# TResearch

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**BACK IN TIME**
20 years of Teagasc and APC Microbiome

**CEREAL KILLER**
Improving fungicides against Septoria blotch

**VITAMIN "SEA"**
Seaweed's potential for immune benefits

**TEAM SPOTLIGHT: Inside the new BIA Innovator Campus, p20**

Research at Teagasc Ashtown is examining ways to make bread even more delicious and nutritious

# It's the yeast we could do

Teagasc
Agriculture and Food Development Authority

# Welcome

**Ireland's first National Centre of Excellence for start-up, micro, and small food businesses was officially opened by An Taoiseach Leo Varadkar in Teagasc Athenry, Co. Galway recently. The BIA Innovator Campus aims to drive regional and national growth in Ireland's agri-food sector. It is designed to help the launch and development of new and existing food businesses at all stages of their entrepreneurial journey. To learn more about BIA's new offering, an interview with its core team is available on p20 of the publication.**

APC Microbiome Ireland is a more established institute that has recently celebrated its 20th-anniversary milestone. It was set up in 2003 with funding from Science Foundation Ireland, with a mission to investigate the complex environment of the gastrointestinal tract and its microbial community. APC is based at UCC and Teagasc. On p30, we celebrate some of its achievements, including several landmark discoveries.

Engage@Teagasc, the Technology Transfer Office of Teagasc, outlines commercialisation offers for industry consideration on pages 38 and 39. Teagasc researchers, in collaboration with the University of Helsinki, have developed a highly bioactive, spoonable plant-based snack through bioprocessing and using brewer's spent grain. The second offer is a novel, environmentally friendly, and sustainable two-step method to preserve freshly harvested seaweed for an extended period before further processing.

Lastly, on p40, we showcase the winning photo from Teagasc's annual Vision of Research competition, which celebrates the perfect apple. The photo depicts an apple that was grown at a newly established research orchard in Oak Park. We hope you enjoy reading about how Teagasc is nourishing the development of the Irish food industry.

**Catriona Boyle**
Editor, *TResearch* magazine, Teagasc

**Rinne an Taoiseach Leo Varadkar an chéad Ionad Barr Feabhais Náisiúnta in Éirinn do ghnólachtaí bia nuathionscanta, micreaghnólachtaí bia agus gnólachtaí bia beaga a oscailt go hoifigiúil in Teagasc i mBaile Átha an Rí, Co. na Gaillimhe le déanaí. Tá sé mar aidhm ag Campas Nuálaithe BIA fás réigiúnach agus náisiúnta a spreagadh in earnáil agraibhia na hÉireann. Dearadh é chun cuidiú le seoladh agus forbairt gnólachtaí bia nua agus ceann atá ann cheana ag gach céim dá n-aistear fiontraíochta. Chun tuilleadh eolais a fháil faoi thairiscint nua BIA, tá agallamh lena chroífhoireann le fáil ar lch 20 den fhoilseachán.**

Institiúid sheanbhunaithe is ea APC Microbiome Ireland a cheiliúir 20 bliain ar an bhfód le déanaí. Bunaíodh é in 2003 le maoiniú ó Fhondúireacht Eolaíochta Éireann, agus is é a mhisean imscrúdú a dhéanamh ar thimpeallacht chasta na conaire gastraistéigí agus a pobail miocróbach. Tá APC bunaithe ag Coláiste na hOllscoile, Corcaigh agus ag Teagasc. Ar lch 30, ceiliúraimid cuid dá éachtaí, lena n-áirítear roinnt fionnachtana suntasacha.

Tugann Engage@Teagasc, Oifig Aistrithe Teicneolaíochta Teagasc, achoimre ar thairiscintí tráchtálaithe lena mbreithniú ag an tionscal ar leathanaigh 38 agus 39. D'fhorbair taighdeoirí Teagasc, i gcomhar le hOllscoil Heilsincí, sneaic plandabhunaithe ard-bhithghníomhach, is féidir a ithe le spúnóg trí bhithphróiseáil agus trí úsáid a bhaint as triosc grúdaire. Modh dhá chéim úrnua atá sa dara tairiscint atá neamhdhíobhálach don chomhshaol agus atá inbhuanaithe chun feamainn úrbhainte a chaomhnú ar feadh tréimhse fhada sula ndéanfar tuilleadh próiseála.

Ar deireadh, ar lch 40, taispeánaimid an grianghraf buaiteach ó chomórtas bliantúil Fhís Taighde Teagasc, a cheiliúrann an t-úll foirfe. Taispeántar sa ghrianghraf úll a fásadh ag úllord taighde nuabhunaithe i bPáirc na Darach. Tá súil againn go mbainfidh tú sult as léamh faoin dóigh a bhfuil forbairt thionscal bia na hÉireann á cothú ag Teagasc.

**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.

www.teagasc.ie



**EDITOR**
**Catriona Boyle**
*catriona.boyle@teagasc.ie*



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*Cover image: Andrew Downes (main image); Tina Darb (back in time); Teagasc (cereal killer); Simon Roughneen/istock.com (vitamin "sea"). Main image shows Bárbara Biduski of Teagasc Ashtown's Food Research Centre.*

# Contents










*Throughout* TResearch, *we include icons alongside articles where there is a clear link to the urgent actions in our Climate Action Strategy. These actions are: Reduce Nitrogen Emissions, Reduce Methane Emissions, Increase Carbon Capture, Enhance Biodiversity, Increase Diversification, Enhance Adaptation, Circular Food System, and Supporting Policy.*

# News

Celebrating 60 years of peer-reviewed publishing at Teagasc are members of the editorial board and Teagasc senior staff and authority members

## Celebrating 60 years of academic publishing

Teagasc recently launched a special print version of the 60th Anniversary Special Issue of the *Irish Journal of Agricultural and Food Research* (*IJAFR*) (Volume 61, Issue 1).

This special issue consists of 12 papers, compiled in 2021 — the journal's anniversary year. It highlights scientific advancements made over the last 60 years, while also looking to the future to see how current knowledge, methods, and tools can help us to meet the grand challenges facing the sector and wider society, as well as identifying gaps in knowledge that need to be filled by new research.

This issue contains scientific papers on topics including forestry, potato breeding and production, pig production, milk quality and processing, meat processing, ruminant nutrition, ruminant breeding, the Agricultural Catchments Programme, grassland, animal health and welfare, and the role of social science in agri-food research.

Speaking at the launch of a special edition print version to commemorate the 60th anniversary issue, Professor Frank O'Mara, Director of Teagasc, says: "Irish agriculture is in an ever-changing environment. Farmers and food processors are faced with a range of challenges on an ongoing basis. Research that provides farmers and food processors with technical solutions to meet these challenges sustainably is as important as it ever was. This issue of the *IJAFR* reviews research over 60 years and highlights how current knowledge can be used to address current and future challenges."

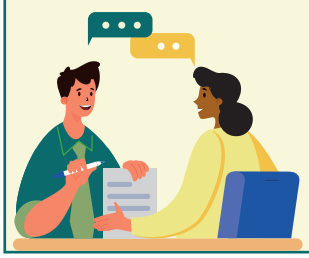
Deirdre Hennessy, Senior Editor of the *IJAFR* and Lecturer in Sustainable Agriculture at University College Cork, adds: "This special issue brings together a wealth of research knowledge from the last 60 years, and provides a great reference resource of Irish agriculture, which will be of benefit to researchers, students, farmers and the wider agricultural industry."

## BIA Innovator Campus

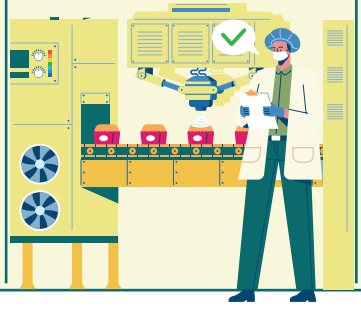
**The BIA Innovator Campus is a National Centre of Excellence for innovation in food development. Located at Teagasc's Athenry campus, the BIA Innovator Campus offers start-ups and small businesses a unique opportunity – production spaces, on-site mentoring and access to a wider network of peers, all in a single location**

### The campus comprises four key elements

**BIA Eolas**
Access to food sector training, expert knowledge from Teagasc, peer-to-peer networking for SMEs



**BIA Obair**
State-of-the-art, food-grade production space, lease and pay-per-use units to suit the needs of start-ups and scaling food businesses



**BIA Blas**
A centre for food culture and tourism – with a culinary training centre, exhibition room and auditorium

**BIA Luas**
Accelerate and grow – access to food technology and business mentoring, buyers and investors. Buyer showcase, meeting room and hot desk rentals

# McCarthy wins prestigious chemistry prize

Congratulations to William McCarthy for being awarded the Kathleen Lonsdale Royal Irish Academy Chemistry Prize 2024. His research on understanding the entry, partition, and fate of chlorates in dairy processes is not only significant for the field of chemistry but also crucial for ensuring the safety and quality of dairy products globally.

The use of membrane filtration as a critical control step for chlorate management in milk demonstrates the practical applications of his research. William's dedication and innovative approach have earned him this prestigious recognition, and it's commendable to see his work contributing to the advancement of the chemical sciences.

The Royal Irish Academy's acknowledgement through this award, named after the renowned Irish *X*-ray crystallographer Kathleen Lonsdale, adds an extra layer of honour to William's achievement. We wish him continued success in his research ambitions and his career in chemistry. The awards ceremony in the Royal Irish Academy later in the year will undoubtedly be a well-deserved celebration of his accomplishments.

Declan Troy, Teagasc, can be seen presenting the 'Teagasc Special Award' to Abigail O'Brien Murray, Erica O'Brien Murray, and Olivia O'Shea, Loreto Secondary School, Balbriggan

## Teagasc BTYSTE 2024 Award for Ash Dieback Project

Abigail O'Brien Murray, Erica O'Brien Murray, and Olivia O'Shea from Loreto Secondary School in Balbriggan won two awards at the recent BT Young Scientist and Technology Exhibition 2024. They received the 'Best Group Project' award and the 'Teagasc Special Award' for their remarkable project on Ash Dieback disease. Their project, 'Let's Save the Common Ash: A Continued Story', showcased their dedication, creativity, and passion for scientific inquiry.

The students worked under the guidance of their teacher, Dan Toomey, and their project stood out for its thorough research, experimental methodology, and potential impact on addressing the disease.

Declan Troy, Assistant Director of Research, Teagasc, presented the students with the award and praised their hard work, curiosity and commitment to scientific inquiry.

The competition attracted over 1,100 participants from schools across Ireland and provided a platform for young minds to showcase their talents in the field of science.

The Teagasc stand at the exhibition was a huge success, where Teagasc's Advisory, Education and Research work were showcased to over 50,000 visitors, including students, teachers and the general public. A diverse team of Teagasc staff and students collaborated, led by Public Engagement Officer Eimear Ferguson.

# News in brief

### Agricultural Economics Society of Ireland Early Career Day winners

The AESI Early Career Day event was held recently at Teagasc Ashtown. Congratulations to Marie Merlo from UCC and Teagasc, who won the Bob O'Connor prize for her discussion paper titled *Evaluating Irish farms' contribution to food and protein security nationally and globally*.

Úna Sinnott from UCD and Teagasc won the standard session prize for her work, *User personas as a tool to identify farm-specific barriers and influences to the reduction of GHG emissions*.

Chathurrdhika Yogarajah from UCD and Teagasc was awarded the Teagasc REDP-sponsored 1st-year PhD student prize for her research on bioeconomic models for the inclusion of protein crops in cereal rotations.


From left: Erin Sherry (AFBI and AESI President-Elect), prize winner Marie Merlo, and Fiona Thorne (Teagasc and AESI President)

### Walsh Scholar Gold Medal winner

The Teagasc Walsh Scholars Gold Medal was awarded to Davor Daniloski from Teagasc's Food Programme. The Gold Medal, which is the Programme's highest accolade, was presented at an awards ceremony at Teagasc Ashtown in November.

Davor's research project is looking at how the genetic profiles of milk proteins called β-casein affect milk functionality. A1 and A2 are variants of β-casein. The research has proven that A2 milk is associated with lower heat stability and soft gel, which can be a negative attribute for dairy processing when producing milk powder, yoghurt and cheese. However, it may prove favourable for human digestion when softer gel formation, as a precursor of milk products, is needed.

Davor, who is a native of North Macedonia, is a dual-located student, spending his time studying between Victoria University, Australia, and Teagasc Moorepark, Fermoy, County Cork.

**Davor Daniloski (right) celebrates his award with his mother at the event**

# News

O'Gorman Photography

**Muireann Egan from the Teagasc Food Research Programme is pictured with Blackwater Childcare, Fermoy, pupils, Caelan Corcoran and Roisin Roche on a visit to Moorepark during Science Week at Teagasc**

# Science Week at Teagasc

Science enthusiasts of all ages joined Teagasc for an exciting week of exploration and discovery for Science Week at Teagasc in November.

Teagasc lined up various engaging events to captivate the curious minds of children, teenagers, and adults alike.

Teagasc research centres around Ireland opened their doors to students from primary and secondary levels, to highlight the work that we do in agriculture and food research. Attendees got to try out many hands-on experimental activities. There were also several public events for all ages.

Dylan Vaughan

**Teagasc Forestry Officer Michael Somers and Biodiversity Specialist Catherine Keena hosted the Trails and Tales event in Kilkenny Castle Park**

## Enjoying the magazine?

**In service of our readers, the team at *TResearch* aim to make each issue of the magazine as engaging and illuminating as we can — but we know there's always room for improvement. That's why we're asking you to take part in our reader survey. Are there certain features or topics you want to see more of — or less of? Make your voice heard and have a say in shaping the future of *TResearch* by taking part in our reader survey.**
**Open until the 31st of March.**

**TResearch**
**Reader Survey**


Members of the AgTech Ireland board at Teagasc Moorepark (L-R): James Greevy, Herdwatch; Ursula Kelly, Cormac Tagging; Padraig Hennessy, Chairman AgTech Ireland and CEO Terra Nutritech; Catherine Lascurettes, COO AgTech Ireland; Lloyd Pearson, Pearson Milking Technology

# Within farms' reach

Industry collaboration with Teagasc is key to sustainability-enhancing agtech adoption.

AgTech Ireland was set up three years ago to act as a single, strong voice to represent, promote and advocate for our diverse sector. Our members range from young start-ups to established companies — offering a variety of innovative technologies in the digital, machinery, biotech, genetic, feed, fertiliser and energy spaces. We see ourselves as a crucial link between industry, policy and research, and have woven close relationships with the food and agtech industry, government departments (especially the Department of Agriculture, Food and the Marine), universities and, of course, Teagasc. Because the sustainability challenges that underpin our sector, just like the agtech scene, are global, we regularly collaborate with AgriTech New Zealand, and it's our ambition to engage with agtech sector operators across Europe.

The global climate and biodiversity crises are increasing legal, economic and societal pressures to improve the sustainability of agriculture and food production. To produce food with fewer resources and a smaller environmental footprint, farmers are having to adopt new practices and new technologies. The Irish agtech sector has kept close to farmers, identifying these sustainability challenges and developing specific innovative solutions. Hence, some of the most widely used technologies on Irish farms today include precision machinery to spread fertiliser and pesticides, integrated farm data systems with sensors, analysis software and smartphone apps, and delivery methods for feed, minerals and additives. What is clear is that agtech is becoming critical to improving the sustainability of agriculture, farming and food production.

The global value of agtech has been valued at around US$20–25 billion, expected to more than double by 2030. Enterprise Ireland estimates Irish agtech sales amount to around €1.1 billion, of which 60% are generated through export. The sector is estimated to employ just short of 3,000 people, with a strong rural footprint — 87% of the companies are based outside Dublin.

**Words by:**
Catherine Lascurettes, Chief Operations Officer at AgTech Ireland.
*catherine@agtechireland.ie*

## Strengthening adoption

A recent study by the Irish Farmers' Association has shown that Irish farmers are strong adopters of digital technology, with 70% of farmers — mostly dairy and tillage — using farm apps. While 46% of farmers were found to already use tech on their farms, 40% planned to do so in future. The Ifac 2023 Farm Report found that farmers expected technology to address better management of production and growth rates (59%), land/soil efficiencies (48%) and farm financials (46%).

AgTech Ireland values the engagement with research-performing organisations, farm advisory and validation services to help member companies match their offering to farmers' needs, and to increase farmers' trust in validated technology. This is critical to optimise and speed up the necessary adoption by farmers of innovative sustainable practices. We welcome the two-way relationship we are developing with Teagasc's Technology Transfer Office. Our first common project was the AgTech Ireland Avenue, with support from Enterprise Ireland, which enabled us to bring 23 of our member companies to exhibit their dairy-relevant innovations to the Moorepark 2023 Dairy Open Day last July. There is ample scope to do more: from identification of specific on-farm challenges and solutions to the validation of products and services, and their promotion to farmers in all sectors through Teagasc events and publications. We look forward to continuing this fruitful collaboration. T

Teagasc


# Bread for success

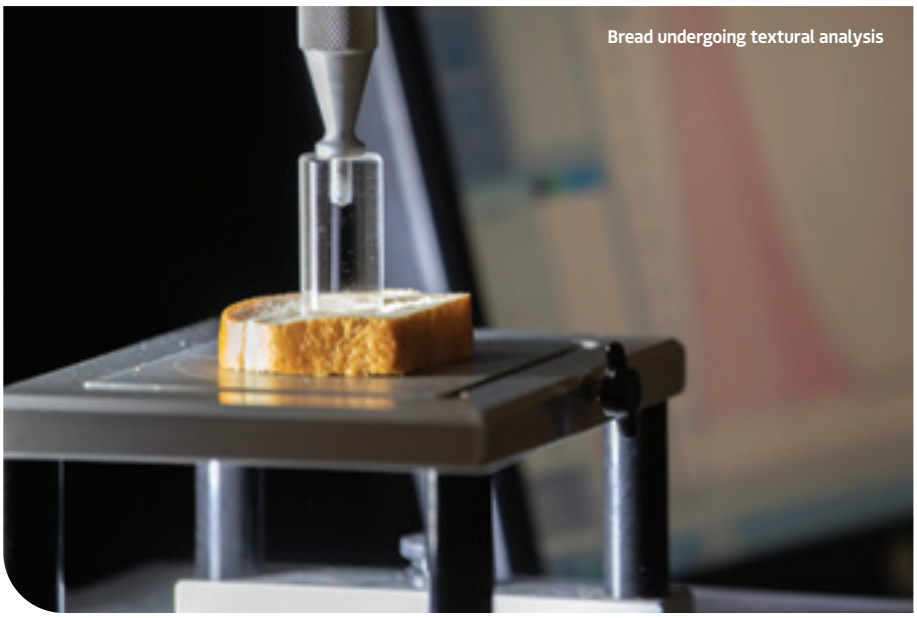
Research at Teagasc Ashtown's Food Quality & Sensory Science Department is examining ways to attain balanced breads that are both nutritious and delicious.

It can be challenging to achieve a perfect balance between a bread that's high in both nutrients and in technological quality — i.e. in terms of volume, texture and taste. However, incremental changes and continuous improvements can lead to bread that is equally appealing in terms of nutrition and technological quality.

Barbara Biduski, a Research Officer at Teagasc Ashtown, explains: "Bread is a complex matrix, composed mainly of protein (gluten), starch, lipids and water. To achieve the desired balance between nutritional quality and technological properties, experimentation is required with different incorporation levels of ingredients, fermentation times and baking techniques.

"There are multiple factors that play into the technical aspects and sensory perception of bread. Thus, the challenge is to choose suitable ingredients that can enhance health benefits whilst maintaining a high quality for consumers."

The selection of good quality flour is essential to ensuring a high quality loaf. Wholegrain flours can offer more nutrients and fibre compared to refined flours, and blending wholegrain flour with wheat flour can enhance both nutritional and baking properties. Incorporating sources of fibre or protein while controlling the substitution level of wheat flour can also increase nutritional value content with minor changes to the overall properties of the resulting bread.



Bread undergoing textural analysis

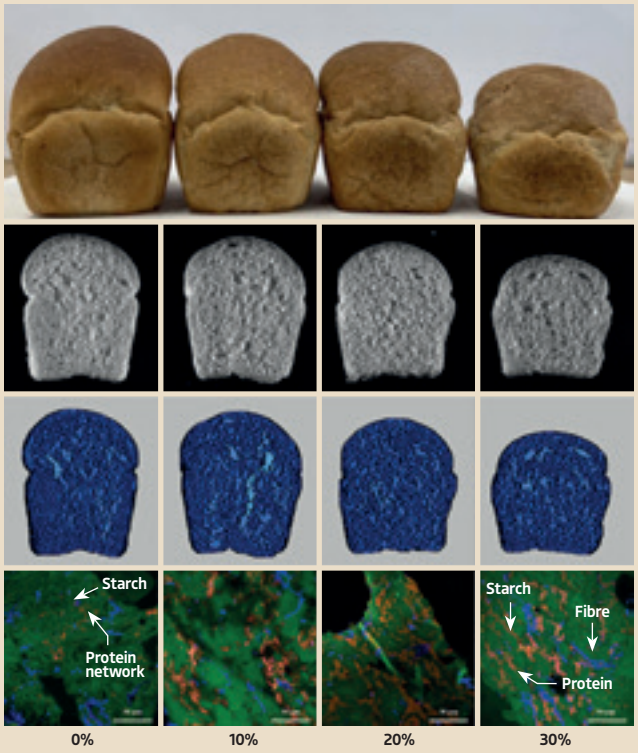
Andrew Downes

Buckwheat is a highly nutritious pseudo-cereal that can contribute positively to both the nutritional quality and technological aspects of bread. It is rich in nutrients such as fibre, protein, vitamins (particularly B vitamins), minerals (magnesium, iron) and antioxidants. Barbara explains that applying buckwheat flour as a bread ingredient can significantly enhance its nutritional profile.


Barbara Biduski removes baked bread from the oven

Andrew Downes

## Internal structure of bread using different technologies




Buckwheat levels of inclusion

Barbara Biduski

"In addition, buckwheat flour has a unique, slightly nutty flavour that can enhance the taste of bread. When used in moderation or in combination with other flours, buckwheat flour can help to enhance dough elasticity and structure and contribute to better baking properties."

> **"Buckwheat flour is [a viable substitute] for wheat flour... increasing fibre content and amino acid profiles."**

### Bucking the trend

To address potential challenges such as loaf density or crumbliness, a research team from Teagasc Ashtown has been addressing the processing, rheological, structural and nutritive properties and the sensory challenges of incorporating buckwheat flour into a wheat bread model system.

As Barbara explains: "The findings revealed that buckwheat flour is viable as a partial substitute for wheat flour, causing non-significant changes in dough rheological behaviour and maintaining bread technological quality while enhancing its nutritional profile by increasing fibre content and amino acid profiles."

Substituting up to 20% of wheat flour with buckwheat flour resulted in a bread exhibiting similar specific volume, internal structure, and texture profile as the control formulation (without buckwheat flour). However, increasing buckwheat levels to 30% led to a decrease in specific volume, a more compact internal structure and a firmer crumb during the staling process.

Increasing the level of buckwheat in the formulation decreased flour water absorption, dough stability and development time, with increased gluten weakening. The bread quality remained unchanged at levels of up to 20% buckwheat. Dietary fibre increased from 4.2% to 6.3% — particularly soluble fibre, which increased from 0.08% to 2.8%. There was an overall increase in total essential amino acids, particularly lysine, with the highest observed in the bread produced with a 30% of buckwheat flour.

Barbara adds: "From a nutritional perspective, lysine stands out among the buckwheat proteins due to its potential to lower cholesterol levels. Furthermore, buckwheat flour can increase satiety, lower postprandial blood glucose and insulin responses."

The research team's findings — which were recently published in the international journal *Food Structure* — highlight the potential of buckwheat flour as a promising alternative with which to re-design baked goods with enhanced nutritional value and satiety. T

**FUNDING**

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**CONTRIBUTORS**

**Barbara Biduski**
Research Officer,
Food Quality & Sensory Science Department, Teagasc Ashtown.
*barbara.biduski@teagasc.ie*

**Eimear Gallagher**
Head of Food Quality & Sensory Science Department, Teagasc Ashtown.

Enhance Adaptation

The soilborne disease clubroot is increasingly prevalent and difficult to control. To help manage clubroot, Teagasc researchers are investigating the potential of naturally occurring predators in the soil microbiome.

# Root behaviour

The Brassica plant family includes a large range of agriculturally important crops, which are grown as vegetable or oil crops for food, animal feed and industrial purposes (i.e. cabbage, broccoli, cauliflower, kale, rapeseed or Brussels sprouts). Clubroot is a major challenge for the production of brassicas. In Europe clubroot has affected Brassica cultivation for centuries. The exact origin of the disease is unknown, but it is believed to have spread inside Europe and from there to other parts of the world via infected plant material since the Roman era.

To date, the disease is globally present in all areas where Brassicas are cultivated, resulting in an estimated loss of 10–15% of Brassica crop production worldwide — locally, complete yield losses can occur. In Ireland, reports on the incidence of clubroot have increased, possibly related to the use of brassicas as cover crops, increased brassica weed pressure and shortening rotations due to land availability.

Arne Schwelm, a Teagasc Research Leader, explains the details of clubroot: "The clubroot pathogen *Plasmodiophora brassicae* is somewhat unusual as it does not belong to the better known fungal, bacterial or oomycete plant pathogens. Instead, it is a plasmodiophorid protist, belonging to the Rhizaria. Plasmodiophorids also include other plant pathogens such as the potato powder scab agent and virus transmitter *Spongospora subterranea* and the virus-transmitting *Polymyxa betae* and *Polymyxa graminis* species.

"*P. brassicae* infection induces tumorous growth of the host roots – forming characteristic 'clubroots'. These malformed roots inhibit nutrient and water uptake of the infected crop. *P. brassicae* build very resilient resting spores which allow the pathogen to survive in the soil for decades."

**15%**

**15% of Brassica crop is lost to clubroot**

## Persistent pathogen

When the infected clubroots decay, fresh resting spores are reintroduced into the soil. The spores can survive and remain viable for up to 20 years, but as *P. brassicae* can infect all cruciferous plants, weed species — such as Charlock — and volunteer Brassicae crops can be involved in maintaining and refreshing the disease cycle. Current control strategies include pH adjustment by liming, extended crop rotation times, and developing and utilising crop varieties that are resistant to the disease. However, clubroot resistance has been overcome for both oilseed and vegetable crops resulting in more frequent occurrences of clubroot cases, including in Ireland. Fungicides have been applied in an attempt to reduce clubroot disease with limited success, likely because *P. brassicae* is not a fungi. While some older chemistries and soil sterilants were more successful in managing clubroot, they have subsequently been removed from the market for environmental reasons. Thus, it is crucial to explore alternative, biological approaches for more effective and sustainable ways to mitigate clubroot disease.

Teagasc

A typical clubroot formation

Despite its challenging biology and persistence, the resting spores of the clubroot pathogen are not without foes in the soil. Soil houses nearly 60% of all living organisms. This high biodiversity might hold the potential to help manage and mitigate clubroot. Microbiome predator species, such as protists and nematodes, could help to reduce infections by soilborne pathogens such as clubroot. Arne explains: "A reduction of a pathogen load in the soil would substantially aid any other management

Bert Swandi/shutterstock.com

Characteristic 'clubroots' inhibit nutrient and water uptake of affected crops

practices to mitigate a disease — especially when it comes to such a persistent disease as clubroot. Predators that include the pathogen in their diet might turn out to be new tiny little helpers for farmers."

The impact of those predators on clubroot is largely unknown. But as the diet of many soil-dwelling organisms includes bacterial, fungal or oomycete pathogens, predators might equally reduce other pathogens in soils. Additionally, by selective feeding, soil predators can shape the plant-associated biodiversity towards plant-beneficial microbes or induce production of antibiotics from their prey, thereby indirectly inhibiting potential plant pathogens.

It is reasonable to consider that clubroot may be influenced by direct predation or the interactions between predators and the microbiome mentioned above, suggests Arne. "Indeed, at least in culture some protist predators can engulf the clubroot resting spores. As part of our research, we are investigating the potential roles of soil microbiome predators on the presence and longevity of clubroot. Our aim is to identify microbiome predators in clubroot suppressive soils and how they impact clubroot disease development. Potentially this could lead to the discovery of novel biocontrol species."

> **"It is crucial to explore alternative, biological approaches for more effective, sustainable ways to mitigate clubroot."**

By using clubroot as a model pathogen system in this research, the findings and insights gained have the potential to be applied to other challenging, soilborne plant diseases that are difficult to control. T

**FUNDING**

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**CONTRIBUTORS**

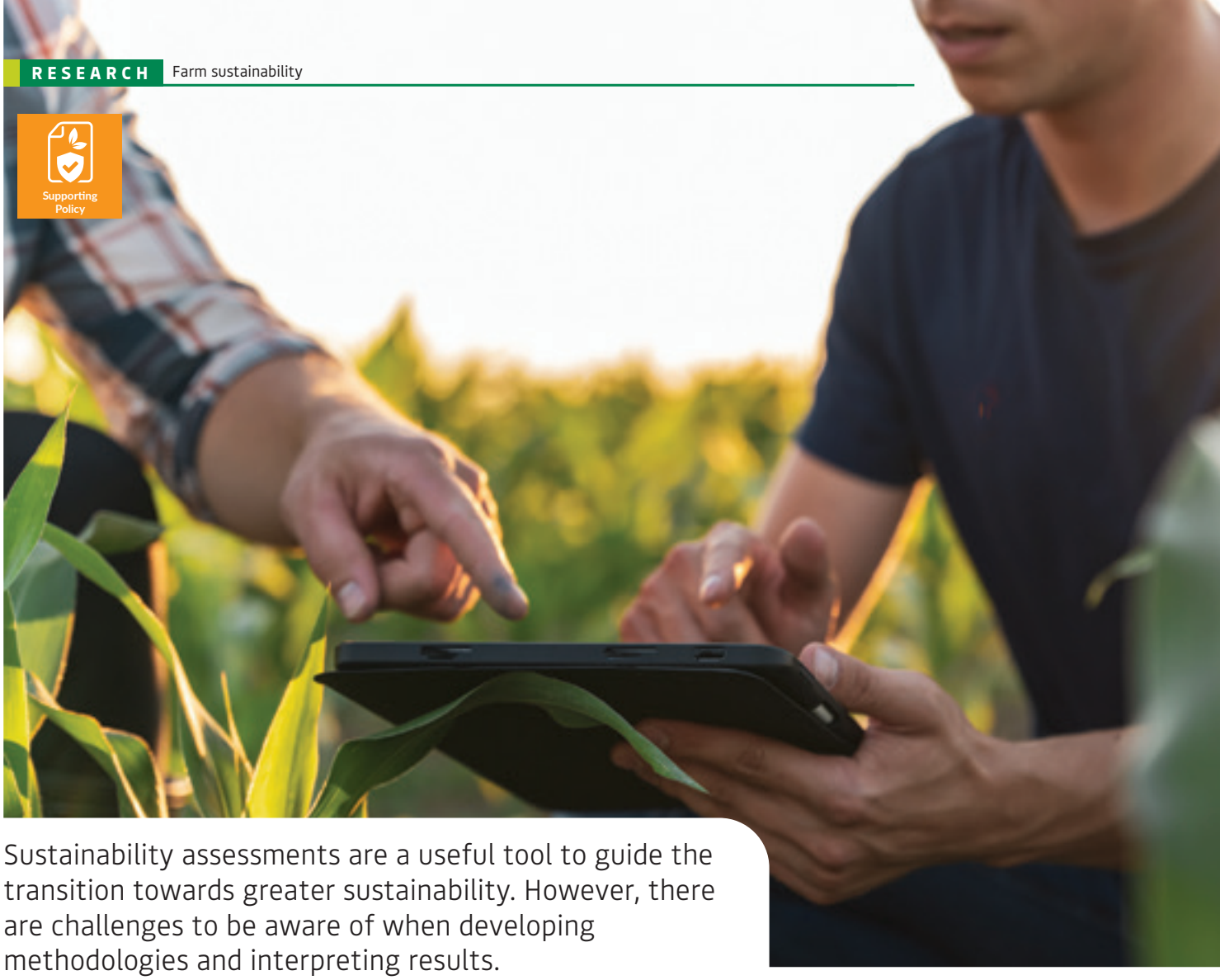
**Arne Schwelm**
Research Leaders 2025 Programme, Teagasc Johnstown Castle.
*arne.schwelm@teagasc.ie*

**Stefan Geisen**
Assistant Professor, Laboratory of Nematology, Wageningen University, The Netherlands.

**Michael Gaffney**
Principal Research Officer, Horticulture Development Department, Teagasc Ashtown.

**Fiona Brennan**
Senior Research Officer, Teagasc Johnstown Castle.

Supporting Policy



Sustainability assessments are a useful tool to guide the transition towards greater sustainability. However, there are challenges to be aware of when developing methodologies and interpreting results.

# Assessing agricultural sustainability

Improving the sustainability of our food systems is an ever-pressing need. The cost-of-living crisis and depletion of our natural resources are examples of the issues that can challenge the way we produce and consume food. All actors of the food chain, including farmers and consumers, have an important role to play in contributing to the transition towards greater sustainability.

To provide guidance as to the "where to from here", sustainability assessment tools are useful. Once populated with agri-food data, these tools can provide the evidence base needed to inform public policy. They can also help demonstrate the sustainability credentials of our agri-food production systems to succeed in the marketplace and guide consumers in their food choices. At the farm level, these tools can reveal strengths and weaknesses of the farm system, thus creating useful benchmarks and pointing out areas where improvement is possible.

Despite recent advancements, assessing sustainability still remains a challenge, says Lorraine Balaine, a Research Officer at Teagasc Athenry: "Methodological choices in sustainability assessments can influence results and their interpretation. Thus, practitioners and users must exercise caution. Research conducted in Teagasc, notably within an EU project called MilKey, can point the way towards some of the key challenge areas."

## Sustainability in 3D

Agricultural sustainability is a three-dimensional concept, which encompasses economic, environmental and social considerations, explains Lorraine.

"Failure to achieve a suitable performance in any of the three sustainability dimensions can lead to 'make or break' situations, endangering the system's balance and hindering it from thriving. Moreover, improved recognition of agriculture's multi-functionality suggests that our sustainability assessment frameworks must capture impacts and externalities across a wider range of issues."

It follows that the scope of assessment frameworks must be holistic by nature, with equal weighting of the economic, environmental and social dimensions. Integrated assessment tools, such as the recently developed multi-criteria DEXi-Dairy tool, are needed to enable practitioners to simultaneously consider and visualise performance across the three sustainability dimensions.

Before developing integrated assessment tools, one must first be able to successfully assess each sustainability dimension separately. However, as Lorraine points out, "to date, the three sustainability dimensions have not received equal attention in the

SimonSkafar/istockphoto.com

> **Assessing social sustainability is challenging due to the lack of consensus over its definition and scope.**

literature, partially due to the evolution of the sustainability concept as a whole, as well as specific methodological challenges."

While economic sustainability has traditionally been in the spotlight, environmental sustainability is increasingly gaining attention. Assessing economic sustainability is less challenging than environmental sustainability as it is comprised of observable and thus easily measurable aspects that do not require expensive equipment (e.g. production costs and output). Conversely, in the environmental dimension, many aspects are not easily observable (e.g. gaseous emissions, water quality).

Even if they can be measured, equipment costs are prohibitive for large-scale rollout; therefore, modelling approaches tend to be favoured, despite being less accurate. For example, this is the case of agricultural greenhouse gas (GHG) emissions. They can be measured through a comprehensive set of equipment such as an Eddy Covariance Flux Tower or the GreenFeed System, or modelled through approaches such as a Life Cycle Assessment (LCA) methodology.

Lorraine adds that social sustainability remains "the forgotten child".

"Despite progress, assessing this dimension is challenging due to the lack of consensus over its definition and scope, as well as difficulties in measuring multi-dimensional and somewhat abstract concepts such as farmer wellbeing and animal welfare."

## Indicators and implications

Agricultural sustainability can be broken down into a suite of sustainability indicators. These indicators should be easy to calculate and understand, and sensitive to variations in sustainability performance across time and farms. The Teagasc Sustainability Report, published on a yearly basis, is a good example of how a suite of sustainability indicators can be put together to comprehensively assess and compare farm systems over time. In this way, synergies and trade-offs within and across sustainability dimensions can be revealed.

Nevertheless, it is important to critically appraise selected indicators to avoid drawing conclusions that may negatively impact aspects of the farm system (or the food production chain) that lie beyond assessment boundaries, continues Lorraine.

"Because of practical considerations, one must find a happy medium in the number of indicators represented in sustainability assessments. Choice is a necessary evil, but it implies restricting the assessment lens. In a sense, we must bear in mind that some farms may perform very badly or very well in certain sustainability aspects because of inherent characteristics, some of which may be outside of the farmer's control, such as geographical location and soil type."

Hence, purposely omitting sustainability aspects from assessments can lead to an incomplete and sometimes misleading view of farm systems. While we will never be able to fully resolve the issue of subjectivity and simplification in selection processes, assessments of shortcomings and transparency should be guiding principles in this line of work and when communicating with stakeholders.

## Quality data and methods

Farm sustainability is assessed through a combination of robust assessment tools (developed by science) and farm activity data (provided by the farmer). Hence, the quality of the data is equally as important as the developed methodology in sustainability assessments. Overall, recall data is less accurate than farm records. Misrecorded data can slip through the cracks, even in official data platforms. Thus, it is important to establish verification procedures to ensure the validity of sustainability estimates.

With this in mind, says Lorraine, "it is worthwhile to mention that access to higher levels of data disaggregation can open possibilities to use more advanced (and thus more accurate) assessment methodologies. For instance, this is the case when modelling farm GHG emissions to move from Tier 1 assessments (default emission factors) all the way to Tier 3 (farm specific)".

One final point is that assessment methodologies evolve over time as science progresses. For example, the Intergovernmental Panel on Climate Change recently updated GHG equivalencies to convert different gases to carbon dioxide equivalent. Advancements in science can lead to changes in sustainability estimates, and it is difficult to communicate to stakeholders how and why their sustainability performance might be revised. This issue must be reflected upon more deeply, notably when designing decision-making tools and monitoring systems for policy or certification schemes. T

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**CONTRIBUTORS**

**Lorraine Balaine**
Research Officer,
Agricultural Economics & Farm Surveys Department, REDP,
Teagasc Athenry.
*lorraine.balaine@teagasc.ie*

**Cathal Buckley**
Senior Research Officer,
Agricultural Economics & Farm Surveys Department, REDP,
Teagasc Athenry.

**Dominika Krol**
Senior Research Officer,
Environment, Soils and Land-Use,
Teagasc Johnstown Castle.

Circular Food System

# Coming out of its shell

Shell waste from commercial fishing has long been an untapped resource, but new research suggests it could have great potential for industrial packaging applications.

The world's population is swiftly increasing; urbanisation and improvements in economic status are leading to concerns that people's dietetic patterns are shifting and increasing demand for nutritious, high-quality food. Interestingly, at the same time, it has further been identified that the global consumption of fish — particularly shellfish, including crustaceans, molluscs and cephalopods — has increased enormously over the last few years in the developing world owing to its rich flavour, perception as an important constituent for a wholesome lifestyle, balanced diet and diminution of livestock.

As a result of this huge demand, shellfish processing generates waste encompassing exoskeletons, internal organs and other solid and liquid organic matter effluents. However, among the total waste generated, shell waste — a blend of polysaccharides and numerous minerals — accounts for the major portion, which is about 65–90% of fresh biomass for shellfish suppliers as well as for customers.

## An IMPRESS-ive feat

It has been reported that for each species of shellfish harvested, around 10 million tonnes of waste are generated annually and dumped, mostly into open fields or nearby water bodies, leading to ecological issues such as awful smell, soil contamination, and water pollution. However, these vast quantities of waste may present an interesting opportunity to solve an ongoing issue in the packaging sector. Researchers at Teagasc are enthusiastically involved in the IMPRESS project, a European Union research project chiefly focused on building a waste-sustainable, aquatic food value chain. The researchers are currently focused on extracting targeted compounds from crustacean shells and raising biopolymers from the shell waste, explains Rifna Jerome, a post-doctoral fellow at Teagasc Ashtown's food research

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Shell waste matter from commercial fishing may be an exciting new source for biodegradable polymers

centre: "Imagine taking this apparent waste matter — shells, once simply discarded as mere leftovers from the ocean ecosystem — and transforming it into a highly valued resource. Shell waste has a potential place at the cutting edge of biopolymer applications. This research will not only valorise shell waste, but marks a fascinating next step in the quest to develop robust, eco-friendly substitutes for polymers – materials which themselves raise numerous environmental concerns.

"The project's groundbreaking methodology encompasses integrating non-thermal technologies — namely ultrasound, microwave and cold plasma — into the extraction step, as well as refining the developed film characteristics, resulting in a versatile and sustainable biopolymer as the final product."

This collaboration highlights Teagasc's continued commitment to advancing environmentally sustainable solutions in material science. Rifna adds that although shell waste valorisation for production of biopolymer shows strong potential, the process is not without hurdles. "Escalating production, improving the extraction process, and confirming cost-efficiency are challenges that scientists and industry experts will need to overcome. Nonetheless, this research also opens up greater possibilities for the conception, use and spread of sustainable methodologies."

## Packed with properties

Cellulose, a polysaccharide derived from plant sources, is well known for its polymeric properties and has established numerous applications in the packaging industry for ages. However, less well-known is the world's second-most abundant polysaccharide, chitin. While chitin is abundantly accessible from sea waste such as crustacean or mollusc shells, it has long been considered a structural molecule devoid of any remarkable biological properties. Fortunately, in the past few years, greater attention has been focused on the chitin present within these shell resources, leading to more comprehensive research into its potential applications.

Rifna explains further: "Chitin, also recognised as poly 2-acetamido-2-deoxy-β-D-glucose, possesses brilliant film-forming properties such as biodegradability, chelate metal ions, non-toxicity, as well as adsorption properties, which give it its novel and robust biopolymer properties for food, biochemical, pharmaceutical and water purification applications. Crucially, the chief properties of the biopolymer nature of chitin are its tensile strength, moisture barrier property, permeability, stability and versatile nature with high molecular weight.

"This biopolymer, developed from shell waste, possesses multi-dimensional benefits, from waste valorisation to inhibiting lipid oxidation, halting microbial proliferation, guaranteeing food safety and — most importantly — being decomposable".

## Shaping the future

All of which means that chitin biopolymer has the ability to be combined into both active and intelligent packaging structures to prolong the expiration period of packaged foods. The production of this biopolymer begins with the extraction of minerals, chiefly calcium carbonate from the shell waste, followed by the deproteinisation and deacetylation process. Numerous extraction techniques, namely chemical, mechanical, and use of non-thermal technologies, have so far been used to extract and isolate this high-value compound. Once isolated, the chitin molecule undergoes thorough processing steps to get shaped into the most robust form for biopolymer synthesis.

Biopolymer production through waste shell valorisation showcases a remarkable combination of technical innovation and ecological responsibility, concludes Rifna.

"By identifying the hidden treasure among these discarded side streams from the ocean, we can pave a path to a more resilient future. As long as the scientific community continues to discover and refine the necessary processes, the effect of shell-obtained biopolymers on the industrial sector can be groundbreaking, pointing us towards a more sustainable tomorrow." T

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**CONTRIBUTORS**

**Rifna E. Jerome**
Post-doctoral fellow,
Food Research Centre,
Teagasc Ashtown.

**Ramesh Babu**
School of Chemistry,
Trinity College Dublin.

**Brijesh K. Tiwari**
Principal Research Officer,
Food Research Centre,
Teagasc Ashtown.
*brijesh.tiwari@teagasc.ie*

Supporting Policy

# Nit-rate of change

Ireland's Nitrates Action Programme (NAP) aims to address farming practices relating to issues of declining water quality. Teagasc researchers have examined some of the top measures and their implications.

In 2023, Ireland's 5th Nitrates Action Programme (NAP) introduced a number of changes to existing farming practices to address trends of declining water quality. Changes include calculations around livestock excretion rates and fertiliser use. Although the measures are obligatory for all farmers, there are various options for farmers, all of which can contribute to achieving the same objective. A panel of 16 experts identified the top three measures in the 5th NAP that would achieve the greatest improvements in water quality. These measures were changes relating to:

- soiled water management and storage,
- livestock excretion rate calculations, and
- chemical nitrogen fertiliser allowances.

Michele McCormack, a Research Officer in Teagasc's Agricultural Catchments Programme, explains: "To assess farmer preferences, a survey was carried out of dairy farmers participating in the Agricultural Catchments Programme. Farmers were asked to rank in order of preference which options they were willing to implement on their farms in order to remain compliant with the new regulations."

## Soiled water storage management

The new regulation stipulates that "all holdings producing soiled water must have a minimum of three weeks' soiled water storage capacity in place by the 1st December, 2023 and four weeks' soiled water storage capacity in place by 1st December, 2024".

Almost one-third of farmers said that in their own estimation, they had sufficient storage to comply with the new rules. For those farms who needed to carry out additional measures in order to comply, 19% said they would store excess soiled water in an existing slurry tank and 12% said they would be open to investing in building additional storage for soiled water.

The least popular options were to change farming system and reduce cow numbers. In addition to the survey, farmers were also interviewed. Their comments reflect a high level of understanding in relation to the storage of soiled water but they also called for a common sense approach. Comments included:

*"I suppose the clamp down on spreading soiled water had to come, it's a way of clamping down on spreading slurry in the closed period."*

*"I think it's more common sense that needs to be used rather than calendar farming."*

Mark Heighes/istock.com

Fertiliser use calculations are a key measures in Ireland's 5th Nitrates Action Programme

Oleksii Kononenko/Istock.com

## Livestock excretion rates

The new regulation around the calculation of organic nitrogen (N) produced by dairy cows moves from a single calculation of 89kg/N/ha to three different calculations based on milk yields.

Farmers with the highest yielding cows will experience the greatest level of change, moving from 89kg/N/ha to 106kg/N/ha.

Regarding options to reduce livestock excretion rates, the option favoured by 15% of farmers was to increase the land area. At the time the survey was carried out some farmers had not thought about what course of action they would need to remain compliant, and 11% of farmers indicated that they would consider reducing cow numbers. On the qualitative side, some of the remarks in relation to this new policy measure included:

*"It's a disaster because you're penalising the most efficient cows."*

*"It's a new quota being put on farming. I think we're just out of the milk quota situation, and we were encouraged by every organisation and everyone to push on, and drive on, and I think we're being hit badly again."*

## Chemical fertiliser

In regards to chemical fertiliser, the changes in the 5th NAP require a national 10% reduction from March 2022 onward, and a further 5% reduction as of 1st January, 2024.

The option most favoured by farmers in relation to this change was to improve soil fertility (15%), followed by improving grassland management (12%) and incorporating clover in grazing swards (11%).

When interviewed, farmers exhibited a strong level of existing knowledge regarding the reduction of the use of chemical fertilisers. This was due, in part, to existing knowledge transfer measures such as discussion groups. However, farmers did highlight a need for more information on newer approaches, such as the introduction of a multispecies sward:

*'Before I would go to sow that multispecies sward I'll be talking to [my farm advisor] for advice ... I would always ask them before growing multispecies; they're good support."*

The changes as part of the 5th NAP present a significant challenge to dairy farmers. An important part of farmer compliance will be the provision of support in the form of financial aid and management advice. Since the collection of this data, additional Targeted Agricultural Modernisation Scheme funding has been announced, alongside a number of national information events being held.

Additional advice tailored to individual farms will be required to support the implementation of measures. Further research will look at how these changes impact milk production nationally. T

**CONTRIBUTORS**

**Michele McCormack**
Research Officer
Agricultural Catchments Programme,
Teagasc Athenry.
*michele.mccormack@teagasc.ie*

**Edel Kelly**
Assistant Professor
School of Agriculture
and Food Science, UCD.

**Brian Leonard**
Assistant Professor
School of Agriculture
and Food Science, UCD.

**Diarmuid Mulkerrins**
Walsh Scholar
Teagasc/UCD.

Enhance Adaptation

**Further research into fungicides is needed to combat the pervasive crop disease *Zymoseptoria tritici***

# Cereal killer

*Zymoseptoria tritici* continues to be highly destructive to cereal crops across Europe. However, advances in fungicide are seeking to manage future strains.

In the early 1980s, Septoria tritici blotch (STB) or *Zymoseptoria tritici* came to be known as the most destructive disease to Irish winter wheat crops. While STB continues to be highly destructive, a combination of improved agronomy, genetics and fungicides means that Irish farmers have been able to minimise its potential impacts.

However, nature never stays still, and in the past decade significant changes in the causal pathogen *Z. tritici* — including the development of fungicide resistance and virulence — have meant that farmers have had to adjust their control programmes.

Fortunately, innovations in the form of new fungicide chemistries have helped. Both fenpicoxamid (Inatreq, developed by Corteva AgriSciences) and mefentrifluconazole (Revysol, developed by BASF) were registered for use in Irish fields in 2020, and are now key tools in the control of STB.

**"Site-specific fungicides are often at risk of resistance development, with only a single change in the pathogen required to render the fungicide ineffective."**

## Contrasting starting points

Prior to their commercial launch, Inatreq and Revysol demonstrated greater efficacy than current fungicide standards, with European *Z. tritici* populations displaying sensitivity to both. However, the history of fungicide use in wheat crops means that these two fungicides may have been starting from different points in their sensitivity journey, explains Steven Kildea, a Research Officer in the Crops Research Centre at Teagasc Oak Park.

"Azole fungicides have been intensively used in wheat crops to control STB and other diseases for over 30 years. During this time *Z. tritici* has unfortunately developed mechanisms to survive the inhibitory effects of these fungicides. Whether these changes in the pathogen population impacted sensitivity to mefentrifluconazole remained unknown.

"Conversely, fenpicoxamid, as a Quinone inside Inhibitor (QiI), was a novel fungicide in cereals and, with no other fungicides acting on this specific target having ever been used in cereals, *Z. tritici* populations were presumably completely naïve. However, the history of fungicide usage to control *Z. tritici* has demonstrated that site-specific fungicides are often at risk of resistance development, with only a single change in the pathogen required to render the fungicide ineffective."

For these reasons, it was important to establish a collection of isolates representative of European *Z. tritici* populations prior to the commercial use of either fungicide. As part of the EURORES project (Eurowheat Fungicide Resistance Network), populations of *Z. tritici* were collected from wheat crops in spring 2019 prior to fungicide applications in Ireland, Belgium, Denmark, Germany and Sweden. Using culture assays, the sensitivity of the collections to both fungicides were investigated, with differences being explored by examining the potential mechanisms of resistance that are known to exist in the pathogen.

## Managing resistance

Unsurprisingly, differences in sensitivity were evident between the collections, irrespective of the fungicide tested. For both fungicides the Irish population was less sensitive when compared to those collected further east in Europe, in particular the Nordic countries, Steven explains.

"For mefentrifluconazole, this undoubtedly reflects the intensive azole use in winter wheat production in Ireland when compared to the Nordic countries, and evident by the presence of different target site mutations. The differences in sensitivity observed toward fenpicoxamid were not associated with target site changes."

Glasshouse-based trials, using strains representative of the range of sensitivities present in European wheat fields, mirrored those of field trials conducted across the region. These trials also demonstrated the continued need for resistance management, to ensure that strains exhibiting greater resistance do not emerge and get selected.

As the recent history of fungicide usage in wheat in Europe has demonstrated, *Z. tritici* has an adept ability to overcome the inhibitory effect of fungicides, Steven says.

"As part of the EURORES project, and with knowledge of the target sites of the fungicides used for STB control — including mefentrifluconazole and fenpicoxamid — methods to rapidly screen populations were developed. These included probe-based and high-throughput assays based on Illumina sequencing. These allow us to screen populations for individual target site alterations or multiple alterations in the same gene respectively. A long-range multiplex sequencing assay based on PacBio sequencing provides knowledge of individual strains' resistance status to multiple fungicide modes of actions."

These assays will allow the detection of known or novel alterations that may impact fungicide sensitivity. Together with the network of researchers and agronomists established, they can be tracked across Europe and strategies implemented to prevent or delay their selection. T

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**CONTRIBUTORS**

**Steven Kildea**
Principal Research Officer,
CELUP, Teagasc Oak Park.
*stephen.kildea@teagasc.ie*

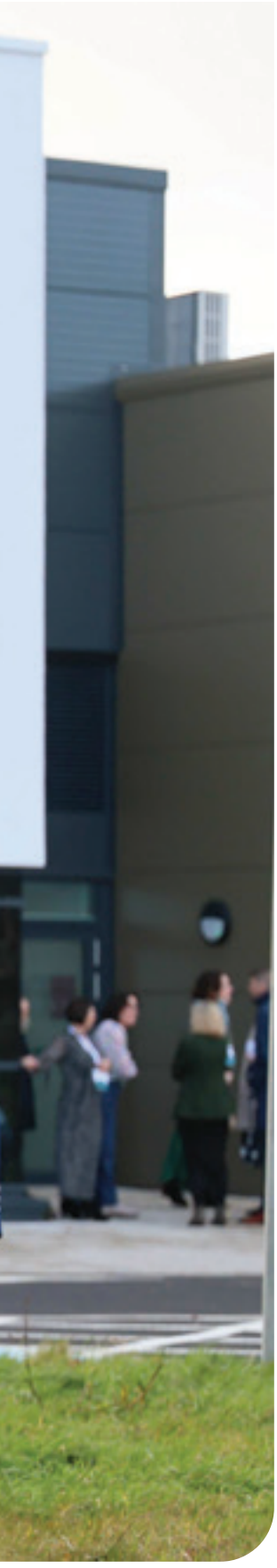
**Stephen Byrne**
Senior Research Officer,
CELUP, Teagasc Oak Park.

**Fiona Hutton**
Technologist,
CELUP, Teagasc Oak Park.

Teagasc


**The core team at the official opening of the BIA Innovator Campus: (L-R) Anita Furey, Food Technologist; Elaine Donohue, General Manager; Ciara McDonagh, Head of Food Industry Development Department; Colm Foley, Food Technologist**

Circular Food System



# Destination: innovation

The newly opened BIA Innovator Campus at Teagasc Athenry offers a unique single-location centre for food innovation and development in Ireland. To learn more about BIA's exciting new offering, *TResearch* spoke to its core team: General Manager Elaine Donohue, Food Technologists Colm Foley and Anita Furey, and Head of Department for Food Industry Development Ciara McDonagh.

**Photography: Mike Shaughnessy**

## What is the BIA Innovator Campus, and how did it come about?

**Elaine**: BIA is a new National Centre of Excellence at Teagasc Athenry. The Campus offers small food businesses a range of food-specific facilities, support, services and experiences from one central location. In 2017, a feasibility study established the need for a food innovation hub based in western Ireland with a regional and national reach. Since then, more than €8 million in capital funding has been raised with support from Enterprise Ireland, the Department of Rural and Community Development, Galway County Council, Teagasc, LEADER and the Western Development Commission to deliver a state-of-the-art campus.

## What are your core priorities and objectives?

**Anita**: The objective is to provide a new food innovation and entrepreneurship ecosystem, closely linked to the Teagasc Food Programme with access to the research facilities and food pilot plants in Ashtown and Moorepark. BIA will provide state-of-the-art food production and training facilities, as well as knowledge resources needed for food start-ups and SMEs to become self-sufficient.

**Colm**: As part of the Food Industry Development Department within Teagasc, our priority is to support the growth of the food industry in Ireland. We work with all types of businesses, from start-ups and cottage industries, to companies scaling up with potential to export. BIA's facilities are well suited to providing support to the artisan sector.

## How do you plan to meet these objectives?

**Anita**: We offer an holistic approach to food innovation. The BIA campus offers a blend of practical workspaces, technical and business advice, knowledge transfer opportunities and links to wider food systems. As well as gaining deep insights into the food industry from the highly experienced team at BIA, it allows entrepreneurs to be part of a community, drawing on each other's experience and insights.

**Elaine**: BIA will help food start-up and micro-businesses by giving them access to low-cost, low-commitment production facilities, and offering technical and commercial support. For existing small businesses, we can lease them high-spec, food-grade production facilities that will allow them to scale up and develop new products. For the farming community, BIA can help farmers develop off-farm income food projects and provide them with a variety of diversification ideas and supports. We also provide and facilitate a range of training and education programmes. Together, these components deliver a new ecosystem of food entrepreneurship that is truly unique in Ireland.

**Colm**: Alongside high-quality food production space, the Campus offers technical support from two onsite food technologists — myself and Anita. We can advise and troubleshoot on many areas that cause issues for new food businesses, such as producing a food safety plan, advising on packaging or equipment selection, and developing a recipe or formulation. This allows companies to grow and progress at a faster rate. There is a range ▶

Food Technologists Colm Foley and Anita Furey conducting new product testing in the food production units

of other support available such as business planning, marketing and commercial development.

## What are the key facilities available on campus for food companies? Is there anything particularly innovative or ground-breaking you can share?

**Elaine**: The campus spans over 29,000 square feet across three buildings. There are four food-grade production units that are available for hourly or daily rental, and 12 own-door units that can be leased. In addition to these workspaces, the campus also comprises a 60-seat auditorium with demonstration space, a 14-station Culinary Training Centre, 12 hot-desks, a showcase room and a range of meeting rooms.
**Colm**: We offer state-of-the-art-food production units for four key areas of production: dairy, butchery/meat, seafood, and general production. These units are fitted with the necessary equipment and services. The pay-per-use model reduces the risk to food business operators and allows for multiple companies to benefit from the facilities. The units are also used for running development trials and training workshops. My favourite element of the campus is the auditorium, which has a demonstration station with a full audio-visual set-up allowing for recording and live streaming.
**Anita**: All units are designed to operate in a safe and hygienic environment to de-risk starting out in food business. Technical and business mentoring is available from our in-house experts. There's also a hugely important community aspect to the campus as being an entrepreneur can be a lonely business.

## What support do you provide for food companies?

**Elaine**: On the commercial side, our support involves mentoring, business planning, and assistance with grant funding. We have a well-established network across both private industry and state agencies and can provide signposting to service users. While support is currently available across a range of enterprise agencies, food technical specialists and education and knowledge providers, they must be accessed on a stand-alone individual basis. This makes BIA unique in that we bring it all together in one package.
**Anita**: As Food Technologists, Colm and I help existing food businesses and start-ups with any technological or scientific knowledge gaps — developing new products, compliance with food safety standards, product testing and analysis through laboratory testing and consumer panels. On a day-to-day basis, I support the shared co-working production units. I also develop and deliver training modules to food entrepreneurs and learners in the wider food industry.

> **Together, [the] components [of BIA Innovator Campus] deliver a new ecosystem of food entrepreneurship that is truly unique in Ireland.**

## How important is this initiative to the region?

**Ciara**: The BIA Innovator Campus will enhance the innovation and accelerate the growth of start-ups and existing food businesses operating in the Galway and Atlantic economic corridor. The newly opened incubation and production facilities, together with the commercial and technical support on offer, will be a game-changer for companies in the region and across Ireland.
**Elaine**: There is a dearth of food incubators and support in general for the grassroots food sector in Ireland. Much of the support available to the food industry is for companies already of some scale — not at BIA. We're a broad church; it doesn't matter if you're a small farmer trying to develop off-farm income with a new food product, or a college student with a food business idea, you'll get a warm welcome at BIA.
**Colm**: The west of Ireland was highlighted as having a lack of support services for food businesses. The region has many primary producers, and we can now assist them in creating value-added products from their high-quality raw materials. We want to create a diverse and energetic community where knowledge and ideas can be shared with ease. Once fully operational, there will be upwards of 40 food businesses operating from the Campus. Our location increases the catchment area for Teagasc technical services and training programmes, as producers no longer need to look elsewhere for this support.
**Anita**: As well as creating employment locally and providing incredible facilities in which to manufacture food safely, the BIA Innovator Campus also has a positive impact across the region and the island of Ireland: last year alone, we advised, trained and worked with food entrepreneurs from 28 of the 32 counties. We also worked with over 30 European partners to develop resources for our food community which are free to access and focus on all aspects of the agri-food industry.

## Can you describe how your team will contribute to Teagasc, and vice versa? How does this fit in with wider Teagasc food industry development and networks in the region?

**Ciara**: In line with our own strategic goals, BIA will contribute to the national

development of our most important indigenous sector, agri-food. The Teagasc link is key to the innovative nature of BIA. Client companies benefit not only from the expertise of our technologists, Colm and Anita, but they also have access to the wider support of the Teagasc Food Programme. This will accelerate technology transfer to the food industry, for small-scale, local and start-up food companies in particular.

**Colm**: As members of the Food Industry Development Department, Anita and I have access to the breadth and depth of knowledge and experience available within Teagasc. Our colleagues in Teagasc have always been obliging and a great support. In turn, we can guide producers towards the range of facilities and services available at the research centres in Ashtown and Moorepark.

## What does the near future hold for your team?

**Ciara**: Sustainability is a key focus across the industry, regardless of company size or sector. It's no longer a trend but a requirement for businesses to guarantee sales, growth and investment. We're seeing an accelerating interest in sustainable packaging and the reduction of food waste and loss. Companies are looking at new technologies to extend shelf life and exploring how they can extract value from by-products and waste. A lot of these technologies are being applied and trialled by companies within the innovation facilities in Teagasc. Reformulation is another key priority for anyone producing food products, with companies being asked to reduce calorie content and the levels of saturated fat, sugar and salt in their products.

**Anita**: Sustainability, circular economy and climate change all require immediate action and directly impact the food industry. Adding value to food waste and underused foods at a community level to reduce food waste is an exciting area of the circular economy.

**Elaine**: Industry-wide, the overarching theme right now is sustainability. That extends all the way through the supply chain, from raw material to the finished goods on the consumer's plate. Everyone in the industry needs to engineer their product or service to be more sustainable. There is also a lot going on around food tech and digitalisation and how existing and emerging technologies can improve and drive food production, distribution and supply.

**Colm**: We receive many queries from companies who wish to develop and reformulate products with specific nutritional and functional attributes, I believe this will continue in line with consumer dietary trends. Producers will also need to focus on recipe and production efficiencies to ensure they can continue to provide high quality products at an acceptable price point.

## What are the team's values? What are the principles you work to that you think make your team successful?

**Colm**: The team at BIA is passionate about food and developing the food industry in the region. We are keen to offer support and growth potential to smaller operators. As we deal with many single-operator businesses, developing strong and supportive working relationships is a guiding principle; we feel as invested in their businesses as they are.

**Anita**: We all genuinely care and are passionate about food. Everyone on the team has invaluable experience in the food industry. Hard work, creativity and flexibility are at the heart of all that we do. I think what makes our team work effectively is the open communication, trust and respect we have for one another.

**Elaine**: Humility and passion! We understand the food business can be an intimidating place to early-stage entrepreneurs. We make sure all our service users get a warm welcome and are comfortable in coming to us for support. We're all very flexible and willing to help each other out and do whatever is in the best interest of our service user. T


Among the Campus's new features is a fully-equipped audio-visual room for livestreaming and podcast recording

## What are you proudest of as a member of the team?

**Ciara: I was brimming with pride at the official opening of the BIA Innovator Campus by An Taoiseach recently – it was so fulfilling to see what the team has achieved, and the hurdles overcome in bringing this multi-agency food ecosystem from concept to completion.**

**Colm: Playing even just a small part in the delivery of this Campus has been an immense source of pride for me, as it is a unique centre of excellence for the industry.**

**Elaine: I'm most proud of the work the team has done over the last two years, particularly in getting the build over the line and the campus fully operational.**

**Anita: I'm proud to be able use my scientific background to help food producers create new products and navigate through the myriad of food law requirements.**

Supporting Policy

Increase Carbon Capture

# Worth re-peat-ing

Peatlands are a particularly effective soil type for carbon storage. Assessing their drainage status can help harness their potential towards emissions reductions.

Peatlands form where high rainfall or impeded drainage causes waterlogging, restricting oxygen supply and suppressing decomposition of organic matter. Given the accumulation of vast amounts of organic material, peatlands offer significant value in terms of carbon (C) storage.

Peatlands cover only 3% of the Earth's land surface but store about 15-30% of the world's soil C as peat. In Ireland, peat soils cover approximately 1.46 million ha or 21% of the land surface and store approximately 2.3 billion tonnes of C.

Over many generations, drainage of these peatlands was actively encouraged and incentivised with a focus on maximising the peat resource in terms of energy production, horticulture and agriculture. It is estimated that 335,000ha of peat soils are under grassland today.

At present, as no information has been available on their drainage status, all of these soils are assumed to be artificially drained within national emission inventory reporting and are therefore responsible for significant emissions of 8–9 million tonnes $CO_2$-equivalent annually.

## Raising the water table

The water table is the upper level of an underground surface below which the soil is saturated with water. The depth of the water table within the peat is the key factor that controls whether accumulation or decomposition of organic matter is the dominant process. Consequently, the long-term stability of peat is very sensitive to any changes brought about by drainage, explains Pat Tuohy, a Senior Research Officer at Teagasc Moorepark.

"When drained effectively, aerobic conditions mineralise C stored in the peat; greenhouse gases (GHG) such as carbon dioxide and nitrous oxide are then released to the atmosphere. This process transforms peatlands from C-sinks into C-sources. Characterising the water table behaviour and — where possible — controlling the

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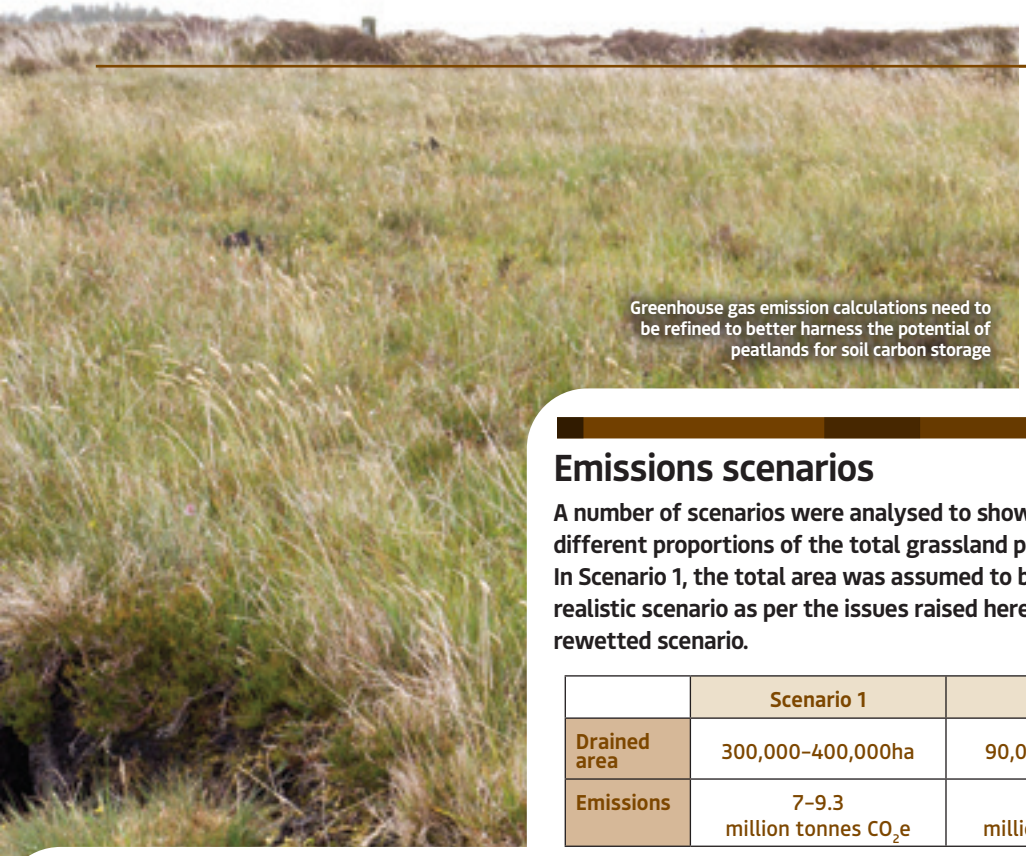


Greenhouse gas emission calculations need to be refined to better harness the potential of peatlands for soil carbon storage

## Emissions scenarios

**A number of scenarios were analysed to show the possible range of emissions, where different proportions of the total grassland peatland area are considered to be drained. In Scenario 1, the total area was assumed to be drained, Scenario 2 represents a more realistic scenario as per the issues raised herein, while Scenario 3 represents a fully rewetted scenario.**

| | Scenario 1 | Scenario 2 | Scenario 3 |
|---|---|---|---|
| Drained area | 300,000–400,000ha | 90,000–120,000 ha | None – full rewetting |
| Emissions | 7–9.3 million tonnes $CO_2e$ | 3.6–4.8 million tonnes $CO_2e$ | 2–2.6 million tonnes $CO_2e$ |

water table is the major lever at our disposal in managing C storage on these soils. Water table management — or rewetting — is defined as raising the water table in soils that had previously been drained. This can be done by reducing water losses from the site by decreasing surface drainage, surface runoff, sub-surface seepage or groundwater extraction."

Substantial cuts in GHG emissions are required in line with international agreements to reduce climate change and its impacts. The land-use sector therefore needs targeted changes in management such that C sources are minimised and sinks promoted on a local and global scale. Management of grassland peat soils at farm scale will require a knowledge of the distribution of peat soils and their drainage status.

However, the drainage status of such soils is extremely complex. This creates problems when trying to account for drained and undrained areas at national scale, where estimates can tend towards an "all or nothing" approach with little room for subtlety, explains Pat. "Currently, using national statistics in a Tier 1 approach (default emission factors), all of the 335,000ha of the grassland peat soils are assumed to be drained for the purposes of National Inventory Reporting. This assumption has not been justified, and such crude estimates make it difficult to form clear policy in supporting GHG emissions reductions."

### Drain strain

Land drainage works typically comprise a network of open drains — running at a relatively low intensity — acting as an outlet from an in-field drainage system, itself comprising sub-surface pipes installed at relatively high intensity. While most of the managed grassland on peat in Ireland would have been subjected to the installation of open drains, in-field drainage would have been less common.

In many cases, effective field drainage is economically infeasible. It must be remembered that effective lowering of the water table over wide areas is unlikely where only open drains are installed, and intensive in-field drainage is required to achieve water table control in peat soils. In addition, different peatland types require different drainage system designs and all drainage systems have a limited lifespan, requiring regular repair and replacement to retain long-term functionality.

Pat adds: "Such insights challenge the assumption that peat soils are uniformly and optimally drained and maintained over time and calls into question the existing assumptions of drainage status of peat soils, their associated emissions and our impression of what does and does not need water table management. Quantifying these aspects will establish a starting point for restoration efforts."

### Reassessing emissions

The total emissions from grasslands on peat soils are overestimated due mainly to the imposition of a simplistic assumption with regard to drainage status. As such, while large areas of peatland have been transformed from their natural state to grassland agriculture, there is no evidence to support that effective drainage ever occurred on much land assumed — for the purposes of GHG estimates — to have been drained. Therefore, a refinement of the GHG emissions associated with this land use is required. A number of other factors currently being investigated, such as peatland extent, land use, nutrient status and associated emissions factors, are all subject to refinement over time. A significant research focus on these areas is ongoing.

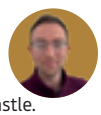
To harness the potential of peat soils and the scope for rewetting as a climate change mitigation tool, alternative estimations of the assumed emissions are put forward. The application of these findings can impact significantly on estimated emissions from grassland peat soils and more broadly on the land use, land use change and forestry sector, while offering clarity regarding future policy and management of these soils. T

**CONTRIBUTORS**

**Pat Tuohy**
Senior Research Officer, Animal & Grassland Research and Innovation Centre, Teagasc Moorepark.
*patrick.tuohy@teagasc.ie*

**Lilian O' Sullivan**
Senior Research Officer, Teagasc, Environment Research Centre, Teagasc Johnstown Castle.

**Conor Bracken**
Research Officer, Environment Research Centre, Teagasc Johnstown Castle.



**Owen Fenton**
Principal Research Officer, Environment Research Centre, Teagasc Johnstown Castle.

Enhance Adaptation

# One way or an udder

Automation technology which mitigates over-milking is an important consideration when scaling up milking facilities. Research at Teagasc Moorepark is examining the optimal balance for milking efficiency.

Milking is the main chore on dairy farms and typically consumes over 30% of total labour input. With high labour costs and problems accessing skilled labour, the recent trend has been to install milking parlours, with a greater number of clusters to be handled by one operator. Automatic cluster removers (ACRs) are a useful automation to facilitate single-operator management of a greater number of milking clusters. They also offer consistency around the endpoint of milking and can eliminate over-milking of cows.

Over-milking should be avoided to keep teats in good condition and to maintain cow comfort during milking. Much work has already been conducted to provide strong support for significant reduction in milking duration without impact on milk yield through increasing the flow-rate at which the ACRs detach the milking cluster (ACR threshold). However, in practice, many farms have not adopted this labour-saving technology on the basis that it may increase milk somatic cell count (SCC – an indicator of udder health).

Researchers at Teagasc Moorepark have tested the effect of removing milking clusters earlier than normal to examine the effects on milk yield and SCC. John Upton, a Senior Research Officer in the Livestock Systems Department, explains:

"Typically, the ACR threshold is set at a flowrate of 0.2kg/min, i.e. completely milking the cow out. The objective of this study was to increase the ACR threshold from 0.2kg/min to 0.8kg/min in steps of 0.2kg/min and document the effects on milk yield, milking duration, average milk flowrate, strip milk — milk left behind after cluster removal — and SCC over a 31-week period."

## Increasing ACR thresholds

Four treatments were deployed over 31 weeks to cows at the Moorepark research centre. The treatments consisted of ACR thresholds increasing from 0.2kg/min to 0.8kg/min in steps of 0.2kg/min (ACR0.2 ACR0.4, ACR0.6, ACR0.8). A mid-line 30-unit Dairymaster


Data from Weigh-All milk meters were used to generate milk flow curves for every milking

Teagasc

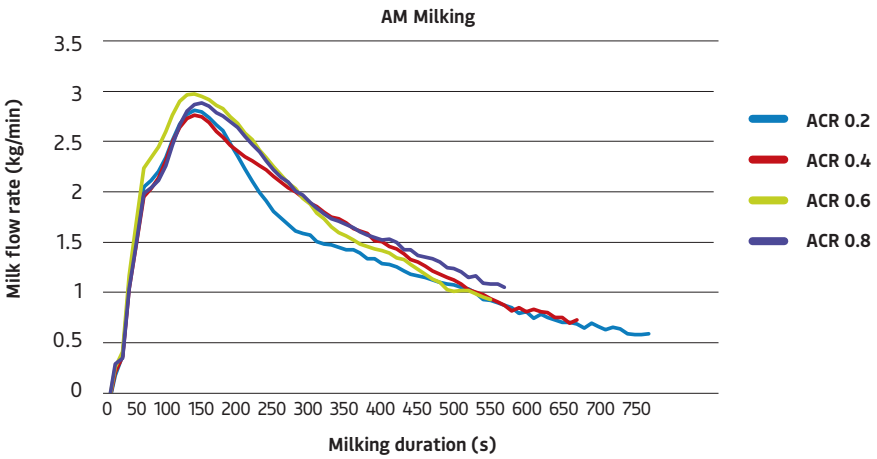
Data loggers were used to capture vacuum conditions during milking

herringbone, swing-over milking system was used for twice-daily milking of the cows on the study.

John further explains the methodology: "The milking system utilised simultaneous pulsation (i.e. 4x0 pulsation) and was fitted with ACRs and Weigh-All milk meters. The standard farm ACR threshold was 0.2kg/min. The milking parlour software was modified to apply a pre-defined ACR threshold to a specific cow regardless of when she presented for milking. Cows were managed in a pasture-based system and were milked twice per day with a 16:8h milking interval. Each experimental group had 27 cows at the beginning of the study.

"Strip milk was recorded on four separate occasions over the course of the study," says John. "This was carried out by reattaching the cluster to the cow after it had been removed by the ACR, adding a 2.5kg weight to the cluster, and removing the unit once milk flow had ceased. The strip milk yield was then recorded from the milk meter. The strip milk data of 64 randomly selected cows spread evenly across all four treatments were collected."

**Average milk flow rate curve by treatment for AM milking where the cluster was removed at 0.2kg/min, 0.4kg/min, 0.6kg/min, and 0.8kg/min thresholds**




**FUNDING**

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## Milking duration, yield and SCC

The milking duration for ACR0.8 was significantly shorter than ACR0.2, by 95s (14%). Similarly, the average flow rate for ACR0.8 was significantly larger than ACR0.2, by 0.26kg/min (16%). There was no treatment effect on milk yield or strip milk — i.e. increasing the ACR threshold did not affect the milk yields of the cows, or the amount of milk left behind in the udder after milking.

There was no significant effect of treatment on SCC. The SCC values were 71,700, 67,000, 69,900 and 67,700 cells per ml for the ACR0.2, ACR0.4, ACR0.6 and ACR0.8 treatments respectively. The researchers found a significant effect of week on milk SCC, whereby the SCC of the cows on the experiment increased as lactation progressed in a similar way across all treatments.

There were 10 cases of clinical mastitis among the cows on the study. There were two cases on ACR0.2, one case on ACR0.4, four cases on ACR0.6 and three cases on ACR0.8. *Strep. uberis* was identified in four cases, *Staph. aureus* was identified in three cases and in three cases no bacteria was identified.

Overall, results are positive, suggesting that milking duration can be reduced without significant effect on milk yield and SCC. John concludes: "We did not find a significant effect of increasing the ACR threshold from 0.2 to 0.8kg/min on milk SCC in this long-term study. We found a significant effect of week on milk SCC, whereby the SCC of the cows on the experiment increased as lactation progressed. We can also conclude that increasing the ACR threshold from 0.2kg/min to 0.8kg/min reduced daily milking duration by 14% without any significant reductions in milk production or significant increase in strip milk in this study." T

**CONTRIBUTORS**

**John Upton**
Senior Research Officer
Livestock Systems Department,
Teagasc Moorepark.
*john.upton@teagasc.ie*

**Martin Browne**
Milking Efficiency Technologist
VistaMilk SFI Research Centre,
Teagasc Moorepark.

**Pablo Silva Boloña**
Research Officer
Animal Bioscience Department,
Teagasc Moorepark.

# Pasture, present and future

Is pasture-based Irish milk truly better than milk from conventional indoor feeding? To examine this question, researchers from Teagasc and Food for Health Ireland conducted one of the largest, most in-depth trials of its kind.

There is a growing demand for dairy products produced from pasture-fed animals, as consumers perceive pasture feeding as a more natural and holistic form of milk production. Pasture-fed differs from grass-fed in that it not only ensures that cows are fed large proportions of grass in their diet, but also warrants that the animals consume this feed while outdoors at pasture and can therefore follow their natural grazing behaviour.

Despite this demand for pasture-fed produce, the majority of dairy products sold around the world do not originate from pasture-fed animals, with farmers worldwide preferring to operate an indoor mixed ration feeding system. This preference often results from the greater difficulty of growing high-quality grass pastures in many regions of the world. However, the feeding of a mixed ration to housed animals also allows a greater control of animal nutrition, resulting in a

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> **Premium dairy products not only provide essential nutrients, but ensure farms are providing animals with a more natural way of life.**

larger milk production than that of pasture-fed animals.

In contrast to this, due to Ireland's ability to grow large quantities of high quality pasture for animal consumption, Irish dairy farms provide higher quantities of grazed pasture in the cow's diet than the majority of countries around the world. Similarly, because of the temperate climate in Ireland, Irish cows enjoy more time at pasture and a much higher number of days at pasture compared to anywhere else in Europe and the majority of the world.

## Fat chance

Recent research conducted at Teagasc Moorepark segregated cows into three herds of 18 cows who consumed three different diets for comparison: a high pasture allowance diet, typical of that operated by Irish farmers; a medium pasture allowance diet; and no pasture allowance diets, typically operated in most regions around the world.

Milk was collected from the three herds weekly across nine months and tested for its composition, properties and nutritional parameters, such as the fatty acid profile, in order to distinguish Irish dairy from that produced worldwide.

Mark Timlin, a postdoctoral researcher at Teagasc Moorepark, explains: "Despite the higher milk yields achieved by the no pasture allowance diet, the high pasture allowance diet, typical of Irish dairy, produced milk with better fatty acids for human consumption. These fatty acids can be absorbed into the human gut and provide vital nutrients for us humans."

The high pasture allowance diet produced milk with the healthiest fatty acids for human consumption, with the fatty acids most notably altered including:

- **141% increase in conjugated linoleic acids (CLA)**
- **83% increase in omega-3 fatty acids**
- **14% increase in unsaturated fatty acids.**

These fatty acids are associated with significant health benefits including improved eye, brain and cardiovascular health in addition to an improved immune response.

Further analysis of the milks also demonstrated an improved udder health of the animals maintained on the high pasture allowance system, as indicated by the lowest somatic cell count in the milks they produced, Mark explains.

"Additionally, the milks increased in yellow colour with an increase in the animals pasture allowance, originating from the relatively large proportions of colour pigments — called carotenoids — in the leafy grass pastures. Not only do these carotenoids naturally provide Irish high pasture allowance milk and dairy products with a characteristic yellow colour, but the carotenoids are also broken down into vitamin A in the body, an important nutrient for normal vision and immune system."

## Setting the standard

The high pasture allowance system in this study is reflective of the Bord Bia standard for Irish dairy. Dairy products sold with this standard displayed on their packaging around the world reassure consumers that the product within is derived from Irish cows that consume a minimum of 90% grass or grass forage and are maintained at pasture for an average of 240 days a year.

To guarantee these products meet the requirements set by the Bord Bia standard, farmers providing milk for these dairy products are assessed regularly through Bord Bia's Sustainable Dairy Assurance Scheme, ensuring these dairy products meet both sustainability and quality assurance criteria.

As Mark says: "Consumers will now have the comfort in knowing they are buying a premium dairy product, which not only provides essential nutrients, but also ensures the farms from which it came from are providing their animals with a more natural way of life."

The researchers of the Food for Health Ireland project in Teagasc and University College Dublin have undertaken further research into increasing animal pasture allowance and its impact on the production, functional properties, textural attributes and their impact on human health of butter, cheese and whole milk powders. This research is reaching its conclusion, and its results will add invaluable understanding to the benefits of the consumption and desirability of Irish dairy products, which are currently retailing in over 130 countries around the world. T

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**CONTRIBUTORS**

**Mark Timlin**
Post-Doctoral Researcher,
Teagasc Food Research Centre,
Moorepark.
*mark.timlin@teagasc.ie*

**Kieran Kilcawley**
Principal Research Officer,
Teagasc Food Research Centre,
Moorepark.

**André Brodkorb**
Principal Research Officer,
Teagasc Food Research Centre,
Moorepark.


# Tiny microbes, big impacts

A world-leading microbiome research centre based at Teagasc and UCC, APC Microbiome Ireland has spent twenty years at the forefront of this dynamic and ever-prevalent field of research.

Last December, the world-leading SFI microbiome research centre, APC Microbiome Ireland, celebrated the 20th anniversary of its founding with an event at University College Cork.

Based at Teagasc and UCC, APC was formed in 2003 with funding from Science Foundation Ireland, with a mission to investigate the complex environment of the gastrointestinal tract and its microbial community. In the 20

John Leech, Teagasc Technologist and Research Officer, preparing fermented foods for analysis

Teagasc

Andrew Downes

Samuel Mortensen, Teagasc and APC Postdoctoral Researcher preparing a run in the DNA Sequencing Centre at Teagasc. The centre is a critical piece of infrastructure for APC's microbiome studies

Catherine Stanton appearing on "10 Things to Know About...Guts" in 2015

10 Things to Know About

years since, it has established itself as one of the world's leading centres of research of gut and other microbiomes — dynamic and complex areas of research with relevance to both the food and pharmaceutical sectors.

Over two decades, APC has made several landmark discoveries and has published over 3,000 research articles in peer-reviewed journals. The significance of this research was celebrated with the publication of *20 Years of APC Impact*, highlighting some of the ground-breaking research on major societal challenges that APC has contributed to addressing, including chronic and infectious disease, anti-microbial resistance and sustainable food development. Many Teagasc scientists have played important roles in this research, particularly in the fields of food, health and wellbeing, sustainability, climate change and early life nutrition.

## Gut instinct

Teagasc and APC researchers have been studying the links between diet, exercise and microbiome composition, from ancient fermented foods to high-achieving athletes.

Paul Cotter and his Vision 1 lab group have demonstrated that fermented foods benefit the gut microbiome, and have identified bacteria (and their genes) that can promote human health, and in other research have demonstrated the influence that specific food bacteria have on the flavour of food.

Paul Cotter also co-ordinated the EU Innovation Action MASTER project which brought together 29 partners to develop new microbial strains, foods, feeds, processes and databases ▶

Paul Cotter appearing on "10 Things to Know About...Viruses" in 2020


10 Things to Know About

of relevance to the food chain, all with sustainability in mind. APC researchers were involved in the sequencing of DNA from food samples, resulting in the creation of a reference database with 10,000 microbial genomes. This has resulted in it now being easier to rapidly identify microbes in the food chain, and use the information to improve food quality and safety.

The study of microbiome composition and its links to physical fitness, athletic performance and recovery has been the subject of Orla O'Sullivan's research with APC. As part of her research, Orla has worked with athletes from the IRFU, Cricket Ireland, Sports Ireland Institute, Ironman Indiana and a Premier League soccer team, investigating how changing the gut microbiome can improve performance or aid muscle recovery. A study of the Irish rugby team, published in the prestigious journal *Gut* in 2017, showed that the athlete's microbiome is primed for tissue repair and to harness energy from the diet, reflecting the significant energy demands and high cell-turnover evident in elite sport.

## Tackling emissions

Methane is a greenhouse gas released by ruminant animals such as cows and sheep as a bi-product of microbial fermentation in the rumen and large intestine. Reducing the volume of methane originating from ruminant livestock will be required for Ireland to reach its emissions reduction targets by 2030. APC researchers led by Catherine Stanton have been studying the potential use of Lactic Acid Bacteria (LAB) to reduce methane emissions in ruminant animals. LAB are already used in the animal diet to boost health and production. On the MethLAB project, after testing on farm and in the laboratory, two LAB strains were identified which could markedly reduce methane emissions from cows, with no effect on animals' health or production parameters assessed. Similarly, APC researchers have studied the use of probiotics and other bacterial molecules and strains to positively support the gut microbiome of livestock such as cows, pigs and sheep.

## Starting advantage

Research led by Catherine has established that the infant gut microbiome is altered depending on mode of delivery (vaginal birth or C-section), antibiotic usage, formula feeding and premature birth. Based on the findings from these studies, Cork University Maternity Hospital now gives probiotics to pre-term infants, and published analysis by APC indicates the probiotics help protect vulnerable babies from severe gut infections such as


John Harrington Photography

**Catherine Stanton (far right) at the announcement of the MiMIC project in Washington DC in March 2020**

Clare Keogh

**An Tánaiste, Minister for Foreign Affairs and Minister for Defence, Mr. Micheál Martin, T.D. (right) launches a 20 Years Impact brochure for APC Microbiome Ireland at a celebration event in The Glucksman Gallery, UCC, on Friday 15th December**

necrotising enterocolitis and mortality. The *Missing Microbes in Infants born by C-section* (MiMIC) project, a collaboration between APC and IFF (previously DuPont Nutrition & Biosciences) is involved in identifying and isolating gut microbes in early life that play an important role in short and long-term health. The project also develops strategies to balance the gut microbiota in infants following antibiotics administration or C-section delivery.

## Future challenges

Speaking at the 20th anniversary event, Teagasc Director Frank O'Mara commented:

Tina Darb

**Samuel Mortensen and John Leech with some examples of fermented foods at Kefir Day 2022**

> **"APC ... is making an impact on several fronts; the potential to ... address the sustainability agenda may be the most important one."**

"APC Microbiome Ireland has made great impacts in the last 20 years on several fronts, particularly in the foods for health sector. But the potential for microbiome science to mitigate climate change and address the sustainability agenda may be the most important one.

"APC researchers at Teagasc and UCC look forward to further impactful science, addressing society's biggest challenges in food, health and sustainability." T


**ACKNOWLEDGEMENTS**

**The brochure *APC Microbiome Ireland – 20 years of impact* can be found in the publications section of the Teagasc website.**


**CONTRIBUTORS**


**Muireann Egan**
Communications Officer
Teagasc Food Research Centre,
Moorepark.
*muireann.egan@teagasc.ie*


Circular Food System

Supporting Policy

# The Vitamin "Sea"

As part of the SunMara project, Researchers from Teagasc and UCD are investigating polysaccharide-rich seaweeds and their potential benefits on the immune system.

Simon Roughneen/istockphoto.com

For centuries, polysaccharide-rich seaweeds have been employed around the world for their dietary and medicinal benefits. Certain polysaccharides are attracting increasing scientific interest, due to their influence on immune system function, inflammation and cancer.

Brown seaweed, in particular, is rich in bioactive compounds, which are increasingly employed in pharmaceutical and cosmetic applications.

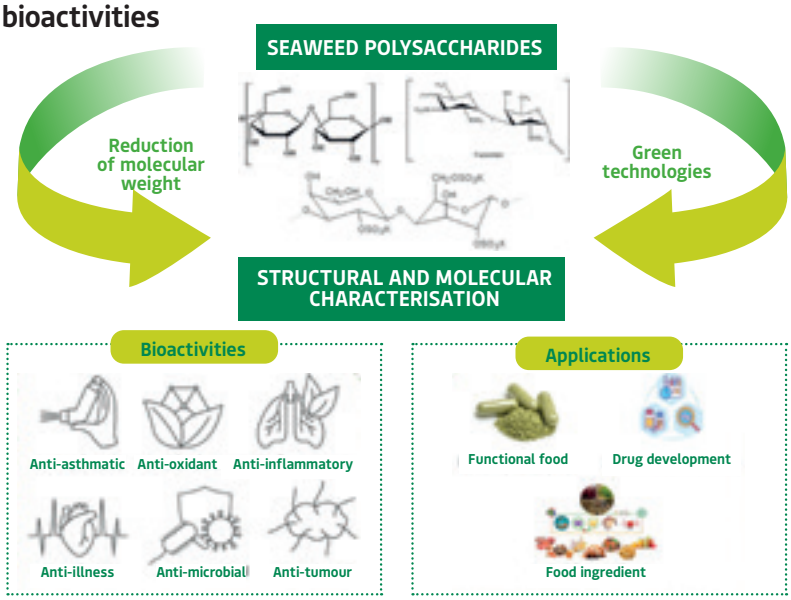
Extraction of these valuable compounds requires green and sustainable technologies. The objective of the SunMara project is to use a biorefinery approach to develop extraction processes for these products using clean, green and novel processing approaches focused on zero waste and reduced carbon emissions.

Shanmugapriya Karuppusamy, a Marie Słodowska-Curie Career-Fit PLUS Fellow at Teagasc Ashtown, explains: "*Laminaria digitata* brown seaweed is suitable for the production of bioactive functional ingredients of the highest quality and bioactivity. Brown seaweed is made up of polysaccharides, which several studies have shown have biofunctional proprieties. Seaweed polysaccharides have attracted strong research interest because the cell wall consists of various types of polysaccharide, polyphenol, protein, lipids, vitamins, etc."

These functional compounds have been reported to possess various biofunctional properties and their potential use for therapeutic applications is an active research area.

Laminarin, a storage polysaccharide from brown algae, has been reported to have potential pharmacological properties, including antioxidant, anti-tumour, anti-coagulant, anti-cancer, immunomodulatory, anti-obesity, anti-diabetic, anti-inflammatory, wound healing, and neuro-protective.

## Seaweed polysaccharides with their reported properties and bioactivities



Shanmugapriya explains further: "Marine-derived polysaccharides are considered as multifunctional supporting biomaterials that can interact with a specific receptor of the immune system for biological properties and immunomodulatory action. Laminarin enhances the immune system with a high accumulation of B cells and helper T cells. It also has anti-inflammatory potential by preventing proliferation of immune stimulatory molecules for cancer immunotherapy applications."

Laminarin is both biodegradable and biocompatible. Due to its properties, it has been widely used as a multifunctional bioactive in biomedical applications. Laminarin is also an excellent source of dietary fibre and an immune modulator of intestinal metabolism and production of short-chain fatty acids. The current research indicates that lamarin has very high potential for biomedical and industrial applications, including nutraceutical, pharmaceutical, functional foods, drug development/delivery and cosmetics. T

## Did you know?

**Laminarin is an excellent source of dietary fibre and a modulator of intestinal metabolism. Laminarin acts as an immunomodulator through its effect on intestinal pH and short-chain fatty acids production. Laminarin is reported to boost immune health, and treat and prevent diseases.**


### ACKNOWLEDGEMENTS

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### CONTRIBUTORS


**Shanmugapriya Karuppusamy**
Marie Słodowska-Curie Career-Fit PLUS Fellow,
Food Research Centre, Teagasc Ashtown.
*shanmugapriya.karuppusamy@teagasc.ie*

**Brijesh Tiwari**
Principal Research Officer,
Food Research Centre, Teagasc Ashtown.

**Colm O'Donnell**
Professor,
School of Biosystems and Food Engineering,
University College Dublin.


# Getting to know

## Anna Fenelon

Wexford native **Anna Fenelon** combines her technical expertise, and passion for working with people, in a national role coordinating laboratories across the Teagasc Research programme.

**Hi Anna! Could you tell us a bit about yourself?**
I'm a Technologist based in Johnstown Castle, with a national role in coordinating Lab and Field Experimentation infrastructure. At Teagasc, we have approximately 150 labs across seven research centres. My primary role is driving coordination between the labs, fostering a culture of communication and collaboration.

**Where does your interest in scientific research stem from?**
My dad was a lab technician and I grew up near Johnstown Castle. From a young age I was familiar with lab work, and the sciences were always my favourite subjects in school. I was never happy learning by rote; I always probed the "why" and "how". I began university in general science but developed a keen interest in chemistry and pursued my career in the physical sciences.

**What led you to Teagasc?**
After completing a PhD and Post-Doctorate in Chemistry, I spent four years at Hewlett-Packard Manufacturing, working on a research development team, setting up new labs. I also worked with external research organisations on industry/academic collaborations, giving me valuable experience in lab management.

I was living near Dublin then, but wanted to return to Wexford. Johnstown Castle were recruiting a lab manager to run the research labs of the Environmental Research Centre. This was the perfect opportunity for me to combine my research and lab skills with my wish to return to Wexford.

**What research/projects are you currently working on?**
My role in the Research Operations Team is multifunctional, but my primary focus is to foster collaboration and communication within the Teagasc technical community. My work varies; last year, for example, I worked on capital equipment expenditure, organising conferences, web development, lab building development and procurement of new information systems for the digital transformation of Teagasc labs .

I enjoy working with people and lead teams for new initiatives such as the sustainable lab committee or advanced technical training programmes. This year my focus is implementing our new LIMS across Teagasc to meet the operational needs of high throughput labs, and implementing electronic lab notebooks.

**What are your interests outside of work?**
I love spending time with family and friends, enjoying the beautiful beaches around Wexford and taking the kids to GAA matches. I've recently taken up golf and am thoroughly enjoying learning this new skill. I also regularly attend the cinema, the theatre and events at the National Opera House in Wexford town.

### CONTACT


*anna.fenelon@teagasc.ie*

Enhance biodiversity

Enhance Adaptation

Teagasc

# Leading the poll-en

Increasing the prevalence of wild pollinators is one of many strategies to combat biodiversity loss. As part of the EU-CAP Network, Teagasc researchers are examining how this may be brought about, explains Research Officer Saorla Kavanagh.

There are many initiatives and strategies in place that aim to help halt and reverse the decline of biodiversity. The European Biodiversity strategy for 2030 and the EU Pollinator Initiative aim to protect nature and reverse the degradation of ecosystems and set the commitment to reverse the decline in wild pollinators by 2030.

Decoupling economic growth from the exploitation of natural resources, protecting ecosystem services, and restoring habitats are some of the key principles of the European Green Deal. The EU-CAP Network is a forum through which administrations, entrepreneurs, farmers, organisations and researchers can share knowledge and information about agriculture and rural policy.

## Assessing the landscape

Using a range of platforms, the network facilitates knowledge sharing on topics relating to biodiversity, pollinators and water on farmland. Last year, it organised the Focus Group *Enhancing the biodiversity on farmland through high-diversity landscape features*.

Saorla Kavanagh, a Biodiversity Research Officer from Teagasc's Environment, Soils and Land-Use Department joined 19 other experts including four farmers to participate. The aim of the Focus Group was to determine how farmers can maintain, enhance and create high-diversity landscape features (HDLF) that positively affect farmland biodiversity. As a result of these meetings, a report and five mini papers were published. Saorla was the lead author on Mini Paper 3: *Managing High-Diversity Landscape Features for Pollinators*. The mini paper gave an overview of:

- what HDLF benefit pollinators and farmers and the associated costs
- how managing HDLF for pollinators on the farm benefits farmers
- what farmer supports are needed to help farmers manage HDLF
- what is needed to maintain, enhance, and create HDLF.

The mini paper also highlights research needs and ideas for innovation.

As Saorla explains: "We are at risk of squeezing nature out entirely from intensive farmland, and in doing this we jeopardise the important free services nature provides. Pollinators can be returned to all farmland without negatively affecting productivity. The important role of measures under the Common Agricultural Policy in encouraging the management of HDLF and adequately rewarding farmers for their conservation cannot be underestimated."

> **"Pollinators provide a vital service to natural ecosystems and farming, and therefore should be offered a high level of protection."**

Managing HDLF on the farm for pollinators can result in an increase in habitats for a much wider component of biodiversity. HDLF can be integrated into any farming system; however, it is suggested that a focus on a whole-farm approach, as compared to a field-by-field approach, will more likely fit within farming systems, and gain farmer support. Managing HDLF across multiple farms and the wider landscape is likely to provide the best outcome for halting and reversing pollinator decline.

Saorla adds: "Pollinators provide a vital service to natural ecosystems and farming, and therefore should be offered a high level of protection given the potentially far-reaching effects of their decline."

To help manage HDLF for pollinators and wider biodiversity on farmland, more resources are needed to help facilitate the transfer of biodiversity knowledge within the farming community. In 2024 there will be an EU CAP Network workshop on halting pollinator decline in Europe. T

# 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 the take-home messages – key pieces of information that our researchers want people to remember – from recent events.

## Farmers central to sustainable uplands

**Event: Upland Farming and Landscape Management Symposium, Westport, County Mayo**
**Date: 16 November 2023**

Upland farming systems that prioritise sustainability offer numerous social, economic, and environmental advantages. The Upland Farming and Landscape Management Symposium, organised by Teagasc in partnership with the College of Agriculture, Food and Rural Enterprise (CAFRE) from Northern Ireland, focused on addressing the sector's challenges and exploring its opportunities.

The symposium centred on four main themes Carbon, Water, Biodiversity, and Livestock and brought together farmers, advisors, researchers, scientists, policymakers and community organisations involved in farming, managing and utilising upland landscapes.

Attendees at a talk by Catherine Keena, Countryside Management Specialist at Teagasc

Michael Mc Laughlin

Throughout the day, a consensus was reached among several panellists that farmers provide a multitude of ecosystem services and should be duly compensated for these contributions to the public. Catherine Keena, Countryside Management Specialist at Teagasc, stresses: "Farmers are pivotal in the uplands as proper management is essential to unlock their full potential. The adaptability and responsiveness of farmers to policy drivers and incentives is key." Catherine also emphasises the crucial role played by agricultural advisors in assisting farmers with the adoption of best practices and the development of farming systems.

Stan Lalor, Director of Knowledge Transfer in Teagasc, expressed his observations on the optimistic outlook displayed by farmers and other stakeholders regarding the sustainability and advancement of upland farming systems. Stan says: "Substantial progress has been made in fostering collaborative initiatives to develop these farming systems, the importance of policy and results-based incentives in providing support is hugely important."

(Text credit: Ivan Kelly)


Attendees at the National Tillage Conference

Finbarr O'Rourke

## Unlocking the potential of protein crops

**Event: Teagasc National Tillage Conference, Kilkenny**
**Date: 31 January 2024**

The success of the Irish dairy industry is largely due to its ability to take milk and produce a whole host of products that later form the building blocks of other food products, but are there opportunities for the tillage sector to achieve similar results?

As part of the U-Protein project, Teagasc researchers are identifying and refining the key technologies used in the dairy industry, along with developing new practices, to achieve similar results in the plant protein space.

Speaking recently at Teagasc's National Tillage Conference, Mark Fenelon, Head of Food Programme at Teagasc, spoke about the alternative ingredients made from crops – particularly grains and legumes – and recent investments at Teagasc to create value-added products for use in the food industry.

As it stands, Irish protein crops are predominately used in the animal feed and specialist fresh/frozen spaces, but there is an opportunity to unlock potential markets through the production of protein flour for use in baked products and protein isolate as an ingredient in many foods.

"We have developed a new process at Moorepark and Ashtown, where we can fractionate different plants. We have looked at optimising this and the effect of the process and the functionality of the ingredients," Mark says.

This process has allowed for the development of a nutritional base that food businesses can rehydrate and later build a product on. Faba beans have already been fractionated to produce a high protein isolate, which can be used in high-end value nutritional products.

"The key is not to disregard the rest of the products," Mark adds. "We can take the protein out but we also need to take the starch and fibre; all have different qualities. When you put all of them together the business model is much more favourable."

(Text credit: Sean Cummins)

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

# BIO-BEV: Novel BSG-based functional snack

## Technology

- Teagasc researchers, in collaboration with the University of Helsinki, have developed a highly bioactive, spoonable plant-based snack
- Through bioprocessing, and by using brewers' spent grain (BSG) – beer manufacturing residue – this product is moving towards green label status

## Value propositions

- For the brewing industry: circular economy approach, given BSG represents 80% of brewing industry waste
- For snack manufacturers: bioprocessing approach to develop functional snack with no additives – clean label status
- For consumers: premium functional snack, rich in protein, fibres, carbohydrates

## Development stage

- Prototype developed, overcoming sensory and technological challenges to achieve stabilised final product
- Sensory studies undertaken – masking of bitterness achieved

## Opportunity to engage

- This novel snack could help manufacturers meet consumers' growing demand for sustainable plant-based functional snacks, while reducing the carbon footprint of the brewing industry
- As such, we welcome engagement with relevant industries to commercialise such a snack

**Research funding**

**Teagasc-Marie Curie Research Leaders 2025 Fellowship**

**Project - BSG BIO-BEV (Fellow Kamaljit Moirangthem)**

**For further information or the opportunity to discuss, contact Miriam Walsh miriam.walsh@teagasc.ie or engage@teagasc.ie (Reference: BIOBEV)**

# Novel, clean seaweed preservation method

### Technology

- Teagasc researchers have developed a novel, environmentally friendly and sustainable two-step method to preserve freshly harvested seaweed for an extended period before further processing
- This could provide additional value-add opportunities in seaweed product development, while potentially significantly reducing drying and labour costs for harvesters

### Value propositions

- Twenty-six weeks' shelf life extension for fresh seaweed: this two-step method involves blanching and storage in a unique chemical-free preserving solution
- Alleviation of harvesters' time pressures and expensive drying, by allowing storage of fresh stock immediately after harvesting

### Development stage

- Efficacy proven at pilot field scale (10kg fresh seaweed) with industry engagement – and scaled up from lab-scale trials
- Published Patent filed at EPO – "Method of preserving seaweed" EP4268609

### Opportunity to engage

- This innovative, cost-effective solution to extending the shelf-life of freshly harvested seaweed would benefit harvesters, seaweed processors and ultimately consumers
- Teagasc is seeking engagement with seaweed harvesters as potential licensees to validate and commercialise this technology

**Research funding**

Science Foundation Ireland - BIORBIC Targeted Project

Lead Teagasc
PI - Brijesh Tiwari

**For further information or the opportunity to discuss, contact Miriam Walsh miriam.walsh@teagasc.ie or engage@teagasc.ie (Reference: Seaweed preservation)**

Agriculture and Food Development Authority

## The perfect apple

**This image was taken in the trial apple orchard in Teagasc Oak Park, Carlow. It highlights one of the 48 apple genotypes that are being assessed to characterise their physico-chemical quality and to develop a comprehensive sensory profile of the different apples grown in the Irish climate, as well as to understand the preferences of Irish apple consumers.**

**Photo and description by:**
Alberto Ramos Luz,
Fruit Research Officer
**Teagasc Project:**
Smart Apples: Develop an apple sensory profile tool by deciphering consumer preference

Circular Food System

Diversification