TResearch
Volume 17: Number 1: Spring 2022
ISSN 1649-8917

**EUCALYPTUS**
Growing demand for Ireland's cut foliage sector

**INTERVIEW**
A researcher's work to prevent tail biting in pigs

**FOOD INNOVATION**
Investing in the future of Irish food and drink

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# Put to good use

Researchers are using innovative processes and consumer insights to help combat food waste

teagasc
Agriculture and Food Development Authority

# Welcome

**In Ireland, it's estimated we waste around 1 million tonnes of food each year. Growing, processing and transporting food uses a huge amount of resources, such as land, water, energy and fertiliser. If food is wasted, these resources are wasted too. In this issue of *TResearch* we look at solutions to tackling food waste from a number of different perspectives.**

Brewer's Spent Grain (BSG) is a waste product of the brewing industry, but it's rich in fibre, protein and vitamins. To develop our knowledge in transforming BSG into functional food ingredients, Teagasc has partnered with the University of Helsinki. Head to page 6 to find out more about Kamaljit Moirangthem's and his colleagues' work.

Consumers have an important part to play in reducing waste; on page 14 you'll find an article by Sinead McCarthy and colleagues unpacking research carried out by Teagasc and National University of Ireland, Galway, designed to better understand our food waste behaviour and identify ways to improve it.

Consumers' purchasing power also matters, and it's known that visual cues impact our decisions. When it comes to beef, a brighter colour is preferred, so Teagasc's Mohammed Gagaoua and colleagues are investigating the causes of a colour defect that darkens the meat (p22). The hope is that a better understanding of this defect will reduce its prevalence, therefore minimising waste from quality beef.

I hope you enjoy reading these, along with the many other articles we have in this issue that cover a range of interesting topics.

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

**Measatar go ndiomlaímidne in Éirinn thart ar 1 mhilliún tona bia gach bliain. Caitear méid ollmhór acmhainní, amhail talamh, uisce, fuinneamh agus leasacháin, chun bia a fhás, a phróiseáil agus a iompar. Má dhiomlaítear bia, diomlófar na hacmhainní sin freisin. San eagrán seo de *TResearch*, féachaimid ar dhóigheanna ar féidir dul i ngleic leis an diomailt bia ó thaobh roinnt dearcthaí difriúla de.**

Fuíolltáirge de chuid an tionscail grúdaireachta is ea triosc. Dá ainneoin sin, tá sé ar mhórán snáithín, ar mhórán próitéine agus ar mhórán vitimíní. Chun cur leis an eolas atá againn ar thriosc a bhunathrú ina chomhábhair bhia fheidhmiúil, chuaigh Teagasc i gcomhpháirt le hOllscoil Heilsincí. Téigh chuig leathanach 6 chun tuilleadh faisnéise a fháil faoi shaothar Kamaljit Moirangthem agus a chomhghleacaithe.

Bíonn ról tábhachtach le himirt ag tomhaltóirí i ndramhaíl a laghdú. Ar leathanach 14, tá alt ó Shinéad McCarthy agus a comhghleacaithe ina spíontar amach an taighde atá déanta ag Teagasc agus ag Ollscoil na hÉireann, Gaillimh, chun tuiscint níos fearr a ghnóthú ar ár n-iompraíocht diomailte bia agus chun teacht ar dhóigheanna ar féidir í a fheabhsú.

Baineann tábhacht freisin leis an gcumhacht ceannaigh atá ag tomhaltóirí, agus is eol go ndéanann leideanna amhairc difear dár gcinntí. Ó thaobh na mairteola de, is fearr dath níos gile. Dá bhrí sin, tá Mohammed Gagaoua agus a chomhghleacaithe in Teagasc ag imscrúdú na gcúiseanna le fabht datha a dhéanann an fheoil níos dorcha (lch 22).

Táthar dóchasach go bhfágfaidh tuiscint níos fearr ar an bhfabht sin nach mbeidh sé chomh coitianta céanna, rud a íoslaghdóidh an dramhaíl ó mhairteoil ardchaighdeáin.

Tá súil agam go dtaitneoidh leat na hailt sin a léamh, mar aon leis an lear alt eile atá againn san eagrán seo ina bpléitear topaicí spéisiúla éagsúla.

**Catriona Boyle**
Eagarthóir, irisleabhar *TResearch*, Teagasc

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

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**Published on behalf of Teagasc**
**Artful Dog Publishing**
*artfuldogpublishing.com*

***Design:*** *Ross Behenna; Asami Matsufuji*
***Editorial:*** *Isabel Overton*

*Cover image: monkeybusinessimages/ iStockphoto.com*

# Contents







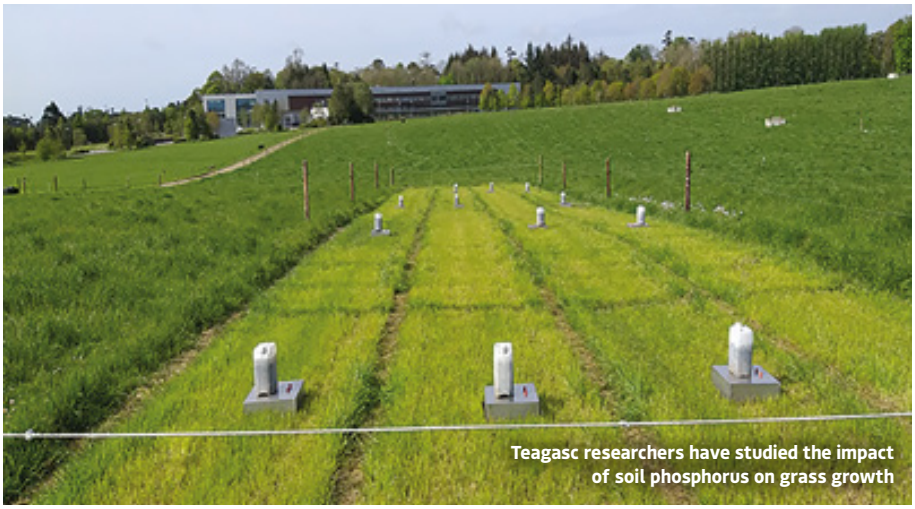

# Getting soil phosphorus right

A new scientific paper from Teagasc has shown that getting soil phosphorus (P) levels right through a fertiliser programme can significantly reduce emissions of nitrous oxide ($N_2O$) – a potent greenhouse gas.

Published in the scientific journal *Nature Scientific Reports*, the paper explains how Teagasc researchers have found that increasing soil phosphorus to the recommended level for grass productivity reduces fertiliser-derived $N_2O$ emissions in intensively managed temperate grasslands. The research is built on a long-running trial at Teagasc Environment Research Centre in Wexford.

"Optimal soil phosphorus is important for grass growth and also influences the soil microbiome," explains Teagasc Senior Research Officer David Wall. "This research is further evidence that maintaining long-term soil fertility will help to deliver on the sustainability objectives for the sector."

Outlining the main findings, Amanuel Gebremichael, Teagasc Postdoctoral Researcher, says: "We found that a long-term increase in soil phosphorus from fertiliser significantly decreased $N_2O$ emissions from field plots. In addition, keeping the soil P at the optimum level has the potential to further reduce $N_2O$ emissions, due to higher grass nitrogen uptake through increased yields. This means that the application of good farming practices has considerable $N_2O$ mitigation potential in temperate grasslands."



Teagasc researchers have studied the impact of soil phosphorus on grass growth

Head of the Teagasc Environment Research Department Karl Richards concludes: "Farmers who improve soil fertility for agronomic benefits can also reduce $N_2O$ emissions. This represents a win-win for the farmer and the environment."

# Teagasc PhD students win external awards

## Unsung Hero Award


Amel Sami holding her Unsung Hero Award

Amel Sami, a PhD student at Teagasc Moorepark and University College Cork, was awarded the ESTHER Ireland Unsung Hero Award for 2021. ESTHER Ireland works to foster international partnerships between Irish health institutions and organisations, and their counterparts overseas, to strengthen health systems and improve health outcomes. Their Unsung Hero Award is presented to individuals who have shown consistent and unshakable commitment to health partnerships between Irish institutions and their counterparts in low- and middle-income countries.

Amel is a member of an Ireland-Sudan team that oversaw the establishment of the first Sudanese microbiome committee. This committee has created a solid support for microbiome science in Sudan.

Amel's PhD research focuses on the oral microbiome and dentistry, particularly related to the Sudanese population. She is currently completing the final year of her PhD under the supervision of Professor Catherine Stanton at Teagasc Moorepark.

You can read more about some of Amel's work on pages 36 to 37.

## AI Awards Ireland

Former Teagasc (VistaMilk) and University College Dublin PhD student Eoin Kenny won the Best Application of Artificial Intelligence (AI) in a Student Project award in the 2021 AI Awards Ireland. Eoin's PhD project led to significant breakthroughs in predictive AI modelling, explainable AI and precision agriculture.

Eoin's PhD focused on the prediction of grass growth in smart agriculture and explainable AI. His early research in this field looked at using machine learning for grass growth predictions, and attracted significant international attention. Eoin's work built on Teagasc's long-standing mechanistic model for grass growth prediction, leading to a new combined model that harnesses the best of both modelling approaches. This combined work resulted in a meta-model that determines when it's best to use the AI model or the more traditional mechanistic model under different environmental conditions.

Eoin Kenny with Denis Canty, Chief Technology Officer at Altada (sponsor of the award)

Another strand of the work looked at how best to explain model predictions to end-users (in this case farmers). Laurence Shalloo, Teagasc Research Officer and Deputy Director of VistaMilk, stated: "Through the combination of traditional techniques and models with the new AI-based techniques, it is possible to increase accuracy of predictions. This will help farmers to make more informed decisions within their day-to-day businesses."

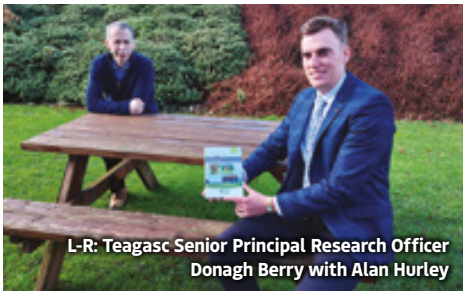
# News in brief

## 300

Since 2008, the Agricultural Catchments Programme has been working with over **300 landowners** in **six catchments** located around the country, monitoring water quality and assessing the impact of changes in Ireland's Nitrates Action Programme and Nitrates Derogation. The programme has been funded by the **Department of Agriculture, Food and the Marine** since its establishment.

## €1.84 billion

The annual economic value of the Irish thoroughbred breeding and racing industries are valued at **€1.84 billion**, while the Irish sport horse sector is estimated to be worth around **€816 million** to the economy. Teagasc Equine Specialist Alan Hurley recently launched a book *Genetics and Breeding of Irish Horses* that illustrates how breeders can improve the genetic merit of Irish horses when backed by science.


L-R: Teagasc Senior Principal Research Officer Donagh Berry with Alan Hurley

A new **Bachelor of Science degree in Agricultural Science** has been launched as part of a partnership between Teagasc and the National University of Ireland, Galway. The degree has a strong focus on sustainable agriculture and has attracted over **500 applicants** in the first year. Teagasc scientists will deliver a substantial component of the new programme.

Johannah Pigott, a Transition Year student from Colaiste Treasa, Kanturk, Co. Cork, was named winner of the Teagasc Prize award at the **BT Young Scientist and Technology Exhibition 2022** (BTYSTE). Johannah's project looked at the potential of **nematodes to replace chemical pesticides**.

# Something to cheers to:

## the value in beer waste

Teagasc researchers are working with the University of Helsinki to find ways to turn spent grain waste from beer production into functional food ingredients.

Brewing is one of the largest global food and drink industries, producing a beverage that's incredibly popular and widely consumed across the world – beer. However, beer production generates a large amount of waste, in the form of a residual malt known as Brewers' Spent Grain (BSG).

Difficult for humans to digest, BSG is typically used as low-value cattle feed and fertiliser. When it's not being used as feed, it's usually destined for landfill.

BSG is rich in fibre, protein, vitamins and minerals, which is why Teagasc has partnered with the University of Helsinki to develop its knowledge in transforming BSG into functional food ingredients.

The project, named BSG-BioBev, aims to re-introduce BSG into the food system through bioprocesses (the production of a value-added material from a living source), making it palatable for humans to eat and drink.

**39 million tonnes**

**An estimated 39 million tonnes of BSG is produced each year by the brewing industry.**

### Adding value to waste

BSG's many health benefits give it great potential in the food market, and the BSG-BioBev project team believes it can meet the growing demand for healthy, protein-rich foods within a plant-based diet.

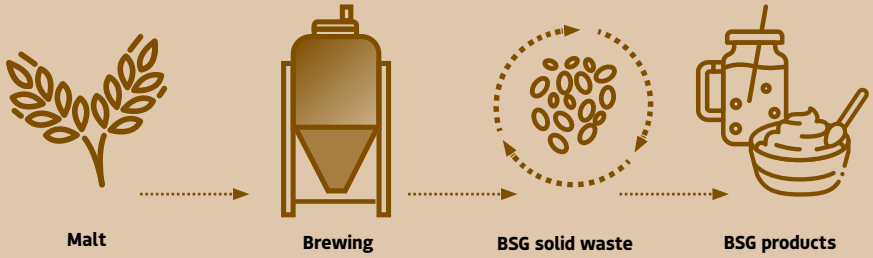
At the University of Helsinki, the team is exploring the microbial bioprocessing of BSG following physical and enzymatic treatments that help to extract the rich source of fibre and protein found within the product, in order to make fortified food products.

There are obstacles to overcome when it comes to applying BSG to food, such as its tendency to deteriorate quickly, its vulnerability to microbial spoilage (damage caused by micro-organisms) and its unpleasant flavour. To address this, at Teagasc the team will be studying advanced processing and preservation techniques such as pulsed electric fields (a non-thermal method of food preservation) on BSG and the prototypes' ability to promote good health in the body.

Doing this will give the team the knowledge needed to transform BSG into a reliable ingredient for plant-based fermented drinks with a smoothie or spoonable yoghurt-like consistency.

Sustainable bioprocessing of BSG to food ingredients is an attractive opportunity because it's a huge resource. The brewing industry has supported investments being

**From residual grain to value-added food products**



## BSG: the by-product of brewing

**BSG accounts for roughly 85% of by-products within the brewing process, present in alcoholic and non-alcoholic beer production alike. This is because all brewing begins by producing malt, which involves steeping, germinating and drying cereals (e.g. barley). The malt then goes through a mashing process, where it is crushed and mixed with hot water.**

**The mashing process produces two components: a liquid called wort, and the remaining malt – known as BSG – which consists of cereal husks, residual starch and other cereal adjuncts such as wheat and rice.**

**Rich in sugars and compounds which add to the body of the beverage, the wort gets fermented into beer. Meanwhile, the BSG remains an unavoidable waste.**

**With sustainable bioprocessing of BSG, we may be able to meet the growing demand for healthy, protein-rich foods within a plant-based diet.**

made to reintroduce BSG back into the human food chain, with companies sharing their BSG for research purposes.

### A social good

Preventing the disposal of BSG in landfills will help to reduce its environmental harm. Furthermore, producing food from this vast untapped resource could improve food security, even for the lowest-income countries.

Various policies such as the EU's Farm to Fork Strategy supports the United Nations' call to action to feed an exponentially growing population. However, this needs to be done within the constraints of our planet's boundaries and rapidly deteriorating global climatic conditions, while also creating circular market opportunities.

Projects such as BSG-BioBev can meet consumers' growing demand for sustainable plant-based diets that go beyond normal nutrition, while reducing the carbon footprint of one of the largest food industries. Now that's something to cheers to!

**FUNDING**

**The BSG-BioBev project is funded by the Research Leaders 2025 Fellowship programme (co-funded by Teagasc and the European Union's Horizon 2020 Research and Innovation Programme), under the Marie Skłodowska-Curie grant agreement number 754380.**

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# *Eucalyptus*: a favoured filler

Demand for *Eucalyptus* within the cut foliage sector has increased, leading researchers at Teagasc to look at ways to improve the quality of *Eucalyptus* trees grown specifically for this purpose.

*Eucalyptus* trees are native to certain southern hemisphere countries, such as Australia, Papua New Guinea and Indonesia, but they are widely cultivated throughout the world. There are over 500 species of *Eucalyptus*, many of which grow well in the mild temperate climate of Ireland.

*Eucalyptus* trees have attractive silvery, blue-grey and green foliage all year round, and as such *Eucalyptus* has become a much-desired element of cut foliage (vegetation that acts as a source of decoration) in mixed flower bouquets. While especially popular during holidays like Christmas, Valentine's Day and Mother's Day, *Eucalyptus*' popularity also garners a year-round demand as it's one of the most popular decorations for events such as weddings.

In Ireland, several species are cultivated commercially, specifically for use as cut foliage, and there are currently over 100 hectares of *Eucalyptus* in commercial cut foliage production. Four species dominate – *Eucalyptus parvula*, *Eucalyptus cinerea*, *Eucalyptus glaucescens and Eucalyptus subcrenulata* – but there is always demand for new and interesting foliage with novel characteristics. The cut foliage sector has to be able to respond to these demands, so researchers at Teagasc's Horticulture Development Department have screened 15 *Eucalyptus* species to evaluate potential new species for foliage as part of the New Leaves project.

**50%**

**Due to increasing demand, the area of land used to plant *Eucalyptus* has expanded by 50% in the past three years.**

## The challenges of reproducing high quality trees

*Eucalyptus* plantations are currently established from seed-raised plants, using seed that has been collected from good quality plantations in Australasia. However, as each seed is unique, there can be considerable variation in the quality characteristics of each individual tree from the same seed lot.

High-quality trees with exceptional characteristics can be identified in plantations from time to time, and it would be very useful to be able to propagate these to bulk up the numbers of plants with the most desirable traits. The technique of vegetative

**Micropropagation generates genetically identical plantlets under laboratory conditions**

Horticulture Technician David Wallace at Teagasc's trial plot in Kildalton

## A cut above the rest

**Cut foliage can be used as decoration on its own, or to complement flower arrangements. But not all vegetation has what it takes to be used in this way. Key attributes of good cut foliage include:**

- **Interesting leaf shape and colour**
- **Long and short stems**
- **Plenty of leaves in the upper portion of the stem (so as to provide a good 'fill' in a bouquet or display).**

propagation (asexual plant reproduction) is used regularly to produce large numbers of identical trees. However, it's difficult to do this with most *Eucalyptus* species.

One way to improve vegetative propagation is to grow juvenile plants close together like a hedge, from which new shoots of *Eucalyptus* can develop and be taken. Work undertaken by the New Leaves project team showed that most of the tested *Eucalyptus* species were capable of growing well this way, producing between four and ten stems after coppicing (a pruning technique where a tree or shrub is cut to promote re-growth). However, the shoots themselves did not respond well when the cuttings were taken for vegetative propagation.

### Finding a solution in the lab

As vegetative propagation was proving difficult, the project team turned to another form of propagation – micropropagation. Typically used to bulk up the numbers of hard-to-propagate species and endangered species, this technique generates genetically identical plantlets of a single plant under laboratory conditions.

Working with *Eucalyptus* seedlings, project team member Farhana Afroze developed a micropropagation technique that successfully micropropagated hundreds of identical young *Eucalyptus* plantlets from the four main species cultivated in Ireland, with multi-stems and good root systems.

This technique is now ready to be applied to unique *Eucalyptus* trees identified in commercial stands that have highly desirable traits for the cut foliage sector, such as those with significantly higher stem yield and quality.

Micropropagation from established trees is more challenging than using seedlings or young plants as older trees lose the ability to form roots as they mature. However, it only needs a small number of successfully micropropagated plants to be produced initially, which would then serve as the source material for further micropropagation.

Key stakeholders in the cut foliage sector have expressed interest in pursuing this line of experimentation, in the hope that a bank of elite trees can be established that will enhance the efficiency of *Eucalyptus* foliage production. T

**ACKNOWLEDGEMENTS**

**We would like to acknowledge the technical support of Danielle Boland, David Wallace, Leo Finn and Liam Foy, all of whom work in Teagasc's Horticulture Development Department.**

**FUNDING**

**The New Leaves project is funded through the Department of Agriculture Food and the Marine Competitive Research Call 2015. Project number 15/S/759.**

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# Raising awareness of data on the farm

The increasing use of digital technologies in Irish farming, such as farm management apps, sensors, drones and GPS-enabled machinery, is increasing the amount of data generated, collected and shared about farms.

A recent survey from Farm Business Skillnet found that 40% of Irish farmers would be happy for their data to be collected in exchange for a reduction in the cost of on-farm technology; however, 44% felt that more information or assurances are needed before they would be comfortable sharing their data.

The AgriDISCRETE project is raising farmers' awareness of data by co-designing communication materials that explain what data on the farm is and how it's shared.

| Area | Theme | Design considerations for communication materials |
|---|---|---|
| Awareness | 1. Lack of understanding/ awareness of where data goes | Becomes theme of infographic and video |
| | 2. Increasing awareness of data possibilities | Include content highlighting types of data on the farm and usage examples |
| | 3. Responsibilities and best practices | Include link to web page with resources including good practice information |
| Concerns | 4. Lack of clarity on end use of data | Include content showing examples of end use of data |
| | 5. Fear of data being used against farmers | Include link to web page with resources including EU Code of conduct on agricultural data sharing |
| | 6. Level of digital/technological comfort | Avoid technological jargon; target it to farmers with low digital comfort levels |
| Value/ benefits | 7. Increased value of digitalised farm data | Include content describing how farm data is valuable |
| | 8. Explicit understanding of benefits | Include content listing potential benefits of farm data |
| | 9. Opportunities for communication | Design as a flyer that can be distributed and discussed in knowledge sharing settings (e.g. farming discussion groups) |
| | 10. Sustainability opportunities | Include content highlighting data contributing to farm sustainability |

**Figure 1. Areas of farmer user needs and gaps regarding data awareness in Irish agricultural practice, and subsequent design considerations for communication materials.**

One way to address concerns around farm data is to increase farmer awareness of how data is generated, used and shared, to better equip farmers to make decisions on data sharing and control. That's why, as part of the AgriDISCRETE project, researchers from Teagasc, the Walton Institute and the RIKON group decided to use a co-design approach to develop communication materials that provide information about data sharing to Irish farmers.

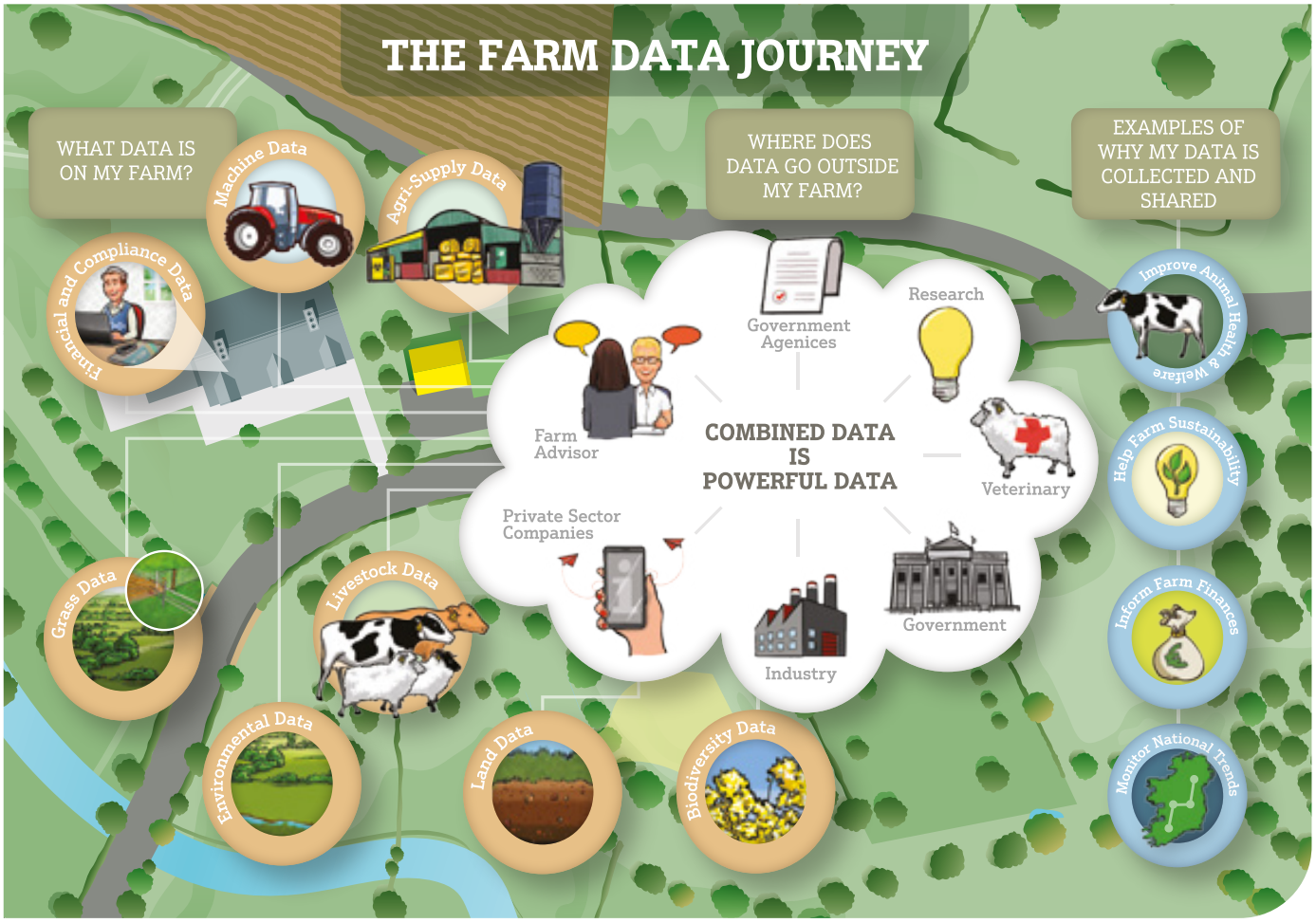
The co-design approach sees stakeholders participate directly in the design process of the task at hand. A social science-based perspective is extremely valuable to a co-design approach, as methodologies such as focus groups and semi-structured interviews create an iterative and collaborative process where the design is continually refined and developed *with* stakeholders during each step.

## Championing stakeholder input

The AgriDISCRETE project team held a series of participatory workshops in 2020 and 2021. A wide variety of agricultural stakeholders took part, including farmer and forester representative organisations, agritech and data companies, advisory services, research institutions, skills development organisations and those employed in tech roles.

Insights from these workshops can be seen in Figure 1 (left), which reflects 10 key themes that represent current user needs and gaps in data governance practices in Irish agriculture.

The 10 identified themes were presented back to key agricultural stakeholders in an additional co-design workshop. They discussed what would be necessary to




**Increasing farmers' awareness of how data is generated and used helps to better equip them to make decisions on data sharing.**

include in communication materials in order to address some of the identified user needs and gaps in farm data awareness.

Members of the project team utilised the feedback from this co-design workshop to create an initial draft of the communication materials. This content was then reviewed further with agricultural stakeholders during one-to-one phone consultations. Working with a graphic designer, members of the project team developed the visual representation of this content. This takes the form of a printed two-sided A4 infographic flyer (the front page of which can be seen above), and a one-minute animated video that outlines the data journey on and off the farm.

Once the imagery was drafted, agricultural stakeholders were again consulted to evaluate the accuracy and clarity of the messaging in the infographic, and further feedback was supplied to the graphic designer.

While these materials on their own won't address all of the issues emerging in data governance, they can be used to empower farmers to start a conversation about data and learn more about how data is collected and shared on their farm, ultimately helping them to benefit from their farm data. T

**To view the animation and full infographic (front and back page), visit teagasc.ie/agridiscrete**

**FUNDING**

**The materials developed through this project are based on research supported by the Department of Agriculture, Food and the Marine under grant number 19/R/539.**

**ACKNOWLEDGEMENTS**

**This work is a collaboration between Teagasc, the Walton Institute at Waterford Institute of Technology (Paul Malone and Kieran Sullivan), and the RIKON group at Waterford Institute of Technology (Pat Lynch and Lorna Bailey).**

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# Nip in the bud

Pigs' tails are commonly docked to prevent tail biting, but a crackdown on this problematic practice means alternative solutions are needed. Teagasc Research Officer Keelin O'Driscoll has been leading projects in this area, to find a sustainable solution to the tail biting challenge.

**Photography:** Fergal O'Gorman

Keelin O'Driscoll is looking for sustainable solutions to the tail biting problem, as the practice is banned in the EU

Tail biting – when a pig bites or chews another pig's tail – continues to be a prominent economic and welfare problem for the pig industry. It's a common response to stress or discomfort, and while it's not meant to be an aggressive act, it can hurt and cause injuries.

Tail docking – the practice of removing part of a pig's tail to reduce the risk of tail biting – is banned in the EU. Legislation states that it should only be used when all other avenues have been exhausted. Very few member states are compliant with the legislation, however, and it continues to be commonly practised – including in Ireland.

In recent years, the EU has taken the breach of legislation more seriously, carrying out audits, study visits and asking for action plans on the limiting of tail docking. As such, sustainable solutions to the problem are needed.

Research Officer Keelin O'Driscoll has a keen interest in animal welfare, and has spent years studying it. She has a Masters in Animal Behaviour and

Animal Welfare, and for her PhD she studied the effect of out-wintering pad design on dairy cow health and welfare, which brought her to Teagasc Moorepark.

Since 2013 she has been employed in the Teagasc Pig Development Department, and has since worked on projects related to tail biting.

## Keelin, why is tail docking so prominent in Ireland?

Tail docking has been used for welfare reasons because there was a genuine belief among vets and producers that it was within the law and an appropriate preventative measure to tail biting.

Tail biting is a common problem in pigs that don't have loose enrichment materials – such as straw, which is considered the gold standard – to bite and nibble. Pigs are very curious animals that like to root around, so if they don't have materials they can manipulate, they instead turn to other pigs' tails.

However, a few years ago the EU announced that there had been a misinterpretation of legislation, and that tail docking should be a last resort.

## Why is there a lack of enrichment materials for pigs on farms?

Most commercial pig farms in Ireland have fully slatted floors. These are easier to clean as muck falls through the gaps, but it also means loose enrichment material would fall through too, potentially clogging the drainage mechanisms underneath.

They often provide plastic in the form of hanging toys and chew bars attached to the pen, but these aren't enough on their own.

## What impact is tail biting having on farmers?

Our research has found that farms in which tail biting is more prominent are less profitable than those with fewer cases. This is because bitten pigs grow less efficiently – they take around seven days longer to get to slaughter weight, requiring more food and resources.

It's a consequence that's unseen almost, as it can be quite subtle. But cutting down tail biting will help profitability in the long run.

## What research have you been undertaking to help farmers improve pig welfare?

We've investigated enrichment for fully slatted floors, such as organic materials like wood. We found that soft wood attracts pigs' attention more than hard wood as it's easier to chomp into, but wood alone wasn't effective enough for pigs that weren't docked.

We then looked at attaching loose material racks to the side of the pen, and filling it with different materials. Interestingly, the pigs liked grass the best, and not straw like we presumed. It was still difficult to control tail biting, but providing racks and multiple chew toys gave farmers a better shot than just a single plank of wood or a single chew toy.

Our research indicated there was more at play than providing them with enrichment, so in 2019 we began focusing on risk assessment procedures to figure out what the other stressors could be.

A PhD student – Roberta D'Alessio – is carrying out a survey on stress factors with stakeholders, and the findings have been very farm specific. What's considered a stress factor on one farm isn't considered a stress factor on another.

We've also newly partnered with universities in Denmark and Belgium to create a tool that uses cameras to detect if pigs are biting tails. If it detects a change in behaviour, it will send an alert to the producer to try and stop an outbreak before it happens.

## What benefits is your research having for producers?

Our enrichment research has shown what doesn't work, which prevents farmers from wasting money on those materials. We've also confirmed pigs' interest in racks, which is one way of getting pigs loose material they'll use.

Through our risk assessment, we're hoping to help farmers pinpoint the main stress-causing factors for pigs, as they could be easy fixes like ventilation or lighting.

## Up close and personal

**What's your favourite animal?**
**Cats. I love them! They're incredibly misunderstood.**

**If you hadn't ended up in agriculture, what other job would you have wanted to give a go?**
**I managed a bar in London before I started my Masters. I thought it was fabulous. It involved lots of the skills I use today, such as interacting with people, being organised and dealing with figures.**

**What are you most proud of professionally?**
**In 2021 I chaired an international animal welfare conference – the first ever held in Ireland. It helped to raise awareness of animal welfare as a science in this country, and we had lots of Irish researchers get involved.**

## What has the response from industry been?

As part of our risk assessment, I collaborated with the Department of Agriculture and Animal Health Ireland to train vets to use a basic protocol we established. Through Government funding, farmers were able to contact vets and have an assessment carried out for free.

As of 2020, about 48% of farmers have had this assessment done at least once. Considering no assessments had been done a couple of years prior, that's a big achievement. And anecdotally, I've heard lots of farmers have begun testing rearing one or two litters without docking tails.

## What do you have planned in 2022?

We don't produce enough straw in this country to offer all pig farms a sufficient amount, and it's difficult to store fresh grass, so we're going to investigate plant materials that could be good alternatives.

Once the survey results are in, Roberta can hopefully go onto commercial farms and apply our risk assessment protocol, which will be a big next step.

Tail biting acts as an iceberg indicator when it comes to pig welfare – it represents bigger stressors. If we can sort this one issue out, we can sort out most of pigs' problems. T

# Waste not, want not

Food waste is a big problem contributing to declining resources and climate change. To try to curb this, researchers from Teagasc and National University of Ireland, Galway are providing insights into food waste behaviour.

The concept of reducing waste and the importance of it is far from new, and yet we currently live in a society where approximately one third of all the food that comes into homes is wasted. This food waste may have dire consequences for us in the near future, when we will need to feed an additional two billion people with the same resources we currently have.

As consumers, we're responsible for a significant proportion of food waste, and it's important that we recognise food as a valuable commodity and radically decrease our tendency to waste it. That's why researchers at Teagasc and National University of Ireland, Galway (NUI Galway) have undertaken research to better understand our food waste behaviour and identify ways to improve and change it.

## The reality of consumer food waste

As part of their Circular Agronomics project, the researchers conducted an exploratory study on Irish adults to examine factors relating to sustainable food behaviours, including food waste behaviour. 263 adults completed the questionnaire, in which they indicated their level of agreement – from 'totally disagree' to 'totally agree' – to a range of statements.

Cluster analysis was used to group consumers based on their responses to food waste statements, and then the resultant clusters were profiled to identify differing behaviours and attitudes. Three different clusters of food waste consumers were identified, as seen in Figure 1.

The first group – 'all waste' – accounted for 32% of respondents. This group was made up of consumers who tended to waste food in every aspect by cooking too much food and throwing away leftovers, as well as wasting food before it was even cooked or consumed. The second group – 'staple waste' – accounted for 29% of respondents. This group was not so wasteful overall, but was more likely to waste fruit, vegetables and bread. The third and largest group – the 'overcooks' – accounted for 39% of respondents. This group was the least wasteful – typically guilty of cooking too much food but rarely throwing it away.

**11%**

**Meat was least likely to be wasted according to the researchers' survey, with just 11% of respondents saying it gets thrown away before it's cooked.**

When these groups were further profiled, it was shown that the 'all waste' group was more likely to purchase or serve more food than was required. The more positive behaviours in the 'overcooks' cluster were significantly influenced by perceived behavioural control. Meal planning was a behaviour practised by this cluster, and checking the fridge and making shopping lists helped to reduce their food waste.

In addition, social norms were also found to have a positive influence in the 'overcooks' cluster – if a peer group important to them promoted the behaviour to reduce food waste, then they too were more likely to behave in the same manner.

## Changing behaviours for the better

The UN Environmental Programme Food Waste Report estimates that, globally, 8-10% of all greenhouse gas emissions come from food waste alone. The resources used to


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## FACT FILE

**The first recorded proverb advising against waste was believed to have been written in 1576 by playwright Richard Edwards in *The Paradise of Dainty Devices*. He wrote: "For want is nexte to waste, and shame doeth synne ensue".**

**48%**

*Fruit and vegetables were most likely to be wasted according to the researchers' survey, with 48% of respondents saying they were thrown away before they were consumed.*

**Figure 1. Percentage of respondents who agreed with food waste statements, split by food waste behaviour cluster.**

| | All waste | Staple waste | Overcooks |
|---|---|---|---|
| Fruit and vegetables get thrown away before they are consumed | 86% | 61% | 7% |
| Bread gets thrown away before it is eaten | 81% | 57% | 4% |
| I tend to cook more food than I or members of my family can eat at once | 78% | 16% | 43% |
| Dairy products get thrown away before they are consumed | 52% | 26% | 3% |
| Food gets thrown away at every meal in my household | 50% | 11% | 7% |
| Meat gets thrown away before it is even cooked | 29% | 5% | 1% |

produce our food also cannot be recouped if it goes to waste and contributes to greenhouse gas emissions.

It is not unsurprising, therefore, that one of the key targets of the UN's Sustainable Development Goals is to reduce food waste globally by 50% by 2030. In line with this, the EU Farm to Fork strategy has proposed to set a legally binging target to reduce food waste by 2023.

Simple measures like meal planning and shopping lists, along with positive behaviours among our peer groups and knowing how to control and minimise our food waste, can be used to nudge consumers in a positive direction of food waste behaviour. And the insights from our researchers on food waste behaviour can contribute to development evidence-based policies targeted to the different ways in which consumers waste food, to more effectively reduce its prevalence. T


### ACKNOWLEDGEMENTS

**This work was conducted in the frame of the 2016 Strategic Research and Training Alliance on Carbon-Neutral Agriculture MoU between Teagasc and NUI Galway, where the Structured Masters degree in AgriBiosciences (StrMScAgriBio) is run in partnership with Teagasc. Jack Bradley was a student on the StrMScAgriBio program (2020-2021).**

### FUNDING

**The Circular Agronomics project is funded from the European Union's Horizon 2020 Research and Innovation Programme, under grant agreement number 773649.**


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# Making a moo-ve on spring grass

Researchers at Teagasc highlight how utilising grazed grass during the spring can make farmers more sustainable and profitable.

Spring is an important time for Irish pasture-based dairy farms – cows have begun to calve, and paddocks that have been closed over winter are ready for grazing.

This spring, almost 40% more cows will calve compared to spring 2012, and as a result will require additional grass on farm. More cows grazing at the same time can result in an increased feed demand on farms, so it's important that grazing management adapts to ensure grazed grass is maximised in the cow's diet and the number of days spent at grass is increased.

Increasing the number of days cows have access to grass over the grazing season can also improve sustainability, as it reduces the need for alternative feed sources such as concentrate and grass silage. This is important because paddocks have greater herbage quality (minerals essential to animal health) than silage. Having more grazing days also reduces the amount of slurry (a natural fertiliser made from cow manure and water) created. Finally, it can increase animal production, which benefits profitability.

## Taking action in autumn to benefit in spring

Research at Teagasc focused on meeting the greater feed demand in spring by increasing the amount of grass available on farms, by altering autumn closing date and spring grazing rotation. Spring and autumn have been identified as the most difficult times for grazing management on farms. This is because soil temperatures are reduced and therefore impact growth rates, and ground conditions are more challenging.

Results show that carrying a bank of grass over winter for grazing in the spring successfully increased the amount of herbage available. That's because the amount of grass available in spring is closely linked to that available at the time of closing in autumn, and can account for 50% of the variability in herbage.

However, this can have varying impacts on the production of tillers (shoots) of perennial ryegrass, depending on the level of herbage on individual paddocks. Perennial ryegrass tillers are continuously producing new leaves, some have had leaves die, some have produced daughter tillers (new shoots), and some have died over winter. This is all part of the natural tiller production cycle; however, tiller death can increase if heavy covers are left on paddocks over a long period of time, so targeted earlier grazing is vital to reduce this negative impact.

## Managing paddock recovery

In early spring, paddocks that have carried greater amounts of grass over winter have increased levels of shading, resulting in increased tiller death and dead tissue in the paddock. The reduced number of tillers seen

> **Increasing the number of days cows have access to grass during the grazing season can improve sustainability and production.**

**1.4kg**

**Cows that have benefitted from an increased proportion of grazed grass in their diet during early lactation can produce up to 1.4kg more milk each day.**

can impact the growth rate of paddocks after they are grazed in spring. An increased amount of dead material in paddocks also reduces the sward quality, which can impact animal production.

While it sounds negative, this impact on paddocks is a necessary compromise to have enough grass for the herd in spring. But there is a key step that can be taken to help paddock recovery.

Beginning on-farm grazing in early February will increase grass utilisation and help the recovery of swards. This is because grazing removes shading and allows light in to the tillers, which helps to promote the growth of new green leaves and the rapid production of daughter tillers.

The growth experienced after grazing allows these paddocks to then be available for the second rotation of grazing, beginning in early April. This is particularly beneficial in swards that accumulate higher herbage masses over winter, as shading and tiller death can be reduced.

## Optimum grazing management

Grazing paddocks provide cows with grass that is extremely digestible and high in crude protein. All paddocks, irrespective of their closing date in autumn, have greater herbage quality than grass silage. Increasing the proportion of grazed grass in the diet of early lactation cows can result in greater milk production, compared with cows with greater amounts of silage in their diet.

The focus for dairy farms in the spring should therefore be on utilising the grass carried over from winter, by allowing cows to begin grazing as soon as possible in February, targeting paddocks with heavier herbage masses first and following grazing targets. T

**FUNDING**

This project is funded by Teagasc's Walsh Scholarship Programme and Dairy Research Ireland.

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# Weather, workload and money

Researchers at Teagasc and Cork University Business School have determined and evaluated sources of stress for farmers, by looking at the impact of both internal and external pressures on stress and wellbeing.

Farmers and farm workers experience high levels of stress and relatively low levels of wellbeing. Sources of stress, or 'stressors', can be external, such as challenging physical conditions or stressful situations, or internal, such as wealth and wellbeing.

Factors influencing this can include financial pressures, challenging weather conditions, workload, animal health issues and a decline in the sense of community or security in rural areas. Another important, albeit sometimes overlooked, factor influencing farmer wellbeing is the inherent attributes of those farmers who experience occupational stress.

A farmer's socio-demographic characteristics – such as age, farm enterprise, debt levels, off-farm employment status and working hours (including those worked in off-farm jobs) – can influence their exposure to occupational stress. Indeed, for a more well-rounded understanding of stress, it's necessary to examine the socio-demographic reality of those who experience it.

To date, there has been a lack of research examining the incidences and sources of stress impacting farmers with reference to their socio-demographic characteristics. So, researchers at Teagasc and Cork University Business School came together to address this gap in knowledge.

## Surveys on stressors

In 2018, 736 questionnaires were completed by farm operators through the Teagasc National Farm Survey, which operates as part of the EU's Farm Accountancy Data Network (FADN). The questionnaires were designed to determine the prevalence of stress amongst farmers.

A supplementary survey accompanied the core questionnaire, providing researchers the opportunity to collect data on emerging farm level issues. The research team used this opportunity to ask farmers taking part a small number of additional questions associated with occupational stress and wellbeing.

Mary Brennan, Teagasc Walsh Scholar and member of the research team, says: "We asked farmers about their experience of farm-related stress and presented them with a list of potential stressors. They then selected those that, if any, they had experienced over the past five years.

"The data collected was then combined with variables categorising the demographic, farm and social characteristics of respondents. We also asked farmers about their sense of personal security, isolation and frequency of contact with those outside of their household, to provide additional data on farm socio-demographic status."

The research team used frequency analysis to report the primary sources and prevalence of farm-related stress amongst farmers, while a probit model was developed to identify and evaluate factors that impacted the probability of experiencing stress.

## Attributes of farmers experiencing stress

The results from the probit analysis demonstrated that as farmers age, they are more likely to experience stress – although this plateaus in middle age. The model indicates that the probability of experiencing stress is less likely for farmers operating sheep enterprises, which is in line with results from the 2018 survey with farmers (Figure 1).

In addition, farmers with higher levels of formal agricultural education were more likely to have experienced stress in the running of their farm operations.

"This was an interesting finding," says ▶

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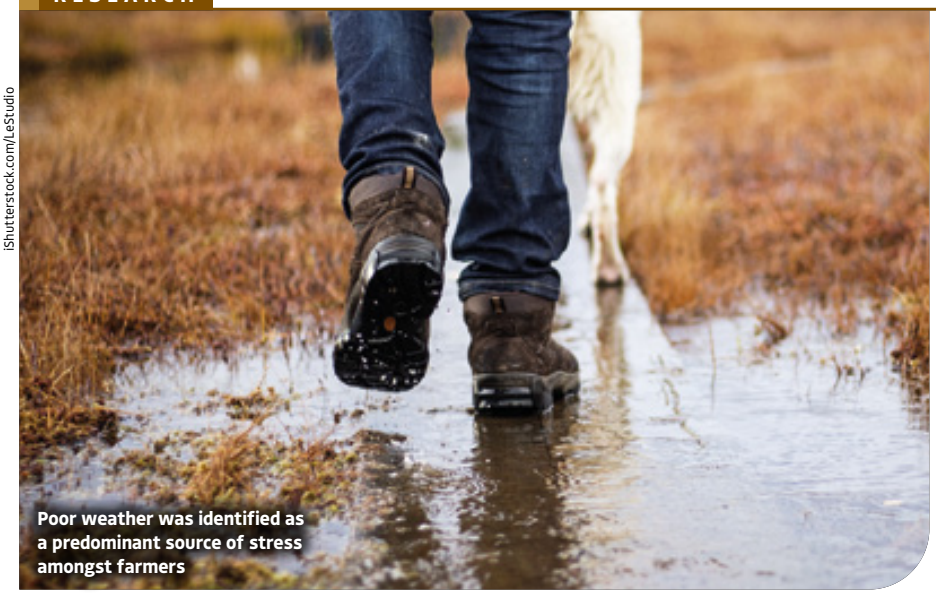
**Financial pressures, workload and animal health issues can all impact farmers' high levels of stress.**



Poor weather was identified as a predominant source of stress amongst farmers

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Mary, "as you might expect such farmers to be better prepared to manage adversarial events. It stands to reason, however, that farmers with specialised agricultural training seeking to optimise their production may as a result be more susceptible to high levels of work, and consequently work-related stress."

The probit analysis demonstrated that intensity of production was negatively significant. In other words, as the output per labour unit increases, the probability of stress declines. This suggests that the profit associated with the additional work offsets the impact of workload on stress, and underlines the importance of farmers receiving a fair return on their labour.

The impact of off-farm employment was also negative and significant, implying that having an off-farm job reduces the probability of stress.

Emma Dillon, Senior Research Officer at Teagasc and another member of the research team, says: "Off-farm employment may provide farmers with an opportunity to 'escape' the various challenges related to modern farming, such as social isolation and loneliness. And indeed, the additional income stream may help to improve risks to farm income posed by external forces.

"The effect of loans was positively correlated and significant upon the experience of stress, as expected, implying that the more indebted the farmer, the greater the likelihood of stress."

A reduced sense of security, infrequent contact with those outside the household and living alone were not statistically significantly associated with the probability of stress. Neither were total working hours nor family farm income (FFI).

Within the FADN, FFI is not inclusive of additional household income, such as earnings generated from off-farm employment or spousal income. It's also presented as an aggregate income figure. As such intermittent fluctuations in cash flow, which may represent a source of stress, are not readily captured.

As FFI is not wholly representative of farm household finances, it stands to reason that financial stress which is independent of farm

## A closer look at farmers' self-reported stressors

**The results from the questions in the 2018 supplemental survey showed that 57% of farmers experienced stress or anxiety as a result of their farm work over the past five years. The figure was highest amongst dairy farmers, almost three-quarters of whom reported experiencing stress. This was followed by cattle farmers (57%), tillage farmers (55%) then sheep farmers (38%).**

**Figure 1 shows that the most frequently occurring source of stress across all farms was 'poor weather', followed by 'workload' and then 'financial' worries. The identification of poor weather as the predominant source of external stress amongst farmers was anticipated, particularly as Ireland was impacted by a number of extreme weather events across late 2017 and 2018. This resulted in the tightening of fodder supplies on many farms, with some regions impacted more than others throughout the course of the year.**

**Stress relating to workload was most prevalent amongst dairy farmers, an understandable finding given the rapid expansion of the sector in the aftermath of EU milk quota abolition in 2015.**

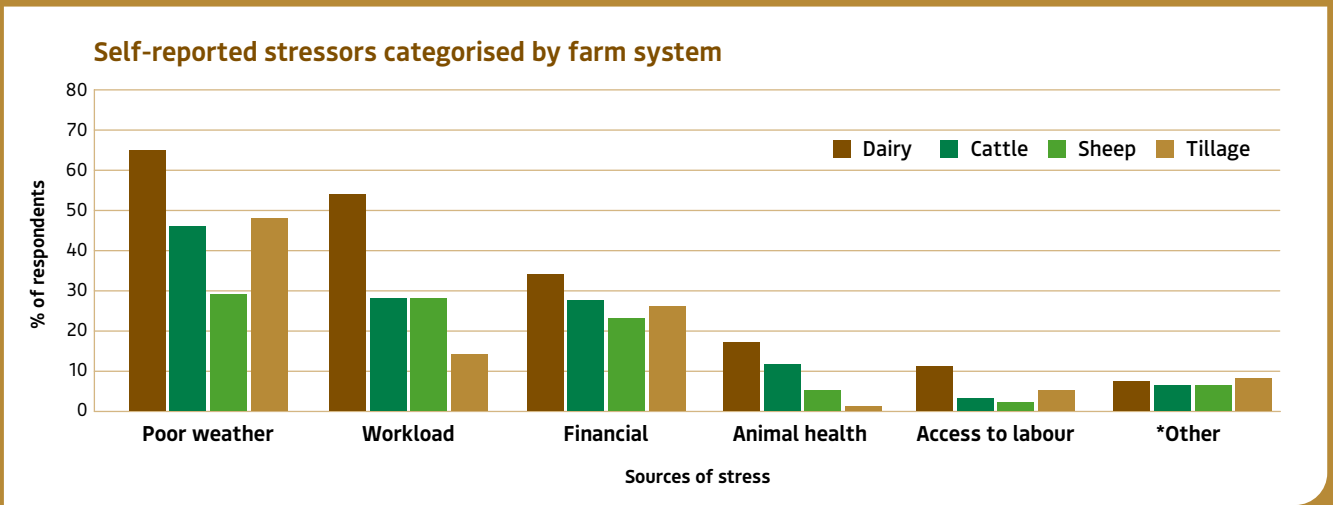


Figure 1. *This graph shows the self-reported stressors of farmers who answered the research team's supplementary survey questions in 2018. Respondents identified stressors they had experienced over the past five years.*

**The 'other' category merges the percentage distribution of the following stressors to an average score: (i) succession planning, (ii) sense of security, (iii) isolation and (iv) regulation compliance.*

income may be a factor, and a more comprehensive assessment of household income within the core FADN would be insightful.

## Support for farmers

A key finding from the research team's work is that farmers' experience of stress is shaped by a number of socio-demographic and farm enterprise factors. As such, they recommend a more regular assessment of farmers' stress levels and sources of stress.

"The current FADN methodology is not overly conducive to collating data on social sustainability, particularly in the consideration of more sensitive issues," says Emma. "Although in its transition to the Farm Sustainability Data Network, the design of such holistic metrics will need to be further considered.

"Additional work is also required to examine how stress manifests, and how it may be mediated through resources, such as support from professionals and peers. And consideration of methodologies such as the Stress Process Theory (a framework used to derive hypotheses about social factors and depression) would also be worthwhile.

"Progress in this regard would assist policy makers in developing strategic and targeted wellbeing support for farmers, in an attempt to improve the overall sustainability and resilience of farms." T


**FUNDING**

**This research was funded by the Teagasc Walsh Scholarships Programme.**

**ACKNOWLEDGEMENTS**

**The authors wish to thank the NFS team and data recorders involved in the collection and validation of data, and the farmers who participated in the survey.**


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# Getting to know

## Sinéad McCarthy

**Sinéad McCarthy** leads Teagasc's consumer behaviour research programme, in relation to food and health. Here, we find out more about Sinéad and her interests inside and outside of work.

**Do you remember when your love for science began, Sinéad?**

Yes! It started in primary school and grew from there. I went to University College Cork to pursue my love of science by completing a Bachelor of Science. While there, I developed a keen interest in the link between food and health, so I went on to complete a Masters in Food Science and a PhD in Public Health Nutrition.

**How did you end up at Teagasc?**

I joined in 2007, after spending nearly 10 years at Trinity College Dublin managing many of the national food consumption surveys. At Teagasc, I've been involved in many areas of nutrition and consumer research.

**What are your current research areas?**

Research areas include food sustainability, consumer acceptance of novel food technologies and nutrition and health for the older consumer.

I'm also the co-ordinator of the Sensory Food Network Ireland (SFNI) – helping to facilitate collaborative and innovative research in sensory science.

**What's the highlight of your role?**

Supervising students and seeing them achieve their degrees, and in some cases doing collaborative research as part of their new careers.

**Finally, does your interest in food and health extend to your personal life?**

Absolutely. My husband, two daughters and I enjoy running, and were involved in setting up our local parkrun.

And at weekends, I love to cook and serve up tasty dishes to family and friends. Although I'm no master chef, they keep coming back for more! T

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# A coloured view of beef

By integrating information from different datasets, Teagasc has successfully published the world's first collection of protein biomarkers (biological measures of a biological state) for dark-cutting beef, improving understanding of what leads to this colour defect.

Colour is an important characteristic of meat quality and a key visual cue that influences our purchasing decisions. Shoppers consider darker beef to be more undesirable, and are therefore much more likely to reach for the brighter coloured beef that's on display. Because of this clear preference, dark-cutting carcasses are usually discounted during meat grading and downgraded in value, leading to economic losses.

Often the colour of meat is simply influenced by exposure to air or packaging conditions, but it can also be a result of a colour defect called Dark, Firm and Dry (DFD) meat. In the past, knowledge on DFD meat has been limited and its causes not well-understood.

**130**

**The project team has created the world's first collection of biomarkers for dark-cutting beef, made up of 130 candidate biomarkers.**

To address this gap in knowledge, Teagasc has undertaken research to define the underlying biochemical pathways that lead to the change in colour. The hope is that a better understanding of the defect will reduce its prevalence, therefore minimising waste from quality beef, and improving the efficiency and subsequent profits of the beef sector.

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## What is dark-cutting beef?

**Dark-cutting is the term used for meat that doesn't bloom or brighten when it is cut and exposed to oxygen, leaving it dark in colour.**

**While safe to eat, dark-cutting beef can have:**

- **a high water holding capacity, causing the meat to lose moisture during cooking and become dry**
- **reduced shelf life – the moisture and increased pH level cause bacteria to grow quicker**
- **a sticky texture.**

## Causes of dark-cutting beef

The conversion of muscle to meat after slaughter usually results in a decline of pH levels, but when the pH level of muscle remains high, DFD meat can occur. This leads to a high ultimate (final) pH (pHu), and prevents the muscle from developing the bright-red colour typically seen when a cut surface is exposed to oxygen.

Mohammed Gagaoua, Marie Skłodowska-Curie Career-FIT Fellow Researcher at Teagasc and project lead, says: "A lack of muscle glycogen (energy storage) at the point of slaughter is considered a key causative factor for DFD meat. And nutritional status and physical and psychological stress close to slaughter are considered key causes of low glycogen.

"Many countries use pHu as a key reference to determine DFD meat. However, the thresholds differ significantly. It's also worth noting that dark-cutting beef has been observed where the pHu is within the normal range, but the cause for this is less evident."

Over the past decade, hundreds of thousands of samples have been tested by researchers under given conditions – including the large-scale study of proteins (proteomics). Comprehensive analysis of proteins has generated significant datasets, which has allowed Mohammed and his colleagues to integrate and analyse information across data types, and gather proteomics data on the quality defect.

## Finding patterns in data

The project team's key objectives were to identify the main molecular signatures and to shortlist robust biomarkers of dark-cutting beef.

"Merging the findings of studies and data-mining (finding patterns in large datasets) have enabled us to examine and compare datasets across a range of meat quality studies, in our search for both the underlying mechanisms influencing the DFD meat trait, and a suite of candidate biomarkers," says Mohammed.

"We applied this approach to proteome studies on dark-cutting beef by gathering papers and datasets of high-pHu versus normal-pHu, with a number of other determined factors."

Eight eligible studies were chosen, which, notably, showed strong disparity when it came to common protein biomarkers. Despite this, 10 were identified, and the features within them that were considered important to the occurrence of dark-cutting beef were revealed.

Analysis confirmed the importance of muscle contraction in dark-cutting beef development, followed by the regulation of apoptosis (the process of programmed cell death used during early development to eliminate unwanted cells), carbohydrate biosynthetic (the production of a chemical compound by a living organism) and protein folding (where the protein becomes biologically functioning).

**ACKNOWLEDGEMENTS**

**We'd like to give special thanks to all the co-authors of this study.**

**FUNDING**

**Mohammed Gagaoua acknowledges the funding support received from the Marie Sklodowska-Curie grant agreement number 713654 under the project number MF20180029.**

> **Dark-cutting carcasses are usually discounted during meat grading, leading to economic losses.**

Across the studies, the loss of oxygen related to energy metabolism after death was also an important common process, but the muscle system of the animal remained the major influencing factor.

"The importance of the physical structure was evident," explains Mohammed, "therefore, we believe that the extent to which muscle protein loses its shape and ability to perform its function may play a role in oxygen diffusion and myoglobin status. These are both known to be influenced by mitochondrial functionality (the ability to convert energy from food into a form that cells can use)."

## Supporting future research

The project team uncovered a number of important findings through its work, and as a result published the first-known collection of protein biomarkers. This innovative database may serve as a reference for future studies, and it has also highlighted a number of areas in need of greater research.

"Our research has shown that there is no unique major pathway underpinning dark-cutting, which instead can be the result of varying interactions along several pathways," says Mohammed.

"Importantly, it has also shown us the areas that need more research and investment, so that we can continue to improve knowledge around the dark-cutting condition and support the beef industry in becoming as efficient as it can be." T

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# Progress in potato production for Eritrea


Potatoes – like the *Electra* variety seen in this picture – are one of the main crops consumed in Eritrea

Teagasc, Irish NGO Vita, IPM Potato Group and the National Agriculture Research Institute (NARI) of Eritrea have introduced a new variety of potato seed – *Electra* – to Eritrea, successfully improving the country's potato seed sector.

To learn more about the project and its impact on communities in Eritrea, we speak to Head of Horticultural Research at NARI Eritrea Medhanie Mehari, Teagasc and University College Dublin PhD Student Fitsum Ghebremeskel, Head of Programmes at Vita John Gilliland and Teagasc Research Officer Denis Griffin.

Potatoes have great economic and food security value for Eritrea, thanks to the crop's nutritional profile, its popularity amongst consumers and the country's favourable climate. But while the Ministry of Agriculture (MoA) of Eritrea is committed to developing production, an inadequate supply of clean seed among other technical and infrastructural constraints have limited it.

To improve production, in 2015 Teagasc partnered with Vita and the National Agriculture Research Institute of Eritrea to create the Seed Potato project. Through this project – which sits within the Eritrea-Ireland Development Programme – they have given significant support to Eritrean farmers, bringing regular access to potatoes within easier reach of the average household.

## What led to the establishment of the Seed Potato project?

**Medhanie Mehari:** Potato is one of the main crops consumed in Eritrea, but it's productivity has declined due to viral potato diseases.

**Fitsum Ghebremeskel:** Over the past two decades, the MoA has launched seed potato interventions in collaboration with partners to increase the supply of quality seed. However, this was slow and inconsistent.

**Medhanie:** When other interventions didn't work, a different approach was sought. The Teagasc model (one that is community based and research led) along with the consultation of experts was chosen as the best option. And so, the Seed Potato project was launched.

## What was the project's main aims?

**Fitsum:** Our aim was to import and distribute new variety seed, train farmers, supervise seed farms and construct storage for seed. And our end goal was to increase the supply of potatoes to the market, reducing the price and in turn increasing consumption.

## What challenges did you face?

**John Gilliland:** An inadequate supply of high quality seed potato combined with a lack of improved potato varieties to meet demand is the main problem contributing to low potato productivity and production in Eritrea.

Diseases from insects, weak institutional capacity, low skills at farm level and low seed imports are all issues that contribute to the problem.

## What measures did the Seed Potato project put in place to address poor seed quality?

**Medhanie:** We tested and evaluated suitable climate smart varieties, imported quality seeds through contract farmers and distributed them to wider farms, and improved farmers' knowledge of seed production and disease management through training and resources.

**Denis Griffin:** Former Teagasc Potato Agronomist John Burke specifically contributed hugely to the physical logistics of the seed system in Eritrea, making recommendations on the physical production of seed.

**Medhanie:** We have a technical committee meet twice during the cropping season, to discuss issues and challenges and propose a mitigation plan. These solutions are then sent to a project steering committee, and those agreed upon are implemented immediately.

**6,350+ tonnes**

**The Seed Potato project has enabled over 4,100 farmers to access more than 6,350 tonnes of quality declared seeds.**

## What areas of Eritrea did you focus on?

**Medhanie:** In 2015 the project piloted at Zoba Debub and Maekel – two main potato-growing regions. In 2016 we expanded into a third region – Anseba. These regions, all located in the highlands, possess many potato farmers. As time went on, we realised a new area free of aphids – small sap-sucking insects that are the main transmitter of potato viruses in the country – was needed.

**Denis:** A high-altitude area was selected following a rigorous assessment, becoming the main area of potato seed production in the country. The first-hand seeds produced from this area – specifically, *Electra* – are then distributed to the other regions. This shift to a main site dramatically improved the quality of seeds produced and distributed.

## Why did you choose to introduce the *Electra* variety of potatoes to Eritrea?

**Fitsum:** In 2013, six new varieties of potato seed – including *Electra* – were introduced from IPM Potato Group, and tested and evaluated in Eritrea. *Electra* stood out in its yield performance.

**Denis:** *Electra* is a Teagasc and IPM Potato Group-bred variety that performs strongly in all global agroclimatic environments, with robust high yield and a very good disease resistance profile. Suitable adapted varieties contribute hugely to sustainability by reducing input costs, decreasing losses and attracting new consumers to increase markets.

**John:** The training of farmers has been crucial to *Electra*'s success in mass production. In the past, low productivity of old varieties was in part due to poor knowledge of seed potato production practices.

## In what areas were farmers lacking knowledge?

**Medhanie:** Knowledge in potato seed agronomic management and disease handling was the main area that had to be improved at the onset of the project. This needed to be addressed so that the seeds provided would be handled properly.

**Fitsum**: There are two categories of potato farmers recognised in Eritrea – seed and ware. The seed potato farmers are well trained in potato agronomy, diseases and storage management, but ware farmers are behind in these areas. While they have good experience in traditional potato growing, they need further training so that they can pass on best practices to wider farmers and contribute to the improvement of the potato intervention.

## Were farmers using any bad practices that you had to break?

**Medhanie:** One of the main challenges from ▶

Denis Griffin discussing potato flower pollinations with Gebremedhin Woldegiorgis from the Ethiopian Institute of Agricultural Research


L-R Fistum Ghebremeskel, Medhanie Mehari and Vita CEO John Weakliam at Medhanie's graduation

the start of the project was farmers' use of unknown varieties through illegal importation, which is prohibited due to its risk of disease. This is now almost under control through intensive training of farmers and mass awareness using local media channels.

## How did you find working with the farmers?

**Medhanie:** You have to listen and have an open-minded attitude in order to be successful. Our project is designed to be community based, so hearing from farmers and understanding their needs is crucial. The day-to-day contact with farmers helped us to build trust, and their local knowledge was indispensable in shaping the activities. It also gave the experts some valuable insights.

We've encouraged the sharing of knowledge, and farmers events have been organised where farmers use practical training to show other farmers first-hand the results of their interventions. Farmer-to-farmer seed sharing is also encouraged and observed to be beneficial.

**20 tonnes per hectare**

**The quality seed provided by the Seed Potato project improved national potato production from 13 tonnes per hectare to 20 tonnes per hectare in most of the beneficiaries.**

## What have the results of this project been so far?

**John:** The availability of quality seed potato has increased, in turn increasing the yield of intervened farms. This ample production has reduced the market price of potatoes, making them more accessible for consumers.

Farmers knowledge in key areas has also increased, as has the understanding of clean seed potato production amongst stakeholders involved in the seed potato system.

**Medhanie:** We take the feedback of farmers very seriously, and the response has been positive. They are satisfied with the variety of potato selected and the knowledge they've gained. Their lives have been improved through the sale of the quality declared seed to other farmers, and overall their income has increased.

## What has it been like working collaboratively across different countries to achieve your goals?

**Medhanie:** The knowledge gained and consultation provided from Teagasc has been a game changer in the technical knowledge of potato seed production. Experience shared with counterparts in Ethiopia and other countries has been key in accessing different knowledge, and has enabled a wider understanding of the crop and its management for a broader audience.

**Denis:** Working collaboratively in Eritrea has taught me a lot about potato production in east Africa, and the challenges faced by growers, regulators and the industry in general. As a breeder this helps to inform me of the traits that are important in new varieties for developing markets such as this.

## What's next for this project?

**Fitsum:** I've recently been developing a road map for seed production in Eritrea. As potato production develops, this will allow a sustainable local system to be put in place, prioritising important next steps in the process.

**Medhanie:** The plan is to scale up access to quality declared seed, and establish an association of potato seed producers. We also want to look at enabling sustainable access to clean seeds and provision of early generation potato seeds through tissue culture, and look at strengthening the value chain.

**John:** Our memorandum of understanding has recently been renewed, and we're all excited to work together for the next four years (at least), with a major strategic focus being to build on our achievements to date in developing a sustainable seed potato system in Eritrea. T

## In good company

**Why are you passionate about this research?**

**Medhanie: I like working with farmers and hearing their indigenous knowledge and experiences in mitigating challenges.**

**Fitsum: Every contribution matters, and I've met some great people along the way! It's also a good opportunity to work alongside incredible researchers, development experts and practitioners.**

**Denis: This work is multidisciplinary, so tangible benefits can be seen and provide constant feedback as to what will be necessary in the future.**

**John: This research is also a wonderful example of knowledge transfer, which is a cornerstone of the development programmes Vita undertakes with its partners, and how we work with our partners in Eritrea.**

**FUNDING**

**The Eritrea-Ireland Development Programme is funded by Irish Aid – Ireland's overseas aid programme.**

# A positive performance from PCF

State agency Bord Bia has been tracking the performance of Prepared Consumer Foods (PCF) exports, as it supports the growth of Irish companies in this valuable market.

**Words by:** Aoife Glennon, PCF Executive at Bord Bia

In 2021, Ireland's Prepared Consumer Foods (PCF) exports market was valued at €2.5 billion – a 2.7% increase from 2020. As a category, PCF covers a breadth of products ready for consumer consumption, and its success heavily follows consumer lifestyle trends.

The positive performance seen in 2021 is due to sustained strong sales across retail – most notably for the meal solutions category, but also bread and value-added pigmeat.

PCF exports are very dependent on the UK market, and despite the challenges raised by Brexit, there remains opportunity for growth. The scope of Irish exporters able to take advantage of that growth will depend to some degree on the implementation of the EU-UK Trade and Co-operation Agreement, however.

## Exploring potential new customers

Irish PCF exporter sentiment on UK growth is strong, and Bord Bia provides support to companies looking to increase their UK exports. To help Irish companies overcome barriers to trading with the UK, Bord Bia has launched a Brexit hub, hosted events and webinars, conducted UK consumer research and created a Brexit Action Plan, amongst other things.

Many Irish PCF exporters are also pursuing diversification strategies. Growing a strong understanding of target markets in terms of tastes, requirements and the prevailing distribution network takes time, but opportunities exist for companies with the capability to adapt to local requirements.

The opportunity for diversification rests most significantly in the EU within the meal solutions subcategory, which includes pizzas, ready meals and soups. The logistical challenges of chilled exports to those markets should not be underestimated, and significant inflation across the supply chain and shipping remains the number one challenge for all Irish exports.

**68%**

**68% of all PCF exports are destined for the UK market, up from 62% in 2016.**

## Understanding the value areas in PCF

The largest single element of PCF is value-added meats (VAM). Destined for quick service restaurants and retail ready environments, VAM's were significantly negatively affected by closures resulting from the pandemic in 2020. As foodservice – particularly quick service restaurants – returned in 2021, VAM's sustained exports at a value of €677 million, up from €670 million in 2020. This export figure is still below pre-pandemic levels (VAM exports in 2019 were €755 million), but it demonstrates a gradual recovery.

Elements of the PCF category dependent on the retail channel had a very positive year. The meal solutions subcategory increased the value of exports by 5% to €517 million, a 10% increase on 2019's record value of €471 million.

Non-alcoholic beverage exporters balanced between the return of demand for foodservice and continued robust retail. Exports in this category were worth an estimated €110 million in 2021, a 27% increase on 2020's value and up from 2019 also.

Export figures for 2021 demonstrate Irish PCF companies' resilience and ability to adapt to the changing market environment, and promisingly, Bord Bia has 16 Irish companies exhibiting at the Food and Drink Expo 2022, all hoping to increase their UK exports. Similar agility and responsiveness will be required from companies throughout 2022, however, if exports are to successfully grow in this wide and complicated category. T

# A way of life

By exploring the benefits of developing a national social organisation for the older generation of the farming community, an age-friendly environment can be created in the farming sector.

It's been reported globally that policies designed to stimulate generational renewal in agriculture pay little attention to the mental health and wellbeing of older farmers. Such policies often overlook their identity and social circles, which are intertwined with their occupation and farm.

Researchers at National University of Ireland, Galway (NUI Galway) and Teagasc are diving deeper into this issue, through a study looking at contrasting literature connected to transferring the family farm and social gerontology (the study of ageing and how it affects the individual and society).

Shane Conway, Postdoctoral Researcher at NUI Galway and project lead, says: "Our goal is to determine what steps, if any, could or should be taken to minimise the disconnect between policy and realities on the ground.

"We're paying particular attention to practical 'farmer-sensitive' actions that can be taken at both policy and societal level. This is to reassure older farmers that their sense of purpose and legitimate social connectedness within the farming community will not be jeopardised when they hand over the farm business to the next generation."

The project team's study opens up a broad international conversation on the place of older farmers in society, and the part this plays in generational renewal and broader agriculture policy narratives.

"This insight is particularly timely as rural

## Livestock marts: hives of social interaction

**The roll-out of a national social organisation for older farmers may seem challenging, but it could be relatively easy to instigate. The project team proposes drawing on already existing channels to establish the organisation, namely that of the long-established livestock mart sector.**

**In addition to their primary function of providing a consistent, stable and transparent method of buying and selling livestock through a guaranteed payment structure, marts also provide a vital social facility for the farming community, some of whom have no other social outlet.**

**Many older farmers rely on their weekly visit to the mart to meet friends, exchange ideas and catch up on local news in an informal setting. This has almost grown in significance in recent years as many of the natural meeting points within rural communities have been removed due to the closure of post offices, pubs and local shops.**

**Livestock marts could help to facilitate a national organisation as they already play a considerable role in providing a social hub for older farmers. With an existing positionality and reputation as a 'buzz' of activity within the heart of rural communities, marts have a ready-made platform and network to establish a social group membership of older farmers in their catchment area.**

## FACT FILE

### What is an age-friendly environment?

**There's no universally accepted definition of an age-friendly environment. However, the World Health Organization defines an age-friendly community as one in which "policies, services, settings and structures support and enable people to age actively".**

communities prepare to adapt and rebuild as part of their Covid-19 recovery plans," says Shane, "Plus, social isolation measures have further highlighted the importance of ensuring social inclusion for society's elderly population, including older farmers."

## Helping older farmers stay social

At present, agriculture policy makers and practitioners are focused predominantly on addressing the needs of younger farmers, but there is an urgent need to re-examine this focus and place greater or equal emphasis on maintaining the social and emotional wellbeing of those most affected by generational renewal – older farmers.

One key way in which the project team believe policy makers can respond positively to the ageing farming population is through the establishment of a national social organisation, similar to those in place for young farmers in rural Ireland.

There is increasing evidence within social gerontology research on the benefits and importance of such social organisations on the lives of older people, particularly in relation to combatting social isolation and loneliness in later years.

Anne Kinsella, Senior Research Economist at Teagasc, says: "Research reaffirms why there should be immediate support of such a venture in the farming sector, which could be funded annually by the Government and through membership.

"Designed to fit the older generation's aspirations, needs and values, such organisations would help to alleviate concerns around the fear of the unknown upon retiring from farming, by providing older farmers with an outlet to remain embedded inside the agricultural sphere.

"A social organisation for older farmers, with a network of clubs in every county (or similar geographic entity), would also promote social inclusion in farming by allowing the older generation of the farming community to integrate within the social fabric of a local age peer group."

Membership of such a group would provide opportunities to develop a pattern of farming activities suited to advancing age, through increased collaboration with farmers at a similar stage of their lives.

"This would contribute to an overall sense of happiness, belonging and self-worth, amidst the gradual diminishment of physical capacities on the farm," says Anne. "And this comradeship would also be beneficial for farmers living alone, or for those who do not have a successor to take over the farm."

## Fostering health and wellbeing in later life

The establishment of a national social organisation for older farmers also has the potential to create an age-friendly environment in the farming sector. The concept of age-friendly environments has garnered international attention among researchers, policy makers and community organisations since the World Health Organization launched its Global Age-friendly Cities and Communities project in 2006.

"Despite the growth of the age-friendly environments movement, existing literature is mainly focused on a model of urban ageing that fails to reflect the broader diversity of rural areas and, more significantly, that of the farming community," explains Shane. "The successful implementation of a social organisation for older farmers in Ireland can help to address this significant underrepresentation by generating a culture of appreciation and respect for their way of life, both within policy circles and society.

"Consequently, it can prevent older farmers from becoming isolated and excluded from society almost by accident, rather than intention." T

**FUNDING**

**This study was funded by the NUI Galway College of Arts, Social Sciences and Celtic Studies Illuminate Programme.**

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# Wheat stem rust:

## the return of an old foe

The reappearance of stem rust on wheat in Ireland after decades of no reports led researchers to investigate the cause behind recent outbreaks of the disease.

In early July 2020, unusual rust pustules were observed in control plots of winter wheat across a number of locations in Ireland. Unlike the typical yellow rust or brown rust pustules that are regularly observed, these were darker and larger in appearance, and were observed both on leaves and – more importantly – on the stems of wheat.

A further detailed look into the characterisation of these pustules confirmed the worst – these were wheat stem rust pustules. Whilst stem rust itself can be found on numerous grasses in Ireland from mid-summer onwards, the last reports of stem rust on wheat are from the early 1960s.

Its identification in 2020 came as quite a surprise, leading researchers at Teagasc and the John Innes Centre in the UK to investigate further.

### The most serious of wheat diseases

Wheat stem rust is caused by a fungal pathogen, and is regarded globally as the most socio and economically destructive wheat disease throughout the majority of wheat-growing regions. The disease is recognisable by its oval shaped pustules that appear on the stems and leaves of both wheat and barley, extruding dark orange-red spores.

By bursting through the leaf or stem, these pustules severely restrict the flow of nutrients to the developing grains. They have the potential to destroy susceptible varieties and inflict significant yield losses.

The pathogen survives the cool winter months in climates such as Western Europe by developing hardy teliospores (the thick-walled resting spore of rust fungi). The development of these teliospores in the latter stages of the disease cycle often give a distinctly black appearance to infected stems, hence the disease is often commonly referred to as black stem rust.

However, for the teliospores to successfully lead to further infections, they require an intermediary host – most commonly, barberry plants. The identification of barberry as the key intermediary host of wheat stem rust allowed control strategies to be developed, limiting the development of the disease by restricting its overwintering capacity. For centuries, this has been the cornerstone of wheat stem rust control.

**60 years**

**The last reports of wheat stem rust, before it's recent re-emergence, are from around 60 years ago.**

The removal of barberry combined with changes in arable (land used or suitable for growing crops) practices associated with more intensive production, meant the once endemic disease was no longer seen in Irish crops. That is, until two years ago.

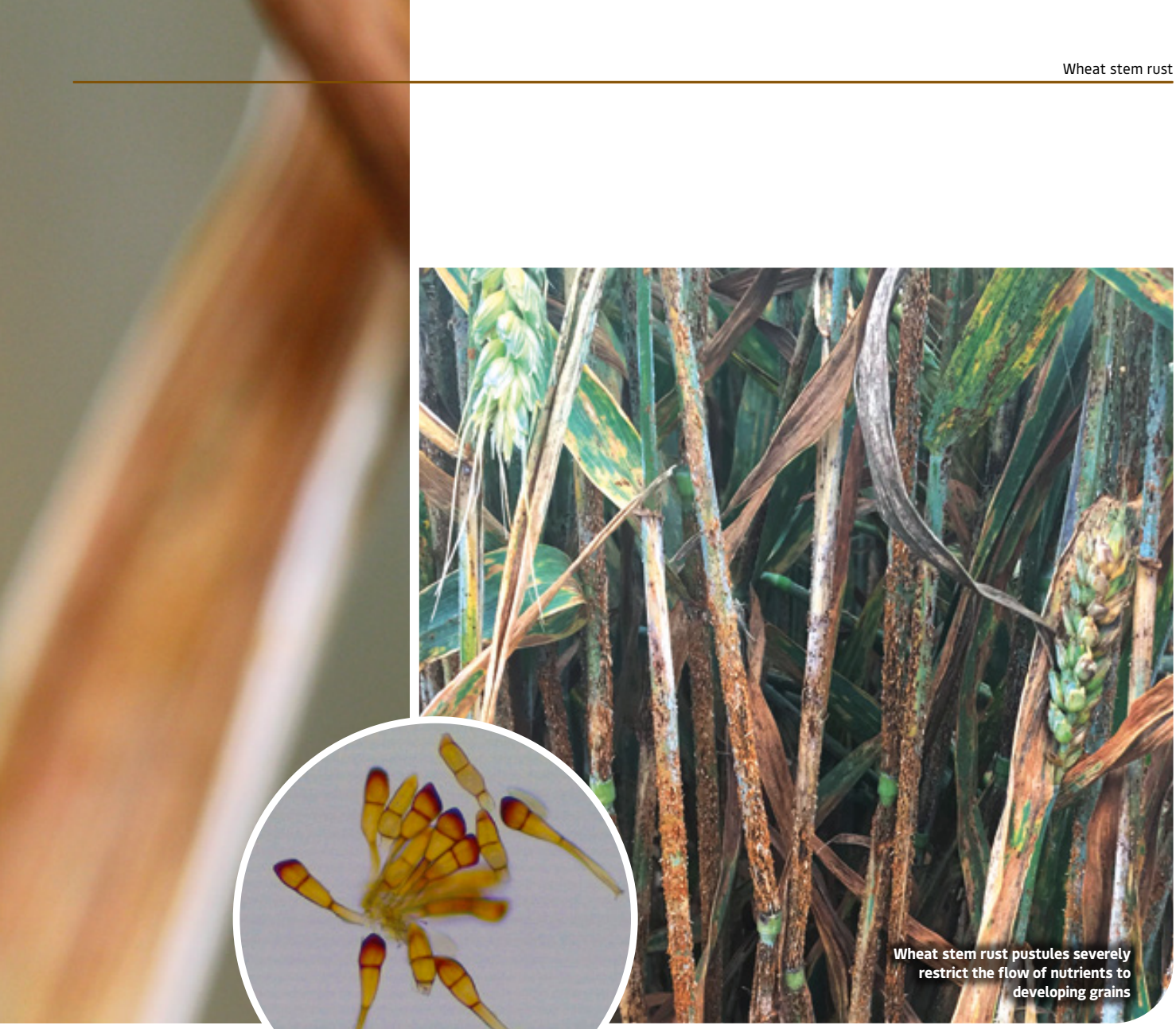
### Investigating the 2020 outbreaks

The detection of wheat stem rust at numerous locations in the southern half of Ireland in 2020 was both unexpected and worrying in equal measure. As most current European varieties of winter wheat are deemed susceptible to the disease, it was important to determine if the strains causing this infection were novel and posed a significant threat to production.

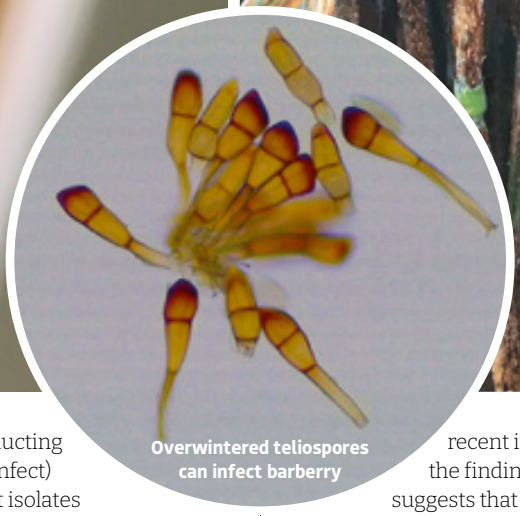
To answer these questions, detailed characterisations of its genetic material and causes of the disease were conducted.

### Did you know?

**Because of barberry's susceptibility to being a host of wheat stem rust, it was included in the Irish Noxious Weed Act of 1958, making it an offence to not remove barberry identified on your land.**



Wheat stem rust pustules severely restrict the flow of nutrients to developing grains



Overwintered teliospores can infect barberry

These included conducting virulence (ability to infect) screens on stem rust isolates obtained from these outbreaks, using an internationally recognised panel of varieties known to carry differing resistance genes. In parallel, novel pathogenomic techniques (high-throughput sequencing technology and bioinformatics) were applied to determine the specific genetic make-up of the strains.

Pathologically, the isolates of stem rust obtained from the Irish outbreaks were assigned to the TKTTF race. This race has also been detected in recent European outbreaks, including those in the UK and Germany. The assignment to this race was further supported by analysis conducted following RNA-sequencing as part of the pathogenomic approach used. It placed the Irish outbreaks amongst those previously reported in the UK and Germany, but also significant outbreaks that occurred in Ethiopia in 2015.

## An ongoing threat

Combined with the fact that no barberry was observed in the local vicinities where recent infections occurred, the findings of this analysis suggests that the appearance of stem rust in Ireland in 2020 resulted from long-distance dispersal of wheat stem rust spores. It also highlights that although wheat stem rust has been absent for well over half a century, it can occur at any time in modern wheat production systems in Ireland.

Given the limited resistance available in commercially available varieties, care is needed to ensure it doesn't become a significant threat in the future. T


### FUNDING

**This project is primarily funded by the UK Biological Sciences Research Council (BBSRC; BB/S003975/1) and the European Union's Horizon 2020 research and innovation programme under grant agreement number 773311 (RustWatch).**

**Additional funding was provided by the European Research Council (number 715638), BBSRC Institute Strategic Programmes BB/P012574/1 and BB/P016855/1, the John Innes Foundation and Teagasc (project 0154).**

### ACKNOWLEDGEMENTS

**We'd like to thank Kerstin Flath (Institute for Plant Protection in Field Crops and Grassland, Germany) for vital contributions to the study, all those who assisted with sample collection and processing and Fiona Hutton for lesion photography.**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# Celebrating 60 years of research

60 years on since the first issue of the *Irish Journal of Agricultural and Food Research* was published, a special issue highlighting the scientific advancements made over this time has been published.

To celebrate 60 years of Teagasc's peer-reviewed *Irish Journal of Agricultural and Food Research* (IJAFR), we've created a special issue. In it we highlight scientific advancements made over the last 60 years, and look to the future to see how current knowledge, methods and tools can help us to meet the grand challenges facing agricultural and food sectors and wider society.

In this article, we share snapshots of three key areas of Teagasc research that feature in our special issue.

## Irish landscape complicates nutrient run-off

When too much nitrogen or phosphorus flows into a local river, it seems logical to think that this is directly linked to nearby farms. However, over a decade of research in six water catchments has revealed why this approach is not so straightforward. Known as the Agricultural Catchments Programme and funded by the Department of Agriculture, Food and the Marine, this long-term study has shown that nutrients flow off some fields easier than others, because of differences in soils and bedrock, as well as farming practices and weather.

Research Officer Per-Erik Mellander, whose paper in this special issue charts the knowledge gained from the study, says: "There are many different factors that impact nutrient loss and influence nutrient flow. We need to consider variability in the landscape, the scale we are observing and changing weather."

More intensive farming inevitably results in more nitrogen inputs, but the complexities uncovered by the catchment programme make it more difficult to introduce countrywide measures that will be effective everywhere.

According to Per-Erik, the situation is best dealt with by interacting with individual farmers.

Giving farmers maps with soil types and nutrient concentrations is one way forward, and tackles another observation from the study – that there is often a mismatch between how much phosphorus is added

**The motto *'In Scientia Copia'* – meaning 'In science is the abundance' – as it appeared in the first issue of the *Irish Journal of Agricultural and Food Research.***

and what a crop requires. Maps allow farms to better tailor fertilisation inputs to crop needs within the same farm.

"We don't want the nutrients leaving the soil around the roots," says Per-Erik, "we want to keep them in place. Farmers don't want to lose nutrients to waterways, especially at a time when fertiliser prices are rising."

## Systems-based approach to research

The research landscape has changed for many reasons, including the need to develop more holistic solutions to complex challenges relating to climate change, food security and health and nutrition.

Maeve Henchion, Head of Agrifood Business and Spatial Analysis Department, explains: "There is an increased emphasis on the production of knowledge to achieve impact, rather than as an end in itself. Other changes in the research landscape include the recognition given to different types and sources of knowledge, and an appreciation that innovation can have unintended and undesirable consequences."

These changes have increased the role policy makers, funding bodies and organisations such as Teagasc play in science governance. As a result, policies relating to research impact, responsible research and innovation and the multi-actor approach have been developed.

Food systems thinking, emphasised in the Food Vision 2030 strategy, is closely aligned to such developments, and requires us to think about the whole system of actors – their different values, expectations and interactions. "This has resulted in changes to how researchers do science," says Maeve, "but also some confusion as to the 'right' way to do it."

**Nutrients flow off some fields easier than others, because of differences in soils and bedrock, as well as farming practices and weather**

Based on an understanding of concepts such as social networks, power and trust, social science enables the development of practical tools to engage diverse actors, incentivise collaboration and facilitate co-creative innovation.

Maeve's co-authored paper provides practical examples of how social science-based thinking has been deployed in a range of transdisciplinary and multi-actor projects. "It illustrates the complexity of the process, but also outlines the practical tools that can be used by all researchers to implement it in practice," says Maeve. "It also signals caveats, qualifications and provisos, emphasising the need for ongoing reflection."

## Accelerating genetic improvements

The rate of genetic improvement for the Irish dairy, beef and sheep sectors has accelerated over the last 20 years, resulting in improved sector profits and carbon efficiency. This could only have been achieved through the fruitful and synergistic collaboration between Teagasc and the Irish Cattle Breeding Federation (ICBF), followed in 2009 by the development of its equivalent Sheep Ireland.

Senior Principal Research Officer Donagh Berry, whose paper in this special issue discusses genetic improvements, says: "Although creating a shared repository of verified data was an ambitious and arduous task for both organisations, the developed infrastructure is now the epicentre of breeding and many management decisions made on Irish dairy, beef and sheep farms."

However, a repository of genetic information needs to be useable in practice, warns Donagh: "Ireland has a farming system based on grazed pasture – the animal being bred must be fit for purpose for this system. If management systems are being developed to facilitate earlier age at slaughter, then breeders must breed the type of animal that is genetically more conducive to earlier slaughter without any repercussions for other traits."

Looking to the future, the traits likely to grow in importance in breeding programmes include product quality, efficiency of production and health and wellbeing.

"What influences their importance is their direct or indirect contributions to the sector's bottom line," says Donagh. "However, there is an argument for putting selection pressure on traits with no current explicit value – often referred to as public-good values." T

**Visit the *Irish Journal of Agricultural and Food Research* website: ijafr.org**


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# The right tools for the job

A fruitful collaboration between researchers at Teagasc and the Irish Cattle Breeding Federation has led to the development of three interdependent tools to support beef-on-dairy breeding, mating and trading.

Beef-on-dairy breeding – the mating of beef bulls with dairy females – increases the value of calves born. This is because such calves typically benefit from the quality genetics found in beef bulls, which often results in superior carcasses compared to calves born of purebred dairy cattle.

Dairy producers are most interested in producing dairy-bred females in order to preserve the mature herd; unless genetically elite, their male dairy-bred contemporaries have a low market value as calves.

In recent years, there has been increasing interest in the use of beef bulls mating in dairy herds. This is due to the fact that fewer dairy females need to conceive to dairy bulls, thanks to a reducing requirement for replacement dairy females on farms, coupled with the availability of laboratory-sorted semen that produces almost exclusively female calves.

A gap in knowledge and tools on how to best facilitate such a breeding policy has been filled by researchers at Teagasc and the Irish Cattle Breeding Federation, who have successfully developed and deployed a trilogy of tools to help guide the shift. The tools are as follows:

**1. Dairy Beef Index** – to establish and deliver year-on-year improvements in beef bulls suitable for mating to dairy females.

**2. Dairy Sire Advice web service** – to recommend optimal individual male-female matings.

**3. Commercial Beef Value tool** – to forecast the likely profit that would result from a calf destined for beef production.

Strong interdependencies exist between the researchers' tools. The Dairy Sire Advice web service leans heavily on the components of the Dairy Beef Index. The Commercial Beef Value tool is founded on the index, the only real difference being that it does not include the calving performance traits.

Crucially, the data underpinning all three tools originate from a single point of truth managed by the Irish Cattle Breeding Federation, who have no conflict of interest in the individual values given to the animals. Values get updated as data accumulates, and additional modules that contribute to profit or public good values can be added.

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## 1. Dairy Beef Index

**A successful beef-on-dairy sector requires germplasm (living genetic resources maintained for the purpose of animal breeding) that produce a valuable calf for the beef producer, without negatively affecting the performance of the dairy cow that gave birth to the calf.**

**Breeding indexes have been used for decades to rank animals on an arrangement of different credentials, many of which are often antagonistically correlated (when a favourable value for one trait is associated with an unfavourable value for another). In 2019, a Dairy Beef Index was launched in Ireland with the goal of ranking beef bulls for suitability to both dairy and beef producers.**

**The index comprises traits of importance to both producers – the dairy and beef components of which are antagonistically correlated. Coupled with a well-structured breeding scheme, the index can help producers to deliver bulls that excel in both characteristics.**

**Concurrent selection for antagonistically correlated traits is possible – the best known example in cattle is the simultaneous improvement in milk production and reproductive performance in dairy cows.**

**Breeders of beef bulls can use the Dairy Beef Index to identify candidate sires and dams of the next generation of genetically elite beef bulls for mating to dairy females. In turn, dairy producers can use it to rank all available beef bulls on suitability for each dairy herd.**

**The publicly available index values are generated by the Irish Cattle Breeding Federation for both artificial insemination bulls and natural mating bulls, and are regularly updated as information on the descendants of the bulls is collected.**

## 2. Dairy Sire Advice web service

**Once the dairy producer selects an appropriate team of beef bulls, the next stage in the breeding programme is to decide which bulls should be mated to which cows – known as sire mating advice. Here, producers must consider the cow's susceptibility to a difficult birth, including the size of the calf and the pelvic width of the cow herself.**

**While no actual measures of these characteristics exist, approximations are made through deep statistical analyses of millions of data points from Irish cattle. Dairy females that are more susceptible to a difficult birth should be mated to beef bulls that are less likely to produce calves that require assistance at birth.**

**Similarly, all else being equal, dairy females that are likely to produce carcasses with poor conformation (flesh coverage and overall shape) should be mated to a bull who, on average, has been proven to generate good conformation carcasses. It's worth nothing, however, that all these combinations become unwieldy in large dairy herds.**

**The dairy-beef sire advice tool uses sophisticated statistical techniques to evaluate every such combination within the confines of certain criteria. The outcome from the web service is a list of dairy females in the herd with a recommended beef bull for mating.**

## 3. Commercial Beef Value tool

**Revenue from beef-on-dairy cattle is predominantly determined by carcass value, which itself is determined by carcass weight and conformation, on average, many months or years post-birth. Predicting the carcass weight and conformation from visual inspection of a young calf can be challenging, even to the experienced eye. However, approximately half of the variation in both carcass weight and conformation in cattle is attributable to genetic differences.**

**The genes of an animal at slaughter are the same genes the animal was born with. Therefore, genetic merit estimates of carcass weight and conformation, along with information like calf gender and dam characteristics, can be used to predict animal performance. This approach has been taken in the Commercial Beef Value tool, available for all cattle.**

# The threat of Toombak in Sudan

Researchers from Ireland and Sudan have partnered up to shed light on the health implications of one of the world's most perilous types of smokeless tobacco.

Toombak is a type of popular smokeless tobacco sold by local vendors in Sudan. Most commonly used by men, it's placed inside the mouth using the fingertips and replaced up to several times a day. Whilst it's never swallowed, the long-term use of Toombak can lead to many serious and life-threatening issues, such as gum disease, oral cancer, cardiovascular disease, prostate cancer and infertility.

Toombak is produced by fermenting the leaves of the *Nicotiana rustica* tobacco plant, in a process that can take months. *Nicotiana rustica* is used because of its rich nicotine content, and numerous additives are added along the way. Sudanese people have found a way to increase the kick even more by adding sodium bicarbonate to the mix.

Sodium bicarbonate creates an alkaline environment that allows for high absorption rates of nicotine through the mouth lining. This makes the habit extremely addictive, and users find it exceedingly difficult – if not impossible – to quit.

Over the last three years, researchers from Teagasc, research centre APC Microbiome Ireland – based in University College Cork (UCC) – and National Ribat University Sudan have come together to explore in more detail the chemical and microbial (microorganism characteristic) composition of Toombak and its health implications.

## The danger within

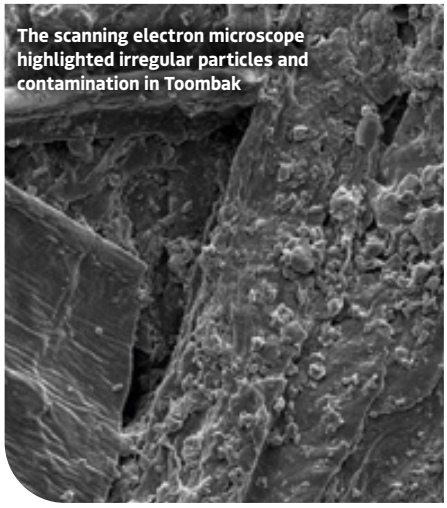
The researchers used ready-to-buy samples of Toombak from different markets in Khartoum, the capital of Sudan, for their analysis. They were looking at structure, composition and microbiome, as well as looking for heavy metals.

Using a scanning electron microscope, they identified plant fibres of Toombak that were rough with visible bacteria. The heavy metal content was then analysed, showing Toombak has considerable amounts of chromium, cobalt and copper. It also revealed that through daily use, users are exposed to between six and fourteen times more iron than the accepted daily level.

GothiaTek, an industrial standard, is adopted by members of trade organisation

Toombak is produced by fermenting the leaves of the *Nicotiana rustica* tobacco plant

Toombak final product



The scanning electron microscope highlighted irregular particles and contamination in Toombak

## Toombak in numbers

**4 to 10 million**
Between 4 to 10 million people use Toombak in Sudan.

**114.3mg**
Users are exposed to an average of 114.3mg of daily iron from Toombak use, far surpassing the accepted daily level of around 8 to 18mg.

**3,210**
There were 3,210 times more tobacco-specific nitrosamines in Toombak compared to the GothiaTek standard limits.

**36**
The metabolite Acetaldehyde was found to be 36 times higher in Toombak compared to the GothiaTek standard limits.

European Smokeless Tobacco Council (ESTOC) to regulate and maintain safe limits of metabolites and other products found in smokeless tobacco in Europe. Following this standard, the researchers found unacceptable levels of toxic metabolites in Toombak.

They also found tobacco-specific nitrosamines (TSNAs), carcinogens that are produced when mushed-up tobacco leaves are left to ferment under intense heat. Not only were TSNAs present in Toombak, but it was found to have the highest content of them in the world when compared to other smokeless tobaccos. TSNAs are one of the main causes of harm from Toombak use, and it is likely that Toombak users are exposed to considerable risk due to its high concentration levels.

> **Toombak is a product of fermentation and contains live bacteria on use, but it isn't healthy in any way.**

When looking at the microbiome of Toombak, the researchers found a number of different groups of bacteria, including bacteria common to chickens, midges, mobile phones and ear infections.

### Exploring ways to make Toombak safer

Interestingly, Toombak is a product of fermentation and contains live bacteria on use, but it isn't healthy in any way. It requires stringent re-evaluation at production and systems levels, in order to reduce the risks associated with it. Smokeless tobacco in Europe and the USA, for example, is pasteurised and packed under sterile conditions in factories, but this is not the case for Sudanese Toombak.

The researchers have established a promising partnership with Esther Health Alliance Ireland to improve microbiome science in Sudan by investing in science, infrastructure and health through microbiome research.

The researchers' study of Toombak sets out a pathway to better understand different areas of Sudanese life and how these can have both positive and negative impacts on societal health. They have successfully shed light on an important cultural aspect of Sudanese life, and through continuing research, hope to bring about necessary changes for optimum health when producing and using Toombak. T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The newly built National Food Innovation Hub

# Food innovation for the future

Teagasc has invested in new infrastructure to support innovation within the Irish food and drink industry.

In 2021, Irish state agency Bord Bia listed 'Health and Wellbeing' and 'Responsible Living' amongst the key trends that will impact the Irish food and drink industry going forward.

In recent years, Teagasc, along with the Department of Agriculture, Food and the Marine (DAFM) and other funders, has invested heavily in the research and development capabilities available to Irish food companies. By improving infrastructure, Teagasc hopes to help companies reach their innovation potential and meet consumer trends.

## National Food Innovation Hub and Moorepark Technology Ltd

DAFM has invested in the development of a National Food Innovation Hub at Teagasc Moorepark, as well as a €10 million upgrade alongside shareholders from the Irish dairy industry to the adjoining Moorepark Technology Ltd (MTL). These investments have created a unique research environment for national and international food companies.

The Hub provides confidential office and laboratory space for companies to establish a research base. Meanwhile, MTL provides a pre-commercial-scale environment for the development of food and beverage products, using the latest thermal, separation, dehydration and biotransformation technologies.

Clients at the Hub and MTL include companies from the dairy industry, along with other enterprises developing and producing natural food colourings, fermented foods, nutritional beverages and probiotic formulations.

A key priority for MTL is driving innovation in sustainable food processing, providing low temperature drying technologies, as well as validating new process analytical tools to improve plant efficiency and energy usage.

## National Prepared Consumer Food Centre

The National Prepared Consumer Food Centre (NPCFC) is a state-of-the-art centre located at Teagasc Ashtown, dedicated to supporting research, development and innovation in companies of all sizes across the sector. Recently extended, the NPCFC incorporates a dedicated packaging suite, continuous thermal processing system and an extensive range of pilot-scale drying, extrusion and specialist food processing equipment, procured through a €10 million DAFM investment.

Access to these advanced facilities, alongside Teagasc expertise, provides crucial support to companies targeting new retail market opportunities, reformulating products, extending shelf life and adopting more sustainable production and packaging practices.

## BIA Innovator Campus

Located at Teagasc Athenry, the BIA Innovator Campus supports food entrepreneurs and small enterprises seeking incubation, scaling and innovation infrastructure in one location. Teagasc is amongst the founding partners responsible for the establishment of this campus, and is actively supporting the growth of the BIA Innovator.

The Campus will provide a mixture of technical, innovation and commercial support for food business, whilst also establishing an active network of food professionals, suppliers and potential investors. An auditorium, classrooms and demonstration kitchens will serve as an engaging visitor attraction for culinary tourism in the west of Ireland.

The recently extended NPCFC incorporates an extensive range of specialist equipment


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# 2022

## MAY

### International Conference on Food Digestion 2022

**Date** 3 to 5 May

**Location** Maryborough Hotel, Cork

The International Conference on Food Digestion is a major event in the field of food, nutrition and health. It is organised by the INFOGEST research network, whose objective is to improve the health properties of food by sharing knowledge on the digestive process. 2022 will mark the 7th conference since it was first established, with an international programme of speakers covering the latest research in food digestion. Early bird registration closes on 17 March 2022.

- **Contact:** **icfd2022@abbey.ie**
- **More information:** **icfd2022.com**

www.maryborough.com

Maryborough Hotel: the venue for ICFD 2022

### World Potato Congress (WPC) 2022

**Date** 30 May to 2 June

**Location** Royal Dublin Society, Ballsbridge, Dublin

The WPC 2022 will bring together a panel of over 60 science and industry speakers representing the seed, fresh table and processed potato sectors from 20 different countries. This year's theme is 'The Changing World of the Potato', and topics explored will include rising costs, sustainability, climate change, the decreasing range of plant protection products, smart farming and smart supermarkets. Congress delegates will also have open access to the brightest and best of Ireland's potato industry in the form of technical and industry tours.

- **Contact:** **info@wpc2022ireland.com**
- **More information:** **wpc2022ireland.com**

## JUNE

### Teagasc Sheep Open Day

**Date** 18 June

**Location** Teagasc, Animal and Grassland Research and Innovation Centre, Athenry, Co. Galway

This open day will offer an opportunity to review the latest research and technical advice from the Teagasc Sheep Programme and its practical application at farm level. There will be a mix of technical presentations and interactive workshops dealing with all the main areas important to Irish sheep production. The open day is free to attend and all sheep farmers and those involved in the sector are welcome.

- **Contact:** **philip.creighton@teagasc.ie**
- **More information:** **teagasc.ie/news--events/national-events/events/sheepopenday.php**

## JULY

### Teagasc Beef Open Day

**Date** 5 July

**Location** Teagasc, Grange, Dunsany, Co. Meath

This open day will showcase the latest research from Teagasc Grange and the new knowledge transfer programmes: Future Beef Programme (for suckler systems) and Dairy Beef 500 (for dairy-beef systems). A major focus will be on the environmental sustainability of pasture-based beef cattle production, given the increasing focus from policy makers and consumers.

- **Contact:** **paul.crosson@teagasc.ie; pearse.kelly@teagasc.ie**
- **More information:** **teagasc.ie/news--events/national-events/events/beefopenday.php**

## AUGUST

### Teagasc Open Day: Technologies for farms of the future

**Date** 30 August

**Location** Teagasc, Environment Research Centre, Johnstown Castle, Co. Wexford

What will farms of the future look like? This open day will demonstrate technologies and practices that can be adopted on farms to help to maintain farm productivity and profitability, while increasing overall environmental sustainability. The latest information for successful management of grass-clover and multi-species swards under winter and spring calving dairy and dairy calf-to-beef systems will be available. Practices to enhance on-farm biodiversity and to reduce losses of valuable nutrients from the soil will be demonstrated. You will also learn about the latest fertiliser and slurry technologies and methods for enhancing carbon sequestration and soil health.

- **Contact:** **david.wall@teagasc.ie**

## Anti-inflammatory Algae

**Bioactives found within brown algae contain anti-inflammatory properties that also help to reduce pain. As part of its Algae4IBD project, Teagasc is using novel processing methods to extract the compounds that offer these benefits, to develop functional food products. As chronic inflammation is a major health issue globally – causing diseases like inflammatory bowel disease (IBD) – many people stand to benefit from this project.**

**Photo and description by:** Maria Hayes, Research Officer, Teagasc