processes while allowing greater concentration and improved throughput. The findings demonstrate the complex interaction between the type of the protein ingredient used during formulation and the sequence of unit operations required to process these formulae.

Acknowledgements

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Genetics of pig growth and feed efficiency data

Jessica Coyne received the best poster award at the recent Walsh Fellowships seminar for her work on genetics and feed efficiency.

The final live weight of an animal, including the rate and age at which an animal reaches this target, is of economic importance. Variation in growth patterns of farmed animals contributes to volatility in performance and, consequently, profitability of producers; therefore, prediction of an individual animal's growth profile is extremely valuable information. Growth functions are mathematical models that have the ability to condense the weight-age relationship into biologically interpretable parameters. These parameters describe the growth potential of animals, including the final, mature weight and rate of maturation. These growth-function parameters also have a genetic component that can be calculated as the proportion of variation attributed to inherited genetic factors, as opposed to environmental influences; this is known as the heritability of a trait. The objective of our research was to investigate the contribution of genetics to pig live weight and feed intake, with the aim of developing a decision support tool to aid breeders when making important feeding and breeding decisions.

Analyses

The pig data analysed in this study were provided by a Finnish company, Figen Oy, and consisted of 51,893 live weight and 903,436 feed intake observations. Three growth functions were tested on their ability to model and predict pig live weight. Heritability of live weight and feed intake, and their genetic correlation, were evaluated using random regressions, which analyse

repeated trait records over a specific period. These results could be used to estimate breeding values, or measures of genetic merit, for individual animals for each day of life. Growth functions adequately modelled and predicted pig live weight, which provides the mechanisms for developing a decision support tool for breeders that could identify faster growing animals that require less time to reach target slaughter weight. Furthermore, slow growing pigs could be identified during the early growing phase and could be separated and fed accordingly.

Moderate to strong heritability estimates for live weight and feed intake were estimated, with up to 50% of the variation in live weight, and 25% of the variation in feed intake, due to genetics. A strong genetic correlation was also estimated between live weight and feed intake; indicating ample genetic variation exists for these traits and, through specific breeding objectives, it would be possible to improve the overall performance of the animals.

Conclusions

Overall results from this study suggest the development and implementation of a decision support tool, used in conjunction with routine genetic evaluations, would provide valuable information for breeders when making important management decisions. The decision support tool is easily transferrable across species and would help align the management of these animals more closely with their genetic growth potential.

Acknowledgements

This research was funded through the Teagasc Walsh Fellowship Scheme.

Novel bacteria potentially associated with pneumonia



Currently unknown and non-culturable bacterial species may be involved in calf pneumonia. Teagasc researchers used a novel molecular diagnostic assay to identify bacteria, including non-culturable bacteria, which were present in the lungs and lymph nodes of calves that died from pneumonia.

Pneumonia in calves

Morbidity and mortality (5.3%) rates in Irish calves are high. In the Republic of Ireland, 6.5% of calves, equivalent to about 132,297 calves, excluding stillborns, die in their first year of life. Pneumonia is the most common cause

of morbidity and mortality in pre-weaned calves. It is a disease of the lower respiratory tract, which causes the following symptoms: an elevated rectal temperature, an increased respiratory rate, nasal and ocular discharges, coughing, dyspnoea, a decreased appetite and depression (Figure 1). Pneumonia is normally contracted by calves following periods of stress and/or inhalation of primary pathogens, including viruses such as bovine herpesvirus 1 (also known as infectious bovine rhinotracheitis), bovine respiratory syncytial virus, bovine parainfluenza 3, bovine viral diarrhoea virus, bovine coronavirus, and mycoplasma. They compromise lung function and allow colonisation by secondary bacterial pathogens, many of which are normal flora of the bovine upper respiratory tract, which are generally responsible for the progression of the disease and the ultimate death of the animal.



Figure 1. A calf displaying symptoms of pneumonia.

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Diagnosing bacteria causing pneumonia

The diagnostic tools used to identify bacterial species that cause pneumonia are culture and a molecular test known as the polymerase chain reaction (PCR). However, these tests cannot be used to identify unknown or non-culturable bacteria that may be involved in respiratory diseases. Furthermore, antibiotic treatments and vaccinations are targeted against known bacteria associated with pneumonia. Consequently, unknown bacteria, which may be key players in the development and progression of pneumonia, are escaping detection. This lack of knowledge about bacteria, present in the bovine lungs that currently cannot be cultured, may contribute to the poor efficacy of vaccination and antimicrobial treatments against pneumonia-associated bacteria. Therefore, our group at Teagasc Grange Animal & Grassland Research and Innovation Centre, in collaboration with the Department of Agriculture, Food and the Marine (DAFM) regional veterinary laboratories (RVLs), decided to use next generation sequencing (NGS) of the bacterial 16S ribosomal RNA (rRNA) gene PCR amplicons, which is a culture-independent, open reference method, to examine bacteria present in lung and lymph-node samples from fatal cases of pneumonia and from clinically healthy calves.

Study design

Vets at Sligo, Athlone and Kilkenny RVLs collected cranial lung lobe and corresponding mediastinal lymph-node post-mortem tissue samples (Figure 2) from 32 beef calves and six dairy calves that had pneumonia as a cause of death. We also collected 20 cranial lung lobe and mediastinal lymph-node tissue samples from clinically healthy dairy calves that were slaughtered at Teagasc Ashtown.

At Teagasc Grange Animal Bioscience centre, we prepared bacterial 16S rRNA gene amplicon libraries by extracting DNA from the lung and

lymph node tissues and performing two rounds of PCR amplification. Initially, we PCR-amplified a small portion of the bacterial 16S rRNA gene, as this gene contains regions that are conserved and regions that are variable between bacterial species. The conserved bacterial sequences enabled PCR amplification and the variable sequences would allow subsequent identification of bacterial genera by comparing the variable PCR-amplified sequences (amplicons) with databases containing bacterial 16S gene sequences. In the second round of PCR, we added barcodes to the amplicon targets so each sample could be identified following NGS. Finally, we sequenced the libraries on an Illumina MiSeq and used bioinformatics software to determine which bacterial genera were present in each lung and lymph node sample.

Identification of *Leptotrichiaceae* in pneumatic tissue

We found bacteria present in all lung and lymph node samples, including both samples from calves that died from pneumonia and from clinically healthy calves. Therefore, like other recent studies, we confirmed that lung tissue from clinically healthy calves is not sterile, as was once thought. However, the frequency of the detection of bacteria associated with pneumonia was lower in the lungs and lymph nodes of clinically healthy calves, compared with fatal pneumonia cases.

The most abundant bacterial genera/families identified in the lungs and lymph nodes of the calves that died from pneumonia were *Leptotrichiaceae*, *Mycoplasma*, *Pasteurellaceae*, and *Fusobacterium*. While the *Pasteurellaceae* family and the *Fusobacterium* and *Mycoplasma* genera contain bacterial species that are known to cause pneumonia, the *Leptotrichiaceae* family is not currently associated with pneumonia. However, *Leptotrichiaceae* sequences were only found in lesioned tissue in our study and were not present in the lung or lymph nodes from the clinically healthy calves that had no lung lesions.

Using DNA from one of the pneumatic calf lung samples, we then sequenced longer regions of the *Leptotrichiaceae* genome in order to identify this bacterium to species level. However, despite being identical to an uncultured bacterium obtained from the reproductive tract of cows at University College Dublin, our *Leptotrichiaceae* bacterial genome sequences did not match any known bacterial species in the sequence databases. This suggests that we have identified a novel bacterial species within the *Leptotrichiaceae* family that is potentially involved in bovine pneumonia. It is not possible yet to infer whether this novel *Leptotrichiaceae* species is pathogenic and causing lung lesions or whether it is merely able to grow opportunistically in the lung lesions. However, as we have discovered it in bovine lung lesions and as it has also been identified in cows' reproductive tracts in an independent study, it may be an emerging pathogen in Irish agricultural systems.

Acknowledgements

We would like to acknowledge Gerard Murray, the vets and technicians from the RVLs who were involved in sample acquisition.

We would also like to acknowledge David Kenny, Alan Kelly and Sinead Waters for their help with the study, particularly for acquisition of samples from calves.

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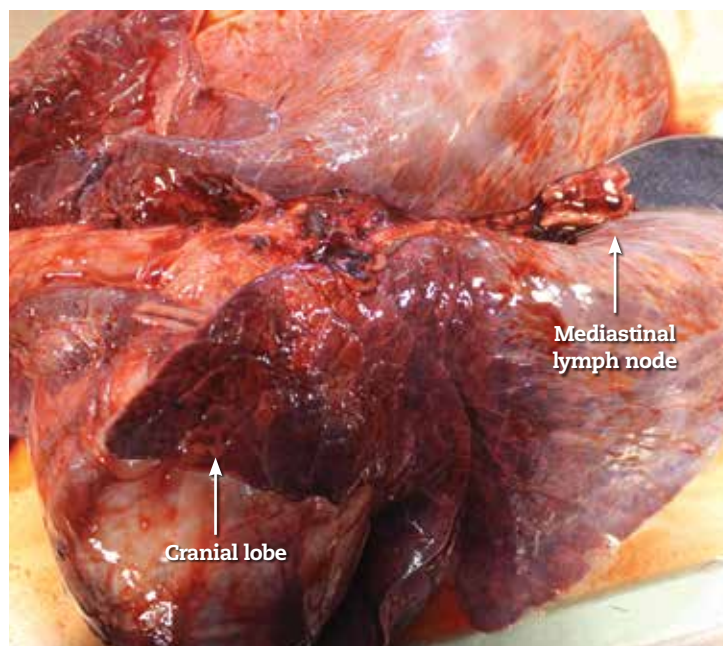


Figure 2. Calf lungs from a fatal case of pneumonia with the cranial lobe and mediastinal lymph node indicated with arrows.



CELU

Kildalton Open Source Sustainable Demonstration Farm

Global demand for food is projected to double by 2050 and, with concurrent challenges presented by climate change and increasing greenhouse gas emissions, meeting this demand and protecting our natural resources will require sustainable production practices. The Kildalton Open Source Sustainable Demonstration Farm has been set up to promote and transfer the sustainable farming message.



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Food Wise 2025 was launched in 2015 and sets out a sustainable growth vision for the Irish agri-food sector. As Ireland's farmers manage the majority of the country's natural resources, it places them in a unique position of delivering many public goods and social benefits, which contribute to the wellbeing of the country. In doing so, Irish producers are playing, and must continue to play, a vital and positive role in the protection and the potential further enhancement of Ireland's landscapes, waterways, biodiversity and air quality. This position is particularly important given the increased global demand for food where current projections predict that by 2050 the demand will have doubled. Ireland has a track record of sustainable food production and we are in a good position to deliver sustainably produced food while better protecting our natural resources.

Origin Green and Glanbia

Origin Green was introduced in 2012 by Bord Bia and was the first national sustainability programme uniting Government, the private sector and food producers. The programme involves ongoing measurement throughout both farm and food manufacturing units. Participating farms are assessed on an 18-month cycle on measures ranging from their carbon footprint to water, energy and biodiversity. To date, over 90,000 farms have been audited and carbon footprinted as part of Origin Green.

Glanbia Ingredients Ireland (GII) has recognised its comparative advantages in sustainability as a key difference between it and its competitors in global dairy markets. Consequently, the company has prioritised the drive to develop the sustainability of its products along the food chain from the farm to the customer. GII is a key partner in the Kildalton Open Source Sustainable Demonstration Farm, providing financial support and technical expertise. GII is a founding member of Origin Green and in preparing its milk suppliers for auditing and, further developing its sustainable approach, Glanbia has developed the Glanbia Open Source Sustainability and Quality Assurance code.

Objectives

The Kildalton Open Source Sustainable Demonstration Farm builds on the large body of research and knowledge-transfer experience in Teagasc and draws on international knowledge to showcase solutions to the economic and environmental sustainability challenges facing the Irish agri-food industry. Collaborating with GII, work has started on the high output dairy unit (463kg milk solids per cow) at Kildalton to transform it into a showcase of sustainable dairy production



Figure 1. Soil testing and grass monitoring are key elements ensuring we get best value from nutrient inputs.

Defining and measuring sustainable farming

While there is universal agreement on the desirability of the concept of sustainable agriculture, there are differences on how it is interpreted. There is general agreement that sustainability should be considered under three pillars: economic, environmental and social. It is common for most analysis to be focused on the environmental dimension. Echoing the 1987 Brundtland Report, Teagasc has succinctly defined sustainable agriculture as an approach that we can sustain into the foreseeable future. This project focuses on seven dimensions of sustainability: resource use efficiency; water quality; biodiversity; economic sustainability; gaseous emissions; animal welfare; and health and safety. These sustainability variables are not independent and links can exist between them, e.g., spreading slurry using low-emission technologies can reduce greenhouse gas emissions but may also reduce impacts on water quality.



Figure 2. Seven elements of sustainable farming.

Implementing the sustainable farming plan

Implementing the plan was covered in depth in a previous *TResearch* (see spring 2015 issue) article and can be summarised as being delivered over four distinct phases, although these phases will overlap with each other to some degree.

- Phase 1: Benchmarking the sustainability performance of the farm to provide a baseline against which future changes can be measured.
- Phase 2: Implementation of proven technologies and best practices.
- Phase 3: Redesign and improvement of the farm infrastructure (including ecological infrastructure).
- Phase 4: Step-by-step implementation of emerging technologies.

Progress on implementation

A project coordinator was successfully recruited and work commenced in 2016. As per Phase 1, a baseline is being established with the installation of electricity and water metering, soil sampling of the entire farm, establishment of nutrient-use efficiencies, completion of annual carbon navigators, participation in the National Farm Survey, mapping biodiversity resources, development of animal welfare metrics and installation of sampling points for ground and surface waters. Further work is needed in developing a baseline, namely carrying out spring surveys of biodiversity elements, e.g., birds, hedgerows, woodland etc., and developing a water quality baseline. In line with the showcasing element of the

project, there have been visits from international dairy processors, food manufacturers and academia. The farm also hosted the Irish Grassland Association student conference.

Work in 2017 will carry on the baseline assessments but will also progress to a greater adoption of proven technologies and best practices, including a field trial of protected urea and greater establishment of clover through overseeding with white clover and correcting soil pH and nutrient status. Recent research from Johnstown Castle shows that urea protected with the urease inhibitor N-(n-butyl) thiophosphoric triamide (NBPT) reduces greenhouse gas emissions compared to calcium ammonium nitrate (CAN). Protected urea also consistently yields as well as CAN and has higher fertilizer efficiency than urea (Forrestal et al., 2017) because of reduced ammonia gas loss. Protected urea products are now available from several fertilizer companies in Ireland and the Kildalton Sustainable farm will integrate protected urea into its fertilizer plan.

Teagasc aims to continuously improve the sustainability of the farm, seeking new opportunities to improve performance in practical and financially sound ways. Kildalton Open Source Sustainable Demonstration Farm will, thus, play an important role in supporting the Irish dairy sector in reaching its sustainability goals.



Figure 3. Improving local habitats will have positive impacts for biodiversity and also improve the provision of other ecosystem services such as climate regulation and aesthetic.

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Figure 1. Male and female spotted wing drosophila. The species gets its name from the spots carried on the wing of the male.



Spotted wing drosophila in Ireland

The unexpected arrival of a new pest species can cause economic loss and disrupts existing crop protection strategies. Spotted wing drosophila, (*Drosophila suzukii*), a fruit fly that attacks soft fruit, was identified in Ireland during 2015 and Teagasc research is developing strategies to manage this new pest, through on-farm population monitoring and grower training.

A specific monitoring survey for the detection of the invasive insect pest, *D. suzukii* or spotted wing drosophila (Figure 1) commenced in 2015 and was further expanded in 2016. *D. suzukii* is causing severe economic loss to soft and stone fruit crops throughout Europe and the US, since its detection in 2008. This invasive fruit fly was detected in Ireland in 2015 at multiple locations (EPPO, 2015) and its spread throughout Ireland continued during 2016. With no natural predators or parasitoids identified to date and a limited number of other control options, it's likely that this pest will severely impact soft and stone fruit yields in the coming years.

Fast establishing species

D. suzukii or spotted wing drosophila, was first detected in Europe in 2008, initially in Spain in late 2008 and in Italy in 2009. At the same time, the first confirmed

findings in California were also reported. Over the period of 2010 and 2011, this pest invaded much of continental Europe, mostly through the unintentional transportation of infested fruit, reaching the UK by 2012. Unlike other fruit flies, which have ovipositors that are blunt and are only able to pierce the skin of over ripe and rotting fruit, the female *D. suzukii* has a serrated ovipositor (Figure 2), which has the ability to damage ripening and ripe fruit. *D. suzukii* also has an extremely wide host range, which allows it to reproduce on many common fruiting ornamental and hedgerow species of plants, which allows it to very quickly to establish itself into new territories and habitats. Research in Europe and the US has tested dozens of native and hedgerow species of plants that this insect can reproduce on, such as Viburnum, Honeysuckle, Portuguese laurel, however it is its ability to infest commercial soft and stone fruits that is of most concern.

Monitoring programme

In 2015, Teagasc launched an early detection monitoring programme for *D. suzukii*. With the importation of fruit from impacted countries commonplace, it was deemed prudent to commence

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monitoring due to the potential negative impact of this invasive pest. Also, given its size and behaviour, it was likely that the pest could become established and attain large populations before being identified. The monitoring was conducted using non-specific vinegar traps. Fruit flies are attracted to the smell of vinegar and 'trapped' as they usually drown in the solution. Traps attract many different insect species however, so they need to be monitored weekly to avoid a build-up of insects. These traps were placed in hedgerows around Leinster in the first week of June 2015. Traps were placed in the hedgerows as the habit of this invasive pest is to initially establish itself in a hedgerow of suitable host plants, where it may stay and reproduce for months and years before it is observed in commercial crops. By the third week of June 2015, three of the traps returned samples that were positively identified as *D. suzukii*. Initial identification of the pest was made by Teagasc and was confirmed by two international laboratories. As the traps were separated by a considerable distance (150km), it is reasonable to assume that this pest was present in Ireland for some time and was established in several locations around Ireland before monitoring had commenced. As the maximum flying distance for *D. suzukii* is 2km, its reasonable to assume that the pest was introduced on imported damaged fruit. The immature stages of the fly can successfully survive composting and even being buried to a depth of 20cm. Therefore, it's likely that there have been multiple (and continuing) introductions into the country.

Crop damage

The confirmed arrival of this pest in Ireland has serious implications for Ireland's soft and stone fruit sectors. The level of damage that can be inflicted on crops is severe. A recent survey of affected growers in the eastern US (where *D. suzukii* was first identified as being present in 2010) stated high levels of crop loss in key crops such as raspberries (41%), blackberries (29%), blueberries (13%) and cherries (9%). Given the high levels of crop loss observed, the economics of growing these crops are now being re-evaluated in parts of the US and Europe. Most retailers in the US and Europe have taken a zero tolerance approach to this pest, consequently, if detected, it can cause a significant loss to the grower through rejected fruit crops.

High replication rate

In the US and southern Europe, populations have increased significantly since 2008. This fruit fly has an extremely high reproduction rate, and can complete its lifecycle from egg to adult in as little as eight days in ideal conditions. More typically, you can expect 10 to 13 generations in a calendar year, with each female capable of laying over 300 eggs. *D. suzukii* has adapted to many different climates and can survive extremely harsh winters (temperatures as low as -16°C). Studies in the US have highlighted its ability to adapt to different environments by altering its body size and body colouration, to allow it adapt to changing climates. The ideal temperatures for *D. suzukii* development are between 13.4°C and 29.3°C and this, combined with Ireland's temperate winters and high rainfall (access to water), makes Ireland, and particularly the east coast of Ireland, an extremely favourable habitat for this pest. However, in reality, pest risk analysis has indicated, that apart from some areas of northern Scandinavia, the entire European continent is a suitable habitat for its survival and reproduction.

Minimising the impact

The overall impact that this pest's introduction will have on Irish growers is unclear. *D. suzukii* populations are very low by international

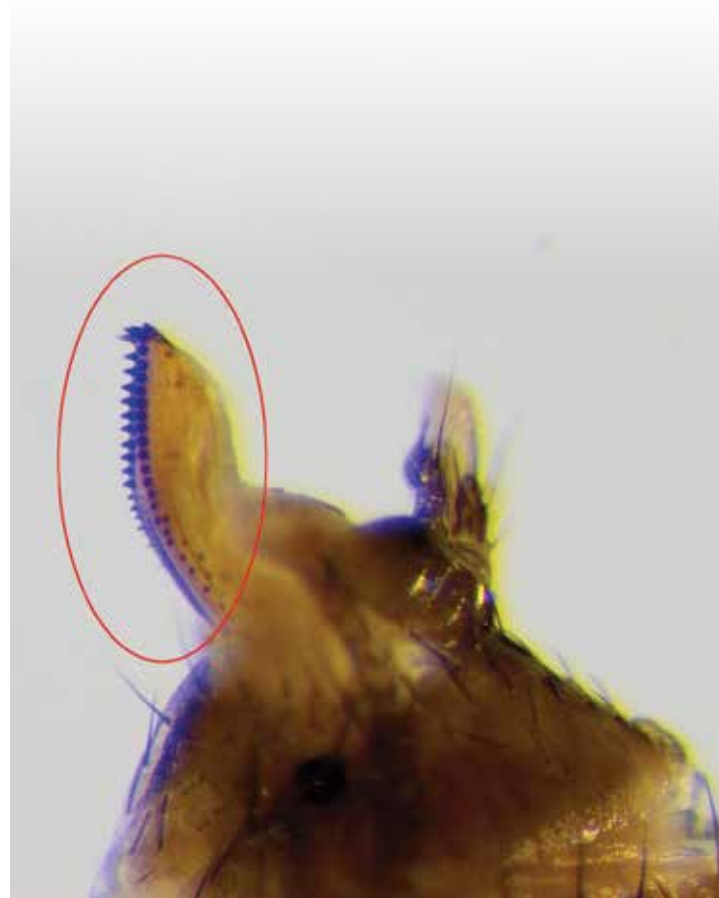


Figure 2. The female serrated ovipositor (circled in red) allows her to pierce the skin of ripe and ripening fruit.

comparison, as Ireland was one of the last countries in western Europe to be affected. However, populations are increasing and it is prudent to study what is currently occurring in the US and Europe to identify the best control strategies available. It is possible that it may be another 18-24 months before we start to observe the first economic losses due to *D. suzukii*, so the early detection monitoring system has been successful in giving the Irish soft fruit industry the necessary warning and time to adopt necessary cultural control strategies, identified in other countries to help minimise the impact of *D. suzukii*. To that end, Teagasc recently commenced a collaborative research project with University College Dublin (UCD), as well as American and British institutes, to assess cultural (non-pesticide) control strategies developed internationally to combat this invasive pest. Teagasc are currently compiling international research on the most effective cultural control strategies and this information will be compiled into a fact-sheet and will be available for the 2017 growing season.

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Humanisation of bovine milk fat



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Mother's milk is still considered the 'gold standard' in infant nutrition. However, ongoing research is exploring ways to 'humanise' bovine milk fats to bring infant milk formula closer in line with breast milk composition.

Ireland is one of the world's leading producers of infant milk formula (IMF) and accounts for about 10% of global production. Exports of IMF reached €1.5 billion in 2015, with China accounting for the majority of this figure (€400 million). Ireland exports 25,000 tonnes of infant formula to China and is now the second largest exporter to China after the Netherlands. Ireland is host to a number of major, multinational producers of IMF products including Abbott, Danone, Wyeth (Nestlé) and Kerry Group, all of whom are supplied directly by Irish dairy processors.

Human milk and infant formula are the only nutrient sources available to the new-born infant. Human milk provides all the nutrients and physiologically active substances required and remains the 'gold standard' in neonatal nutrition.

Historically, alteration of bovine milk for use in IMF has focused on the non-fat components, i.e., lactose, proteins and minerals, which are present at higher quantities in cow's milk compared to human

milk. Particular attention has been paid to providing the correct balance of casein and whey proteins. In contrast, fats and oils for inclusion in IMF are derived mainly from vegetable sources. Although blends of vegetable oils can, quite adequately, match the overall fatty acid (FA) composition of human milk fat, isomeric (structural) differences exist between lipid sources.

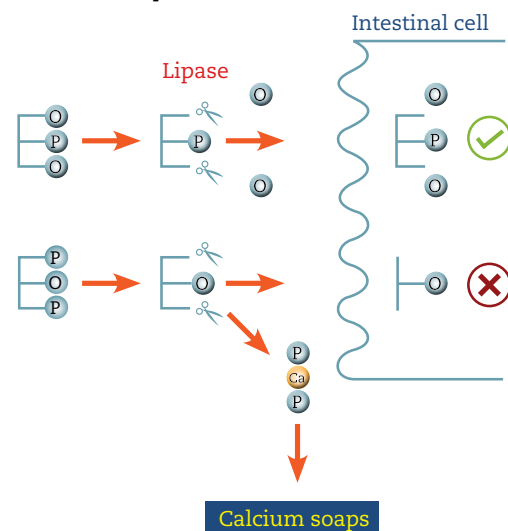


Figure 1. Effect of triglyceride structure on lipolysis and absorption of fatty acids. O: oleic acid. P: palmitic acid.

Human milk fat

Human milk contains 3-4.5% lipids, which account for >50% of the total energy available in milk. The vast majority of milk lipids (>98%) are present as triglycerides in which three FAs are attached to a glycerol molecule. Triglycerides are made up of saturated, unsaturated and polyunsaturated FAs differing in carbon chain length and the number of double bonds between carbon atoms. The major unsaturated FA in human milk is palmitic acid (C16:0) and is located primarily (60-70% of total) at the *sn*-2 (middle) position of the glycerol backbone. The predominant unsaturated FA is oleic acid (C18:1 *n*-9) and it occupies the *sn*-1 and *sn*-3 (outer) positions. This unique structure has significant implications for milk fat digestion in human infants.

Milk fat digestion

During digestion, fats undergo lipolytic breakdown by pancreatic lipases, which hydrolyse the triglycerides and release FAs from the *sn*-1 and *sn*-3 positions while leaving the remaining FA attached to the glycerol molecule at the *sn*-2 position. These two monoglycerides are readily absorbed, regardless of constituent fatty acid. In contrast, absorption of free FAs are dependent on type with longer chain FAs (C12:0-C18:0) less readily absorbed than medium-chain FAs (C6:0-C10:0).

Free palmitic acid, emanating from *sn*-1 and *sn*-3 positions, can combine with calcium to form calcium soaps, which can have negative impacts on calcium absorption and can cause loss of energy (see Figure 1). Stool hardness, constipation and digestive discomfort may result (Sahin *et al.*, 2005).

Recent years have seen increased interest in improving the fat fraction of IMF in order to better mimic human milk. Most research has examined lipase-induced, structural modification of plant oil triglycerides to create human milk fat substitutes (HMFS), i.e., structured triglycerides resembling human milk fat (Soumanou *et al.*, 2013; Zou *et al.*, 2013). Palm oil has the highest level of C16:0 of any commercial vegetable oil and is an important component of IMF fat blends. Concerns relating to deforestation and sustainability in developing countries, however, have identified a need to find alternative sources of C16:0. Bovine milk fat is high in C16:0 (ca. 30% of total FAs) and, although the proportion at the *sn*-2 position is significantly lower than human milk fat, it represents an excellent candidate for HMFS production.

Lipases

Lipases are enzymes derived from a range of microbial, animal or plant sources and play an important physiological function in digestion and absorption of lipids. Their ability to redistribute FAs (interesterification) on triglyceride molecules forms the basis for their use in altering the compositional, physical and nutritional properties of fats and oils. Lipases, however, show preferential selectivity for *sn*-1 and *sn*-3 FAs rather than *sn*-2 FAs, which adds additional challenges to the development of structured lipids.

HMFS production

The objective of this work was to produce, in a cost-effective way, a HMFS product that: i) meets the FA nutritional profile of human milk; ii) maximises the proportion of C16:0 at the *sn*-2 position; and iii) maximises the ratio of anhydrous milk fat (AMF) to palm oil.

Ten commercial lipases were compared for their ability to alter the triglyceride structure of AMF. Changes in the proportion of C16:0, at the *sn*-2 position, were relatively minor with a maximum increase of 9.5% (weight for weight [w/w]). Fractionation of AMF, by controlled cooling, followed by lipase-induced interesterification of the stearin (solid) fraction improved yields to 18% (w/w).

A series of experiments, under batch conditions, were carried out to modify the structure of AMF-vegetable oil blends (including palm oil as C16:0 donor) as a function of FA composition, time, temperature and enzyme/substrate ratio. An HMFS product with AMF content of 50% and approximately 35% (w/w) C16:0 at the *sn*-2 position was developed, which compares very favourably with commercially available structured lipids.

A continuous, packed-bed, lipase reactor system is currently under examination as a means of stabilising the enzyme in order to allow multiple use – a prerequisite to commercial viability. Short path distillation is also being employed to remove reaction side-products (free FAs, mono- and di-glycerides) in order to meet regulatory and sensory requirements.

A number of challenges remain before a HMFS product containing significant proportions of AMF becomes available commercially. The high-volume/low-cost model associated with most food production systems means that more expensive ingredients (such as AMF) and processes (lipase modification) must be counter-balanced by high-end production efficiencies and identification of targeted, value-added markets. Successful development of such products, however, are expected to exploit valuable international markets and develop important additional streams for bovine milk fat.

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Kefir – molecular insights into a fermented food



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Kefir is a traditional fermented milk product that has been consumed for hundreds of years and is becoming increasingly popular among consumers worldwide. The popularity of kefir can be attributed to its pleasant, yoghurt-like flavour, as well as its purported health benefits, including claims of anti-carcinogenic, anti-inflammatory and anti-pathogenic effects.

Linking microorganisms to flavour in kefir

Kefir 'grains' are naturally-forming organic structures, which are composed of a mixture of microorganisms contained within a matrix that has a cauliflower-like appearance. Kefir is produced by adding a kefir grain to milk, which is then incubated at room temperature for around 24 hours before the grain is removed (and re-used) and the fermented milk is consumed. A number of studies have demonstrated that the kefir microbiota is dominated by a mixture of lactic acid bacteria and fungi. Here, we describe our recent studies that used state-of-the-art approaches to more extensively characterise the microorganisms present, establish how they contribute to kefir flavour and begin to unravel how they might contribute to health. The findings of the study were recently published in the highly regarded journal, *mSystems* (Walsh et al., 2016).

In our study, we used three varieties of kefir grain: one each from France, Ireland, and the UK. We collected milk samples at different stages during the fermentation process. Next, DNA extracted from the kefir was subjected to DNA sequencing, using a method called whole-metagenome shotgun (WMS) sequencing, to facilitate an in-depth characterisation of the microbial population and the gene content of the samples. In addition, we used gas chromatography mass spectrometry (GC/MS) to measure the levels of flavour compounds present in the kefir.

WMS-based analysis revealed that our kefir samples were dominated by the lactic acid bacteria *Lactobacillus helveticus*, *Lactobacillus kefiranofaciens*, and *Leuconostoc mesenteroides*, and the yeast *Saccharomyces cerevisiae* (Figure 1).

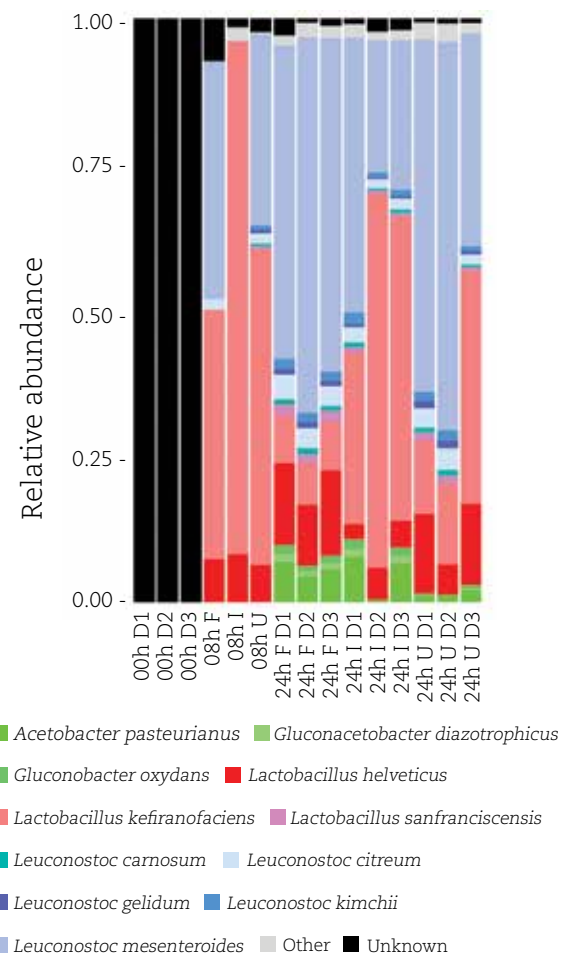


Figure 1. Stacked bar chart presenting the bacterial compositions of kefir samples after 0 hours, eight hours, and 24 hours of fermentation, as determined by whole-metagenome shotgun sequencing.

Interestingly, we observed that levels of the different types of bacteria fluctuated during the fermentation process. More specifically, we found that *L. kefiranofaciens* was the dominant bacterial species at eight hours, but its abundance decreased by 24 hours. The decrease in *L. kefiranofaciens* corresponded with a significant increase in *L. mesenteroides*. The changes in microbial population correlated with differences in the levels of different types of genes and, in turn, flavour (Figure 2). We found that *L. kefiranofaciens* correlated with ketones associated with cheesy flavours, whereas *L. mesenteroides* correlated with diones associated with buttery flavours.

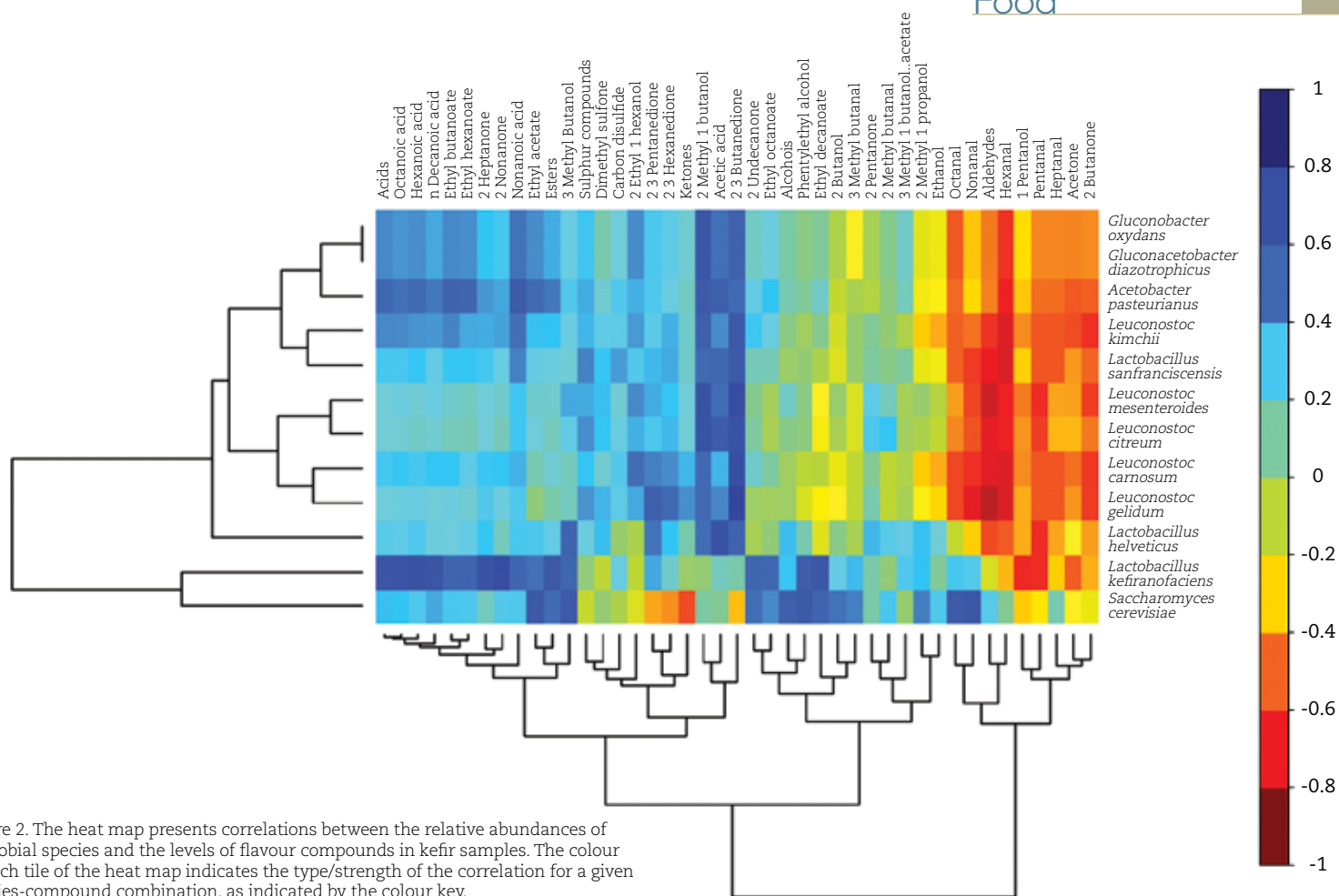


Figure 2. The heat map presents correlations between the relative abundances of microbial species and the levels of flavour compounds in kefir samples. The colour of each tile of the heat map indicates the type/strength of the correlation for a given species-compound combination, as indicated by the colour key.

Based on our results, we predict that it may be possible to tailor the flavour of kefir by manipulating the levels of the microbes present. Ultimately, the knowledge gained from this work might be applied to produce better-tasting kefir on a large scale. Additionally, the approaches we used here can be extended to other fermented foods, like cheeses, meats, sourdough breads and yoghurts, to identify new starter cultures to optimise fermentation processes.

Probiotic genes in kefir

As mentioned above, kefir has been linked to many health benefits (Bourrie et al., 2016), and there is increasing evidence to suggest that the microorganisms in kefir are responsible for at least some of these effects. Indeed, kefir is frequently referred to as a probiotic drink. Probiotics are defined as living microorganisms that exert health benefits when they are ingested at sufficiently high levels by the consumer (Walsh et al., 2017). Generally, probiotics contain a number of genes that enable them to survive gastrointestinal transit, bind the host's mucosal cells and exert health benefits. After linking kefir microorganisms with flavour, we were also curious to determine if such probiotic genes might be present in our samples.

Computational analysis of our DNA sequencing data identified potentially beneficial bile resistance genes, cell adhesion genes, and antimicrobial peptide-encoding genes in *L. kefirifaciens*. Prompted by these findings, we examined several other fermented food metagenomes and we discovered that probiotic genes are also present in several cheeses and in kimchi, a

traditional Korean food with reported health benefits. Thus, our work suggests that fermented foods are a potential reservoir of microorganisms with health-promoting properties.

Significance for the food industry

Our work highlights how a molecular-level understanding of fermented foods can guide efforts to optimise fermentation processes, like flavour formation and health-promoting properties. More specifically, it can be employed to select microbial strains to facilitate the development of the next-generation of value-added fermented foods.

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Novel strategies for salt reduction in processed meat

Researchers are investigating the applicability of ultrasound technology in the production of low-salt meat products.

Sodium chloride (NaCl) is one of the most widely used additives in the food processing sector. Currently, the daily adult sodium intake is approximately three-times the recommended daily allowance (in Ireland and the UK) and processed meat products contribute about 20% of the total sodium dietary intake.

The risk associated with a diet high in sodium has been identified as one of the top two dietary risk factors; the effect of high sodium intakes on blood pressure is known to be linked with a higher risk of cardiovascular disease, heart disease, and stroke. Concern regarding sodium intake has led to an increase in the development of methods to help reduce the quantities of salt used in manufactured food (Inguglia, *et al.*, 2017).

The dietary concern about salt consumption has encouraged food industries to consider methods for lowering salt use. Current approaches for sodium reduction in processed meat products include: the reduction of salt levels over time; the use of salt substitutes and flavour enhancers; alteration of the NaCl crystal shape; and, as described in this article, application of novel technologies such as power ultrasound.

Function of salt in processed meat

NaCl is the principal ingredient in processed meat products. Its functions in meat are multiple: it activates the extraction of proteins by enhancing hydration and water holding capacity (WHC), it increases cooking yield and viscosity of meat batters and it helps decrease fluid loss. Moreover, the traditional function of salt is as a preservative agent. A major challenge when a lower salt concentration is used is to maintain the required quality characteristics, without affecting the shelf-life and safety of the products.

Strategies for salt reduction

Current approaches to reduce the content of sodium in processed foods and meat products relies on the following strategies:

- Use of salt substitutes and salt mixtures: Common types of salt substitutes are made of mineral salt, of which the most commonly used is potassium chloride (KCl). Lower-sodium ingredient options have been successfully used in restructured items, such as sausages and deli meat, where substitution of NaCl with KCl can be tolerated up to 30%, without impacting meat taste.
- Use of taste enhancers: These are used to improve salt flavour. The most frequently used are ingredients such as yeast extracts, vegetable

Table 1. Comparison in NaCl content and quality parameters between sonicated (US) and non-sonicated (Control) pork loin samples brined for different lengths of time. Values represent means \pm SD (N=4). Different letters in the same column indicates significant difference ($P<0.05$).

	Curing time (min)	NaCl content	Moisture content	Curing yield	Cooking loss	Firmness (N)	Total colour difference
Control	210	1.80 \pm 0.76 ^a %	72.89 \pm 1.58 ^a %	0.13 \pm 1.57 ^b %	23.45 \pm 3.86 ^a %	19.39 \pm 2.66 ^a	10.49 \pm 1.59 ^a
	240	2.21 \pm 0.34 ^b %	73.02 \pm 1.17 ^a %	0.13 \pm 1.69 ^b %	23.60 \pm 5.41 ^a %	19.68 \pm 3.32 ^a	9.54 \pm 2.65 ^a
US	60	2.23 \pm 0.06 ^b %	73.52 \pm 0.57 ^a %	1.79 \pm 1.85 ^a %	14.16 \pm 1.04 ^b %	28.58 \pm 4.11 ^a	6.26 \pm 0.74 ^b
	90	3.36 \pm 0.25 ^c %	72.69 \pm 0.28 ^a %	3.07 \pm 1.54 ^c %	24.36 \pm 3.11 ^a %	20.57 \pm 2.41 ^a	11.23 \pm 1.76 ^a
	120	3.32 \pm 0.15 ^c %	71.89 \pm 1.06 ^a %	0.49 \pm 1.25 ^b %	22.21 \pm 3.29 ^a %	24.42 \pm 4.35 ^a	11.18 \pm 0.54 ^a

protein hydrolysates (HPV), monosodium glutamate (MSG) and 5'-nucleotides. MSG and yeast autolysates can be added to sausage products to mask the replacement of NaCl with KCl, allowing higher sodium substitution.

- Changes in the physical form of salt: A variety of studies have demonstrated that different salt shapes can deliver different grades of saltiness. In particular, salt particles with a size of $<20\mu\text{m}$ can deliver a higher salty taste perception. Thereafter, by increasing the perceived saltiness, less salt can be used.

Novel technologies: ultrasound to increase salt diffusion

Investigations carried out by Teagasc researchers have shown that when ultrasound is applied to meat tissue, the rate of gain of NaCl increased, compared with curing under static conditions (McDonnell, *et al.*, 2014, Ojha, *et al.*, 2016). In a recent study, quality parameters were measured on pork loin samples, cured in an ultrasonic bath (33kHz) containing a commercially representative brine solution, at a temperature of $2.5\pm 0.5^\circ\text{C}$ for different times, while irradiated from the top with an ultrasonic probe operating at 20kHz. The ultrasound-treated sample reached the required NaCl concentration (2.2%) in 60 minutes, while conventionally cured samples required 240 minutes to reach the same NaCl level. Moreover, the sonicated meat sample showed higher curing yield and lower cooking loss. No significant changes ($P<0.05$) were observed for firmness, expressed in Newton (N), and total colour difference (TCD) between conventionally cured samples and ultrasound-assisted cured samples (Table 1). Preliminary shelf-life studies were also carried out, looking at changes in total viable

counts, lactic acid bacteria and pH values during 28-day storage. These show no negative effects as a result of the ultrasound treatment. The results demonstrate that ultrasound technology can be successfully used to enhance brine diffusion rates, while maintaining the quality parameters of cured pork meat.

Conclusion

There are a number of challenges to address in order to achieve high-quality, reduced-salt meat products: product taste, physical meat parameters (i.e., texture), microbiological safety and extended shelf-life. Further applicability of ultrasound technology in the production of low-salt meat products is currently under investigation. These studies will determine the diffusion coefficient of salt in meat tissue under different conditions, in order to develop a faster method to obtain higher quality and microbiologically safe reduced salt products.

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Novel technology for dried ingredients



Novel airborne acoustic technology is being used for dried ingredient safety.

The majority of ultrasound technology employed for food processing applications, including pasteurisation of fresh fruits and vegetables and extraction of valuable compounds from various food matrices (potato peel waster, vanilla pods), are contact-type ultrasound systems. However, there are some challenges associated with the use of contact-type systems that limit their suitability for liquid food or food immersed in liquid media. Contact-type, probe-based systems are prone to pitting due to intense cavitation resulting in the erosion of the radiating surfaces and may leave residues in the sonicated food. Airborne ultrasound employs non-contact transducers that are capable of transmitting ultrasonic waves to the product using air as the coupling medium. In recent years, the design of airborne ultrasonic devices has advanced significantly and has been successfully demonstrated for various food industry applications including drying, destruction of foam and inactivation of microorganisms in the food matrix. Research carried out in Teagasc has demonstrated

the potential of airborne acoustic technology for decontamination of dried food ingredients, including milk powder, starch and spices.

Airborne acoustic technology

Airborne ultrasound systems transmit ultrasonic waves that are produced by mechanical vibrations of the propagation medium (air). The efficacy of non-contact ultrasound is limited by the weak transmission of acoustic waves through gases. Since gases have low acoustic impedance and high acoustic absorption, high ultrasonic energy loss occurs in these mediums. The main focus of investigations to date has been the design and development of the typology of airborne ultrasonic transducers to ensure efficient energy transmission. The simplest radiator configuration is the flat-plate transducer. However, the design of transducers has significantly improved recently, enabling the tailoring of the acoustic fields according to specific operational requirements. Therefore, high focused and high directive coherent fields can be achieved at a higher power and effectiveness using stepped-plate and stepped-grooved plate transducers, which can be circular, rectangular or cylindrical depending on the application, as shown in Figure 1.

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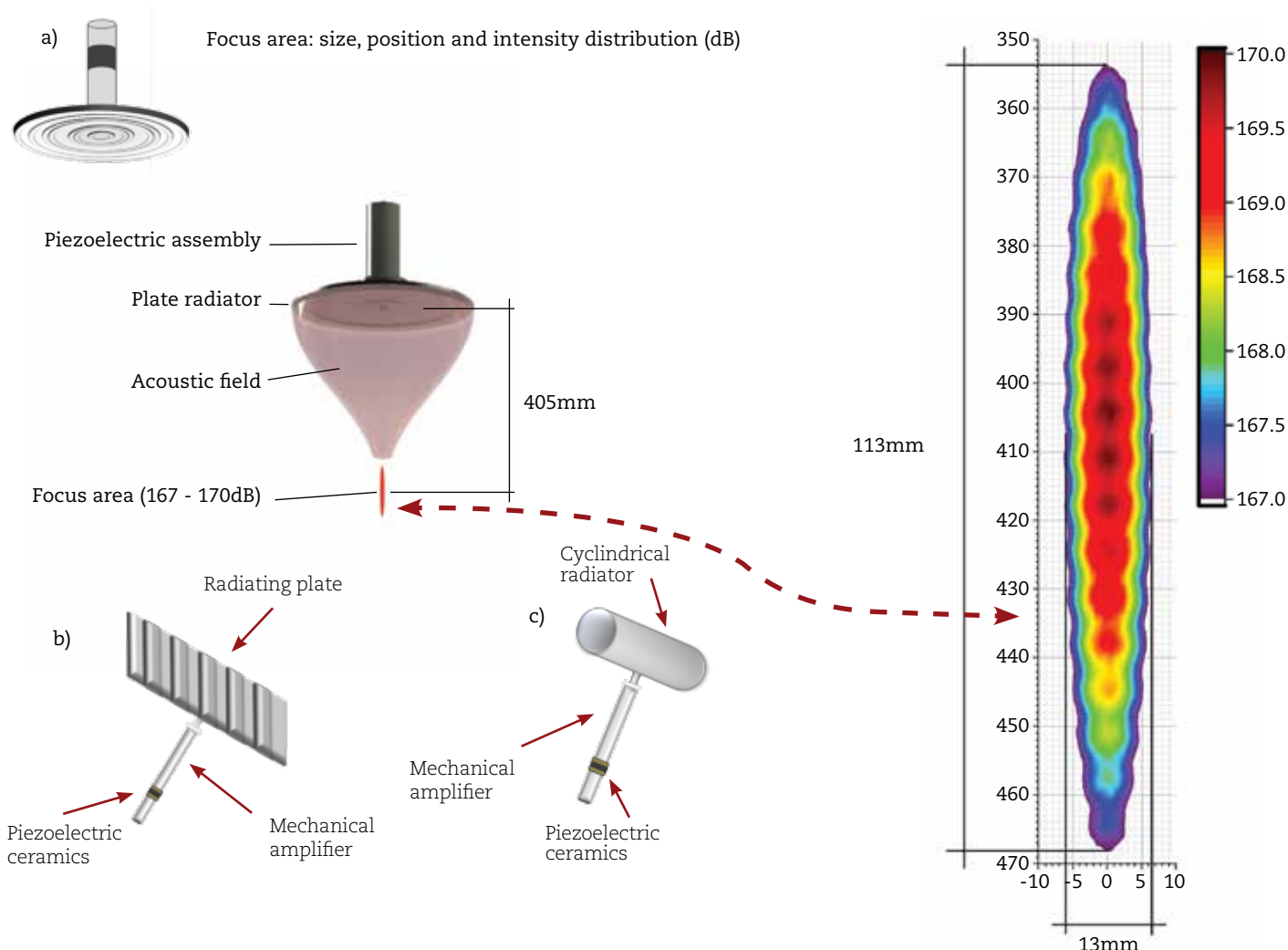


Figure 1. Airborne acoustic transducers: (a) circular stepped-plate; (b) rectangular stepped-plate; (c) cylindrical radiator.

Inactivation of microorganisms

Studies carried out by Teagasc have shown a three-log reduction of *Bacillus subtilis* cells inoculated into tapioca starch (starch extract of the cassava plant, which is used as a thickening agent in various foods) can be achieved by airborne acoustic technology as shown in Figure 2. The exact mechanism of microbial inactivation by this technology is not fully understood. Various possible mechanisms responsible for bacterial inactivation have been proposed, including standing waves, micro-mechanical shockwaves, compression and rarefaction and sonochemical reactions (generation of free radicals). Cavitation produced by contact-type transducers in liquid media is capable of generating localised high temperature and pressure due to the implosion of oscillating micro-bubbles. In the case of non-contact, ultrasonic transducers, mechanical effects are more pronounced. High ultrasonic stresses due to a rapid series of contractions and expansions along with acoustic pressure are reported to induce various morphological changes, such as the formation of pores, thinning/disruption of cell membranes and altering genetic mechanisms. While these inactivation mechanisms have been hypothesised and proposed, the definitive reason for the lethality of ultrasound, including the frequency-dependent effects on microbes in non-contact mode, is a subject of active research.

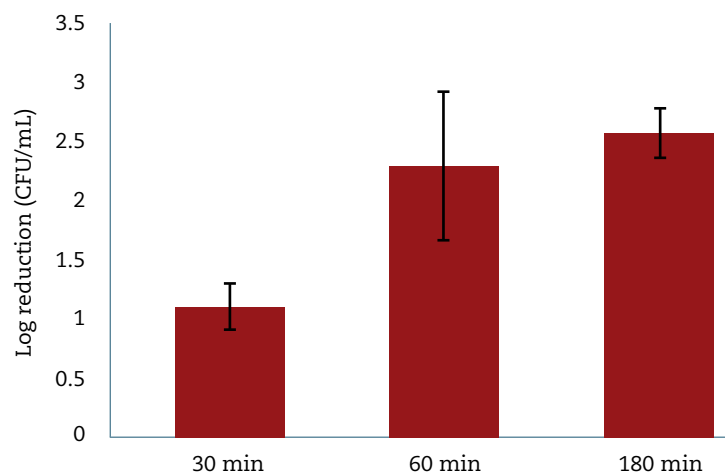


Figure 2. Inactivation of *B. subtilis* cells inoculated in tapioca starch using airborne acoustic technology at 170W.

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Eat well-age well: healthy food product development for older consumers



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The world's population is getting older with people living longer than previous generations. Life expectancy at birth in Ireland is approximately 81 years. While this is a positive message, we now face the challenge of maintaining health into old age. Consequently, healthy ageing is an increasingly important issue, with food and nutrition playing a central role.

Food, nutrition and ageing

Nutritional requirements change throughout life, from infancy into senior years and, although we see supermarket shelves packed with carefully formulated products developed to meet the nutritional requirements of infants, products developed specifically for older consumers are less common. It can be difficult for older people to meet their nutritional requirements due to reduced appetite, reduced mobility and access to food. This

puts the older person at risk of malnutrition and associated health conditions, such as sarcopenia and osteoporosis. Malnourished individuals can have frequent, long hospital stays, more GP visits and high prescription costs. This can have negative effects for our economy, with malnutrition in older individuals estimated to cost as much as €1.5 billion each year, over 10% of the total Irish healthcare budget.

Currently, there are few new foods launched to market that take into consideration the nutritional needs, eating behaviours, and physical ability of this older segment. A recent review of the Mintel Global New Products Database for foods targeted at older consumers showed that most products launched were in the Asian market with very few on the EU market. These products, such as meal replacements and white milk powders, had a medicinal focus in terms of product type, packaging and design.

Designing foods for older consumers

Considering the lack of products currently available on the Irish market, we undertook a series of focus groups with consumers aged 65 to 84 years of age, from varying socio-demographic backgrounds, with the aim of understanding food choice attitudes, motives and behaviours. Discussions took place



regarding cooking, food shopping and eating in general, with an emphasis on the way in which ageing influenced food consumption. The use of functional foods to address age-related health issues was also discussed.

Knowledge, motivations and barriers

In general, older consumers placed a lot of emphasis on food and healthy eating and had a good awareness of the link between healthy eating and healthy ageing. Sugar was a key concern, with high sugar content in foods a deterrent to purchase and many expressing concern at the amount of sugar in foods. This reflects the recent negative attention sugar has received in the media. Moreover, despite protein being an important and an essential nutrient for healthy ageing, most participants had little knowledge on the topic; the link between protein and maintaining good muscle was not well known.

Cost was an important motive in food choice due to changes in personal finances following retirement. Although, the majority were budget-conscious, the perceived worth of a food item had an impact on food choice, with many citing good quality as a reason to spend more than usual. Products that fulfilled certain needs, such as healthy yet convenient, were also seen as worth paying a premium for. In addition, products that came in single servings and prevented food waste in the long term were considered better value.

Many of the older population are living alone and this presents challenges in terms of food behaviour. Some participants felt

that food stores did not cater for those living alone and that the portion size of food items was often too large for one person. Many adapted their food purchasing behaviours by doing smaller, regular shopping for items that could be used immediately, to avoid food waste. When this was not possible, leftover meals were frozen for future consumption or friends were invited to dinner. Having guests took the loneliness out of eating alone and fulfilled the need to prevent food waste. Highly perishable foods, such as milk, were avoided to prevent waste. Participants reported difficulties with opening packaging, such as lids of vacuum-packed items, packaging with child safety locks (including tablets), and re-sealable meat packages. The changes in food behaviours, combined with avoidance of certain foods, can have negative implications for the older consumer, increasing the risk of malnutrition.

The role of functional foods in the older person's diet

The concept of functional foods and their role in providing health benefits was discussed in each focus group. Consumers expressed a certain level of scepticism towards functional foods. The functional foods most familiar and commonly used were fortified milks and cholesterol-lowering spreads. The participants that were consuming these saw them as easy substitutions for their non-functional food counterparts. However, while these participants believed that such products would not cause them harm, they were less convinced of their beneficial effects. Often these products were consumed on the recommendation of a doctor. Participants who were not consuming functional foods felt that it would be important to consult with their doctor if considering consuming foods that claimed a health benefit. Many participants felt that they were consuming a healthy, balanced diet and they did not have a need for functional foods. This shows how important it is to communicate with the older consumer how functional foods can potentially be a beneficial addition to their diet.

New food product development opportunities

Opportunities exist for the Irish food industry to produce foods that are fortified with targeted nutrients or enhanced with novel, health-promoting ingredients that are specifically designed to meet the needs of the older person. However, certain considerations must be addressed to ensure the purchase and use of these foods. Such foods must fill an existing gap for the consumer and engage with the changing food choice motivations and behaviours of older people. The message used to promote functional foods needs to be clear, simple and emphasise the benefits of these foods. Moreover, it must come from trusted sources, to ensure success. Functional food ingredients must be easily incorporated into, or substituted for, existing products. The daily obstacles faced by older people when using food products, such as packaging problems, price, portion size and waste need to be recognised by industry to prevent negative food experiences. Ease of use will ultimately result in acceptance. This strategy has already been shown to be successful in other markets.

Acknowledgements

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RED

Transferring the family farm: farmer concerns



The process of transferring the family farm has been labelled as one of many serious issues facing today's agriculture. For the transfer of a family farm to take place in a timely and efficient manner, multiple actors are required; this includes family members, accountants, solicitors and other professionals.



Young farmer entry

The average age of farmers continues to be of concern both in Ireland and most European countries. Young farmer entry into the sector is stifled by a reluctance of older farmers to exit, coupled with a low level of land mobility. Research to date indicates that young farmers tend to have a positive impact at farm level in terms of efficiency, environmental awareness and higher incidence of new technology uptake.



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Teagasc Transferring the Family Farm Clinics

Over a two-year period, in the autumn of both 2014 and 2015, Teagasc held a series of Transferring the Family Farm Clinics (TFFCs) around the country. The purpose of these seminars was to inform participants about key issues to be taken into account when planning a transfer and to outline the importance of careful planning. These events invited farmers to attend to discuss their concerns about transferring their farms to the next generation. The farmers had the opportunity to speak with a series of experts from the legal, accountancy, state pensions and family mediation fields on a one-to-one basis. The farmers in attendance at both year's events were asked to complete a survey that included questions about their farm succession and inheritance concerns. There were 690 farmer responses to the survey over the 2014/2015 period. The respondents were given the opportunity

to give feedback on what they thought of the clinic and the reasons as to why they attended. Other questions surrounding the format of the event were also included.

Main clinic survey results

In general, the feedback on the clinics that the farmers provided was positive. Of particular interest was the information farmers were looking for from attending the clinics (see Figure 1). The two most prominent reasons farmers attended were information on taxation around land transfer and how to plan for succession and inheritance.

Farm transfer taxes

The main taxes associated with land transfer are Capital Gains Tax (CGT), Capital Acquisitions Tax (CAT) and Stamp Duty. These taxes are subject to a range of reliefs, depending on the farmer's/successor's age, level of qualification and number of years farming. As land taxation can be complex farmers should consult relevant professionals for advice in a timely manner to avoid any unexpected outcomes regarding farm transfer taxation.



Fintan Phelan, Head of Farm Management and Rural Development Programme.



At The Teagasc Successions Inheritance Clinics held in The Errigal Hotel, Cootehill, Co Cavan are (from left): James McDonnell, Teagasc Farm Management Specialist; Kevin Connolly, Teagasc Farm Management Specialist; and Tom Curran, Collaborative Farming Specialist.

Succession and inheritance planning

Regarding planning for farm succession and inheritance, farmers are encouraged to engage in planning for the future of both their farm and family in as timely a manner as possible. Some of the planning options include entering a farm partnership so that both the farmer and their successor are fully aware of plans regarding succession and inheritance. A farm partnership would also allow the young farmer to enter gradually while facilitating the planned exit of the older farmer over time. In addition to this, the knowledge gained by the young farmer in agricultural education, coupled with the experience of the older farmer, should further benefit the farm. The suitability of the farm system to such arrangements is one issue that needs careful consideration. The Succession Farm Partnership Scheme (coming soon) will allow a farmer and their successor to split a €5,000 tax credit for the first five years of a farm partnership. Schemes such as this are essential to encourage farmers and their successors to engage in farm transfer. Discussions with an advisor should assist and inform farmers in making such decisions.



Conclusions

Farm succession and inheritance is an issue that transcends all farm systems and thus must be addressed appropriately in order to ensure the agricultural sector continues to thrive and progress. In the case of this article, it is evident that farmers have concerns surrounding the process. With almost 5,000 farmers attending the TFFCs over the two-year period 2014/15, it is clear that farm transfer remains high on the agenda. To this end, Teagasc plans to hold a forthcoming series of clinics during autumn 2017 in six locations in an effort to continually address farmer concerns on this pertinent issue.

Acknowledgments

The authors wish to recognise the considerable administrative, event coordination, staff training and event participation effort made by all farm management staff (specialists, advisors, regional managers and especially administrative staff) in the seminars/clinics, which has been rewarded by excellent feedback from the farming public and demand from the farming community and local legal and financial professionals for further similar events.

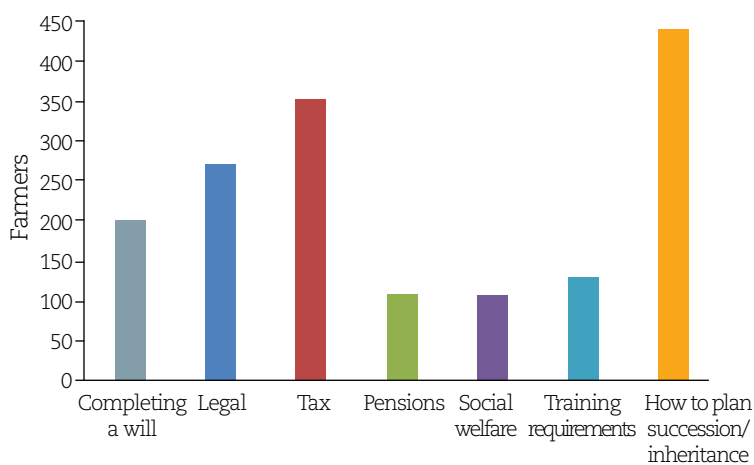


Figure 1. Farmer response to 'what information were you looking for?'



RED

Contract rearing – who are the farmers signing up?



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This article examines the participation of farmers in contract rearing arrangements in Ireland. The analysis is based on survey data on collaborative farming arrangements, never previously collected on a nationally representative basis in Ireland, thus affording us a unique opportunity to look closer at the farmers signing up to such contracts.

Current issues and policy initiatives

As a result of pressures on contemporary agriculture and in order to meet Ireland's current (Food Wise 2025) and future public policy targets, farmers must respond in increasingly innovative and cost-effective ways for their holdings to remain viable. In Ireland, the traditional structure of the family farm remains central and continues to remain the dominant model of ownership. However, this family farm structure is changing, taking on a distinct social and economic form in its own right. The family farm stays central to social and economic ownership and operation but farmers are increasingly using land-based assets via legal and financial structures that more adequately reflect the wider economic context in which they operate (Pritchard et al., 2007).

Current and future policy initiatives are targeted at driving changes to address structural deficiencies in Irish farming and to enable the industry to achieve its maximum potential.

Additional questions pertaining to collaborative farming arrangements were added to the Teagasc National Farm survey (NFS) in 2015. Survey participants were asked a range of questions on contract rearing (CR) activities, share farming and partnerships. These additional data provide us with a better understanding as to who these contract rearers are and analysis of farmers as collaborative participants will provide us with data on the current situation and the resultant impacts of supports provided to date. This and subsequent data, coupled with more in-depth research, will help to highlight ways in which institutional and agricultural policy supports may be better directed at supporting farmers in collaborative farming arrangements and so develop further the capacity and confidence of farm families to innovate through CR and other business structures.

What is contract dairy heifer rearing?

Contract dairy heifer rearing is a collaborative farming arrangement where a dairy farmer pays another farmer to rear replacement heifers on contract, away from the home farm. To be successful, the arrangement must provide benefits to both parties. The benefits to the dairy farmer may include



dairy herd expansion, as moving replacement stock off the grazing platform can allow the farmer to focus on the herd at critical times of the year. It may result in fewer stock groups to be managed. It also provides an alternative to renting expensive land to carry replacement heifers, as well as reducing labour requirements to manage the stock.

CR must also provide benefits to the heifer rearer. These may include the opportunity to increase output per hectare at a lower cost, which could deliver higher profits than a drystock enterprise where technical management is of a high standard. Furthermore, as the animals are not purchased by the rearer, there is no money tied up in the stock. Payment is normally by monthly direct debit, providing a steady cashflow. This arrangement thus avoids market price fluctuation associated with trading cattle.

CR – initial results

Additional questions pertaining to collaborative farming arrangements were added to the Teagasc National Farm survey (NFS) in 2015. Survey participants were asked a range of questions on CR activities, share farming and partnerships. The focus of this article will be on the CR-rearing segment of the sample.

The total farming population represented by the Teagasc NFS data in 2015 equates to just over 84,000 farms nationally, of which 1,276 farms represent CR participants. This equates to 1.5% of the farming population. As we are dealing with a small sample of farms for this subset it is, therefore, not possible to carry out detailed statistical analysis by farming systems and by farm sizes. However, it gives us a good indication of the current situation. Future data collected through Teagasc NFS surveys will provide us with more extensive statistics on which to base more in-depth analysis.

Farm structure of CR

Farmers in the CR group, on average, are much younger than non-CR (NCR) farmers, 44 years of age compared to 55. They also have marginally larger farms of 47 hectares. Of the 1,276 farms that indicated that they are participants in CR, the vast majority, i.e., 62%, are in the specialist dairy category, while one third are classified as cattle farmers. The remaining 7% are in the tillage category. These farms have a much higher stocking rate than average at 2.76 livestock units (LU) per hectare.

Eighty four per cent of contract rearers operate on a full-time basis, with only 16% of farm holders having a wage/salary outside of farming. The majority of these waged/salaried (75%) are the non-dairy farmers.

Contact with an advisor is an important factor for farmers in this arrangement with 69% of CR farmers indicating they have advisory contact, while one quarter of CR farms complete a Teagasc eProfit Monitor.

Specialist dairy contract rearers

Five per cent of specialist dairy farmers indicated that they are participating in CR of dairy heifers. One third of this group are located in the south, a further one third are in the south-east region while one fifth are located in the east. Non-dairy specialist CR farms are mainly located in the border and midlands regions.

How do NCR farms compare?

NCR farms represent 80,556 forms nationally (96% of farms), excluding farms on which no response was obtained. Of these, 18% are defined as specialist dairy farms with 70% being drystock farms. The average age of NCR farming participants is 54 years. Sixty per cent of these farmers indicated that they have advisory contact while 18% complete an eProfit Monitor. One third of NCR farm holders indicated that they have an off-farm wage/salary. As would be expected, farmers in the NCR specialist dairy subset have a lower stocking rate at 1.98LU per hectare when compared with those who are participating in CR.

Acknowledgements

We gratefully acknowledge Teagasc National Farm Survey staff for their cooperation and assistance in collecting collaborative farming data, in addition to other farm data, allowing us to carry out analysis for this article and forthcoming research.

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A Written Agreement: Like all collaborative arrangements, a written CR agreement is an essential record of all the details agreed between the heifer rearer and the dairy farmer. Template agreements to facilitate the formation of contract rearing arrangements are available from Teagasc at <https://www.teagasc.ie/rural-economy/farm-management/collaborative-farming/contract-rearing-of-heifers/>



Social media: can it connect science and society?



Social media is society's favourite platform for sharing, seeking and consuming information, so what opportunity is there for the scientific community in this environment?

have been heard and responded to quickly and directly. Had there been more open, interactive and public platforms mediated by scientists during this time, could we have avoided the 'crisis of trust' in science, governance, and the agri-food sectors that followed?

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When the BSE-CJD crisis unravelled in the early 1990s, social media was a term not yet invented. Mark Zuckerberg was still more than a decade away from founding Facebook, and a tweet was still associated with the birds. But, what might have unfolded had social media existed back then? The damage to the farming and food sectors was devastating, but would unverified 'facts' spread through Facebook and Twitter and emotive viral videos on YouTube have further amplified the situation? Or, perhaps, social media could have provided a platform for the scientific community to have a strong and reassuring public presence in the midst of communicative chaos. Perhaps it could have instilled the sense of transparency that was so desperately lacking at the time – where public questions and commentary could

Making science accessible

Crises such as BSE-CJD and the public rejection of genetically modified organisms (GMOs) catalysed a new era of science governance, which promoted principles of transparency and public engagement. The most recent governance approach to draw on these principles, Responsible Research and Innovation (RRI), attempts to reconcile our current need for techno-scientific progress with the moral, social and ethical expectations and requirements of society as a whole (PROSO, 2016). RRI is now a cornerstone of research policy at EU level and features heavily in Horizon 2020 funding proposals and evaluations. A multi-faceted concept, at its core RRI encourages the engagement and inclusion of societal actors in research and innovation. Simply put, we need to make science more accessible.

Science needs to be communicated in a language and place that is familiar to broader society. Can high-

speed fibre broadband and smartphones provide the solution? Built on principles of inclusivity, openness and user-led interaction, social media platforms are argued to embody many of the key elements of RRI, including empowering all actors in society to get involved in discussions around science. With platforms offering different functionalities, scientists can be creative in how they use social media, such as: producing YouTube videos; engaging in conversation on Twitter or Facebook; posting inspiring images on Instagram; or utilising crowdfunding websites to fund society-supported research.

Are scientists interested in engaging society?

Rather than being a single entity, 'society' is made up of a diverse group of actors. In our recent qualitative study of 80 publicly-funded researchers, working in the area of food in Ireland and the UK, we found respondents were most interested in engaging with actors that have a professional interest in science (See Table 1).

Table 1. Perceived importance of engaging with different sections of society about science – the views of 80 publicly-funded researchers working in the area of food in Ireland and the UK.

Importance of engaging with societal actors about your science	Very important
Researchers within your academic discipline	79%
Funding bodies	73%
Policy-makers	50%
Industry	49%
All citizens/general public	39%
Regulatory agencies	31%
Researchers in other academic disciplines	30%
Non-governmental organisations	28%
Consumer organisations	25%
News media (journalists)	19%
Politicians	18%

This trend also applied to social media. Our sample was mostly interested in engaging online with other academics, industry, media, and policy-makers. Only a small number of respondents actively used social media to engage with the general public. The preference to engage with individuals already operating in the same circles as them is perhaps not surprising. These interactions were of personal benefit, keeping up-to-date with their field of research, maintaining geographically-dispersed academic connections, and providing fulfilment from discussing mutual academic interests with peers.

Scientists, like all humans, only put time and effort into an activity if they are adequately rewarded. The majority of the respondents saw little personal reward in engaging with broader sections of society. If anything, there was concern about negative interactions with members of the public and misinterpretation of their work by those who might not understand it.

Social media engagement is not as highly regarded as traditional academic metrics when it comes to hiring, tenure or promotion, so it's little wonder that researchers fail to find time for it. With the setting up of an 'Expert Group on Altmetrics' by the European Commission's Directorate General for Research and Innovation, efforts are ramping up to understand the role of additional metrics in science. Altmetrics are web-based metrics that aggregate the online metrics of a peer-reviewed paper's impact, including, for example, the number of views, clicks, saves, comments, or downloads it gets, along with its shares or mentions in social media platforms (Woolston, 2014). They are quite some way from being recognised as a formal metric, but they could be the incentive required to motivate researcher engagement with social media.

Where to next?

While 'fake news' may be the en vogue phrase of 2017, it's not a new concept in science. Unreliable reporting of science has always been an issue – particularly where food is concerned. However, with social media, there are increased opportunities for spreading misinformation to a global network in a much faster period of time. During the deadly 2011 German *E.coli* outbreak, the inaccurate message that Spanish cucumbers were to blame spread like wildfire on Twitter, escalating the social and economic losses suffered by Spanish farmers (Gaspar *et al.*, 2014). With social media remaining a powerful communications platform, the narrative of future science-related stories will increasingly be written by many different actors in society and these narratives will influence public sentiment. In the spirit of RRI, it's a welcome development that all of society is empowered to take part in conversations around science. At the same time, we need to ensure that these conversations are not just taking place within circles of like-minded individuals, leading to polarised views. In the true spirit of RRI, engagement needs to occur between different sections of society so that research and innovation can best accommodate the needs of all of society. If we expect the scientific community to lead the way, it would appear from our exploratory study that we need to ensure that they are properly incentivised and supported to do so.

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Events

2017 MARCH

March 14

Teagasc, Ashtown, Dublin 15

How Safe is Your Crop? Seminar for the Horticultural Sector

There is increasing importance attached to the area of microbiological contamination of fresh fruit and vegetables. A major source of contamination can be the water used on farms. This seminar will feature new Food Safety Authority of Ireland guidelines on fresh produce safety and offer advice on: producing safe food, taking water samples, boring for water and wells, as well as discussing water quality of our rivers and so on. There will be a panel of renowned national and international experts.

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www.teagasc.ie/news--events/

March 20

Teagasc, Ashtown, Dublin 15

BioEire results launch

BioEire was launched in April 2015, funded by the Department of Agriculture, Food and the Marine, to provide part of the knowledge base necessary to develop a national bioeconomy strategy for Ireland. The project was led by Teagasc, with partners across UCD, DIT and Technology Centre for Biorefining & Bioenergy RESOURCE. This workshop will present the results of the project, taking stock of the current status of the Irish bioeconomy and, importantly, highlight the next steps for its development.

Contact: maeve.henchion@teagasc.ie

Registration: <https://www.eventbrite.ie>

March 22

Dunboyne Castle, Co Meath

Septoria Conference

This conference will update the industry on the latest position on septoria-fungicide resistance and outline effective and sustainable disease control programmes with international experts. Attendees must register online.

Contact: eleanor.butler@teagasc.ie

www.teagasc.ie/news--events/

March 28

Animal Bioscience Research Centre,
Teagasc Grange, Dunsany, Co Meath

Assessing the Viability of On-farm Co-digestion Systems

Experts, from the Irish farming, energy, biomass and waste industry and Irish research institutes, will present on the potential and challenges facing the development of on-farm biogas plants in Ireland, particularly co-digestion of manure and food waste on pig farms. Additionally, researchers within the Green Farm project will present their research results and its potential impact for industry. Attendance is with prior registration only. The event is now fully booked.

Contact: peadar.lawlor@teagasc.ie

Registration: <https://www.eventbrite.ie>

APRIL

April 6

Tullamore Court Hotel, Co Offaly

Teagasc Agri Environment Conference

This conference will address sustainability, GLAS, river-basin management, MCPA and other pesticides. In the sustainability session greenhouse gas emissions, biodiversity, the use of urea fertilizer and the sustainability project in Carbery will be covered. The GLAS session will look at the management of uplands, hedge laying, commonage, wild bird covers and nutrient management planning.

Contact: pat.murphy@teagasc.ie

www.teagasc.ie/news--events/

April 10-12

University College Cork

Advances in Nutritional Dairy Products and Ingredients

Organised by the Society of Dairy Technology, the technical programme includes sessions on: markets and regulatory issues; technology; products and processes; nutrition requirements of population sectors; nutritional ingredients; and an open forum discussion. There will also be a poster exhibition and student competition. Teagasc's Mark Fenelon contributes to the organising committee and Teagasc will sponsor a session.

Contact: mfhickey@oceanfree.ie; execdirector@sdt.org <http://www.sdt.org/>

April 24-26

RDS, Dublin

Agricultural Economics Society's 91st Annual Conference

The Agricultural Economics Society (UK) will visit Ireland to hold its annual conference. Teagasc successfully bid to host this event (second time since its founding in 1926) and secured a range of high-profile speakers, including EU Commissioner for Agriculture and Rural Development, Phil Hogan. The keynote session will discuss agricultural policy in Europe. Two plenary workshops will be devoted to the Brexit debate, while other workshops will address vine economics, agri-environmental schemes and rural development. A mini master class will be held on choice modelling methodologies. Deadline for full paper submission and early bird registration is March 27.

Contact: vera.eory@sruc.ac.uk

<http://aes.ac.uk/>

April 27

Teagasc Ashtown Research Centre, Dublin 15

Horticulture Technology Conference

This one-day, grower-focused event will update the growers on advances in horticultural technologies, such as lighting, protected structures and crop protection.

Contact: michael.gaffney@teagasc.ie

www.teagasc.ie/news--events/

MAY

May 29/31

Cavan/Moorepark

Pig Research Dissemination Days

These two events will feature the broad array of research projects currently ongoing in Teagasc's Pig Development Department. The events will provide attendees with the most up-to-date research results and the opportunity to meet with researchers and postgraduate students.

Contact: ciaran.carroll@teagasc.ie

JUNE

June 28

Teagasc Crops, Environment & Land Use Research Centre, Carlow

Crops and Cultivations - Oak Park Open Day

An opportunity to view and discuss the crop research experiments at Oak Park, as well as machinery stands and live cultivation demonstrations.

Contact: eleanor.butler@teagasc.ie

AUGUST

August 13-18

Rochestown Park Hotel, Cork

ICoMST - 63rd International Congress of Meat Science and Technology

The theme of the Congress is 'nurturing locally, growing globally'. Exploring how science can offer the meat production and processing sector solutions to enable it to nurture sustainably at local level while offering opportunities to grow globally. This will be discussed through several session themes such as the science of meat sustainability, genomics, animal welfare, meat safety, emerging technologies in meat processing, consumer marketing and perspectives, meat biochemistry, advancements in meat packaging and ends with a discussion on the role of meat in the diet.

Contact: Icomst2017@teagasc.ie

<http://icomst2017.com/>

SEPTEMBER

September 4-6

Clayton Whites Hotel, Wexford, Ireland

17th International RAMIRAN Conference

RAMIRAN 'Recycling of Agricultural, Municipal and Industrial Residues in Agriculture Network' is a research and expertise network dealing with environmental issues relating to the use of livestock manure and other organic residues in agriculture. This conference is the primary output of the network, which is held every two years and attracts up to 250 delegates from across Europe and further afield. RAMIRAN 2017 will be organised by Teagasc. The overall theme is 'Sustainable utilisation of manures and residue resources in agriculture', which will be examined under the following sub-themes: advances in technologies; crop nutrition; gaseous emissions; soil and water quality; and, adoption and impact.

Contact: ramiran2017@abbey.ie

<http://www.ramiran2017.com/>

For a full list of Teagasc food industry training events see: <https://www.teagasc.ie/food/food-industry-development/>
For presentations from previous Teagasc events see: <https://www.teagasc.ie/publications/>