TResearch

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FERMENTED MILK
Supporting gut health with lactic acid bacteria

BURIED SECRETS
Building a picture of rural life in medieval Ireland

CALVING MYTHS
The truth about calving heifers at 24 months

Better by design

Our researchers are using novel technologies to enhance the health and wellness benefits of foods

Interview: Introducing our new Bioprocess Innovation Suite with Olivia McAuliffe
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Teagasc
Agriculture and Food Development Authority

Welcome

Fermentation is the one of the oldest food production technologies known to man – natural fermentation even predates human history. Towards the end of the 19th century, fermentation underwent a technological revolution after it was discovered that microbes were responsible for food transformations. With recent advances in DNA sequencing technologies, these foods are now experiencing a new surge of innovation. Teagasc is at the forefront of this wave, and a number of the articles in our Winter issue of *TResearch* celebrate that.

Fermented foods are known to have a range of health benefits, which can be attributed to the microorganisms used to produce them. For this issue, we spoke to a team of researchers who are investigating the gut health benefits associated with the fermentation of milk using lactic acid bacteria. Harsh Mathur and colleagues at Teagasc Moorepark explain their findings so far and their plans to investigate further in human trials (p10).

Fermented foods such as kombucha and kefir are gaining in popularity, as customers become more aware, adventurous and curious about live foods that have proven health benefits. John Leech, one of the recipients of Teagasc's START Fund, explains how he would like to exploit this growing interest and lead the market with innovative live fermented foods (p13).

And excitingly, Teagasc's new Bioprocess Innovation Suite has recently opened. In an interview with Olivia McAuliffe (p24), we find out how it will be used for the development of new fermented food products and the production of new food ingredients.

Catriona Boyle
Editor, *TResearch* magazine, Teagasc

Tá coipeadh ar cheann de na teicneolaíochtaí táirgthe bia is sine atá ar eolas ag an duine – tagann coipeadh nádúrtha roimh stair an duine fiú. Ag druidim le deireadh an 19ú haois, tharla réabhlóid theicneolaíoch sa choipeadh nuair a fuarthas amach go raibh miocróib freagrach as claochluithe bia. Le dul chun cinn le déanaí i dteicneolaíochtaí seicheamhaithe DNA, tá borradh nua nuálaíochta curtha faoi na bianna sin anois. Tá Teagasc chun tosaigh sa tonn sin, agus sonraítear é sin i roinnt ranna inár n-eagrán Geimhridh de *TResearch*.

Is eol go mbaineann go leor buntáistí sláinte le bianna coipthe, agus is féidir é sin a chur síos do na miocrorgánaigh a úsáidtear chun iad a tháirgeadh. Don eagrán seo, labhraíomar le foireann taighdeoirí a bhfuil fiosrú á dhéanamh acu ar bhuntáistí sláinte na putóige a bhaineann le coipeadh bainne ag baint úsáid as baictéir aigéid lachtaigh. Tugann Harsh Mathur agus a chomhghleacaithe ag Teagasc ag an gCloch Liath míniú ar a gcuid torthaí go dtí seo agus a gcuid pleananna chun tuilleadh imscrúdaithe a dhéanamh i dtrialacha daonna (lch. 10).

Tá an-tóir ag teacht ar bhianna coipthe ar nós kombucha agus kefir, de réir mar a éiríonn custaiméirí níos feasaí, níos fiontraí agus níos fiosraí faoi bhianna beo a bhfuil tairbhí sláinte cruthaithe maidir leo. Míníonn John Leech, duine d'fhaighteoirí Chiste START Teagasc, conas ba mhaith leis leas a bhaint as an tsuim seo atá ag méadú agus an margadh a threorú le bianna beo coipthe nuálacha (lch. 13).

Agus rud iontach, osclaíodh Svuít Nuálaíochta Bithphróisis nua Teagasc le déanaí. In agallamh le Olivia McAuliffe (lch. 24), faighimid amach conas a úsáidfear é chun táirgí bia coipthe nua a fhorbairt agus chun comhábhair nua bia a tháirgeadh.

Catriona Boyle
Eagarthóir, iris *TResearch*, Teagasc

TResearch is an official science publication of Teagasc. It aims to disseminate the results of the organisation's research to a broad audience. The opinions expressed in the magazine are, however, those of the authors and cannot be construed as reflecting Teagasc's views. The Editor reserves the right to edit all copy submitted to the publication.

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Contents

News

Leading scientists advance science in global meat debate

In October, world-leading experts gathered at Teagasc Ashtown for the International Summit on the Societal Role of Meat. The summit, hosted by Teagasc, explored the role of livestock farming and meat in society, economics, and culture, diet and health and a sustainable environment. It included presentations by experts from leading research institutions and universities from across the globe.

Evidence reviewed at the Summit and conclusions from the Summit will feature in a peer-reviewed edition of the scientific journal *Animal Frontiers*, to be published in early 2023. Summit attendees were invited to endorse the evidence base by signing the 'Dublin Declaration of Scientists on the Societal Role of Meat'.

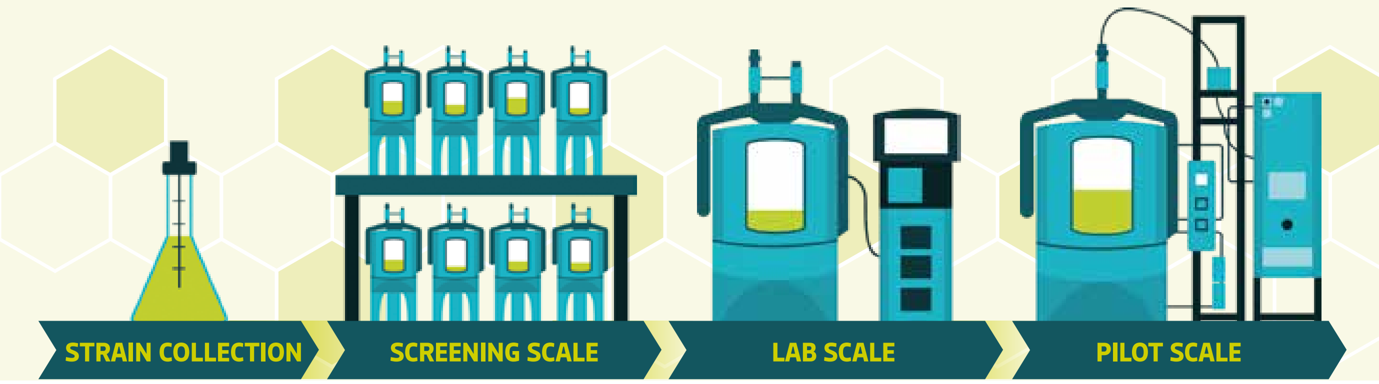
Martin Heydon, Minister of State at the Department of Agriculture, Food and the Marine (centre) at the opening of the Summit with (L-R) Teagasc's Declan Troy, Kaye Burgess, Director Frank O'Mara and Ciara McDonagh

Declan Troy, Assistant Director of Research at Teagasc, comments: "Teagasc was thrilled to have the opportunity to host the International Summit on the Societal Role of Meat. There is an urgent need to ensure that agricultural, industrial, governmental and educational stakeholders act on the basis of the best available scientific information – both regarding livestock farming and the impact of meat consumption on health, the environment and livelihoods."

Bioprocessing: bringing biotechnology to life

Bioprocessing uses living organisms to produce value-added, bio-based products. These processes have the capacity to transform low-value products (including waste streams) into higher value products with enhanced functional properties, extended shelf-life and improved safety. It is key to the food, pharmaceutical and energy sectors, and has been identified as a key technology that can help develop solutions to sustainability challenges.

New product development begins with large numbers of candidate microorganisms, taken from a **strain collection**, that can be rapidly screened. As design and optimisation proceeds, the number of microorganisms of interest decreases as the scale (or volume) of the bioprocess increases, from **screening scale** and **lab scale** through to **pilot scale**. Parameters critical to the bioprocess are identified as the scale increases, allowing better decision-making in the early stages of bioprocess design and development.



See pages 24-25 for an interview with Olivia McAuliffe on Teagasc's new Bioprocess Innovation Suite

Sustainability performance of Irish farms in 2021 revealed

Teagasc has released its latest sustainability report for the year 2021. The report uses the Teagasc National Farm Survey to track the performance of dairy, cattle, sheep and tillage farms across Ireland to understand changes in their economic, environmental and social sustainability.

"Results from the report show an increase in dairy output, incomes and greenhouse gas emissions, with smaller changes in these same areas across the other farm types," says lead author of the report and Teagasc Research Officer Cathal Buckley.

"However, greater evidence in the report suggests that actions to address gaseous emissions are being adopted, particularly by dairy farmers. For example, on an aggregate basis, 48% of all slurry applied on farms was via Low Emissions Slurry Spreading (LESS) equipment. For dairy farms, the comparable figure was 74%. This transition to LESS has helped lower ammonia emissions across all farm systems."

At the report launch, Emma Dillon, from Teagasc's Rural Economy and Development Programme, presented developments in social sustainability measurement through the Teagasc National Farm Survey, including data on health and wellbeing, connectivity and community engagement.

She states: "The social dimension of sustainability is reflective of its holistic nature, and its importance is increasingly emphasised in agricultural and broader policy."

You can access the 2021 Sustainability Report here: *teagasc.ie/publications/2022/National-Farm-Survey---2021-Sustainability-Report.php*

Leaf No Waste research team wins €2 million in funding

Leaf No Waste – a joint project that includes Teagasc researchers – has won the Science Foundation Ireland Future Innovator Prize's Food Challenge. As a result, it has been awarded €2m in funding.

The team is developing novel solutions that have the potential to address food waste by combining plant fortification with sustainable compostable packaging to enhance the shelf life of fresh produce.

Teagasc's Lael Walsh and Shivani Pathania are core members of the team, which is led by Technological University Dublin's Lorraine Foley and Jesus Maria Frias Celayeta.

Commenting on the project, Minister for Further and Higher Education, Research, Innovation and Science, Simon Harris says: "This innovative idea represents the true nature of challenge funding. This clever solution to reducing food waste could not only have significant influence across [scientific] research, but across all aspects of society as we work together to meet our sustainability goals and protect our planet for future generations."

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News in brief

Teagasc Senior Research Officer Daire Ó hUallacháin delivered a presentation on **Agricultural Biodiversity: Current Policies, Programmes and Practices** to the **Citizens' Assembly on Biodiversity Loss**. A key message was that nature conservation in Ireland is dependent on farm-scale efforts, which will be guided by effective policy and implementation. The presentation highlighted the challenges associated with the existing complex policy environment and the opportunities for greater policy coherence.

10 years

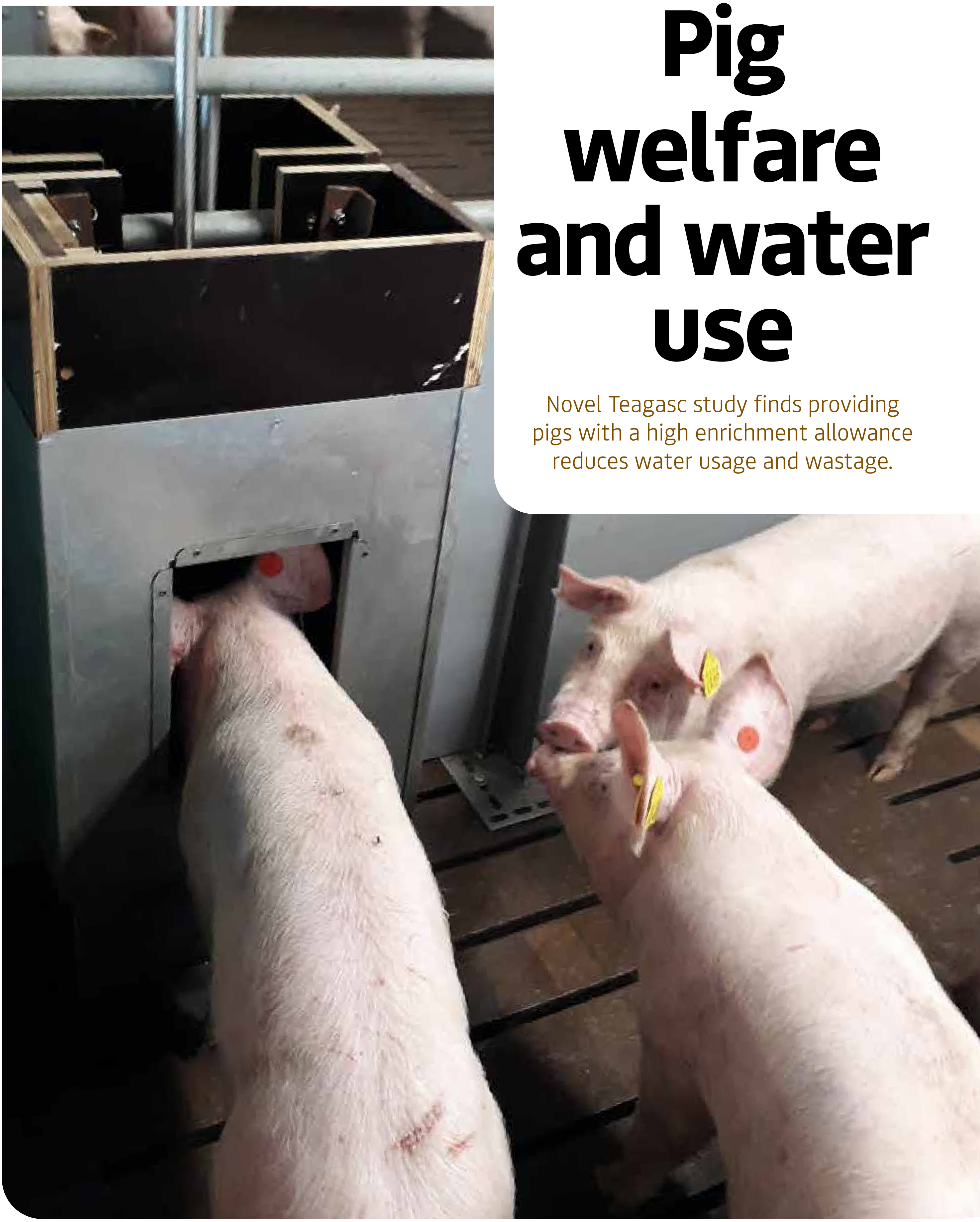
Food Works – Ireland's leading food and drink accelerator – celebrates 10 years of operation. Coordinated by three state agencies (Teagasc, Bord Bia and Enterprise Ireland), the programme has helped to raise over **€6.5m in funding for early-stage companies**. To celebrate its milestone anniversary, Food Works has launched a **video podcast series '10 at 10'**, featuring interviews with leading Irish food and drink companies who have been through the programme.

This year's **Teagasc Signpost Sustainability Week** (14 – 21 October) had a theme of 'Farming for a Better Future'. The week began with a launch event dedicated to reducing greenhouse gas emissions on farms. Speaking at the event, Deirdre Hennessy, Senior Research Officer at Teagasc, said: "We must now reduce chemical nitrogen fertiliser at farm level. Getting the basics right it crucial to grass growth, and we must **implement management strategies that protect herbage production**, to ensure farmers have adequate grass supply to feed their livestock."

€9.7 million

Teagasc's **VALPRO Path project** – which will deliver new added-value opportunities that support the **expansion of plant protein production** – has been kicked off. The project, co-ordinated by Teagasc's Ewen Mullins, is a Horizon Europe Innovation Action and has secured co-funding of €9.7 million. VALPRO Path will design and deliver **sustainable and competitive plant protein crop systems and value chains,** with the involvement of up to 25 leading academic and industry teams across 10 European countries.

Attendees at the commencement meeting of the VALPRO Path project



Pig welfare and water use

Novel Teagasc study finds providing pigs with a high enrichment allowance reduces water usage and wastage.

The provision of sufficient drinking water is important for animal agriculture and is essential for good welfare. Freshwater is a limited resource, and therefore the water used in agricultural systems needs to be optimised.

Pork – one of the most globally eaten meats – requires freshwater for production. Drinking water accounts for up to 87% of total farm water use, with the grower-finisher stage accounting for 64% of this. Pigs consume only part of this drinking water, with the rest going to waste. As well as being a poor use of an already limited resource, wasted freshwater also increases the volume and disposal costs of slurry and dilutes its nutrient content.

The importance of resource allowance

The amount of drinking water consumed and wasted by pigs is affected by a complex interaction of elements, including feed intake, temperature, humidity and pen design. Fundamentally, it is affected by factors that impact behaviour directed towards the drinkers. Understanding this is essential in order to reduce water wastage.

A significant factor is that pigs are highly motivated to perform foraging and exploratory behaviour. When there is a lack of appropriate environmental enrichment to facilitate this, they may redirect their attention towards drinkers, which waste water when manipulated.

Pigs engage readily with loose organic material provided in a rack over the more commonly used items in commercial farms (such as wooden chew bars, rubber toys, etc.), so this has the potential to divert attention away from drinkers. Research has also found that when the stocking density is constant, pigs in larger groups have more shared space to explore, which could also lead to less engagement with drinkers.

As of yet, no study has focused on the impact of group size and enrichment type on both drinking behaviour and water wasted from drinkers, so researchers from Teagasc and Wageningen University & Research have chosen to explore these factors.

Pigs with more enrichment performed fewer aggressive behaviours

Measuring and observing processes

For the research, grower-finisher pigs were divided into three group sizes: small (12 pigs), medium (24 pigs) and large (48 pigs). Each group had a constant space allowance of 0.86 m^2 per pig. Half of the pens of each group size were assigned one of two levels of enrichment: high or low.

For every 12 pigs, the low treatment received one wooden post and one hanging rubber toy. Pigs in the high treatment received the same, as well as a rack containing fresh grass, which is highly favourable to pigs.

Water meters were installed in all pens, covering each wet-dry feeder and the bowl drinker next to it. Water use volumes were monitored every hour on a daily basis for the entire experiment using an automated online water monitoring system.

To record water wasted, a wooden box with an opening for pigs to access surrounded each drinker on all sides. Water overflow from each drinker was collected using a container placed underneath the drinker. The volume of waste water was measured one day per week for six weeks.

The researchers were primarily interested in the demonstration of damaging behaviours (such as fighting, ear and tail biting and belly nosing), enrichment use and drinking behaviour.

Damaging behaviour of pigs and enrichment use was directly observed once per week. Infrared night vision cameras were installed directly over the drinkers midway through the finisher stage, and drinking behaviour was observed continuously for one hour during the most active time of the day (10am to 11am). The duration and number of drinking bouts and total drinker occupancy during the hour were observed.

More enrichment, less waste

Daily water use recorded by the meters had a cyclical pattern, increasing from approximately 8am to 4pm, and thereafter declining during the night. It was found that group size did not affect the overall water use. However, the researchers were correct in their hypothesis regarding the provision of enrichment – overall, pens with high enrichment used less water than pens with low enrichment.

The results also showed that high-enrichment pens wasted less water compared to low-enrichment pens. This was likely because pigs in the low group had more drinking bouts than those in the high group, and as such spent more time occupying the drinkers.

As expected, pigs in the high group interacted more with the enrichment, and they also performed fewer aggressive and damaging behaviours. While group size did not affect water use, it did seem to impact behaviour, as pigs in the large group performed fewer aggressive and damaging behaviours.

The moisture content of fresh grass is approximately 80%, so it is possible that grass consumption could have somewhat satiated the pigs' thirst, making them less motivated to visit the drinkers for the purpose of drinking. As such, further research with other materials should be performed in order to determine whether the researchers' results are somewhat specific to the provision of grass as an enrichment material. Nevertheless, this study is novel in that it demonstrates how improving animal welfare can also provide benefits for the environment – and for the producer – when it comes to managing resources. T

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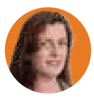


Near-Infrared Reflectance (NIR) spectroscopy is a reliable method for measuring forage quality

Photography: Andrew Downes

Measuring the value of plants with DNA

Teagasc researchers are using DNA technologies to improve the efficiency of plant selection and deliver highly digestible cultivars.

Improving perennial ryegrass cultivars in order to support pastoral-based production systems for milk and meat is critically important. Specifically, better digestibility of the forage is an important target trait for forage breeders, as it leads to an increase in animal performance. It also has the potential to reduce methane emissions within agriculture.

Disappointingly, genetic gains for important forage quality traits have been modest over recent decades. However, an increased focus on trait evaluation during breeding and the adoption of genomic evaluations can address this, and researchers at Teagasc have been studying the use of breeding technologies that can help.

One such technology is genomic selection (GS), which uses genome-wide DNA markers to estimate breeding values on selection candidates. GS can assist traditional breeding programmes and increase genetic gain by shortening the selection cycle, increasing the accuracy of selection and increasing the number of selection candidates that can be evaluated.

Measuring forage quality

A prerequisite to developing GS approaches is the establishment of a reference population that is a) evaluated for the target trait in field trials, and b) characterised for differences in DNA profiles among the population.

Near-Infrared Reflectance (NIR) spectroscopy is an indirect approach that can be used to measure forage quality. It illuminates a forage sample with light and measures the near-infrared region of light reflected back. The absorbance of light at different wavelengths is plotted to provide a spectrum for each sample (Figure 1). The resulting shape is a unique fingerprint of the sample that is influenced by its composition.

Agnieszka Konkolewska, Marie Skłodowska-Curie Fellow and project researcher, says: “We used NIR spectra on a reference population of more than 15,000 samples, then selected a subset of these samples for chemical analysis based on scan diversity.

“Doing this enabled us to develop calibration models for a number of forage quality traits – including organic matter digestibility, crude protein and neutral detergent fibre – that can now be used for the routine evaluation of breeding material during selection. It also proved that NIR spectra is a reliable method for measuring forage quality, removing the need for expensive chemical analysis.

"Furthermore, working with over 15,000 samples enabled us to collect forage quality data on a large reference population of breeding material, for use in our development of GS models."

DNA and genomic selection

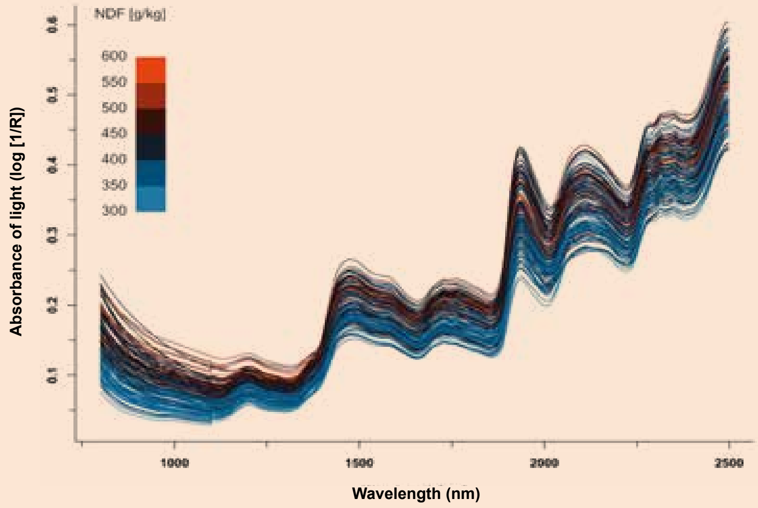
In forage breeding, the goal is to use the best plants as parents to produce a new generation, where the new generation will be on average superior to the previous generation. Finding the best parents can be achieved using field evaluations or by studying DNA through genomic selection.

Teagasc Research Officer Stephen Byrne worked closely with Agnieszka in building models to enable GS. Describing how they did this, he says: "We combined the evaluations of forage quality on the reference population with genomic evaluations of the same plants. This enabled us to build predictive models for genomic selection, which can now be used to predict the value of a plant to a breeding programme, based only on DNA information."

Forage quality is just one trait of importance to forage breeders. With this in mind, the researchers are also developing genomic selection models for other traits measured in national list trials.

"Our vision is to employ multi-trait GS, using index selection with weights from the Pasture Profit Index (PPI)," says Stephen.

Figure 1. NIR spectra of calibration samples, coloured by the respective high (red) and low (blue) neutral detergent fibre (NDF) values.



"This will enable the selection of the best plants within the best families, which has already been shown to be an effective way to increase genetic gain in forage breeding.

"When combined with inexpensive approaches to evaluate DNA, this will be a powerful tool. It will support forage breeders in selecting the best plants to combine to produce new cultivars, and help them to identify the best plants to use as parents to start a new round of selection. At Teagasc, work is already underway to validate and quantify genetic gain using this approach." T

In forage breeding, the goal is to use the best plants as parents to produce a new generation

FUNDING

This work is supported by the European Union's Horizon 2020 research and innovation programme, under the Marie Skłowdowska-Curie grant agreement number 841882. It also received support from Science Foundation Ireland and the Department of Agriculture, Food and the Marine on behalf of the Government of Ireland – grant 16/RC/3835 (VistaMilk).

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LAB-work: the benefits of fermented milk

There are a number of potential gut health benefits associated with the fermentation of milk using lactic acid bacteria (LAB), which can be accessed in powdered form.

It has been widely reported that fermented foods – for example fermented milk – have a range of health benefits, such as anti-inflammatory, anti-hypertensive and anti-cholesterolaemic properties. These benefits are attributed to the live microorganisms present in fermented foods, as well as the compounds that the microorganisms produce (known as bioactive metabolites) during the fermentation process of a given substrate.

Consuming fermented foods is not the only way to unlock these benefits, however. Fermentates (a term used to describe the powdered preparation of a fermented product) can also provide improvements to our health; and yet, reports on the benefits of fermentates are not as common.

Fermentates typically contain some combination of live or heat-inactivated microorganisms, cell surface components of these micoorganisms, pre-digested nutrients and bioactive metabolites. To test their effectiveness, researchers at Teagasc conducted a series of studies using milk-based fermentates.

Fermentates can improve our health

Studying bacterial populations in faeces

The researchers used skimmed milk and fermented it with individual bacterial strains belonging to the lactic acid bacteria (LAB) group, a class of bacteria commonly involved in the fermentation process of dairy fermented foods. They then heat-killed the LAB strain.

Next, the milk-based fermentates were added to faecal samples obtained from healthy volunteers, in order to rapidly test their impact on microbes in the human gut.

Harsh Mathur, Teagasc Research Officer, says: "The aim of our study was to investigate if dairy fermentates produced by individual LAB strains have the potential to confer gut health benefits. To do this, we used a 'faecal fermentation' model system involving the microMatrix bioreactor platform in the laboratory, to mimic conditions found in our colons."

Faecal samples contain thousands of bacterial species, some of which are considered 'friendly bacteria', while others are associated with ill-health and disease. The researchers added the powdered skimmed milk fermentates to the samples, and screened them to see what effect they had on the bacterial populations in the faeces.

"We were interested in seeing if the fermentates caused the populations of friendly bacteria and disease-causing bacteria in the faecal samples to increase or decrease," explains Harsh. "We compared all the fermentates to standard, non-fermented skimmed milk, which acted as a negative control in the experiment."

A boost to gut health

The researchers' faecal fermentation studies are ongoing, but they have already obtained some promising preliminary results. Several milk-based fermentates have demonstrated the potential to elicit gut health benefits by increasing friendly bacteria – such as *Bifidobacterium* and *Lactobacillus* – typically associated with good gut health.

> **Several milk-based fermentates have the potential to elicit gut health benefits.**

As the milk-based fermentate powders contain heat-inactivated LAB strains, the researchers believe that any gut health benefits associated with the fermentates is linked with the bioactive metabolites that are produced during the fermentation process, as well as the components of the cell surface of LAB strains.

"We're encouraged by the promising effects of the LAB dairy fermentates with regards to their ability to increase populations of friendly gut bacteria," says Harsh. "However, we don't currently have insights into which bioactive metabolites are responsible for such positive effects.

"To address this, we're collaborating with researchers at University College Dublin to delve deeper into the actions of these

The researchers used skimmed milk and fermented it with individual bacterial strains belonging to the lactic acid bacteria (LAB) group before heat-killing it

iStockphoto.com: VM; ddukang

fermentates and identify the specific bioactive metabolites that are present in them. At the same time, collaborators at University College Dublin and Dublin City University are testing the anti-inflammatory and pro-inflammatory effects of the fermentates."

The researchers hope to collate the data and come up with comprehensive insights into which of the LAB dairy fermentates have the best overall gut health benefits. The team also hopes to test large-scale amounts of these powdered fermentates in human trials, where a number of volunteers will consume them over a period of time.

It is hoped that the promising gut health benefits seen in the researchers' lab experiments will translate to good gut health effects in human trials. T

FUNDING

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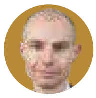


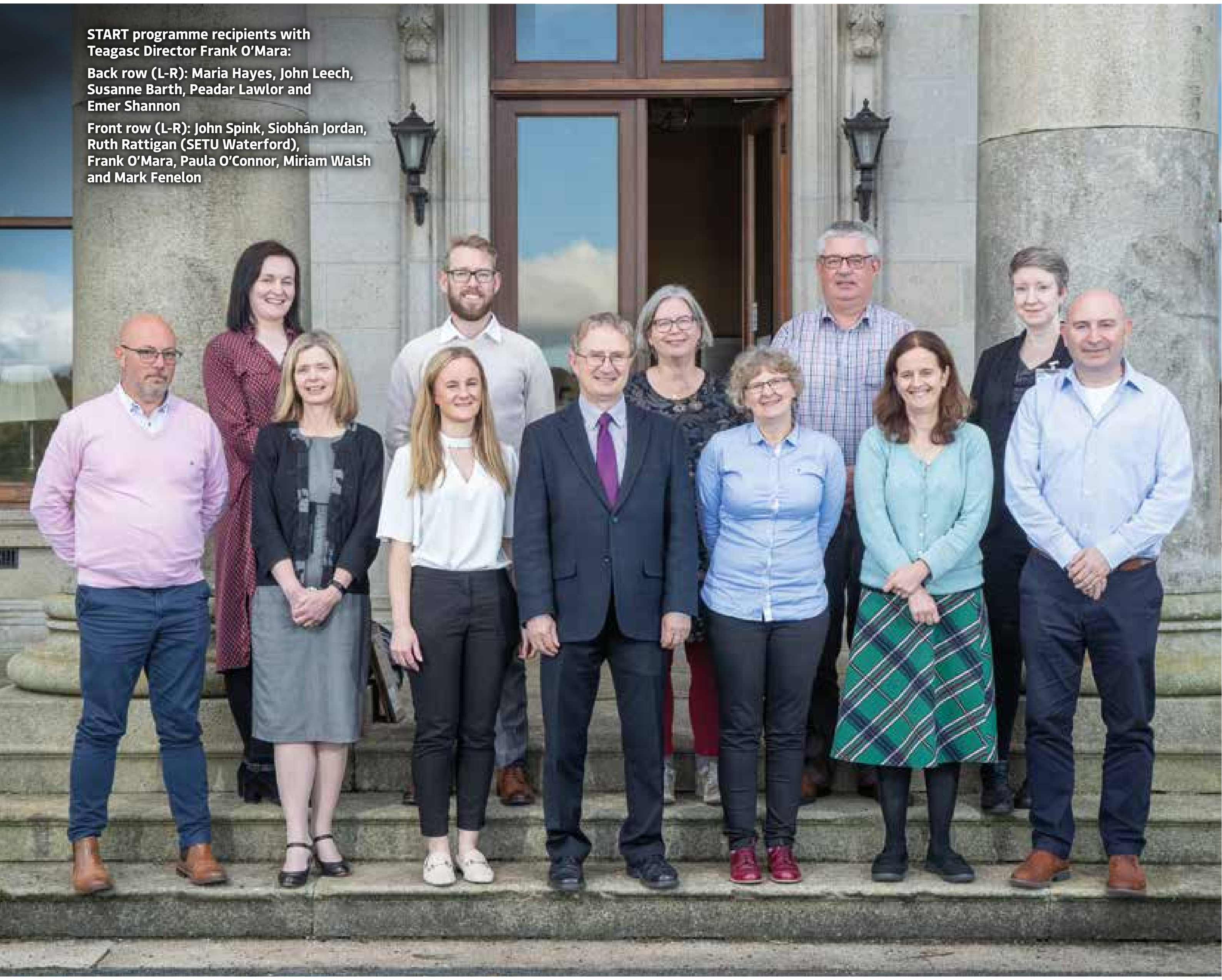
Off the START line

Teagasc's START Fund proactively supports researchers in proving early-stage concepts, deepening connections and cooperation with companies during concept development and determining market potential.

The Teagasc START Fund is an annual internal research fund, offering researchers the opportunity to avail up to €15,000 for a six-month project to aid early-stage assessment of concepts and ground-breaking innovations with commercial potential. Launched in 2021, the Fund aims to support the development of early-stage commercialisation projects that may in time form new spin-out companies.

The ripple effects from the Teagasc START Fund are varied for all of the teams that take part. Participating in the process has unlocked significant support and opportunities for our researchers, including engagement from Enterprise Ireland and Local Enterprise Office specialists, and participation in the UCC SPRINT Accelerator Programme.

For a better insight into the impact of the Fund, we spoke to three award winners.



START programme recipients with Teagasc Director Frank O'Mara:

Back row (L-R): Maria Hayes, John Leech, Susanne Barth, Peadar Lawlor and Emer Shannon

Front row (L-R): John Spink, Siobhán Jordan, Ruth Rattigan (SETU Waterford), Frank O'Mara, Paula O'Connor, Miriam Walsh and Mark Fenelon

Photography: Finbarr O'Rourke

Shivani Pathania

Job role: Research Officer
Location: Teagasc Food Research Centre, Ashtown
START Fund project: Clean Green Packaging

What is the focus of your commercialisation project?

My project aims to fill a gap in the market regarding cost effective and sustainability-focused packaging solutions, identified during extensive industry engagements that I undertook through Teagasc's National Prepared Consumer Foods Centre.

Why is this area of work important?

For small companies, the existing packaging machines are very costly and limited in scale. With a more compact design and a small production output specifically designed for smaller food manufacturers, my solution will offer convenience and efficiency in enhanced throughput while facilitating reduced food loss and plastics waste.

What opportunities has the START Fund opened up for you?

The financial support provided by the START Fund has resulted in the freedom to operate, generate data and validate concepts. It has also given me knowledge about future funding applications such as commercialisation grants.

Why is it so beneficial for you?

Receiving this award is an affirmation of the commercial significance of Clean Green Packaging. Furthermore, I have received invaluable advice and support from the Technology Transfer Office regarding managing the IP rights and meeting ambitious project deliverables.

John Leech

Job role: Research Officer
Location: Teagasc Food Research Centre, Moorepark
START Fund project: Bespoke Fermented Foods

What is the focus of your commercialisation project?

Along with Paul Cotter, Head of Food Biosciences Department, I am testing the feasibility of establishing a company that would design and create food products with scientifically validated health benefits, for which there is market and consumer demand.

What is important about this area of work?

Fermented foods such as kombucha and kefir are gaining in popularity, as customers become more aware, adventurous and curious about live foods that have proven health benefits. Consumers are looking for ways to improve their own gut-microbiome health, and fermented foods are seen as a powerful tool to this end. We would like to exploit this growing interest and lead the market with innovative live fermented foods.

What opportunities has the START Fund opened up for you?

The funding was the tipping point between tentatively approaching commercialisation and really going for it. Both the commercial project and our own entrepreneurial knowledge has developed immensely in the year since our START grant. We have experienced pitching to a variety of stakeholders, undertaken mentorship courses and begun efforts to fundraise the next step.

Why is it so beneficial for you?

Before the START Fund, commercialisation was primarily an intention. Since the Fund, commercialisation has become the focus and reality. It is an essential first step to moving towards an entrepreneurial career with my research.

Seven teams in total have received funding through the START Fund since it was launched:

Team	Project
Susanne Barth, Sergei Kushnir and Ewen Mullins	Ryegrass Hybrid Breeding Service
Maria Hayes and Emer Shannon	BioHealth Products
Maria Hayes and Paula O'Connor	Pet Aging and Wellness (PAW) Products
Peadar Lawlor, Gillian Gardiner (SETU, Waterford) and Ruth Rattigan (SETU, Waterford)	ProSwine – mapping a path to market for a novel probiotic feed additive for pigs
John Leech and Paul Cotter	Bespoke Fermented Foods (BFFs)
Norah O'Shea	VisioBot – robotic and vision system platform technology
Shivani Pathania	Clean Green Packaging

Peadar Lawlor

Job role: Principal Research Officer - Pig Management & Nutrition
Location: Teagasc Animal & Grassland Research and Innovation Centre, Moorepark
START Fund project: ProSwine

What is the focus of your commercialisation project?

ProSwine is a technology that reduces the need for antibiotic interventions for pigs. I have developed the technology in collaboration with Post-doctoral Researcher Ruth Rattigan and Lecturer Gillian Gardiner from South East Technological University (SETU) in Waterford.

What is important about this area of work?

Increased restrictions on the use of in-feed antibiotics and a ban on supplementation with pharmacological levels of zinc oxide in pigs come into effect in the EU this year. This has necessitated the development of alternative sustainable strategies for cost-effective pig production.

What opportunities has the START fund opened up for you?

The ProSwine project is at a critical stage. In the next 12 months we will fine tune our business plan and identify a strong commercial lead to drive the ProSwine spin-out. The START Fund has enabled our team to attract one of the leading Irish agri-entrepreneurs and investors as a commercial consultant to guide us through these next steps.

Why is it so beneficial for you?

We have been able to fund tasks that will be key to our decision-making and further develop some outstanding aspects of our quality control processes. T

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Wild potato genes: the future of late blight control

Researchers are studying the genes of wild potato species in the hopes of finding a novel approach to mitigating crop losses caused by the persistent late blight disease.

The destructive potential of the late blight crop disease pathogen *Phytophthora infestans* impacted and shaped global society throughout the 19th century. It caused unprecedented potato crop failures in Ireland which led to the Great Famine. Despite it happening over 175 years ago, the disease has still not been eradicated, demonstrating the aggressiveness, adaptability and fitness of this significant crop pathogen.

In Ireland, the potato industry remains a crucial part of the arable sector, with an estimated annual contribution to the national economy exceeding €111 million at farm gate level. Yet, each season, potato farmers are wholly dependent on the use of

crop protectants to mitigate loss of yield and quality because of the late blight. This typically equates to upwards of 12 sprays each season, primarily due to the absence of robust genetic resistance against the disease in commonly grown potato varieties.

To combat this, researchers from Teagasc and the University of Dundee are employing novel enrichment sequencing technologies to get a unique insight into *P. infestans* and identify durable host resistance genes in wild potato species. This research is being completed through the ESoLaB project.

Fact!

***Phytophthora* is Latin for plant (*phyto*) destroyer (*phthora*).**

***Phytophthora infestans* is an aggressive and persistent crop pathogen**

Fungicide resistance and the emergence of new strains

P. infestans was introduced to Ireland through infected potato shipments from South America in the early 1840s. Its genotype (genetic material) dominated the global *P. infestans* population, but was displaced by another genotype in the mid-20th century. Later on, so too was this genotype replaced by more aggressive *P. infestans* lineages, showing a continuous adaptation and evolution of the pathogen.

In the 19th century, a strategy to combat the disease was to use a copper-based fungicide. This was followed by the introduction of highly efficient fungicides such as metalaxyl in the 20th century. Unfortunately, the rapidly evolving *P. infestans* developed resistance to the fungicide, with the first confirmed case of metalaxyl resistance reported in 1981.

This vicious cycle has recently been repeated, with the emergence of a *P. infestans* strain that has the capacity to resist the inhibitory effects of fluazinam, an important active ingredient heavily used in modern-day fungicides. Consequently, the Irish potato sector faces a challenging future, with the efficacy of the chemistry toolbox decreasing and an absence of varieties with durable genetic resistance.

Novel strategies to target resistance

A natural wealth of *P. infestans* resistance (R) genes are available in wild potato species, which can be exploited for the deployment of R genes in commonly used potato cultivars through breeding approaches. To date, around 56 commercial potato cultivars are available in Ireland, out of which 34 are commercially grown.

Studies conducted as part of the ESoLaB project have revealed a noticeable gap between the number of functional R genes cloned and those that are utilised in the agronomically most important cultivars. The data shows that potato breeding has largely focused on the continuous use of four R genes (albeit with some geographical differences), whereas at least 17 distinct R genes against late blight have been cloned and described in scientific literature. This indicates that a number of novel resistances are available for consideration as part of an integrated crop protection strategy.

During *P. infestans* infection, plants undergo an immune response with various changes at both cellular and molecular level. This includes the activation of a plant's first line of defence, after its cells recognise *P. infestans* cell surface receptors. To overcome this immune response, *P. infestans* releases specific proteins (termed 'effectors') to suppress the immune system of the plant. In turn, and as a counter defence mechanism, plants have developed a second line of defence that includes the recognition of these effectors by specific potato R genes.

Effectors recognised by R genes are in effect dysfunctional. As such, they are not able to further support the infection and are labelled as Avirulence (Avr) factors. In fact, the virulence potential or 'profile' of *P. infestans* is determined by the variation in its effectors or Avr genes, driven by widely utilised R genes. As a result, the effector profile of *P. infestans* is an important predictive tool to assist breeders in deciding what R genes to incorporate into the breeding of novel potato varieties.

In spite of this, effector diversity within *P. infestans* has largely been ignored in the deployment strategies of new resistances against the disease. To address this, ESoLaB has utilised recently developed and validated genome technologies to study R gene deployment in top grown potato cultivars and to quantify the effector diversity within the Irish *P. infestans* population. This information will be utilised as a means to inform and guide the future breeding and commercialisation of novel potato varieties with durable resistance to late blight disease. T

FUNDING

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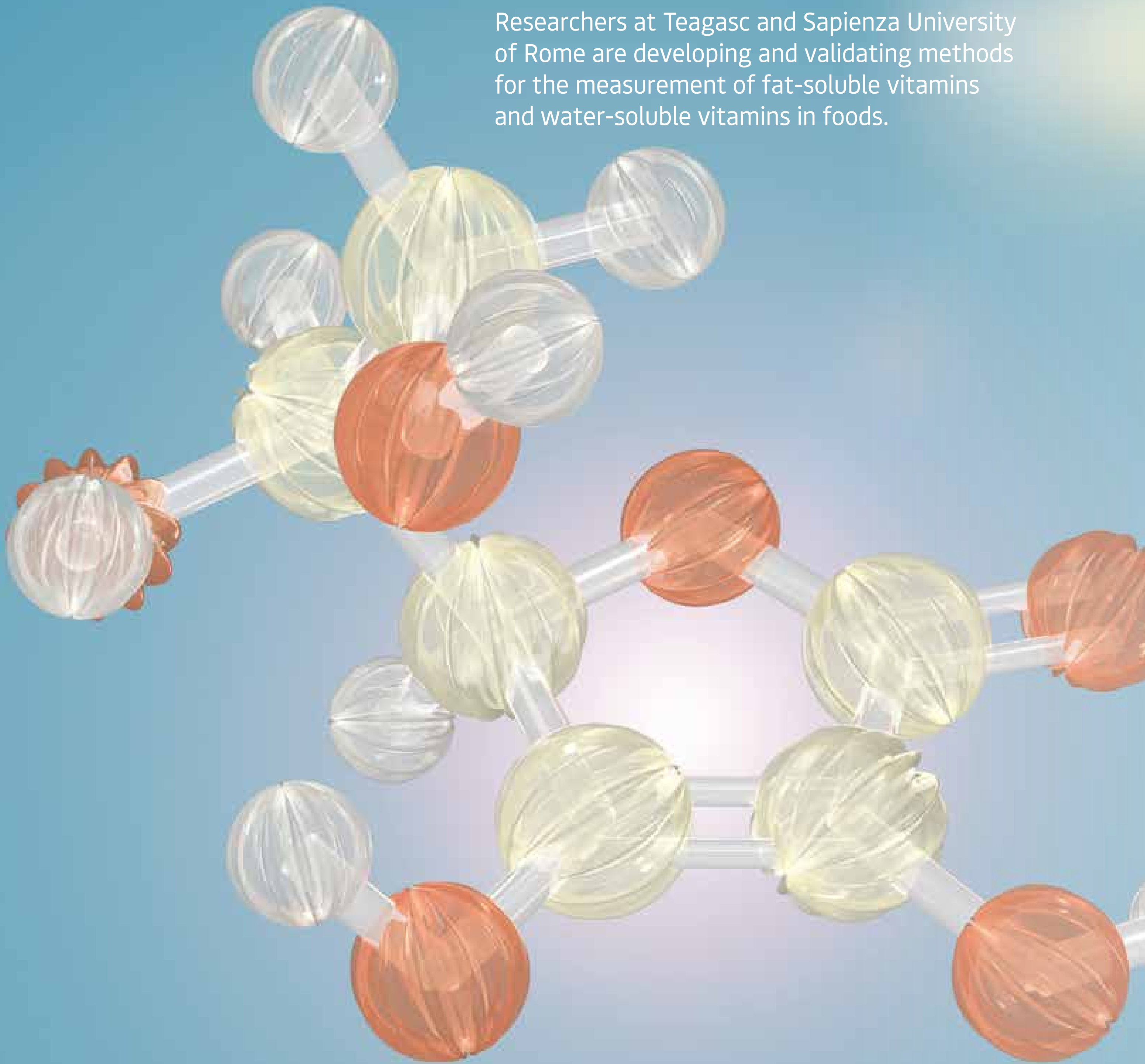
Advancing vitamin analysis in foods

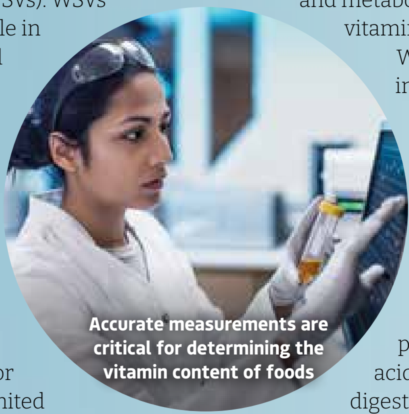
Researchers at Teagasc and Sapienza University of Rome are developing and validating methods for the measurement of fat-soluble vitamins and water-soluble vitamins in foods.



Vitamins are a vital component of our diet, essential for the normal functioning of the human body; prolonged deficiencies can lead to serious health issues. They have widely varying chemical and physiological functions and are broadly distributed in food sources.

Vitamins A, D, E and K are fat-soluble vitamins (FSVs), and play an essential role in a number of physiological processes, such as metabolic health, vision, bone health and immune response. The body stores FSVs in the liver, fat tissue and skeletal muscle, and reserves can stay in the body for months.

Vitamins B and C, on the other hand, are water-soluble vitamins (WSVs). WSVs are well known for their role in energy metabolism as well as in the maintenance of healthy muscles, skin, eyes, hair and liver. Unlike FSVs, they do not stay in the body for long and have limited storage, and are rapidly excreted by the kidneys (vitamin B12 is the exception to this, as it can be stored in the liver for many years). Due to the limited storage of WSVs in the body, they require routine intake.


Accurate measurements are critical for determining the vitamin content of foods

Limited vitamin research capabilities in Ireland

Accurate measurements are critical for determining the vitamin content of foods, the bioavailability of vitamins from food, and vitamin stability during handling, processing, storage and preparation. This information can be used to estimate population intakes, to establish dietary requirements, for governmental food fortification strategies and to research the relationships between diet and health.

In the food industry, the accurate measurement of the vitamin content of foods is required to ensure foods meet the specifications required by manufacturers and are within limits laid down by EU and international legislation.

At present, there are limited analytical methods for measuring vitamins in laboratories within Ireland, leading to a major gap in both analytical and research capability. The exception to this is the emerging capacity to measure vitamin K at Teagasc, and the measurement of vitamin D at University College Cork.

Teagasc's George Hull – a Research Leaders 2025 and Marie Skłodowska-Curie Fellow – is leading a project to bridge the gap in knowledge and produce two improved methods for measuring vitamins. He is doing this by exploring the use of liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) – a powerful analytical technique.

The challenges of vitamin extraction

The analysis of vitamins is challenging due to their unstable nature. Many factors contribute to this, such as exposure to heat, light and air. They also have complex chemistries and a range of compounds and metabolites that define each vitamin.

WSVs can be present in free form or bound to proteins or polysaccharides that are present in the food matrix, or they can be phosphorylated (attached to a phosphate group). To release bound or phosphorylated vitamins, acid hydrolysis or enzymatic digestion is required to enable the quantification of the total WSV content of food items.

FSVs can be present in free form, esterified (combined with an acid) or complexed (containing several groups of vitamins) to the food matrix. Alkaline digestion or enzymatic digestion is therefore required to release the bound forms of the FSVs and enable the quantification of the total FSV content of the food item.

Methods for vitamin analysis

The official international analytical chemistry reference methods for vitamins – those used to obtain and process information about composition and structure – are based on high pressure liquid chromatography (HPLC) techniques with ultraviolet (UV) or fluorescence detection (FLD). For WSVs, some microbiological assays are also used.

These techniques use old technology, with some of these methods having been established more than 25 years ago. For most of the vitamins, the official reference methods require a different method, which makes the analysis of vitamins very expensive and time consuming.

Research-performing organisations and private sector companies performing vitamin analyses routinely use official reference methods, as they are considered the gold standard and give a high level of assurance in the result obtained. However, the expense and time-consuming nature of these methods greatly impedes the vitamin research capabilities in Ireland.

LC-MS/MS has many advantages over HPLC and microbial assays. Concerning the latter, even though microbial assays are inexpensive and rapid, they have low specificity and sensitivity when compared to HPLC and LC-MS/MS. Moreover, microbial assays for WSVs require an individual method for each vitamin.

LC-MS/MS combines the chromatographic separation capabilities of HPLC with the identification capabilities of mass spectrometry, and thus has the ability to use isotopically labelled (those in which atoms are replaced by their stable isotopes) internal standards. Due to this, LC-MS/MS has a higher level of specificity, sensitivity, accuracy and precision when compared to HPLC. This therefore enables the ability to measure a greater number of vitamins in a single method, and provides a greater level of assurance in the result obtained.

Through this project, George and the wider project team aim to produce two LC-MS/MS methods – one for WSVs and one for FSVs – that are capable of measuring all the major vitamin forms and are compliant with the standards required to produce an official reference method. T

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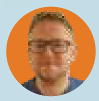
CONTRIBUTORS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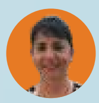
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iStockphoto.com: Shunyu Fan; sanjeri

A helping hand

The work Teagasc's Research Support Team does to assist researchers in their funding needs and reduce their administrative burden plays an integral part in Teagasc's success.

Photography: Finbarr O'Rourke

Research support is a vital function for researchers. At Teagasc, our researchers benefit from a research support team that is different from others. Covering the full spectrum of research activity, the team operates as a one-stop shop for researchers who want to apply for funding.

Making up the team is Head of Research Support Raymond Kelly, Research Support Executive Administrator Philomena Haughney, Senior Research Officer Órlaith Ní Choncubhair, Research Officer Ridhdhi Rathore and Research Support Administrator Siobhan McDermott.

The team may be small, but its impact is big. It provides clarity on funding agency

L-R: Research Support Team members Ridhdhi Rathore, Órlaith Ní Choncubhair, Siobhan McDermott, Raymond Kelly and Philomena Haughney

rules, assist in making connections for researchers internally and externally, endorse proposals on behalf of Teagasc and look after contracts and collaboration agreements for projects. This frees up researchers' time, allowing them to focus on the proposals themselves and helping to increase their success rate.

And that's not all. The team is also involved in other activities, including contributing to national and European research policy, leading European research coordination projects and running a fellowship programme cofunded by the EU. This additional activity contributes to the overall research ecosystem in Ireland and the EU, and increases Teagasc's profile. Crucially, it gives the team a better perspective on the entire research funding landscape, which allows them to perform their primary task – assisting researchers – more effectively.

To find out more about this impressive team and the work they do, we spoke with Raymond, Philomena, Órlaith and Ridhdhi.

When was Teagasc's Research Support Team officially established?

Raymond: Teagasc used to have administrative officers in each location, who provided support for the financial parts of research applications. However, there was no dedicated resource to assist researchers in applying for funding or managing the contracts that go with funded projects, which meant researchers had to figure out many aspects for themselves.

When Teagasc Director Frank O'Mara joined the organisation in 2006 as Assistant Director for Agriculture Research, he streamlined a number of mechanisms to support researchers. I then joined shortly after in 2008 as the first member of the official Research Support Team.

How has the team's scope grown since then?

Philomena: The initial idea was that our team would assist with applications, but that soon expanded to managing contracts and collaboration agreements that arise from successful applications. Over time, we also started to provide more support to the director of research for input to national and European research policy.

Órlaith: We also lead European projects and consortia ourselves. We have just wrapped

up the leadership of a six-year network of European funders that ran funding calls in the area of greenhouse gases in agriculture and forestry, known as FACCE ERA-GAS. That network funded 27 projects worth €37 million across four continents. And excitingly, we have just been awarded funding to lead a €4 million project that will support the work of the European Commission's Standing Committee on Agriculture Research (SCAR).
Ridhdhi: Another funding call we run is a €5 million programme for post-doctoral research fellows called Research Leaders 2025. This allows researchers to spend 18 months outside of Ireland at top research organisations worldwide, followed by an 18-month return phase in Ireland.

What are the core values of your team?

Philomena: One of our main values is that we are focused on our primary customers – the researchers within Teagasc. Our job is to make the process of applying for funding as smooth as possible for them, while also protecting Teagasc's interests.
Órlaith: We try to be innovative when finding new opportunities and collaborators for our researchers, adapting our operational practices to best serve staff.
Ridhdhi: Integrity is also very important to us. We are committed to honesty, sincerity and fairness in every facet of our work.
Raymond: As head of the team, I have always tried to foster a sense of teamwork. We all support each other and share the workload when needed.

€1.1 million

The Research Support Team has directly been awarded €1.1 million of Horizon Europe funding in the last six months.

How does Teagasc benefit from your work?

Raymond: Within the team, we have experience across the full range of research funding activity – from writing research agendas to managing the contracts and collaboration agreements that govern funded projects. This breadth of experience puts us in a better position to assist Teagasc researchers in securing funding to conduct the research that is core to Teagasc's mission. It also allows Teagasc to contribute to the wider research ecosystem at a national and European level.

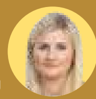
What are some recent achievements your team has contributed to?

Ridhdhi: In 2011, the total funding Teagasc secured was €9.6 million. In 2021, the total funding secured was €26.2 million. This success is primarily due to the hard work of Teagasc researchers, but we hope that we have also contributed to the increase in funding secured.
Philomena: We have also run a research images competition over the past five years. This has led to the production of a calendar every year and we now have a bank of images that can be used by Teagasc for promotion. We even held an exhibition of the images at the Department of Agriculture, Food and the Marine's head office.
Órlaith: Over the course of the European Commission's research and innovation funding programme Horizon 2020 (2014 to 2021), Teagasc was ranked sixth of all applicant organisations in terms of projects awarded in Societal Challenge 2, which deals with food, agriculture and the bioeconomy. In Horizon Europe, the successor to Horizon 2020, Teagasc is already ranked sixth for both the number of projects awarded and value of funding awarded in Cluster 6, which is focused on food, bioeconomy, agriculture and the environment.

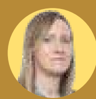
In good company

What is your favourite part of your role?

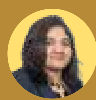
Raymond: I love the variety of the role and the opportunity to contribute to national and European policy.



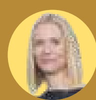
Philomena: For me it's helping and supporting colleagues, knowing that you are making things easier for researchers to carry out their projects.



Orlaith: My favourite part is when a connection we have made between researchers and external partners results in a lasting and successful collaboration.



Ridhdhi: I like that this role offers me the chance to see a variety of research proposals and research ideas pitched in innovative ways.



Siobhan: I enjoy assisting researchers with administration tasks and liaising with Teagasc colleagues and external collaborators in the review of agreements.

What are the challenges your team faces?

Raymond: The breadth of activities are our strength in that they allow us to see the full picture of research funding; however, it is challenging to maintain such a wide remit. We have to make sure that we continue to prioritise work and to act strategically.
Ridhdhi: Another challenge we face comes from the continuously changing national and EU research priorities and strategies that are needed to address emerging societal, economic and environmental challenges. In order to support this change, funding calls are also evolving.

Keeping ourselves up to date with funding calls' rules and research policies, and finding a way to marry these changes with Teagasc's

Team members all support each other in their roles

Integrity is very important to us. We are committed to honesty, sincerity and fairness in every facet of our work.

research activities, is the key challenge. However, this is the beauty of this area of work.

How does trying to secure national funding compare to international funding?

Órlaith: National funding programmes are informed by developments at EU and international level; however, they are tailored to the national context – our economic and political system, our most pressing societal and environmental issues, promising opportunities for development and our research ecosystem. This means that the scope of funding calls may differ from national to international level.

When applying for international funding, researchers have to find commonalities between partners operating in different geographical regions and diverse agricultural, food and forestry systems in order to create a cohesive project plan.

Have you noticed any trends or changes in funding processes over the years?

Raymond: Soon after I started at Teagasc, Ireland faced economic difficulties and the government prioritised applied research that would deliver impact for the economy and society. This focus fitted very well with Teagasc's remit. Over time, the national position has broadened, and the current national strategy refers to the full spectrum of basic and applied research.

However, given the centrality of climate change and food security as the key challenges of our time, I think that Teagasc is well placed to successfully attract funding at an Irish and European level in the years ahead.

What advice do you have for researchers looking to secure funding?

Órlaith: Tailor your application carefully to the specific funding programme and its aims and desired impacts, and take into account the policy context. Start preparations early and seek input or advice from colleagues, myself and the wider Research Support Team and other Teagasc offices.

Ridhdhi: I would add that you should build your network of collaborators. For early-career researchers, it is OK to start with a relatively small role in projects as you are building your reputation. If you contribute to the project, you will have an opportunity to join the next proposal with greater involvement, and soon enough, you will have the opportunity to lead projects. Also, consider signing up as an evaluator. It is an invaluable experience in understanding the review process.

Getting to know

Philip Creighton

Research Officer Philip Creighton currently leads the Sheep Grassland Systems research programme at Teagasc Athenry. Here, he explains the influence his sheep farming background had on him and what he enjoys most about grassland research.

Where did your interest in agricultural science stem from?

For as long as I can remember, I have been interested in farming and agriculture and wanted to work within the industry. Studying agricultural science at university allowed me to develop the skills and knowledge needed to achieve this.

I come from a sheep farming background, so I wanted to pursue a PhD that would allow me to develop skills relevant to the sheep industry. Teagasc had a strong grassland research programme with PhD opportunities available when I was finishing my undergraduate degree in 2008, so I applied. Thankfully, I was successful!

Why have you chosen to build your career at Teagasc?

I have been fortunate to meet and learn from some very good people at Teagasc. Having the opportunity to work on relevant areas of study, but also being involved in knowledge transfer through collaboration with our advisory colleagues, makes Teagasc a unique place to work.

Why have you chosen to focus on grassland in your research?

Grassland research is very varied. It provides opportunities to work on impacting many different areas of agriculture, including animal nutrition, economics and environmental sustainability.

Why did you establish the Sheep Research Demonstration Farm at Athenry?

It was set up to enable researchers to carry out detailed research on grassland systems for sheep. This allows us to expand our knowledge base and to act as a focal point for knowledge transfer activities for the sheep sector. It is very important that the industry can come in and see research as it happens and be involved in the process.

What has been a highlight of your career so far?

I was appointed as Teagasc's new Sheep Enterprise Leader last year, which is a great opportunity for me to continue to develop the Teagasc Sheep Research programme.

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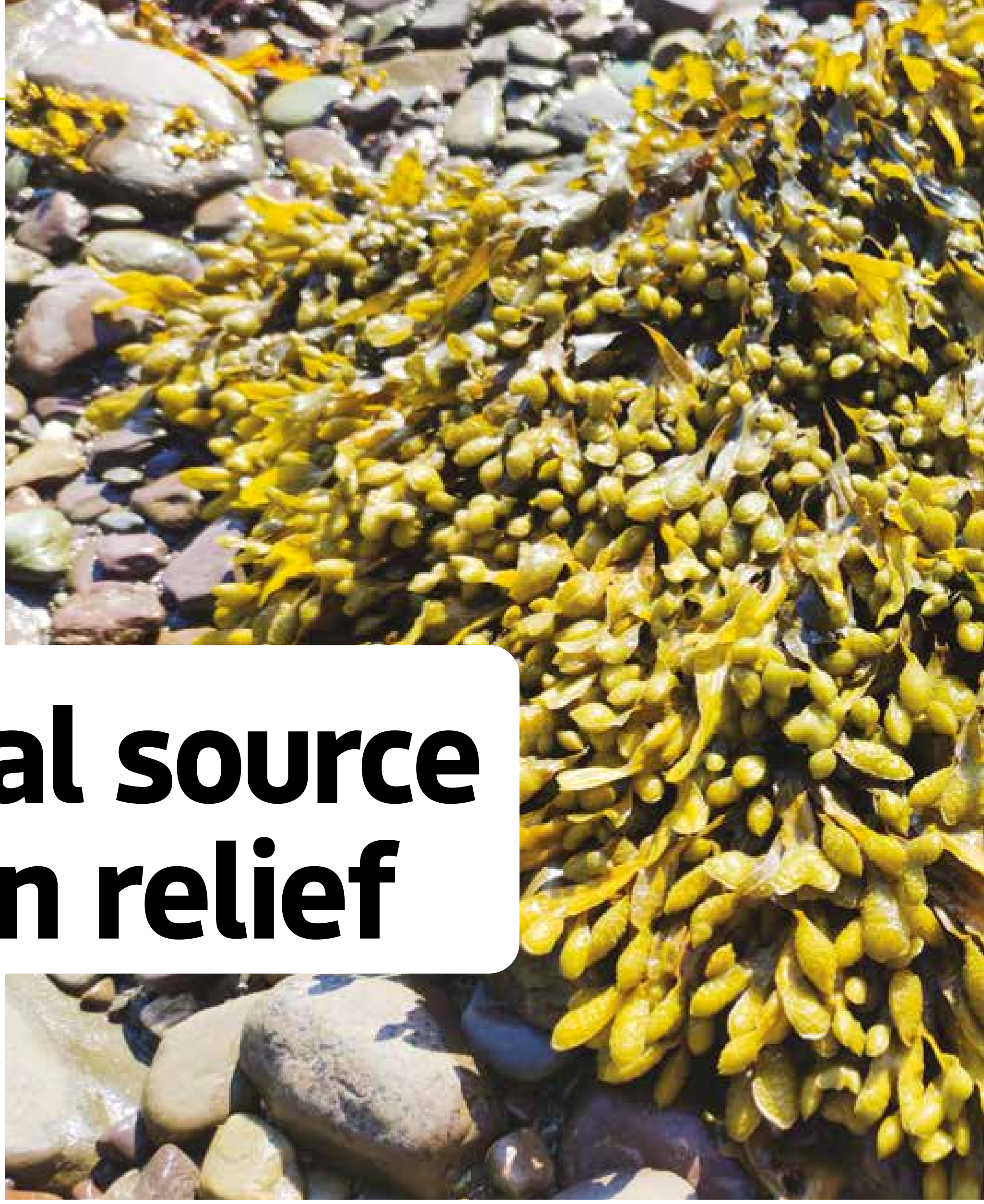

Algae: a natural source of pain relief

Molecules within algae are being used to develop functional foods and medication to relieve pain and inflammation.

Inflammatory Bowel Disease (IBD) is a serious disease that causes prolonged inflammation and damage to the human digestive tract. The term is usually used to describe Crohn's disease and ulcerative colitis – both of which, if left untreated, can result in permanent damage. More than six million people suffer from IBD globally; it can be very painful and disruptive, and in some cases may even be life threatening. The exact cause of the disease remains a mystery, and there is currently no cure.

As part of the European Union Horizon 2020 Algae4IBD project, researchers at Teagasc are exploring ways to identify and develop a set of novel small molecules derived from seaweeds and microalgae that can provide relief for sufferers of IBD. The project involves research institutes with experience in the harvest and aquaculture of seaweeds and microalgae, as well as gastroenterologists, food and functional food product developers and the pharmaceutical industry.

Teagasc's Maria Hayes, a researcher and coordinator of Irish activities in the Algae4IBD project, says: "The ultimate goal of the project is to develop nutraceuticals and drugs that can treat IBD and potentially prevent it, in order to support the wellbeing of sufferers."

Enzymes and inflammation

Inflammation is a form of protection for the human body, existing to help fight infection, disease and injury. However, if left unchecked, it can cause chronic or acute inflammation that results in pain, gastrointestinal issues and fatigue.

Several key enzymes in the human body – including cyclooxygenase enzymes 1 and 2 (COX-1 and COX-2) and monoacylglycerol lipase (MAGL) – play a role in the development of inflammation. These are considered targets that should be inhibited with drugs or functional food ingredients, to prevent inflammation and pain.

"Non-steroidal anti-inflammatory drugs (NSAIDs) like aspirin are commonly used pain relievers that decrease pain and inflammation by inhibiting COX enzyme activity," explains Maria. "The problem is, NSAIDs often have negative side effects for the gastrointestinal tract. The reaction caused by inhibiting MAGL activity, however, is known to stimulate natural pain relief within the body.

"The aim of Algae4IBD is to isolate and develop natural inhibitors of these enzymes and formulate them into functional foods for IBD sufferers."

Factfile

Microalgae are expected to become a key protein source in the EU within the next 50 years.

Why algae?

Although consumed for millennia as a food source in Asia and South and Central America, use of algae in Europe as a food, functional food or drug is largely only just beginning to be explored. The health benefits of small molecules found in seaweeds and microalgae is a relatively new area of biodiscovery for researchers, but marine species of both seaweeds and microalgae have tremendous potential for use as a reservoir of health-beneficial bioactive

Maria Hayes/Teagasc

> **Algae has tremendous potential as a functional food ingredient that can help to relieve pain.**

molecules and food ingredients.

The environment in which they are found lend these plants and microorganisms to develop defence mechanisms that often result in enhanced antimicrobial and antioxidative activities. In Ireland, there are over 600 species of seaweeds found around our coastline. In addition, microalgae can be successfully grown indoors using controlled conditions to optimise production and reduce contamination.

The catalyst for the Algae4IBD project came from the promising results of preliminary studies looking at microalgae. At the Algarve Centre of Marine Sciences in Portugal and the MIGAL Galilee Research Institute in Israel, studies identified the ability of whole microalgae to inhibit inflammatory biomarkers in cell lines. Before that, researchers at Teagasc and biomarine ingredients company Algaia, France, had identified the ability of extracts generated from the native brown seaweed *Ascophyllum nodosum* to inhibit enzymes key in the prevention of inflammation and pain.

Diving into algae research

Teagasc's main role within the Algae4IBD project is to generate, extract and screen for anti-inflammatory, anti-pain and prebiotic compounds from extracts generated from both seaweeds and microalgae supplied by partners or generated within Teagasc. This includes characterisation work using mass spectrometry.

ACKNOWLEDGEMENT

The project team would like to thank Noel McCarthy (Teagasc) for his contribution to this research.

Once active extracts are identified, the formulation of extract ingredients within functional foods will begin. The aim is to develop functional ingredients that IBD sufferers can consume easily, which provide benefits to them by reducing pain and inflammation, and which will be cheaper to purchase than currently available drugs.

40,000

It is estimated that over 40,000 people in Ireland suffer from IBD.

So far, Teagasc researchers have identified several extracts with prebiotic activities that help to promote the growth of beneficial probiotic bacteria species.

"We have identified two potential oligosaccharides (prebiotics that provide food for the good bacteria in the gut) generated at Teagasc from Irish and French seaweeds," says Maria. "Additionally, we have identified five seaweed and microalgae extracts that have demonstrated significant anti-inflammatory activities and cyclooxygenase and MAGL enzyme-inhibitory activities when assessed *in vitro*."

These oligosaccharides and extracts are proceeding to the next stage of the project – screening in mice to observe anti-inflammatory and anti-pain effects.

"There is more work to be done, but I am already excited about the direction this research has taken – it is exciting to know our work could really provide comfort and benefits to those affected by IBD," Maria concludes. T

FUNDING

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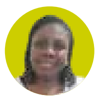


One-stop shop: introducing Teagasc's Bioprocess Innovation Suite

Following years of planning, Teagasc Moorepark is set to launch its new Bioprocess Innovation Suite – a one-stop shop for bioprocess development, optimisation and scale-up. Leading the project is Principal Research Officer at Teagasc Food Research Centre Olivia McAuliffe. Here, she gives us an insight into this exciting expansion and why it's so significant for Teagasc's research platform and the wider industry.

Photography: Fergal O'Gorman

Bioprocessing – a process that uses living organisms such as bacteria, yeast, fungi or animal cells to generate a desired end product – is hugely important for society. It is key to the food, pharmaceutical and energy sectors and several emerging industries and technologies, including the production of renewable biofuels such as biodiesel, therapeutic stem cells and new vaccines. It has also been identified as a key technology in helping to develop solutions to sustainability challenges in the food sector.

In the food industry, the process is often referred to as fermentation. The end product can be a consumer food product, such as yoghurt or cheese, or a compound that is produced by an organism and then purified, e.g. lactic acid, antibiotics or vaccines. Producing these products or compounds at scale requires very carefully controlled growth conditions for the organisms, and specific instrumentation is needed for that purpose.

Teagasc has been planning to expand its bioprocessing capabilities since as early as 2018, beginning with the successful submission of a grant proposal to Science Foundation Ireland seeking funds for new bioprocessing equipment. Acting as lead investigator on the submission was Principal Research Officer Olivia McAuliffe.

Olivia is a graduate of University College Cork where she received a PhD in Molecular Microbiology. She completed a research fellowship in the USA working on the then-emerging field of genomics of food microbes before taking up a role with Teagasc in 2003 developing new biotechnology tools for food-based microorganisms. She currently leads a research programme on cultures, fermentation and biotransformation at the Teagasc Food Research Centre.

Olivia, how did your initial request for new bioprocessing equipment turn into the development of a Bioprocessing Innovation Suite?

Science Foundation Ireland awarded us funds in late 2020, and with co-funding from Teagasc we set about procuring the new equipment. We realised a custom-designed

Olivia McAuliffe has led the project to launch Teagasc's new Bioprocess Innovation Suite

space would be needed to accommodate it, so capital funds were designated for a laboratory refurbishment. In early 2021, my team members and I began the design of the Bioprocess Innovation Suite. The work commenced in late 2021, and is expected to be finished in the coming months. It has been really great to see all aspects of the project coming together.

What does the suite consist of?

The new suite comprises a 64sqm fermentation laboratory that houses a state-of-the-art high-throughput microfermentation system, allowing 48 1mL fermentation reactions to run in parallel. We also have a range of lab-scale bioreactors, from 200mL to 20L. Then, linking with our partners at Moorepark Technology Ltd, we will have up to 270L at pilot scale. This wide range will offer seamless scalability from early bioprocess development to pilot scale production.

How will this new equipment support different research areas?

It will be used to innovate in the development of new fermented food products and the production of new food ingredients, as well as in exploiting the Teagasc bacterial culture collection for new and exciting uses for organisms. Another key area is the use of bioprocessing in the recycling of co-product or waste streams from the food processing industry.

What might the end products from the suite be?

Bioprocessing offers endless possibilities as every organism produces a range of metabolites that could be of value depending on the end user. Some that are of interest to us are natural food ingredients for texture, flavour and colour, protein-enriched fermented food products, bioplastics and biogas.

How will you use the new facility to carry out your own research?

A key research area for my team is harnessing the use of microorganisms to convert waste streams from dairy and plant processing, which would otherwise be discarded (causing damage to the environment), into useful products.

Finding the right combination of waste stream and microorganism can be time-consuming work, but the new facility will allow us to run many parallel experiments with lots of variables at high-throughput scale, providing a step-change in our capability to deliver innovation in this area.

How significant is this suite for Teagasc?

It is hugely significant for Teagasc as it provides for us, for the first time, access to the full value chain of bioprocessing capability, increasing our research in the fermentation and biotransformation space.

It will help to expand our capabilities, particularly in the utilisation of low-value substrates and waste streams, a key element of developing sustainability in the food system.

Is there anything innovative about the suite that sets Teagasc apart from other institutions?

What sets our facility apart from others is the link between the research scale in the Bioprocess Innovation Suite to the pilot plant scale at Moorepark Technology Ltd. This, along with access to other research infrastructure at Teagasc – such as downstream processing, next generation sequencing and flavour chemistry – will ensure that researchers have access to a wide range of high-end analytical capabilities to complete their research.

Up close and personal

What's your favourite animal?
Our 13-year-old collie, Cailín; she's a huge part of our family.

If you hadn't ended up in research, what other job would you have wanted to give a go?
As a kid, I wanted to be an airline pilot. I have taken some flying lessons since, but I think it is best left to the professionals!

What are you most proud of professionally?
I am currently Senior Editor for the Dairy Foods section of one of the leading dairy journals, and I am also Deputy Chair of the Standing Committee on Microbiological Hygiene at the International Dairy Federation. It is always a hugely proud moment to be invited to participate at an international level in your area of work.

See page 4 for an infographic on bioprocessing

Will it only be accessible to Teagasc researchers?

No, our wider research community will have access. As will our academic and industry collaborators, providing a national platform and new opportunities to further collaborate in new research projects.

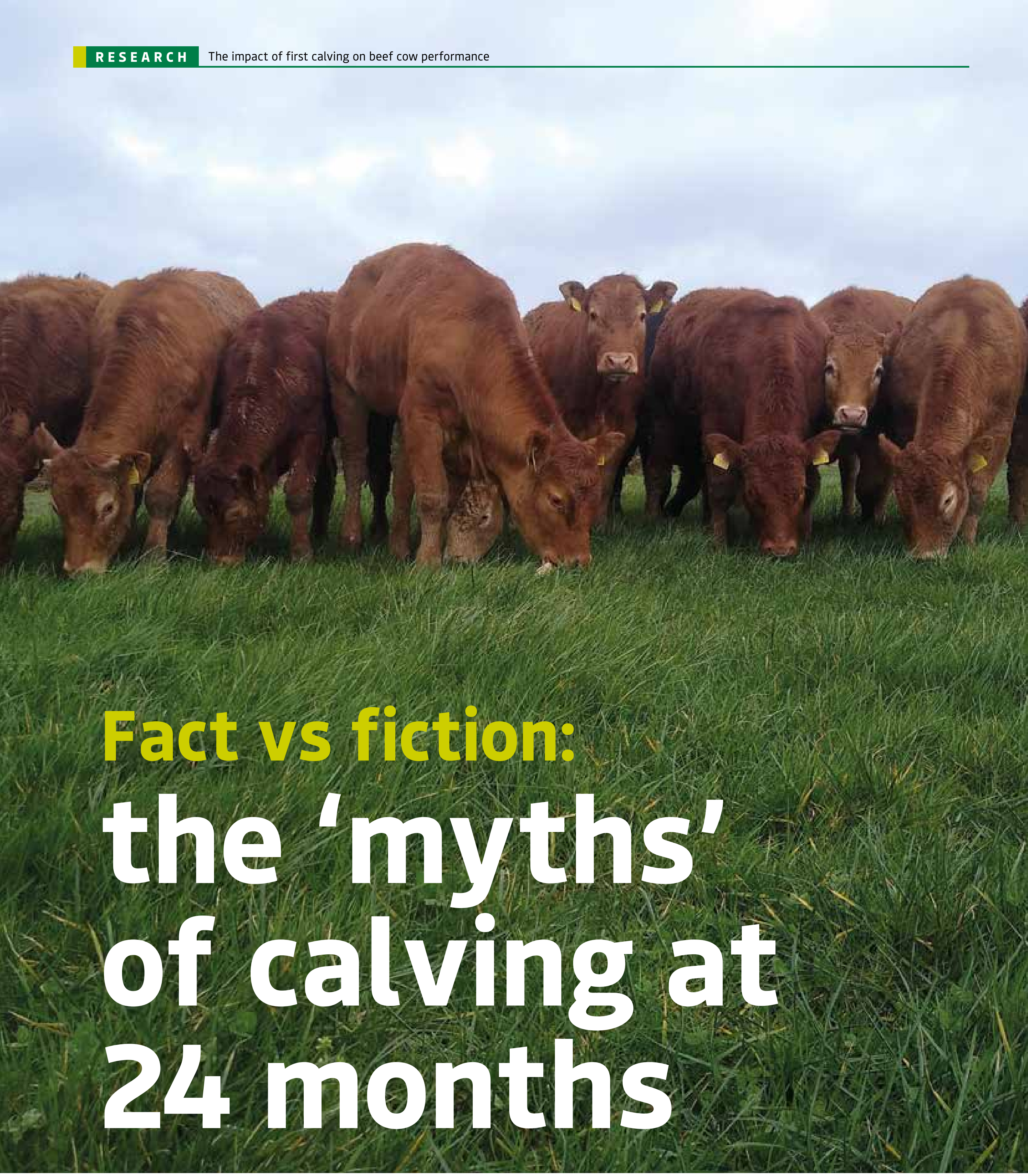
Once fully up and running, the suite will also be available as a direct service model facility to new collaborators and clients.

Having led this project, what are you most proud of?

I am hugely proud of the Teagasc team who worked with me throughout this project. From the researchers to the buildings and facilities staff, I could not have done it without their invaluable help and support and a steer in the right direction from time to time!

What are you most excited about regarding the suite being officially launched?

I am looking forward to the opportunity to meet new users of the facility and the possibilities that this will present for building new partnerships to tackle the major issues facing the food system.



Fact vs fiction: the ‘myths’ of calving at 24 months

Contrary to popular belief, calving beef heifers at 24 months of age has no negative implications on subsequent lifetime performance when compared to calving heifers at 36 months.

Photography: Andrew Downes, XPOSURE

The age beef heifers calve for the first time is a cause of contention among beef farmers. The argument usually boils down to two sides: those that calve heifers at 24 months and those that calve heifers at 36 months.

Although there are pros and cons for both, calving heifers at 24 months of age is the most profitable option for beef farms. Many of the cons for calving at 24 months are anecdotal, but recent research carried out at Teagasc has teased out the truths among these myths.

The realities of calving at 24 months

First and foremost, calving at 24 months reduces the rearing cost of replacement heifers. Older heifers have a higher rearing cost up to the point of calving, with a higher cost to offset when they are productive. In addition to this, older heifers have a larger environmental footprint, as they have higher methane outputs.

Other benefits of calving at 24 months include reduced labour costs, as there are fewer stock groups to manage. There is also an opportunity cost that comes with calving at 36 months, as the increased stocking rate could be replaced with more suckler cows or finishing stock.

It's not without hard work, however. Good management and genetics is required to achieve calving at 24 months. Good growth rates in early life is critical to ensure heifers reach their target weight at breeding, which is 15 months of age. Selecting heifers with a high Replacement Index is known to reduce the first calving age, as they reach puberty sooner and are more fertile. Nevertheless, management is also important to ensure they have the opportunity to express their genetic potential.

While genetics and management are improving on herds nationally, the proportion of heifers calving at 24 months has not improved for 10 years. This could be due to beef farmers' preferences. Heifers may have had the potential to reach puberty and be fertile, but if they are not served, they do not have the opportunity to calve at 24 months of age.

23%

Only 23% of beef heifers were calved between 22 and 26 months of age in 2021.

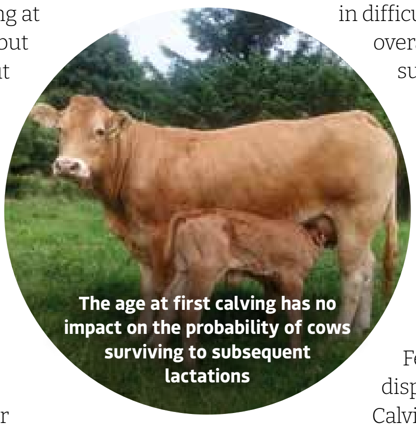
VS

74%

In comparison, 74% of dairy heifers were calved between 22 and 26 months of age in 2021.

Unpacking the preference for calving at 36 months

If farmers decide not to calve heifers at 24 months, they usually wait until the subsequent calving season, which will result in heifers calving for the first time at 36 months. The reasons for this are usually due to perceived anecdotal consequences of reducing the age of first calving. For example, some believe it will stunt growth, result in difficult calving and reduce overall performance in subsequent years.



The age at first calving has no impact on the probability of cows surviving to subsequent lactations

However, recent research using data collected through the Department of Agriculture, Food and the Marine scheme BEEP, as well as national data available from the Irish Cattle Breeding Federation (ICBF), actually dispels some of these myths. Calving difficulties were more prominent in heifers that calved at 24 months compared to 36 months (assuming genetic merit for calving difficulty of sire and dam was equal), but overall there was a higher number of calving difficulties in heifers irrespective of the age at first calving, when compared to mature cows. To mitigate this, farmers could use a very easy calving bull to minimise the risk of a calving difficulty. In addition, age at first calving had no effect on the risk of calving difficulties in future lactations.

It is often believed that heifers at 24 months are not mature enough to calve, which will influence subsequent performance. Fertility of heifers in subsequent lactations is a good indicator of a heifer's ability of coping after calving and being able to cycle again. Heifers that calved at 24 months had a more desirable calving interval in lactation one, compared to heifers that calved at 36 months. As well as this, the age at first calving had no impact on the probability of cows surviving to subsequent lactations.

Doing what is best in the long-term

One performance trait that did tend to be affected by calving at 24 months was weaning weight. Assuming equal genetic merit for beef traits, they weaned lighter calves in early lactations; however, the total amount of weight weaned is more for the cow throughout their lifetime, as they will produce an extra calf over the period, which negates the lighter weaning weight in the early lactations.

Finally, there is anecdotal belief that calving at 24 months will stunt growth. Analysis of the BEEP data showed cows that calved at 24 months were lighter at first lactation, but with each new lactation cycle their weight difference decreased, and by lactation five there was no difference to cows calved at 36 months. This suggests that cows were able to cope with the stress of calving and rearing to continue their growth and reach equal mature weight by the fifth lactation. And having a lighter cow in earlier production years is actually beneficial, as they eat less and have a lower environmental footprint.

Achieving 24-month calving in beef heifers certainly poses many challenges, but it can be done with the right genetics and good management. This research shows that many of the fears around calving at 24 months are unfounded, and that it is actually beneficial for overall cow productivity. T

FUNDING

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Purported tomb of St. Nicholas

Unearthing buried secrets

As well as being the rumoured burial place of St Nicholas, the deserted medieval village of Newtown Jerpoint has many secrets about rural life in medieval Ireland waiting to be discovered.

Ruin of St Nicholas' church, Jerpoint

In the lead up to Christmas, the social media attention generated by the deserted medieval village of Newtown Jerpoint – located on the southern bank of the River Nore near Thomastown, Co. Kilkenny – hones in on a tale in local folklore connecting an elaborate tomb near the village's ruined church with the bones of St. Nicholas, the man who inspired Santa Claus.

This connection is not necessarily as improbable as it first appears: at the time when settlers from Norman England and Wales were establishing the village at Jerpoint in the early 13th century, several churches around Europe claimed to possess relics of St Nicholas' body, some as small as a single finger bone.

While there remains no strong evidence to support this tale, the village is still of intrigue. Places like Newtown Jerpoint have over the last fifteen years become subject to more research in an effort to better understand society, settlement and economy in medieval rural Ireland.

One person conducting such research is Teagasc Walsh Scholar Daniel O'Mahony, whose project has sought to re-examine existing data and incorporate new information from a geophysical survey and previously undiscovered documents to flesh out a narrative about rural life in Ireland from the 1200s to the late 1600s.

Using technology to retrace old structures

By the end of the 13th century, Newtown was known to possess a tannery, a brewhouse, a mill, a court and a parish church. The single biggest industry in the village, however (as was the case everywhere in medieval Europe), was farming.

In 2007, a laser-based remote sensing technique known as LIDAR (Light Detection and Ranging) was carried out by the Discovery Programme – Ireland's national archaeological research body supported by the Heritage Council. Through the resulting survey, scholars were able to identify a rare Irish example of ridge and furrow (an archaeological pattern of ridges and troughs), synonymous with high-yield arable output across the continent at the time.

"This type of agriculture was typically carried out in an unenclosed three-field crop rotation system," explains Daniel, "where tenants of different grades would hold strips scattered across the fields, ensuring them a fair distribution of planted and fallow ground.

"These strips were ploughed into ridges using a heavy plough drawn by a team of oxen. In order to turn across the headland, the team had to be directed to the left to be brought back around for the next pass, resulting in a reverse 's' shaped mound. These 'selions', as they are known, are visible in the boundaries of the property plots within the village (Figure 1), indicating that the land was under cultivation before the foundation of the village."

This method of landscape organisation and cultivation for increased crop yields was connected with a growing population and a warm climactic period that lasted until the start of the 14th century. In this period, a numerically small but socially impactful population movement from the central continent and Britain to peripheral countries like Ireland, as well as Slavic countries in the East, resulted in many new settlements such as Newtown.

Mixed farming

After the end of the warm period, reliance on arable farming – particularly in marginal areas – proved impractical and possibly resulted in the shrinkage of a number of settlements. The Bruce Invasion of Ireland (1315-1318) and the Black Death during the mid-century also contributed to the declining fortunes of Ireland's agricultural settlements.

Newtown Jerpoint has become subject to research to better understand society in medieval rural Ireland.

Newtown continued to exist mainly thanks to the existence of its market, a nearby bridge and the fertile lands of the Nore valley.

"Farming became more mixed, incorporating sheep and other livestock," says Daniel. "The nearby Cistercian monastic community at Jerpoint Abbey were known to have been expert sheep farmers, and the market at Newtown would have benefited from the trade they brought in wool and meat."

A record from 1375 lists a great number of goods likely to appear for sale at the market in Newtown, including a variety of oats, animal meat and hides, cloth, fish and raw materials. The importance of husbandry can be seen reflected in the domestic architecture in the village. Peasant longhouses have been identified for the first time by this research both on LIDAR imagery and on a recent geophysical survey of the settlement (Figure 2). These buildings had two chambers, with the eastern end usually functioning as a shed for the housing of animals.

Desertion and destruction

Newly discovered documents detailing late 17th century landholding in the area points to the consolidation of farm land by wealthy individuals – a process which appears to have begun as early as the 15th century, and which went hand in hand with depopulation and, ultimately, land enclosure.

By the beginning of the 17th century, the village of Newtown was largely deserted, with perhaps only a handful of cottagers inhabiting the 'long street' through the village. These were likely labourers on one or more large farms held in tenure by wealthy locals.

Based on field surveys and cartographic analysis carried out during research, it can been shown that the land around the village was not enclosed in the manor we are familiar with today, until after it had been deserted in the late 17th or early 18th century.

"Around the time of the Great Famine in the mid-19th century, locals cleared the ruins of the village to make room for potato drills," says Daniel. "Further geophysical survey is planned for later in the year to determine the full extent of settlement at Newtown, and possibly the location of an earlier settlement called Oldtown.

"Today, the owners of the land provide tours of the site, while sheep browse the grass over its remaining hidden secrets." T

FUNDING

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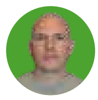


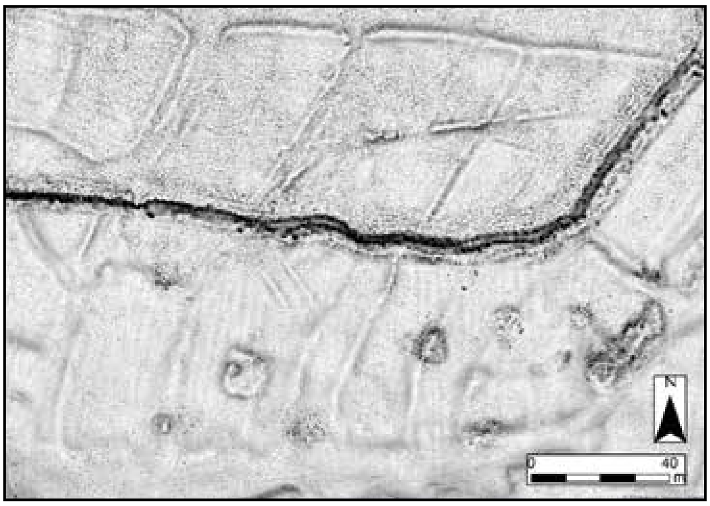


Figure 1. LIDAR image showing curving boundaries likely formed from earlier 'selions'

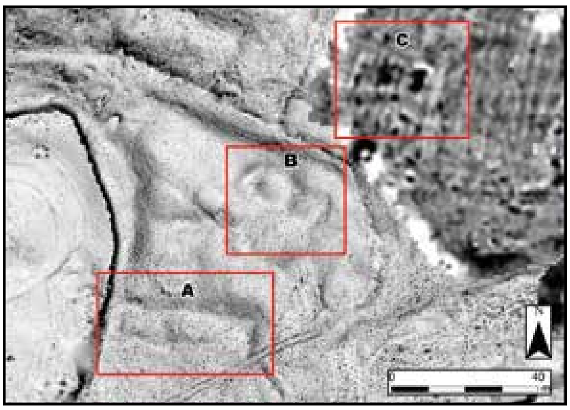
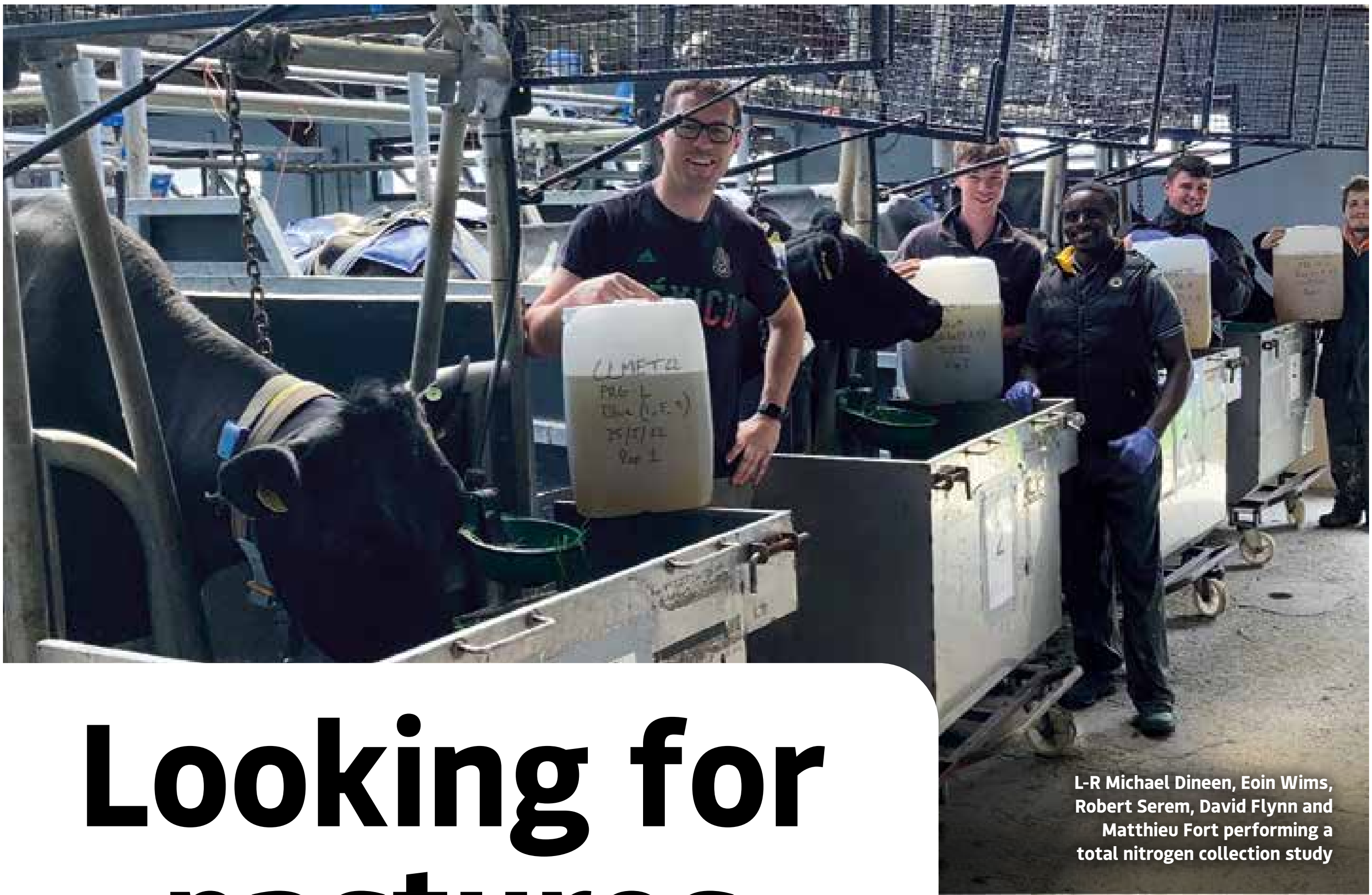


Figure 2. LIDAR image showing longhouses (combined with a magnetic map)



L-R Michael Dineen, Eoin Wims, Robert Serem, David Flynn and Matthieu Fort performing a total nitrogen collection study

Looking for pastures NUE

Researchers from Teagasc, University College Cork and University College Dublin have come together to reduce the output of ammonia, nitrous oxide and nitrate emissions from grazing dairy cows.

Despite the positive effect nitrogen fertiliser use has on agriculture production, it is poorly utilised. Due to the high nitrogen requirement of perennial ryegrass (PRG), excessive amounts of nitrogen relative to the animals' demand can accumulate in the sward.

Farm gate nitrogen balance and nitrogen use efficiency (NUE) are the two most widely used indicators of nitrogen efficiency in pasture-based systems. Animals consuming such swards typically exhibit low NUE, contributing to environmental challenges such as ammonia and nitrous oxide emissions and nitrate leaching into groundwater.

PASTURE-NUE – a collaborative project between Teagasc, University College Cork and University College Dublin – is actively exploring how the agricultural industry can improve management practices to mitigate the current trade-offs between the production of agricultural goods and environmental sustainability. It will quantitatively measure the NUE and environmental footprint of various pasture-based diets, and highlight dietary strategies with the greatest potential to abate nitrogen emissions.

Plantain's role in supporting white clover

PRG-based systems require 200–300kg of nitrogen input per hectare to maintain productive growth rates of high-quality pasture. The incorporation of the biological

PhD student Chris Heffernan collecting pasture samples from a commercial dairy farm nitrogen fixation capability of leguminous plants – those that can convert nitrogen gas into a usable form for plants – will be imperative to ensure the economic sustainability of farms. This will also maintain Ireland's ability to produce nutritionally superior dairy products from home-grown pasture.

The inclusion of white clover (WC) into PRG swards can increase the milk production efficiency of lactating dairy cows while simultaneously reducing the amount of chemical nitrogen fertiliser required. Furthermore, PRG-WC swards increase the farm gate NUE compared with PRG-only swards.

The issue, however, is that as a system's total nitrogen inputs increase, there is an exponential rise in the amount of nitrogen that can be leached, regardless of where the nitrogen input comes from.

Plantain, a forage herb, has been shown to complement PRG-WC swards by further increasing milk production efficiency while reducing the risk of nitrogen leaching and nitrous oxide emissions. In a series of experiments in New Zealand, the inclusion of plantain was demonstrated to increase the overall NUE of lactating dairy cows, partition a greater proportion of the excreted nitrogen into faeces rather than urine and alter the animal's urinary physiology, resulting in waste with a lower nitrogen concentration.

20%

less fertiliser must be used within agriculture by 2030, according to EU targets.

Testing the benefits of plantain

Recent research in Teagasc, where researchers conducted a grazing plot study over two years investigating plantain inclusion, showed that PRG-WC-plantain swards achieved higher dry matter production (crucial for livestock's health and production) when compared to PRG-WC swards. Furthermore, at the end of the experiment the plantain still contributed substantially to the sward's dry matter production. Due to the numerous benefits plantain could offer, it is critical that such swards are further evaluated under Irish conditions.

Perennial ryegrass-white clover-plantain swards

Researchers at both Teagasc Moorepark and University College Dublin are performing a number of total nitrogen collection studies to accurately quantify the nitrogen loss abatement potential of swards containing white clover and plantain. These experiments involve mass balance experimental techniques, whereby all animal inputs (i.e. feed) and outputs (i.e. milk, urine and faeces) are weighed and analysed to accurately determine NUE.

Researchers at Teagasc Johnstown Castle will then incorporate the waste material into its studies to fully quantify the environmental nitrogen emissions from cows consuming such swards. Drone imagery (to identify urine and dung patches) will be used for the purpose of upscaling fluxes from single or simulated point sources to the paddock level, to quantify grazing systems' emissions factors.

The outcomes of these experiments will be used to derive new nitrogen emission factors to increase accuracy when determining the contribution from grazing animals to the national nitrogen emissions inventories.

Strategic supplementation

In periods of inadequate grass supply, additional dietary strategies exist to improve the NUE of pasture-based systems, such as low nitrogen strategic supplementation and the incorporation of complementary feed additives. To understand if such strategies would be beneficial across the country, PASTURE-NUE is engaging with 28 commercial farms as part of an 'on-farm' sampling programme.

This programme will develop a national database on the chemical composition of pasture and supplemental feeds across multiple years, as well as tools capable of rapid chemical composition determination and dissemination. From this, new strategic supplementation programmes will be designed. The efficacy of these programmes to increase the NUE of pasture-fed cows will be evaluated in large randomised controlled studies.

Finally, comprehensive characterisation of the dairy products produced from these dietary strategies, as well as from the white clover and plantain swards, will be performed by University College Cork to ensure the superior attributes of 'pasture-fed' products are maintained.

As the knowledge outcomes from PASTURE-NUE are captured in a data centric manner, stakeholders such as regulators and policy makers will be able to implement the outcomes of this project into environmental modelling and national inventory calculations. Ultimately, PASTURE-NUE will increase the efficiency of nitrogen utilisation in pasture-based systems, preventing or diminishing the unwanted impact of nitrogen on the environment. T

FUNDING

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Technologies for today and tomorrow

Teagasc experts are highlighting how technologies are being used to turn the challenges of sustainability into opportunities on Irish farms.

Farmers are facing increasing economic, social and environmental challenges in the drive towards sustainability. The EU Green Deal has set targets to halt biodiversity decline, improve water quality and reduce fertiliser and pesticide use. Nationally, Ireland has set very challenging environmental targets around reducing greenhouse gas (GHG) and ammonia emissions.

Urgent work is needed to implement technologies that are known to support the achievement of these targets, but are at the same time economical for farms. Teagasc's David Wall, Principal Research Officer and Enterprise Leader, and Karl Richards, Head of Environment, Soils and Land-use Research Department, recently highlighted a range of these technologies at their 'Farming for a Better Future' event at Johnstown Castle, to support sustainability on Irish farms.

"There are a large number of proven technologies available to improve environmental sustainability on farms," says David, "but early action is required in order to reverse trends. Farmers need to tap into the support of farm advisory services to adopt these technologies on their farms.

"Many of the technologies have multiple benefits and also improve farm profitability and, promisingly, researchers are continuously investigating newer technologies to help farmers further improve sustainability."

Here, we take a look at some of the technologies available to farmers that can support sustainability goals.

Farmers need to take action to improve declines in important farmland pollinators

Optimising livestock production systems

Continued improvements in grazing management, breeding of efficient animals, reducing the age of slaughter and increasing home-grown feed supplementation are proven technologies that will lead to further reductions in emissions in livestock production systems.

In addition to these, newly emerging technologies are also being tested for Irish systems, such as feed additives for reducing biogenic methane and the breeding of lower methane-emitting animals, holding the potential to reduce emissions further over time.

2050

Technologies at systems level are required to meet climate neutrality by 2050.

Enhancing biodiversity

There are declines in important farmland bird species and pollinators in semi-natural habitats across Ireland. A recent survey of intensively managed farms found that the median wildlife habitat area was 5% (tillage), 6% (intensive beef) and 6.6% (intensive dairying).

There are many ways that farmers can actively improve habitats and wildlife on their farms to help achieve targets. A range of technologies such as multispecies swards, hedgerow management, field margins and results-based payment schemes are available to enhance on-farm biodiversity. Researchers are also investigating approaches to quantifying farmland habitats and management plans.

10%

The EU Biodiversity Strategy aims to have at least 10% of agriculture areas under high-diversity landscape features by 2030.

Reducing fertiliser use

Nitrous oxide (N_2O) emissions from nitrogen fertiliser, manures and urine account for around 30% of agricultural emissions. The remaining 70% comes mainly from slurry management and animals directly.

One big challenge farmers face is to dramatically reduce reliance on imported, fossil fuel-derived fertilisers. There are a range of proven technologies available today to reduce this reliance. Optimising soil fertility releases around 70kg N/ha from the soil and reduces fertiliser requirements, which in turn can reduce emissions by around 40%. The use of low emissions slurry spreading increases the nitrogen supply in slurry, which also reduces fertiliser requirements. Finally, replacing urea and calcium ammonium nitrate (CAN) with protected urea can reduce emissions; so too can certain low nitrate compound fertilisers.

25%

Ireland has set a target for agriculture to reduce greenhouse gas emissions by 25%.

Improving water quality

The effect of agriculture on water quality has been subject to large amounts of research over the past 20 years. While Irish water quality is above average within the EU, only 53% of Irish waters are ranked good or high status, so rapid improvements are needed.

There are a large number of technologies available for farmers to control nutrient loss from farm yards and hard standings and diffuse losses from fields. Good nutrient management planning is a cornerstone to reducing diffuse nutrient losses, and interactive tools such as Teagasc's NMP Online will be critical to support farmers.

Our Agricultural Catchments Programme has greatly improved the science behind water quality and has developed a new critical source area tool, which highlights areas for farmers to address on their farms. Farmers can also make use of the Agricultural Sustainability Support and Advisory Programme (ASSAP), which provides free advice on the implementation of appropriate technologies in areas with poor water quality.

Utilising carbon sequestration

Agricultural soils are a source of emissions in the land-use and forestry part of the national GHG inventory. The potential carbon sequestered in our mineral soils is four times lower than the carbon lost from agricultural peat soils, which need more specific management to mitigate GHG losses going forward.

Currently, carbon sequestration is accounted for in the inventory using default values. New research is underway to produce country specific emission factors for different soil types, land-use, land management practices and water table management of peat soils. This will improve the accuracy of the inventory and quantify a number of technologies to reduce emissions from soils and enhance carbon sequestration.

Increasing trees on farms through hedgerow management, on-farm forestry and agroforestry will increase carbon sequestration and is subject to new research. The emerging area of carbon farming is also being researched.

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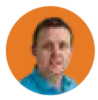

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Decarbonising Ireland's farms

Teagasc researchers are exploring ways in which farmers can reduce their reliance on fossil fuels and improve their energy efficiency.

Fossil fuel costs are continuing to escalate along with future uncertainties in fuel supplies. As such, the use of renewable, home-grown biomass as a heating solution in agriculture is becoming more and more relevant, particularly to the poultry, pig, dairy and horticultural sectors.

To support work in this area, Teagasc is a partner on AgroFossilFree – an EU Horizon 2020 project focused on how farmers can improve their margins by cutting energy costs. The project is helping farmers improve their energy efficiency and deploy renewable technologies, while also improving their farms' financial and environmental sustainability.

AgroFossilFree seeks to create a framework under which farmers, advisors, educators, researchers and technology developers and providers will co-operate to evaluate and promote currently available Fossil-Energy-Free Technologies and Strategies (FEFTS) in EU agriculture.

Contributing to EU policy

AgroFossilFree fits in well with EU policies and strategies. The EU has a target to become the first climate-neutral continent by 2050. At the heart of its plan to achieve this target are policies centred on clean energy and farm-to-fork methodology. They include approaches to energy, climate mitigation and adaptation, land, agriculture and digital technologies, and need to be fostered at European, national, regional and local level.

Many sectors are putting effort into furthering renewable energy and energy efficiency, but agriculture is lagging behind. There are many experiences and lessons that we can adapt from these sectors, however, to apply in agriculture's move towards de-fossilisation.

AgroFossilFree will produce recommendations and ideas on future research and innovation projects that could assist in developing new FEFTS or optimising existing ones, to be integrated in farming processes in the best way for farmers to get along with. In addition, the project will produce policy guidelines to be submitted to the European Council on how to achieve the goal of de-fossilisation in European agriculture.

The steps will be presented as a roadmap, with the analysis of the current energy status in the sector used as a basis. The policies and strategies derived by this process will start from the sub-sectors that are the most fossil-energy consuming and the least energy efficient.

Going national and international

As part of the research project, Teagasc has been involved in three national and two international workshops, focusing on topics such as horticulture glasshouse energy, open field agriculture and livestock energy systems. The main theme of these workshops was the use of FEFTS.

Out of AgroFossilFree also came AgEnergy – an online platform containing all available FEFTS in the form of easily accessible and comprehensive end-user material. It provides easy access to available FEFTS and allows users to interact with relevant stakeholders to express ideas and needs.

It is widely acknowledged that the way we produce and use energy is going to change dramatically over the coming years due to the drive to decarbonise our energy use. Renewable energy options have been offering many benefits for farm businesses across Europe for decades, and the publication of the Irish Government's Climate Action Plan has been positive towards on-farm renewables. Opportunities will exist for farmers to improve their energy efficiency, generate renewable electricity and sell the excess to the grid, and the learnings from AgroFossilFree can help in navigating this. T

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Events: my take-home message

Teagasc's researchers attend many events throughout the year, sharing the findings from their research with national and international audiences. Here, we capture take-home messages – the key pieces of information that our researchers want people to remember – from recent events.

Climate smart technologies for nutritious and safe foods

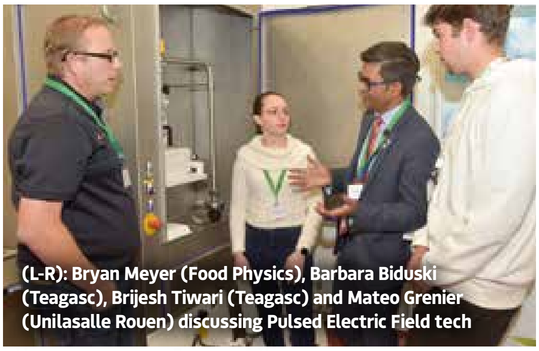
Event: Teagasc Food Innovation Gateways
Date: 5 October 2022

Food Innovation Gateways is part of the Teagasc Food Technology and Knowledge Transfer Strategy to support Irish food companies. This event presented the latest technologies to support food companies in meeting the challenges of producing climate-friendly, nutritious and safe foods. Over 130 people attended from the wider Irish food industry.

"At the heart of this event is the importance of innovation in developing opportunities to meet consumer demands whilst meeting climate change commitments," noted Shay Hannon, Teagasc National Prepared Consumer Food Centre Manager.

"Climate-smart food production is achievable. Through continued research and development and collaboration we can guarantee food security, increasing productivity and incomes, enhancing resilience of livelihoods and ecosystems and reducing and removing greenhouse gas emissions from the atmosphere."

During the day, John Ryan, R&D Packaging Director International at The Kraft Heinz Company, Netherlands, gave a great insight into how Kraft Heinz are developing sustainable packaging formats, such as paper-based Ketchup bottles. This was followed by a presentation from Edel Clancy, Director of Communications and Corporate Affairs at the Musgrave Group, Ireland.



(L-R): Bryan Meyer (Food Physics), Barbara Biduski (Teagasc), Brijesh Tiwari (Teagasc) and Mateo Grenier (Unilasalle Rouen) discussing Pulsed Electric Field tech

Edel spoke about Musgrave's sustainability strategy and its work with retail partners, suppliers and customers to reduce carbon emissions to reach net zero carbon by 2040.

There was also a panel discussion with a number of high profile food industry representatives, chaired by Teagasc's Head of Technology Transfer and Commercialisation Siobhan Jordan.

Save the date

Teagasc national dairy conference – turning challenges into opportunities

Event 1: 6 December – Rochestown Park Hotel Cork
Event 2: 8 December – Mullingar Park Hotel Westmeath

After a three-year absence, this year's Teagasc national dairy conference programme is a welcome return. Leading farmers and researchers will share insights on maintaining farm productivity at lower nitrogen inputs, and the potential for technology to deliver a higher-value calf crop will be explored.

Join us to get updates and participate in practical discussions on technical topics, such as methane abatement, reducing somatic cell count and improving the labour efficiency of the milking process.

Book your place at our event by visiting: teagasc.ie/corporate-events/dairy-conference/

Don't miss out on Teagasc's upcoming events! Visit our website to see what we have planned: www.teagasc.ie

Global agenda for sustainable livestock

Event: Multi-Stakeholder Partnership Meeting of the Global Agenda for Sustainable Livestock
Date: 3 to 7 October

This international meeting – held in Ireland for the first time – addressed the development of practices and policies aimed at increasing the sustainability of the global livestock sector. It was hosted by the Department of Agriculture, Food and the Marine (DAFM), and welcomed around 140 delegates from over 40 different countries.

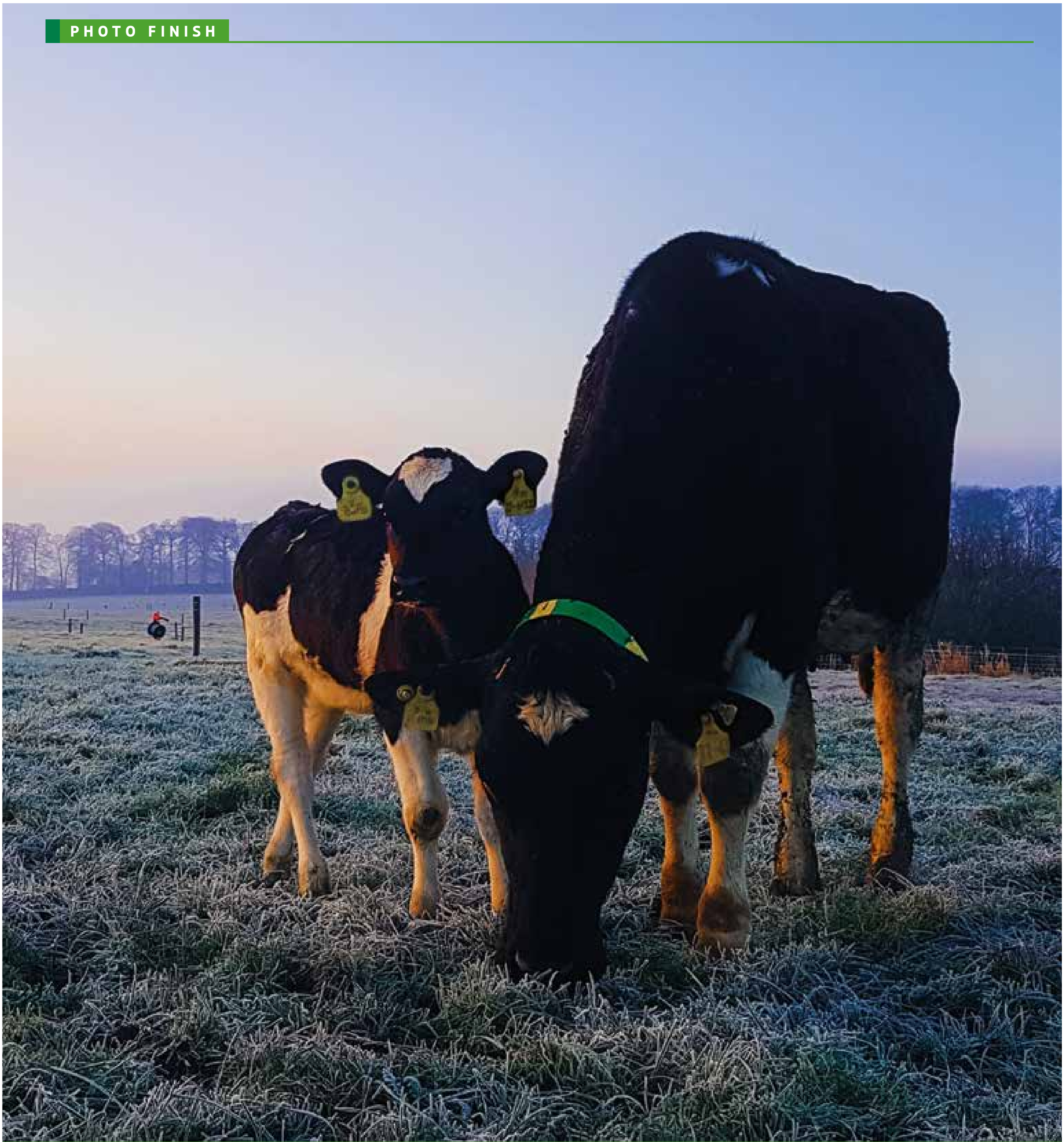
Attendees were given an overview of Teagasc's Signpost programme – a multi-annual campaign to facilitate climate action from all Irish farmers. The programme aims to achieve early progress in reducing gaseous emissions from Irish agriculture. It also aims to improve water quality, maintain and improve bio-diversity, reduce costs and create more profitable and sustainable farming enterprises.

The event was an excellent opportunity for delegates to witness the sustainability of Ireland's grass based livestock production model. They heard first hand about some of the innovations happening on Irish farms through the Signpost programme by visiting Teagasc Grange, Teagasc Signpost Farmer Dermot Heaney's dairy farm in Co. Meath, and Devenish Nutrition's research farm in Dowth.

Teagasc Postdoctoral Researcher Paul Smith was one of the delegates at the event. He says: "Attendees were in awe of both the Irish grass-based livestock production model and research currently being undertaken to further enhance the sector's sustainability.

Tom O'Dwyer, Head of Teagasc Signpost Programme, speaking to delegates at Teagasc Grange

"On numerous occasions, attendees referenced the Irish agriculture sector as being one of the world leaders in sustainable livestock production. In addition, delegates were extremely impressed by the ability of the programme to transfer greenhouse mitigation research into on-farm practice."



Generational bonding

Pictured are a bonded cow and calf at grass on a crisp morning, taken as part of a study investigating the effect of pasture-based cow-calf contact from birth to weaning, measured by looking at dairy cow and calf health, welfare, production and labour.
This study was part of wider research addressing a growing need to look into how cow-calf contact could be incorporated into current systems to improve animal welfare, while remaining practical and feasible for farmers.

Photo and description by:
Alison Sinnott, PhD student,
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Teagasc project: Cowtact