Agriculture and Food Development Authority

TEAGASC

RESEARCH IMPACT HIGHLIGHTS IN 2023

Foreword

Teagasc's vision is to be a globally recognised leader in developing innovative, science-based solutions for the sustainable transformation of Ireland's land resources into products and services that benefit society. Each year, our research, advisory and educational activities contribute towards the achievement of our vision and make a tangible impact on farmers, policy and industry.

This publication contains 20 examples of our research impact from 2023, highlighting just some of the groundbreaking work from our four research programmes: Animal and Grassland Research and Innovation; Crops, Environment and Land Use; Food; and Rural Economy and Development.

To assess the impact of our research activities, we have developed a framework to guide the evaluation of our research. This framework provides a structure to describe how Teagasc's activities contribute to impact in the agri-food sector through three interconnected impact pathways: technology development and adoption; capacity building; and policy influencing. The impact pathway for 2023 'Refining emissions from peat soils' has influenced policy by reducing emissions from approximately 9Mt to 3.9Mt in the EPA National Inventory Report 2024. 'Sustainable Potato Cyst Nematode control through targeted breeding' has increased capacity building by using Marker Assisted Selection in potato breeding to develop sustainable systems with reduced pesticide use. 'Evaluation of the effectiveness of minimum chlorate technologies' has increased technology development and adoption with chlorine-free detergents in the dairy industry. Many of the other research impacts will have similar impact pathways, which can be seen in this publication.

"Each year, our research, advisory and educational activities contribute towards the achievement of our vision and make a tangible impact on farmers, policy and industry."

The power of collaboration

Teagasc is extremely fortunate to have an outstanding core of scientists, supported by top-class technical, farm, advisory, specialist and administration staff whose work contributes to our collective research output. Additionally, I would like to acknowledge our collaborators in universities and other external bodies, including the farming community and agri-food companies, who are directly involved in many of our research projects.

I would also like to highlight our Walsh Scholars and post-doctoral fellows, whose contribution to our ongoing research activities is invaluable. Our research is funded through a variety of sources, including core grant-in-aid allocated via the Department of Agriculture, Food and the Marine and competitive funding awarded nationally. Other important sources include competitive funding awarded from Science Foundation Ireland, Enterprise Ireland, the Environmental Protection Agency, the Irish Research Council, Horizon 2020 and Horizon Europe. Funding is also derived from farmer levy contributions and industry-funded research, as well as earnings from services offered and farming activities.

A key priority

Combined, these significant investments enable Teagasc to continue to support science-based advancements in the agri-food and bio-economy sectors that underpin profitability, competitiveness and sustainability. Ensuring our research delivers real impact for our stakeholders is a key priority for Teagasc.

Finally, I want to acknowledge the dedication of my colleagues in Teagasc who were involved with, or supported, the research activities contained within this publication. I also want to commend the role of our extensive research teams across the organisation, whose work has also made a substantial impact but was not included in our 2023 publication. Thanks to the combined effort of all Teagasc staff, I am confident that we can continue to safeguard our role as the leading organisation in the field of agricultural, environmental and agri-food research in Ireland.

Pat Dillon,
Director of Research, Teagasc

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Teagasc framework for evaluating impact

This framework, included in Teagasc's Statement of Strategy, proposes three interlinked pathways through which Teagasc research impacts the agri-food sector.

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AGRIP

Refining emissions from grassland peat soils

Patrick Tuohy, Owen Fenton,
Lilian O'Sullivan, Conor Bracken

Greenhouse gas emissions from grassland peat soils were previously estimated at approximately 9Mt CO_2e per annum, making this the highest-emitting category from the land use, land-use change and forestry sector (LULUCF). This estimate was based on assumptions regarding the drainage status of these soils. Teagasc research highlighted the nature of these assumptions and proposed refined emissions estimates, which have been incorporated into the updated EPA National Inventory Report (March 2024). These estimates have significantly altered the wider understanding of the emission profile and the management of these soils, currently and into the future.

5.1Mt

These findings have reduced estimated emissions by 5.1Mt

The study offered new insights into the drainage status of grassland peat soils. It showed that the extent of peatland drained for agriculture had been thus far overestimated in national inventory reporting. Evidence for these emission savings were garnered by compiling decades of evidence related to the drainage status of peat soils and data from national scientific literature. This evidence enabled a more accurate figure for grassland peat drainage status to be used in the national inventory.

These findings have directly and significantly reduced the estimated emissions from grassland peat soils (and the LULUCF sector more broadly) by 5.1Mt CO_2e per annum (from 9Mt to 3.9Mt, equating to approximately 7.5% of the total national emissions from all sectors as previously estimated). This change will inform and have a considerable influence on future policy around such soils regarding their management, and their rewetting and restoration potential.

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Impact pathway: Policy Influencing.

Teagasc / MACC – stock

CELUP

The Teagasc MACC: a pathway to emissions reduction

Gary Lanigan, Kevin Hanrahan, Karl Richards

Agriculture must reduce greenhouse gas (GHG) emissions by 25% by 2030. In addition, the EU has set a land use, land-use change and forestry (LULUCF) GHG reduction target for Ireland of 0.73Mt CO_2e by 2030. The Teagasc Marginal Abatement Cost Curve (MACC) was developed to identify the most cost-effective pathways to reduce agriculture and LULUCF GHG emissions, and to quantify the contribution that bioenergy could make to decarbonising the energy system.

Three scenarios of agricultural development over the 2021-2030 period were examined using the FAPRI-Ireland economic model. Two adoption levels of each mitigation measure were analysed, and MACCs were generated for agriculture, LULUCF and bioenergy. The analysis showed that the 25% reduction target is achievable, but only with high levels of adoption and relatively stable livestock numbers. EU LULUCF reduction targets could also be achieved with the higher levels of adoption.

Principal agriculture mitigation measures included: reduced finishing age; reducing N fertiliser; feed additives; increased dairy Economic Breeding Index; and diversification into organic farming, forestry or feedstock provision for biomethane.

The main measures for LULUCF were the management, respectively, of current forests, water tables on peat soils, and grasslands. Afforestation, particularly, is crucial for achieving net-zero by 2050. The majority of fossil fuel displacement is projected to be due to the use of wood biomass and the achievement of the Government's target of replacing 10% of gas demand with biomethane by 2030. If achieved, bioenergy would contribute about 10% to decarbonisation of the energy system.

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Impact pathway: Technology Development & Adoption.

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REDP

Mitigating agricultural impacts on water quality

Mary Ryan, Paula Cullen, Noel Meehan, Lori-Rae van Laren, Pat Murphy

Research on agriculture's impacts on water quality is increasingly needed to inform farm mitigation measures. Working with the Agricultural Sustainability Support Advisory Programme (ASSAP), the WaterMARKE project is using data analysis to identify behavioural drivers that impact farmers' uptake of measures. The findings are currently being implemented within ASSAP and in the design of the Teagasc Water Quality Campaign.

The research shows that measure uptake tends to be higher in cases where farmers find that measures are viewed positively by respected sources – e.g. other farmers, family, farm advisors and farming media. Farmers feeling that they have adequate knowledge and capacity to implement measures also increases uptake.

Using this research, greatest behavioural impact can be achieved through advisor-led, group-based interventions that provide technical knowledge on water quality issues and mitigation, together with local, respected farmers who have successfully implemented measures. WaterMARKE also identified easy wins, allowing for the focus of efforts where uptake is greater, i.e. on larger farms, participants in agri-environment schemes, and locations with high awareness and implementation of measures.

However, the research also found that the cost of implementing measures is a barrier to uptake. This information provided important research evidence to justify the need for the Water European Innovation Partnership (EIP). From a wider policy perspective, this research has highlighted a need to focus on behavioural drivers of measure uptake. In tandem with the technical elements of knowledge transfer initiatives, this can help achieve wider uptake of water quality mitigation measures.

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Impact pathways: Capacity Building; Policy Influencing.

FOOD

Supporting Oatier Ltd.'s first product launch

Miriam Walsh, Shivani Pathania, Ciara McDonagh

Kildare-based Oatier Ltd. has a mission to create an oat drink that is tastier and creamier than its competitors. Their challenge has been to find a research partner with knowledge and insights that can be applied in developing and optimising its formulation, while also solving its manufacturing challenges.

Oatier engaged with Teagasc for specialist expertise in the formulation, process development, scaling and validation of bespoke, market-leading oat drinks, focusing on the hospitality and food retail sectors. This included research into reformulation and troubleshooting optimisation of the manufacturing process to facilitate outsourcing of manufacturing capabilities.

Key deliverables achieved included a superior product formulation, supported by sensory and related studies, and a solution to Oatier scale-up challenges through validation of contract manufacturing capabilities. This was all undertaken at Teagasc Ashtown Food Research Centre, through staff within the Food Industry Development Department and including access to the National Prepared Consumer Food Centre.

Through brand development within the hospitality and food service sector, and a targeted sales focus, a client base of over 100 cafes was established in 2023. This represents significant impact for a start-up company, as confirmed by its Managing Director. "Working with Teagasc has been key to our success in developing superior oat drinks. Such research in the early days of product development and overcoming scaling challenges has created a platform for growth for our brand, and a product with the potential to scale and go global."

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Impact pathway: Technology Development & Adoption.

FOOD

Protein variants influence milk functionality

Noel McCarthy, Davor Daniloski, Sinead McParland, André Brodkorb

Bovine milk contains two major groups of milk proteins: casein and whey protein. Further, there is broad diversity in the composition of these proteins, linked to the genetics of the cow.

One protein in particular, β-casein, has garnered widespread discussion relative to two of its genetic forms, β-casein A1 and A2. The A2 milk story began in 2000 in New Zealand, based on a study indicating that its consumption may ameliorate stomach discomfort in certain cohorts. This has created a drive in some markets towards the promotion of A2 milk over A1.

As the proportion of A2 milk increases in our national herd, research at Teagasc Moorepark has investigated the potential effects β-casein A1 or A2 polymorphic structures have on the production of dairy products during processing, consumption and digestion. In general, A2-variant milk creates weaker gels with implications for yogurt and cheese production. This is an important consideration, with cheese exports valued around €1.3 billion in 2023 and milk powders and yogurts at around €850 million. However, there was no obvious effect on milk powder production or powder particle properties.

Subsequent evaluation of gastric digestion of milk and yogurts has shown significant differences between A1 and A2 milk, with slower digestion and softer gastric curd formation noted during simulated in-vitro digestion of A2 milk, which may have potential benefits for infant nutrition products.

The results of the project have been discussed with several Irish milk processors, and the dairy industry should be aware of the implications of transitioning the dairy herd towards an A2-dominant genotype.

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Impact pathway: Technology Development & Adoption.

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AGRIP

New high-yielding white clover varieties

Patrick Conaghan

The use of white clover on Irish farms has more than tripled over the last three years. Farmers are increasingly using white clover to reduce costs and reliance on chemical nitrogen (N) fertiliser and increase animal output. Hence a need for new, high-yielding and persistent varieties of white clover.

The latest generation of Teagasc white clover varieties was developed from 286 crosses. From these, 25,200 plants were evaluated in 1,260 plots at Oak Park over three years under cutting and sheep grazing. The new varieties have been submitted to the official Recommended List trials in Ireland, England/Wales and Scotland for independent evaluation. Two new large leaf size varieties, named Clodagh and Dungloe, have to date completed the official trials.

Clodagh and Dungloe are the highest-yielding white clover varieties on the Recommended Lists. In Ireland, this equates to over 1t DM/ha more clover than the average Recommended List variety. Large leaf varieties tend to have fewer and shorter stolons than small leaf varieties, resulting in lower ground cover and persistency. Through judicious selection under sheep grazing, Clodagh and Dungloe have been bred to suppress this trend. In the England/Wales Recommended List trials, Clodagh and Dungloe had the highest ground cover of all varieties under cutting or rotational cattle grazing.

1t DM/ha

Clodagh and Dungloe produce over 1t DM/ha more clover than the average variety

Clodagh and Dungloe are among the most productive white clover varieties for farmers in Ireland and UK. The two varieties will be released in spring 2025 by Goldcrop, an Irish seeds and inputs company, that has worldwide propagation and marketing rights on all new varieties. Teagasc and Goldcrop entered into a new long-term forage breeding partnership in 2023, titled 'Pasture Innovations'.

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Impact pathway: Technology Development & Adoption.

Karl McDonough

CELUP

Sustainable Potato Cyst Nematode control through targeted breeding

Dan Milbourne, Denis Griffin

Teagasc

Across Europe, over 50% of potato land area is infested with the Potato Cyst Nematode (PCN) species *Globodera rostochiensis and Globodera pallida*, which dramatically reduce yield and prevent use of the produce for seed. PCN control has become even more difficult since many nematicide products have been withdrawn from the market, creating great demand for resistant varieties.

The Teagasc/IPM Potato Group breeding programme, a collaboration spanning over 60 years, has responded to this demand by developing the variety 'Buster', using an approach called Marker Assisted Selection (MAS), which enables the efficient selection for genes conferring resistance to PCN over multiple rapid cycles of breeding. While a single resistance gene confers resistance to *G. rostochiensis*, multiple partially effective genes are required to control *G. pallida*.

Buster represents a significant technological achievement; the breeding team used MAS to stack six individual resistance genes in the variety, conferring almost complete resistance to both PCN species.

Since its release in 2019, Buster has undergone multiple, independent trials of its resistance efficacy. These trials show that Buster exhibits the most stable and effective resistance of any variety available by reducing the presence of PCN in the soil to near undetectable levels.

While Buster's resistance is exceptional, it also delivers excellent yield with low nitrogen input and great flavour. Although in the early stages of commercialisation, Buster is in extremely strong demand from IPM Potato group customers. Varieties such as Buster represent the next step in sustainable agriculture and reduced pesticide and fertiliser use.

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Impact pathways: Capacity Building; Technology Development & Adoption.

REDP

Advisors supporting the wellbeing and mental health of farmers

David Meredith, John G. McNamara, Francis Bligh, Conor Hamersley

Igor Alecsander /Istockphoto.com

Farmers face many occupational stressors that can have a negative impact on their mental health or wellbeing. This can undermine their and their family's quality of life.

Teagasc, the Department of Agriculture, Food and the Marine (DAFM), the Department of Health, the Health Service Executive and South East Technological University came together to undertake research on this issue. This resulted in the development and implementation of a training programme to equip advisors with the knowledge to engage with farmers on their health and wellbeing. The research highlighted a range of occupational challenges to farmer mental health or wellbeing, including the pace of change in farming, increasing job demands and growing uncertainty.

Over 200 advisors participated in the 'On Feírm Ground' training programme. A quantitative evaluation of the programme established that it improved participants' self-reported levels of knowledge, capacity, and willingness to support farmer mental health. Additional qualitative findings following up on programme participants revealed how the training was being put into use by advisors in their interactions with farmers. The success of the training programme resulted in DAFM providing additional funding for the rollout of the programme to other stakeholders interacting with farmers, such as veterinary surgeons and co-operative employees.

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Impact pathway: Capacity Building.

CELUP

Communicating new integrated forest management systems

Jonathan Spazzi, Ian Short

New integrated forest management systems seek to combine the profitable production of quality timber with the enhancement and protection of biodiversity and ecosystem services. To date, lack of knowledge and expertise of management options has been one of the main hurdles to enabling such systems.

Teagasc collaborated with Irish stakeholders and European forest agencies in an Erasmus+ project to develop 'ForestMoocForChange' – the first free Massive Open Online Course on the management of continuous cover forestry (CCF). This interactive educational tool aims to facilitate transformation of forests towards integrated management systems, promoting production of quality wood, biodiversity and ecosystem services. The eight-week course is in three languages, self-paced and includes 74 tutorial videos, online quizzes and exercises to carry out in the forest.

During the project, each fortnight a live session allowed participants to ask questions regarding topics covered. On successful completion of quizzes and exercises, participants received a certificate and approved a 'Charter of Commitment', to use and further develop their knowledge and understanding of CCF. Over 12,000 learners took the first training course in 2023/2024, with over 2,500 certificates achieved and over 1,000 participants in the English version, co-ordinated by Teagasc.

2,500
Over 2,500 certificates were achieved in 2023/2024

By demonstrating how forest transformation practices and management tools can be applied, the course provides innovative ways to enhance forest owners' and managers' capacity to adopt integrated management systems in their forests and thereby initiate long-term societal change. The course also supports Department of Agriculture, Food and the Marine and European Union forest policies, which increasingly promote integrated management to enhance resilience, sustain production and deliver ecosystem services to society.

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Funding: Erasmus+.
Impact pathways: Technology Development & Adoption; Capacity Building.

FOOD

Applied microbiome mapping for the food industry

Paul Cotter, Raul Cabrera Rubio, Mairéad Coakley, Liam H. Walsh, Samuel Breselge

Microbial communities (microbiomes) within food-processing industries have a significant impact on food quality and safety. DNA sequencing offers improved detection and characterisation of food and food processing-related microbiomes, but kits for extracting high-quality DNA from these sample types have so far been commercially unavailable.

This issue was rectified through the MASTER project. Microbiome mapping in food industries can be challenging, as samples may contain a low number of microbes (thus low DNA concentrations) and may have residues of cleaning agents or organic materials (that impact downstream analysis).

Funded by the EU's Horizon 2020, MASTER sought to take a global approach to developing microbiome products and processes with high commercial potential, benefitting society by improving food safety, quality and quantity. MASTER developed a complete protocol for all steps involved in microbiome mapping during food processing. This protocol was validated on more than 2,000 samples (environmental, raw material, end product, operators, etc.) from five industry types (dairy, meat, fish, vegetables) from 114 food processing industries in five countries.

As well as an article in the journal *Nature Protocols*, and the production of an easy-to-follow video, this work has directly led to the development of a new DNA extraction kit by MASTER partner QIAGEN, dedicated to the specialised needs of these food industry samples. The developed protocols and tools for microbiome mapping of foods and food processing environments will significantly impact food processors, food industry operators, and analytical laboratories, improving and accelerating microbial detection. This will in turn improve food quality and safety and reduce withholding periods and food waste.

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Funding: European Union Horizon 2020.
Impact pathways: Technology Development & Adoption; Capacity Building.

Teagasc / microbiome – Andrew Downes

AGRIP

Evaluating the effectiveness of minimum chlorate technologies

David Gleeson, Lorna Twomey, Bernadette O' Brien, Tom Beresford

Chlorate is a harmful chlorine-based residue in milk and its derivatives. Chlorates have emerged as a pressing issue, particularly for vulnerable groups such as infants, threatening consumer confidence and industry reputation.

As a means of minimising chlorate, Irish farmers and milk processors have replaced chlorinated cleaning chemicals with chlorine-free alternatives. Moreover, chlorine gas water treatment has been adopted by milk processors to minimise chlorate residue in water. This project set out to evaluate the effectiveness of these 'minimum chlorate technologies' in terms of dairy product quality and safety.

Samples of medium heat skim milk powder (SMP) were taken across the manufacturing process at three individual milk processing sites, owned by three respective co-operatives across the months of April, May and June. The three sites, each located in different geographical locations within Ireland, were all using chlorine-free chemicals for Clean-In-Place processes and chlorine gas for water treatment. Single batches of SMP (11 batches in total) were sampled from beginning (whole milk silo) through to the final SMP product. Samples were taken for microbiological and residue analysis at each point of the manufacturing chain.

This study demonstrated that where 'minimum chlorate technologies' were employed, the SMP produced complied with international microbiological standards. Coupled with this, there was a low incidence of chlorate residue across the manufacturing chain. This outcome is not only beneficial for Irish dairy processors who have adopted 'minimum chlorate technologies' to remain competitive in lucrative international markets, but also for dairy processors internationally that wish to minimise chlorate residue without compromising microbiological quality.

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Funding: Dairy Research Ireland; Department of Agriculture, Food and the Marine; Teagasc Walsh Scholarship.
Impact pathways: Technology Development & Adoption; Capacity Building; Policy Influencing.

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CELUP

Conversations for Change

Laura Gribben, Áine Regan, Edgar Garcia Manzanilla

Conversations for Change is a communication skills training programme developed for animal health professionals and Teagasc farm advisors. It aims to support shared understanding, collaboration and decision-making between farmer-facing professionals and farming clients.

The skills training in evidence-based communication techniques helps farmer-facing professionals work through challenging topics with farming clients and have effective conversations about change.

Conversations for Change training is supported by, and based on, behaviour change theory, psychological practice, the Motivation, Action and Prompts (MAP) Model of Behaviour Change and the principles of motivational interviewing. The behaviour change intervention, which forms the scientific basis for the Conversations for Change initiative, was developed out of an interdisciplinary collaboration between psychologists, animal health professionals and veterinary scientists in the *safe*food-funded antimicrobial resistance project.

In 2022 and 2023, Conversations for Change was piloted in the context of animal health with training provided by Animal Health Ireland to 16 veterinary practitioners and eight Teagasc farm advisors. This pilot is being extensively evaluated through a Walsh Scholarship and the evaluation will help provide learning on how best to develop long-term training in this area and expand its application to other advisory programmes.

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Impact pathways: Technology Development & Adoption; Capacity Building.

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CELUP

Using integrated management to protect cereals

Vijaya Bhaskar A.V., Dermot Forristal, Susanne Barth, Michael Hennessy

Grassweeds such as wild oats, Italian ryegrass and blackgrass are very competitive and can cause yield losses of over 50% in severely infested cereal fields. The rapid evolution of herbicide resistance in these species, and practices that allow their spread, such as early autumn-sowing and increased use of non-plough tillage, makes grassweed control an extreme challenge in Ireland. The first step is identifying the extent of resistance in tillage fields.

Researchers, advisors, growers and stakeholders collaborated in the research project Enable Conservation Tillage (ECT), with the aim of preventing grassweeds becoming an insurmountable challenge that could threaten production viability.

A total of 293 grassweed populations were collected between 2019 and 2022. These were collected from grower's fields, either as resistance-suspect samples, or as a part of a 2020/2021 survey mapping the distribution of problematic grassweeds. At least 146,500 individual plants were put through a unique comprehensive resistance testing programme to provide feedback to growers.

26%
of wild oat populations show resistance to herbicide

The ECT research confirmed that extremely aggressive weeds such as blackgrass and Italian ryegrass, that were virtually unknown in Irish crops, are now increasing in occurrence, with 60% of their populations being herbicide-resistant. Overreliance on herbicides has resulted in 26% of wild oat populations becoming resistant.

This research and its dissemination have informed the sector that a radically different approach with less emphasis on herbicides is essential. Developing integrated weed management approaches, including cultural approaches such as rotation and stale seedbeds, is essential. This process has started with advice being provided to farms that submitted samples.

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Impact pathways: Technology Development & Adoption; Capacity Building.

Teagasc

REDP

Rebalancing power in food supply chains

Maeve Henchion, John Hyland, Oluwayemisi Olomo

There is a long-term trend of farmers receiving a decreasing share of the food chain value-added. There are various reasons for this; rebalancing power in the supply chain can be part of the solution. This is one of the objectives of the Common Agricultural Policy (CAP), with short food supply chains (SFSCs) identified as one means of achieving it. However, CAP support for such initiatives only reaches an estimated 8% of all EU farms, hence the need to increase awareness of opportunities amongst farmers.

Teagasc worked with Munster Technological University, within the AgroBRIDGES project, to showcase successful Irish SFSCs; building their capacity by exchanging knowledge with other cases across Europe and supporting others to develop their SFSCs by co-developing and testing a range of tools. Tool development was guided by consumer research and workshops across 12 countries. In total, 12 practical tools were developed, encompassing digital solutions, communication and training materials and event organisation guides. The tools are freely available on the project website.

The knowledge gathered in the project has reached over 350,000 stakeholders in Ireland. This knowledge sharing is a result of contributions to the Teagasc Signpost webinar series, a feature length article in the *Irish Farmers Journal*, two episodes of the Teagasc Agropreneur series, as well as various meetings and testing events organised within the project.

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Impact pathways: Technology Development & Adoption; Capacity Building.

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FOOD

Engaging citizen scientists with fermented foods

Liam H. Walsh, Samuel Breselge, Mairéad Coakley, Eimear Ferguson, Fiona Crispie, Paul Cotter

Andrew Downes

Limited public awareness of microorganisms' vital role in food fermentation may lead to misconceptions, influencing consumer perceptions and choices. Improved knowledge can help consumers make informed, confident choices around fermented foods.

The Kefir4All project aimed to bridge this gap, recruiting 102 citizen scientists from nine schools and 21 citizen scientists from various non-school settings in Ireland. The project comprised of a mix of in-person and online fermentation workshops, covering the topics of microbiology, DNA sequencing and fermented foods, culminating in a hands-on kefir fermentation. All participants received a fermentation kit for the study.

Over 21 weeks, these citizen scientists diligently fermented milk kefir or water kefir grains, documenting their progress, and providing samples to the Teagasc researchers. They also engaged in outreach activities (e.g. career talks, data interpretation sessions, Kefir Day at Teagasc) enriching their educational journey and broadening scientific horizons.

The project exemplifies collaborative efforts between scientists, educators, and citizen scientists, with detailed discussions during and after the project aiming to align the project with educational standards, ensuring scientific rigour. Strategies were explored to integrate citizen science into curricula, offering authentic learning experiences.

As well as a published research paper, the project's collaborative insights will now be documented in a co-authored publication, amplifying the voices of educators and participants alike. This impact is crucial to promote healthier dietary habits, foster scientific literacy, and empower individuals to actively engage in scientific research. Ultimately, initiatives like Kefir4All contribute to a more informed and engaged society, with implications for health, education, and community involvement in scientific endeavours.

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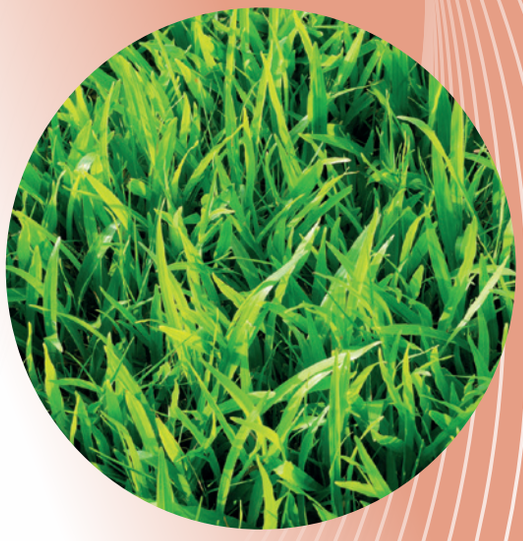
Impact pathways: Technology Development & Adoption; Capacity Building.

AGRIP

Enteric methane at grass: setting new baselines

Ben Lahart, Laurence Shalloo, Johnathan Herron, Charles Dwan, Hazel Costigan



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Methane emissions from enteric fermentation are a by-product of feed digestion within the animal's rumen. Within the agriculture sector, they account for the majority of total greenhouse gas (GHG) emissions. Due to a lack of country-specific data, the national GHG inventory in Ireland uses an international default conversion factor to estimate the amount of methane produced by dairy cows at grass.

Research at Teagasc Moorepark has directly measured the amount of methane produced by grazing dairy cows. The results demonstrate a seasonal nature to methane output at grass, with the lowest values observed in the spring period. The lower enteric methane emissions observed in the spring are related to an increase in pasture quality during this period with low levels of fibre. As the grazing season progresses methane output increases in line with an increased fibre content in pasture. When all available data is accumulated from experiments conducted under Irish grazing conditions to date, the methane conversion factor is approximately 9% lower than currently used within the national GHG inventory.

This data will be used to help inform the methane conversion factor used within the national GHG inventory grazing dairy cows. This will enable for more accurate calculations of enteric methane output from dairy cows at a national level and allow policy makers to make better and more informed decisions when implementing strategies to reduce methane output. It is expected that these new enteric methane conversion factors for Irish grazing dairy cows will be included in the AgNav tool and EPA National Inventory in the near future.

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Other contributors: Tírlan; Kerry; Carbery; Ornua; Dairygold; Nutribio.
Funding: VistaMilk SFI Research Centre.
Impact pathway: Policy Influencing.

AGRIP

Feeding 3-NOP in Irish dairy systems

Hazel Costigan, Laurence Shalloo, Ben Lahart

The majority of the agricultural sector's total greenhouse gas emissions stem from enteric fermentation, a by-product of feed digestion within the animal's rumen. As such, there is an urgent need to develop solutions to reduce enteric methane output. The inhibitor 3-nitrooxypropanol (3-NOP) has proven to reduce enteric methane output by up to 30% when fed indoors to dairy cows as part of a total mixed ration. However, no work has been conducted with the additive in Irish conditions with dairy cows.

22%
methane reduction from mixing 3-NOP through grass silage

Research at Teagasc Moorepark evaluated 3-NOP when fed to spring calving dairy cows across different scenarios. Results show that feeding 3-NOP to grazing lactating dairy cows after milking twice daily reduced enteric methane by 5%. This reduced output is due to the additive's rapid metabolism within the rumen. Slightly greater reductions (-11%) were noted indoors in non-lactating dairy cows when top-dressed onto grass silage twice daily.

However, the greatest reductions (-22%) were observed when 3-NOP was mixed through grass silage using a mixer wagon and fed to non-lactating dairy cows, which is comparable to findings in international research. To demonstrate the application of 3-NOP at farm level, approximately 3,500 cows across 18 Teagasc Signpost dairy farms were successfully fed 3-NOP mixed with grass silage in the winter of 2023/2024.

Ultimately, this research can be used to guide policy on the mitigation potential of 3-NOP across different scenarios in the Irish dairy industry. This enables more accurate calculations of enteric methane output from dairy cows when fed 3-NOP and demonstrating its application at commercial farm level.

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Other contributors: All milk processors.
Funding: Science Foundation Ireland; Teagasc.
Impact pathway: Capacity Building.

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CELUP

Carbon footprint of Irish grain among lowest in the world

Donal O'Brien, John Spink, Gary Lanigan

Grain is an essential component of agricultural supply chains and is of strategic importance to Ireland's large livestock industry. To date, the carbon footprint of grain has been estimated with global models, but none of these tools are representative of the Irish tillage sector, making it challenging for the sector to provide reliable data on the carbon footprint of grain.

Our research goal was to develop a bespoke life cycle assessment (LCA) model focused on the carbon footprint of Irish grains. The model adhered to international standards and computed emissions from on-farm and off-farm activities (e.g. fertiliser manufacture) until grains were sold from the farm. It used Teagasc research to determine agricultural emissions and carbon sequestration. This new LCA grain model was applied in conjunction with Tirlán Co-op to complete the first carbon footprint analysis of commercially grown Irish grains. Activity data was collected from 48 growers who were representative of Tirlán Co-op's 1,100 grain growers in 2022.

This work demonstrated that the carbon footprints of Irish grains are amongst the best in the world. The results showed that the gross carbon footprint of Tirlán Co-op's oats, wheat and barley crop were very low compared to other grain-producing regions in Europe and North America. Accounting for straw incorporation, the Teagasc LCA grain model substantially reduced the carbon footprint values for oats and brought some grower's crops to or below net zero emissions. These findings prove that commercially grown Irish grain has a low carbon footprint. The outputs of this research will be integrated into AgNav, which will in time support the marketing of Irish-produced food and feed ingredients.

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Funding: Tirlán Co-op (LCA survey, grower identification, grower selection, and data validation).
Impact pathway: Technology Development & Adoption.

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REDP

Manure management for national inventories

Cathal Buckley, Brian Moran, Trevor Donnellan

In Ireland, we tend to rely on aggregate-level activity data for national inventory accounting. However, this doesn't exist in relation to important farm level activity data that can influence ammonia and nitrous oxide emissions. These can include: method of slurry storage; duration animals are housed versus grazing outdoors; and when and how slurry is applied. Using data collected by the Teagasc National Farm Survey (NFS), an analysis was carried out of farms with bovine animals in the period 2017 to 2021.

The study provided reliable detail on the duration of bovine animal housing periods, the prevalence of different types of slurry and farmyard manure storage facilities, the proportion of manures generated by different animal types, the extent of seasonality of manure application and the extent to which various slurry application and manure storage methods are employed.

Results were presented at national, nitrate zone and farm system level basis over the study period. Findings indicate a significant transition to low-emission slurry spreading (LESS) methods over the study period. Results indicate that the aggregate volume of slurry applied via LESS has risen from 4% in 2017 to 48% in 2021.

48%
of slurry in 2021 was applied via LESS compared to 4% in 2017

This provides policymakers with critical information to update Ireland's national inventory accounting system for gaseous emissions in agriculture. For example, without such activity data taken into account, ammonia emissions inventory estimates could be up to 18% higher than currently estimated.

It is important to be able to capture farmers' changes to management practices in the greenhouse gas and ammonia emissions in the national inventory accounting systems. The NFS data can be used to measure, report and verify these changes.

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Funding: Teagasc core funding.
Impact pathway: Policy Influencing.

Teagasc

FOOD

Clean extraction of plant proteins

Rahel Suchintita Das, Shay Hannon, Sheila Alves, Marco Garcia-Vaquero, Brijesh K. Tiwari

In recent years, a surge in demand for plant proteins has propelled the plant-based protein market to new heights. However, existing extraction methods are energy-intensive and reliant on chemicals. This project aims to capitalise on this expanding market by adopting a clean and sustainable approach to extract proteins from Irish-grown pulses such as faba bean, pea, and lupins.

Irish cultivated faba beans were used in this project. State-of-the art cavitation technologies were employed to obtain proteins from the faba bean powder using water as the solvent, without any thermal interventions and chemicals. Hydrodynamic cavitation for 35 minutes resulted in protein isolates with nearly 90% purity and 70% yield, while the conventional method, after 18 hours of strong alkali extraction, achieved 4% and 84% lesser purity and yield, respectively

Hydrodynamic cavitation for 35 minutes resulted in protein isolates with nearly
90%
purity and
70%
yield

Additionally, cavitation-extracted proteins demonstrated improved techno-functional properties, including solubility and water-holding capacities, supporting their application in beverage formulations.

These achievements were disseminated through journal publications and an Invention Disclosure Form, complemented by active engagement with industry stakeholders, investors, and regulatory bodies at various networking events. With promising pilot-scale results, the methods are easily scalable for adoption by food and feed manufacturers, reducing dependence on soy protein imports. This initiative aligns seamlessly with Teagasc's Climate Action Strategy 2020–2030, fostering the development of sustainable circular bio-refineries.

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Funding: Department of Agriculture, Food and the Marine; UCD Ad Astra Studentship; UCD-CSC Scholarship Scheme.
Impact pathways: Technology Development & Adoption; Capacity Building.

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Impact of Teagasc research publications

Compiled by Catriona Boyle

Teagasc uses two main approaches to identify the impact of its research: science excellence and societal impact. Science excellence focuses on peer-reviewed publications and their indicators of quality, while societal impact focuses on understanding the pathways through which such science is put into use and the changes it helps to bring about in society. Throughout this publication, we have identified the impact pathways for each of the featured research impacts.

Peer-reviewed publications

Measuring the impact of our research is a key activity for Teagasc. One method we use is to track and monitor the number of articles in scientific journals authored by Teagasc researchers. Another strategy involves tracking how many times these articles are cited by other journal articles.

There are a number of resources available providing these citation counts and other metrics. Teagasc uses Elsevier's abstract and citation database, Scopus, and its accompanying research analysis and strategic insights tool, SciVal, to benchmark its research performance. Teagasc annually compares the performance of Teagasc articles (at least one Teagasc-affiliated author) to that of other relevant Research Performing Organisations for publications in a rolling six-year period.

Publication and citation patterns vary considerably across subject areas. Therefore, comparisons within subject categories are the most meaningful when using publication counts or citation-based metrics. To place our performance in a national context, we can compare Teagasc's performance with that of Irish universities, within three relevant subject categories: (a) the broad category of Agricultural & Biological Sciences; and two narrower categories, (b) Food Science, and (c) Agronomy & Crop Science. Citation counts are merely a snapshot in time, as citations are accumulating constantly. The metrics shown are from SciVal as of 10 May 2024 using the All Science Journal Classification database (ASJC) subject area classifications.

How Teagasc compares

Comparing Teagasc with the top eight ranked universities in Ireland (2024 QS World University Rankings), for 2018 to 2023, in the SciVal broad category of Agricultural & Biological Sciences, Teagasc published the second highest number of publications (349) in 2023 (Figure 1). For the narrower category of Food Science (Figure 2), Teagasc had the highest overall number of publications (178); and, for Agronomy & Crop Science (Figure 3), Teagasc had the second overall number of publications (48).

The citation counts for the three ASJC subject areas were: Agricultural & Biological Sciences (ranked second at 915 citations); Food Science (ranked second at 614 citations); and Agronomy & Crop Science (ranked second at 100 citations).

The strong international and national reputation of Teagasc research is demonstrated by the fact that for 2018 to 2023, 57.5% of the Teagasc peer-reviewed articles indexed by SciVal listed international collaborators, with 36.8% listing national collaborators.

Of course, all bibliometric analysis must be placed in context and the impact of our research must be evaluated in various other ways to give the full picture.

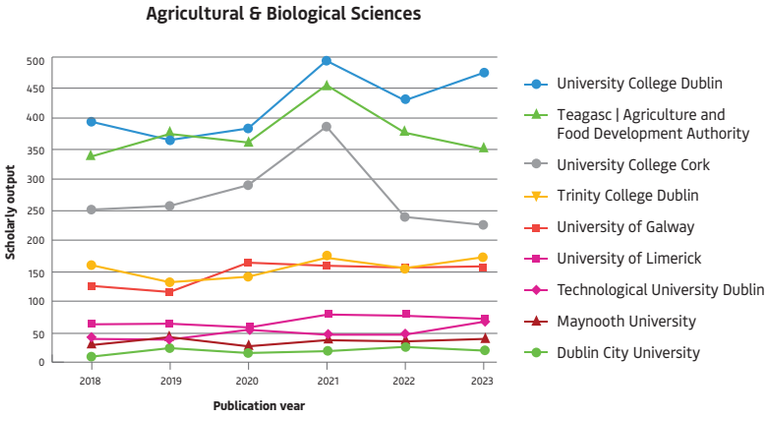

Figure 1: Number of papers by Teagasc and Irish universities that are indexed in the All Science Journal Classification database category Agricultural & Biological Sciences (2018-2023).

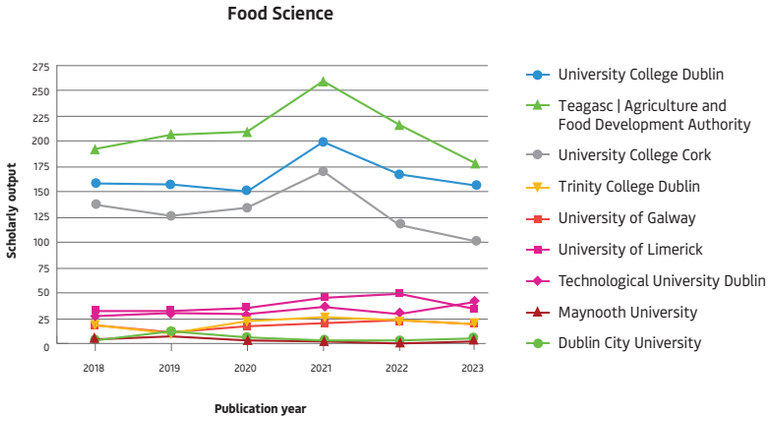

Figure 2: Number of papers by Teagasc and Irish universities that are indexed in the All Science Journal Classification database category Food Science (2018-2023).

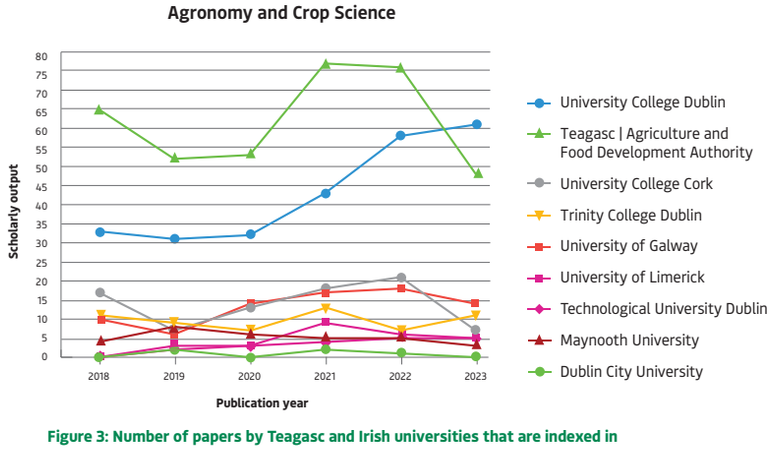

Figure 3: Number of papers by Teagasc and Irish universities that are indexed in the All Science Journal Classification database category Agronomy & Crop Science (2018-2023).

The data presented was generated on 13/5/24 (using data up to 10/5/24). Please note that 2023 full-year data comparisons cannot be made until the Scopus cut-off date of the end of June each year.

Impacts from technology development and adoption by Teagasc researchers

Compiled by Karen Dawson and Siobhán Jordan

With an ongoing commitment to research and innovation, Teagasc has harnessed cutting-edge research and technologies to address critical challenges facing farmers and agri-food producers to enhance productivity, sustainability and competitiveness, and ultimately to enable economic growth.

This year, the World Intellectual Property Organisation is challenging the global research committee to connect intellectual property and innovation with the UN Sustainability Development Goals (SDG) to build a sustainable future for all. Generating knowledge, new tools and resources alone will not deliver on our commitment to Ireland's SDG National Implementation Plan. We also require effective translation of Teagasc-developed technological, economic and social innovations to the outside world, with researchers, knowledge and technology transfer playing a significant role.

Technology Transfer Offices, such as Engage@Teagasc, play a pivotal role in enabling agri-food sector innovation by facilitating the transfer of research findings, inventions, patents and expertise from Teagasc to industry. The team bridges the gap between research and commercialisation, fostering collaboration, driving technology adoption and catalysing transformative innovations that enhances impact from research.

Technology development and adoption significantly enhance the capacity of the agri-food sector to innovate and transform. By leveraging advanced tools such as genetic technologies, digital platforms and novel food processing techniques outlined in the case studies in this publication, farmers and producers gain access to real-time data and insights, enabling informed decision-making and targeted interventions. This fosters a culture of continuous improvement and innovation, driving productivity gains, sustainability and competitiveness.

Moreover, technology adoption facilitates collaboration and knowledge exchange within the agricultural and food community, catalysing the adoption of best practices and accelerating the pace of innovation. Ultimately, scientific insights and novel research empower the agri-food sector to adapt to evolving challenges and seize opportunities for transformative growth.

2023 activities and impacts delivered by Engage@Teagasc

61
Agreements to support engagement

€1,307k
Licensing income

43
Licences, Options & Assignments

42 invention disclosures
1 Patent Filed

16
Entrepreneurship events delivered

A 100-year legacy

Poppies are common weeds in both winter and spring crops. Their impact on agricultural practices relies on their ability to produce high seed yield that can remain dormant in the soil for 100 years.

To understand this impact, imagine that the oilseed rape plant in the picture will produce an approximate number of 200 pods that will contain an average of 4,000 seeds per plant. In comparison, one poppy fruit can produce an average of 20,000 seeds. How old is the poppy seed in your crop field?

This picture was taken in a winter oilseed rape field in Oak Park, Carlow.

Photo and description by:
Elena Grosu,
Postdoctoral Researcher