TEAGASC

Agriculture and Food Development Authority
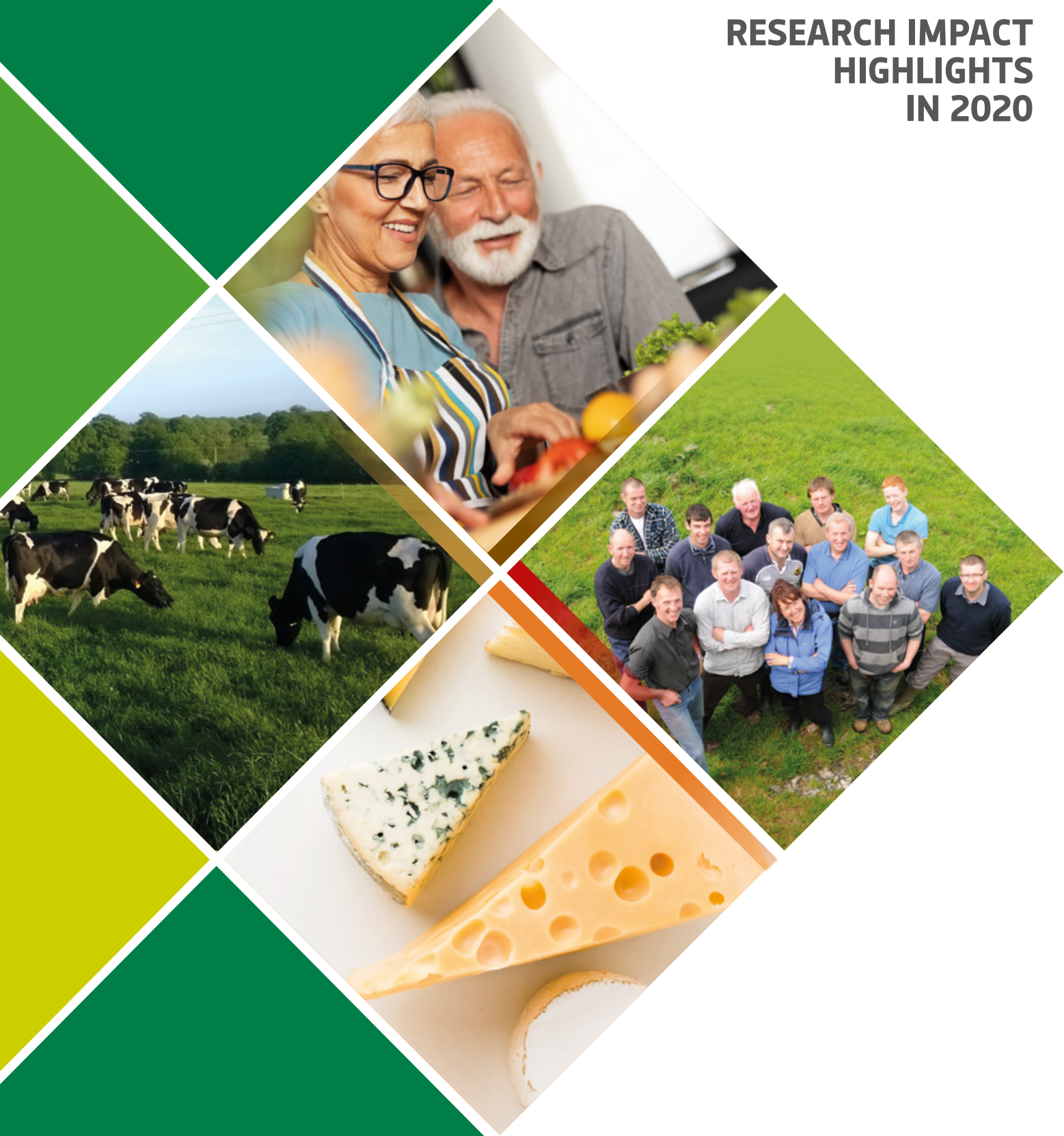
RESEARCH IMPACT HIGHLIGHTS IN 2020

Foreword

The annual expenditure on research in Teagasc is approximately €75 million, which comes from a variety of sources. These include the core grant-in-aid funding allocated by the Department of Agriculture, Food and the Marine (DAFM), and competitive funding awarded nationally – principally, the competitive research call of the DAFM. Other important national sources are Science Foundation Ireland, Enterprise Ireland, the Environmental Protection Agency and the Irish Research Council.

In recent years, our researchers have been very active in winning funding from international programmes such as EU Horizon 2020 and the new Horizon Europe programme. Indeed, in comparison with all other research organisations and universities across Europe, Teagasc is ranked fifth for total number of projects securing European Commission funding in the agri-food area since 2014. Farmer levy contributions, industry-funded research and earnings from services offered and farming activities also provide very important funding.

Given the Teagasc mission to provide scientific leadership and support to Irish farmers and food companies in achieving a sustainable food system, it is very important to demonstrate the impact of this investment. In any given year, the impact of Teagasc research is a combination of the continuing impact of past research and the new impact of recent research. This publication highlights some of these new impacts achieved in 2020.

The examples selected are from across our programme and include research conducted on issues in soils and the environment, animal production, crop production, food processing, food and health, economics and social science. They are not an exhaustive account of the new impacts of Teagasc's research, but they do demonstrate the breadth of research carried out by Teagasc. The impacts are made in a range of areas including livestock and crop production (including horticulture), the food industry, and shaping policy.

Achieving impact requires not just the research, but also the work of our advisors, specialists and education officers, and I am convinced it is when all the resources of Teagasc are brought to bear on an issue that we are a powerful force for change. We also rely on experts in other organisations, industry, farmers, food companies and policymakers. Having a range of these actors involved, who ultimately make the changes in what they do based at least in part on our research, greatly helps the achievement of impact.

I wish to commend my colleagues in Teagasc who carried out the research reported here or supported it in some way, and other researchers whose work also had impact but is not included in these 20 examples.

I would also like to acknowledge the many collaborators we have in universities, institutes of technology and other external bodies, as well as the farming community and agri-food companies, which are directly involved in many of our research projects. We greatly value those contributions. Finally, I would like to thank the funders of the research listed above. I believe their investment will pay rich dividends across the agri-food industry, the wider economy and environment and Irish society over the coming years.

Frank O'Mara
Teagasc Director

> **"I am convinced it is when all the resources of Teagasc are brought to bear on an issue that we are a powerful force for change."**

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Be social! Connect with Teagasc

A supplement of *TResearch* magazine.

ad artful dog

teagasc

AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

AGRIP

Working smarter not harder

Marion Beecher, Conor Hogan and Bernadette O'Brien

The reduced availability of farm workers combined with farmers placing greater emphasis on achieving a good work-life balance has led to an increased focus on work organisation and efficiency. A case study conducted with four farmers highlighted that a 117-cow dairy herd can be managed with less than 3,000 hours of labour input per year (equal to 54 hours per week). This is fewer than the 3,015 hours per year previously reported for labour efficient farms with a herd size of less than 150 cows.

For the most labour-intensive tasks, such as milking, calf and cow care and grassland management, 12 key work practices and technologies
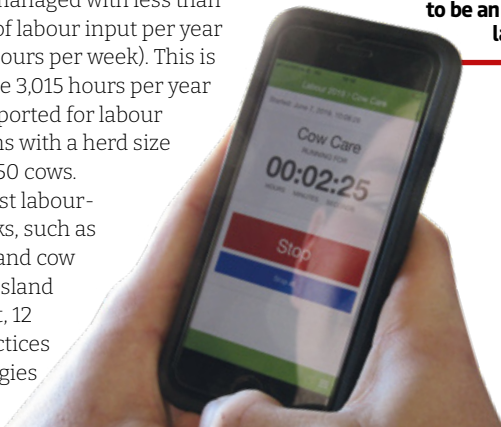
55

Research has indicated that farmers consider anything less than 55 hours a week to be an acceptable weekly labour input.

have been identified to improve efficiency. Once the efficiency is optimised through the relevant facilities, practices and technology, farmers can reduce their own contribution further by hiring staff or contractors. For every additional efficient work practice or technology implemented, the labour efficiency has the potential to be improved by 0.60 hours per cow.

The farmers profiled in the case study contributed 77% of labour input, which equalled 47 hours a week. The farms were still able to meet all of their key targets for a spring calving herd while this was achieved, highlighting the importance of minimising labour requirements through efficient work practices and/or technology.

FOOD

Say cheese: the taste of success

Paul Cotter and Kieran Kilcawley

The flavour of cheese is dictated by the microorganisms that are involved in the fermentation process. In recent years, scientists have begun to use a form of advanced DNA analysis, referred to as 'metagenomics', to study the microbiology of cheese to a greater extent than ever before. This approach has now culminated in the most detailed study of its kind to date.

The Teagasc team employed metagenomics to characterise in great depth the microbiology of 184 samples of cheeses from across the world, including newly studied samples from 55 cheeses sourced from Irish artisanal cheese producers.

This study is of tremendous value to the cheese industry, and after national and international dissemination, it is leading to the better harnessing of microbes that can positively impact flavour and other qualities, with a view to making the most desirable qualities of artisanally produced cheeses available to even wider markets.

Saving our soil

Michael Gaffney, Dheeraj Rathore, Vincent Michel (Agroscope, Switzerland) and Harm Brinks (DELPHY, The Netherlands)

Soils are declining in health globally due to urban expansion, deforestation, erosion and unsustainable land use and management practices. Healthy soils are the foundation of healthy food production, and soil-borne diseases and plant pathogenic nematodes are major limiting factors in current cropping systems.

Thematic network Best4Soil was established to build a 'community of practice' promoting best practices of crop rotations and soil management techniques for maintaining and rejuvenating soil health across Europe. Teagasc and partners created two databases which gathered existing information on crop and soil-borne pathogen interactions. These databases were then used by the University of Wageningen to create a decision support tool (**best4soil.eu/database**) for crop rotations.

Teagasc was responsible for the data mining of 29 horticultural crops, using existing literature to assess their susceptibility to over 106 soil-borne diseases and nematodes. The database aims to highlight the potential for disease transfer within crop rotations and allows for more robust rotation planning.

This web-based tool is currently available in 22 languages, and the databases are averaging over 500 sessions per month. As familiarity with these tools grows across Europe and dissemination and training continues, this engagement should increase.

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A snapshot of Irish farms

Ursula Kenny and Áine Regan

As part of the EU NIVA project, technology developers were tasked with developing an app to provide farmers with the option of uploading geotagged images of land parcels. The goal was to make claim processes more efficient and reduce the need for in-person farm inspection visits.

400+

Over 400 farmers and advisors used AgriSnap to submit geotagged photographs to support their scheme application or resolve queries.

With the help of social scientists, a design thinking (human-centred) approach was used to develop the app for use on smart devices. This novel approach involved target users, such as farmers, farm advisors and inspectors, working alongside research scientists, app developers and Department of Agriculture, Food and the Marine (DAFM) staff on the app development process. In using this approach, multiple stakeholders were supported to express and evaluate the benefits and challenges they associated with the development and final design of a new geotag photo app, and contribute their solutions for a more effective and user-friendly end product.

From this work, the AgriSnap app has been developed. AgriSnap was introduced by DAFM for use in the Results-based Environment Agri Pilot Programme (REAP) and Checks by Monitoring (CbM) for the Protein Aid Scheme in 2021. It will facilitate a faster turnaround of queries by DAFM, thereby minimising payment delays.

The benefits of benchmarking

George Ramsbottom

Irish dairy farms have changed rapidly since EU milk quotas were abolished. A study conducted to evaluate the association between usage frequency of the financial benchmarking tool Profit Monitor (PM) and farm changes on spring-calving pasture-based dairy farms has shown that farmers who benchmark frequently make more progress.

The most frequent users of PM (those who completed the tool between seven and nine times during the period 2010-2018) had the greatest increase in intensification, productivity and financial performance. Infrequent and low users of PM (those who completed

3,000
The number of dairy farmers using PM has doubled over the past decade to approximately 3,000.

the tool between four and six times and one and three times respectively during the period 2010-2018) were intermediate for all variables measured. Non-users, meanwhile, had the least change.

Despite considerable fluctuations over the observation period, the overall increase in total farm net profit between 2010 and 2018 for the frequent PM users was 70% (€37,639); while farm net profit for the non-user category increased by 42% (€10,977). It is believed that further development and extension of financial benchmarking tools may increase dairy farmers uptake and facilitate development of a more sustainable agri-food sector.

Making wood work

Niall Farrelly, Luka Kranjz and Annette Hart

Timber, and its increasing use as a construction material, plays a key role in increasing the competitiveness of the Irish forestry sector; and the long-term storage of carbon in harvested wood products can assist climate change action goals.

New research conducted by Teagasc and National University of Ireland, Galway has established that increasing the rotation age of Irish-grown Sitka spruce, Norway spruce and Douglas fir to 50 years can increase the strength grade of Irish-grown timber to higher strength classes commonly associated with slower grown European timber.

The research found that thinning systems that favour the removal of larger and branchy trees should be favoured, as knottiness and excessive radial growth are the main causes of loss of structural strength in Irish-grown timber. Thinning practices that favour the retention of high quality co-dominant trees grown on longer rotations have more mature wood with thinner rings, both of which improve the structural properties of the timber.

The outcomes of this research have illustrated that, if managed properly, Irish-grown softwood has significant potential for increased usage in higher-end structural applications, offsetting carbon intensive traditional building materials. It has also contributed to the inclusion of Irish-grown Douglas fir for the first time, which can now be graded and used for structural use.

Cherries]D/iStockphoto.com

REDP

Healthy eating for healthy aging

Sinéad McCarthy, Caoileann Murphy and Helen Cummins

People are living longer, and it's important that these years of life are spent in good health and living independently. Protein is essential for healthy aging, and many national dietary guidelines recommend an increase in protein consumption for older adults. Too little protein consumption in older years is associated with muscle loss, and can result in increased frailty and fall risk, and loss of independence.

The Nutrimal project examined novel nutritional means to prevent malnutrition in older people. In order to understand factors influencing acceptance of novel or functional foods for older consumers, research was undertaken to determine attitudes to healthy aging, diet, protein and functional foods.

In general, senior consumers are engaged with the concept of healthy aging and healthy eating, and try to follow a healthy diet. The most salient outcome from this research was that protein did not feature in routine daily healthy eating for many. While discussions covered avoiding sugar and fats, many were not familiar with the important role of protein in their diet. Indeed, some thought their GP would prescribe it if required.

The most trusted sources for health information were mainly doctors and family members, and therefore they play a key role in healthy aging advice. This research has emphasised the need for healthy eating advice around protein to promote healthy aging, and has informed national strategies, food policy and consumer education campaigns.

FOOD

The digestion question

André Brodkorb

One strategy used to better understand the relationship between food and health is to monitor and simulate food disintegration and interactions within the gastrointestinal tract. However, *in vivo* studies on the digestive system can be prohibitively expensive, and require invasive and sometimes unsuitable methods.

To address this, Teagasc researchers, in collaboration with international researchers from academia and industry, have developed and validated *in vitro* digestion models, such as the INFOGEST method. This standardised protocol is based on an international consensus developed by the worldwide INFOGEST network, with André Brodkorb leading the task of harmonising digestion methods.

These methods are now offered as a service to food companies as part of Teagasc Moorepark's technical services to industry. This has led to several successful collaborations, with the results helping industry partners to better position their products on the market. In addition, Teagasc researchers have helped to establish these digestion methods as recognised industry protocols among SMEs, national and multinational companies worldwide.

A monthly webinar series was introduced in September 2020 to share studies and results from the INFOGEST network to academia and the food industry.

Rasi Bhadramani /iStockphoto.com

CELUP

Tackling grass weeds

Vijaya Bhaskar AV, Dermot Forristal, Susanne Barth and Michael Hennessy

The Enable Conservation Tillage (ECT) project has delivered a comprehensive knowledge transfer programme – supported by research – to enable farmers to successfully manage grass weeds, whether practising non-plough or plough-based crop establishment.

Grass weeds, such as wild oats, sterile brome, Italian ryegrass and black-grass, can cause yield losses of >80%. Herbicide resistance and a declining armoury of herbicides are challenging our ability to control these problem species, and a lack of knowledge about the agro-ecology of grass weeds has increased spread and resistance issues.

The ECT project has dramatically increased awareness of grass weeds across the entire tillage industry using a broad range of dissemination activities, supported by research, a nationwide survey and validation of integrated grass-weed control

strategies on 10 commercial or 'Focus' farms.

Overall, there has been a huge increase in awareness of the grass weed challenge across the whole tillage sector, with farmers now prioritising cultural/non-chemical weed control measures in their farming systems. A specific campaign to highlight the extremely concerning black-grass threat was put in place for 2021.

In the last three years, the ECT project team has done the following:

5,000
Held over 40 knowledge transfer events addressing 5,000 growers

12
Released 12 technical videos

4,000
Delivered three webinars with a combined viewership of over 4,000

40
Published over 40 popular press articles

AGRIP

Helping farmers reduce energy use

John Upton

Teagasc has partnered with Munster Technological University (MTU) and the Sustainable Energy Authority of Ireland to deliver an online Dairy Energy Optimisation Platform that helps farmers reduce their energy use and maximise the use of solar energy. Decision support tools such as this are critical in achieving national targets for renewable energy deployment and energy related CO_2 emission reductions in agriculture.

The platform identifies the best blend of energy efficient and renewable technologies for individual farms, based on either economic or environmental criteria. Users are provided with a simple payback period and carbon emissions offset resulting from

any technology changes. The platform is a new addition to the existing Dairy Energy Decision Support Tool, which has been used over 4,000 times since its launch in 2018.

70%
The percentage of farms having installed or intending to install energy efficient technology has increased from 52% to 70% since the launch of the Dairy Energy Decision Support Tool.

Cheese for China

Diarmuid Sheehan, Hao Ouyang (Walsh Scholar), Song Miao, Mark Fenelon and Kieran Kilcawley

The Irish cheese industry is valued at over €1 billion. Traditionally, Cheddar exports to the UK accounted for 65%, but with the impact of Brexit, cheese producers are looking to far away markets for growth, specifically in China. However, there are significant knowledge gaps to overcome – firstly, for Irish food producers to understand evolving consumer preferences for cheese in China, and secondly, for Chinese consumers who have low prior knowledge of cheese, as it is not a traditional part of their cuisine.

Teagasc and UCC researchers have undertaken focus group studies to better understand the perception, experience and expectations of cheese in China. This has identified a preference for cheeses with a mild and milky flavour, as opposed to the stronger sensory profile of Cheddar. The research also shows that certain labelling information, such as flavour profiles and serving suggestions, can better align the consumers' expectations with the actual eating experience.

282,000
Irish cheese exports have grown from 77,000 tonnes in the 1990s to 282,000 tonnes in 2020.

With retail sales of cheese to China predicted to grow by 12.5%, this research is currently being utilised by Irish cheese producers to develop innovative cheese solutions for China.

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Other contributors: Mary McCarthy and Alan Kelly (University College Cork).
Funding: Dairy Research Ireland.

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Mind Meitheal
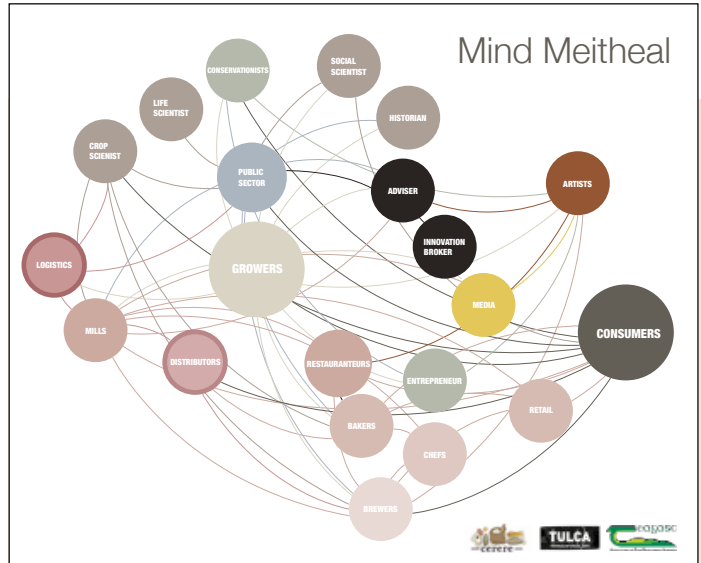
Heritage and organic cereals

Áine Macken-Walsh and John Hyland

Teagasc coordinated a 'multi-actor approach' for the CERERE Horizon 2020 project (a network designed to foster cross-border knowledge exchange around cereal production and food systems) by providing training to the network's consortium of partners.

To do this, Teagasc undertook a social network analysis of all the actors required to support the commercial use of heritage and organic cereals. It then held innovative social networking events across Ireland, bringing together different disciplinary and professional actors (including growers, bakers, brewers, chefs, restauranteurs and crop scientists, etc.,) to share knowledge and establish collaborations.

1,000+
Over 1,000 people participated in the events Teagasc coordinated.

Initiatives resulted in heritage grains entering commercial use by chefs, artists and restauranteurs in three Irish provinces, and this was featured in a number of films. Through collaboration with a public artist, installations were developed to engage and inspire actors across the social network, and an art exhibition showing heritage grains was exhibited in six locations.

Three new varieties of heritage grains were cultivated in three rural regions. These were used as ingredients in four restaurants, and in a cookery school with over 150 trainees who are entering careers in the catering industry.

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Other contributors: Deirdre O'Mahony, Brídín McIntyre and Maeve Henchion.
Funding: European Commission's Horizon 2020 programme. Grant number 727848.

AGRIP

Addressing tail biting on Irish pig farms

Keelin O'Driscoll and Laura Boyle

Tail biting is a serious welfare and economic concern in the pig industry. The causes are complex, and include a wide range of risk factors. Although prohibited, the most common preventative strategy for tail biting in the EU is to dock pigs' tails shortly after birth. To improve compliance across member states and identify and address specific risks, it is recommended that risk assessments for tail biting are carried out on-farm.

In conjunction with the Department of Agriculture, Food and the Marine and Animal Health Ireland, Teagasc researchers developed a Tail Biting Risk Factor Assessment protocol. They have provided training on its use for pig specialist Private Veterinary Practitioners (PVPs). During 2020, a scheme for pig producers allowing them a free risk assessment by their PVP became fully operational. This was taken up by 46% of producers, indicating a growing awareness of the need to reduce docking and that efforts are being taken by both producers and PVPs to enable this. Moreover, summaries of the primary risk factors on Irish pig farms can now be compiled and used to tailor national advice and strategies to reduce docking.

FOOD

Irish Coronavirus Sequencing Consortium

Paul Cotter, John Kenny and Fiona Crispie

The Irish Coronavirus Sequencing Consortium was formed as part of Science Foundation Ireland's rapid response call to the Covid-19 pandemic in April 2020. Led by Teagasc's Paul Cotter, Fiona Crispie and John Kenny, the consortium benefits from the established DNA sequencing and bioinformatics expertise at Teagasc, as well as at other Irish organisations.

The consortium sequenced the RNA genome sequence of the SARS-CoV-2 virus from patient samples. The resulting data was made publicly available to national and international researchers, contributing to the global surveillance of the spread of the virus. The data resulting from this project was also used by the National Virus Reference Laboratory in its response to emerging variants of the virus, such as the Alpha variant in December 2020 and the Delta variant in July 2021.
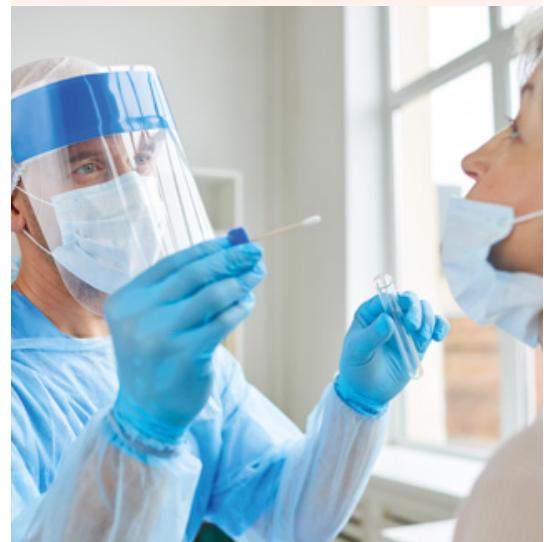
SeventyFour/ shutterstock.com

REDP

The cost of reducing ammonia emissions

Cathal Buckley and Dominika Krol

The need to reduce ammonia emissions is urgent, both in terms of compliance with the EU National Emissions Ceilings Directive (NECD), and as a principal loss pathway for agricultural nitrogen (N). To address this, a report has been compiled to provide farmers and policymakers with key information on how to best achieve national ammonia emissions targets by 2030.

Based on cost and efficiency criteria, the report outlines the best available techniques to reduce ammonia emissions, as evidenced by scientific peer-reviewed research carried out by Teagasc and associated national and international research partners.

When compared to a future where no mitigation measures are deployed to address emissions, by 2030 the average technical abatement potential was estimated to be approximately 15.26 kt NH_3 at a net cost of €10.86 million per annum. However, this net cost is comprised of six measures that are cost negative (-€22.21 million) and seven that are cost positive (€33.07 million).

99%

Agriculture accounts for over 99% of ammonia emissions in Ireland.

Amongst the 13 mitigation measures selected for this analysis, 80% of the mitigation potential can be achieved by the full implementation of the mitigation pathways for protected urea and low emission slurry spreading (LESS) techniques for bovines.

CELUP

Milk matters: testing for protected urea residue

Patrick Forrestal, Chikere Nkwonta, Karl Richards and Martin Danaher

Protected urea (urea with a urease inhibitor NBPT) is a fertiliser technology with the potential to reduce farm emissions significantly, and is a key measure of the Teagasc Greenhouse Gas and Ammonia Marginal Abatement Curve (MACC).

A request from industry that milk from cows grazing pastures fertilised with protected urea be tested for residue potential led Teagasc to develop a highly sensitive validated method for the detection of the urease inhibitor NBPT in 2020. Using this method, researchers found no urease inhibitor residues in the milk of cows grazing pastures fertilised with protected urea. This work was published in an open access journal and has provided reassurance in moving forward with protected urea adoption to reduce farm emissions of ammonia and nitrous oxide.

A window into genetics

Nóirín McHugh, Fiona McGovern, Nicola Fetherstone and Henry Walsh

Across species, more than 50% of productivity gains can be associated with improvements in the genetic merit of animals. Sheep production in both New Zealand and Ireland is operated predominately on grass-based, seasonal and export-focused systems, which is also reflected by the similarity in the national genetic indexes of both countries.

The INZAC (Ireland New Zealand Animal Comparison) flock was established at Teagasc Athenry in 2015 to investigate the potential impact on national genetic and economic gains, through the selection of high or low genetic merit sheep of New Zealand or Irish origin. It acts as a focal flock for the industry and highlights the role of genetic indexes to aid producers in making more informed breeding decisions which can increase the productivity, efficiency and profitability of the national sheep flock.

Regardless of country of origin, animals of high genetic merit demonstrated a superior performance across a range of traits, including the total number of lambs weaned per ewe, days to drafting and ewe milk yield. Ewes of high genetic merit weaned an extra 39 lambs per 100 ewes mated, and such lambs had a greater likelihood of being sold earlier than those born from low genetic merit ewes. Overall, farm profitability was higher for high genetic merit animals, with the high Irish system producing an additional €41 per ha net profit.

Perfecting potato disease predictions

Steven Kildea and Mladen Čučak

Following a critical evaluation of the late blight risk prediction model used to forecast potato late blight in Ireland, Met Éireann has incorporated suggested revisions into its late blight forecasting model. The project was undertaken as part of a collaborative effort between Teagasc, Maynooth University and Met Éireann.

As part of the Teagasc potato breeding programme, from 2006-2016 outbreaks of the late blight disease were recorded together with weather conditions preceding each outbreak, making it possible to improve disease prediction. This included reducing the threshold of relative humidity and the definition of leaf wetness to include both rainfall and/or relative humidity >90%. Using these changes, it was hypothesised that significant reductions in fungicide usage could be achieved.

Field trials undertaken during 2017-2019 validated the improved predictably of these revisions, with significantly lower levels of disease observed in the revised model compared to the model operated by Met Éireann. This increased predictability ensured

fungicide applications could be better targeted, allowing for reduced fungicide usage across the season. Following these findings, from 2021 onwards Met Éireann has issued late blight forecasts based on this revised model.

FOOD

Training abattoirs in animal welfare

Kevin Brennan

New animal welfare regulation aimed at the protection of animals at the time of killing provides a series of measures aimed at avoiding pain and minimising unnecessary suffering and distress during the slaughtering process. The regulation places strong emphasis on well trained and skilled abattoir operatives, and stipulates that abattoirs have a management-designated trained and competent animal welfare officer (AWO).

In response to these new regulations, Teagasc has developed a hugely successful and comprehensive training and competency assessment programme. The programme has been successfully accessed and validated by the EU Food and Veterinary Office (report available online) and has been adopted in other EU states.

In Ireland, over 4,000 meat industry operatives – including managerial staff – have completed certified training programmes, representing over 300 meat processing companies. A welfare assurance standard titled 'Standard for the management of animal welfare at time of slaughter', has also been published and implemented. This standard has been incorporated as a training aid into the above training programme, as well as the national food assurance standard.

REDP

A closer look at manure management

Cathal Buckley, Brian Moran and Trevor Donnellan

Manure management elements of agricultural production account for 10% of agricultural-based greenhouse gas emissions and 77% of ammonia emissions. Bovine animals account for the majority of these manure management-based emissions, so management of this area will play an important role in meeting Ireland's national emission reduction targets.

To support this, the Teagasc National Farm Survey has been adapted over the last few years to collect a wider suite of management data in this area. This report presents data relating to bovine animal housing periods, slurry and farmyard manure (FYM) storage, manure generated by different animal types, season of manure application and application methods and manures stored by different methods. Results are presented over 2016-2018 at an aggregate level and on a national, nitrate zone and farm system basis.

Among other things, the data showed that 81% of manure was stored as slurry, and 19% as farmyard manure (FYM). A total of 44% of slurry was applied to land between January and April, while a further 40% was applied between May and July. Nationally, the vast majority of slurry (84%) was found to be applied via the splash plate method, and the majority of aggregate slurry (87%) was stored under a roofed slatted tank.

Results from this report have provided policymakers with robust time-related information, which has been used to update the gaseous emissions national inventory accounting methodology in the area of manure management.

Impact of Teagasc research publications

Compiled by: Máire Caffrey, Teagasc Head Librarian

Teagasc needs to evaluate research outputs to justify investment, guide decisions on the direction of future research and understand how our performance compares to similar organisations. Funding bodies require data to show return on investment, and researchers like to know how their peers rate their outputs.

Teagasc monitors its research impact in various ways. We track the number of articles in scientific journals authored by Teagasc researchers, as well as counting citations to those articles by other scientific articles. There are a number of resources available providing these citation counts and other metrics. Teagasc uses online subscription-based indexing service Scopus, and its accompanying research evaluation tool SciVal. Scopus enables exploration of the scientific literature, as well as counting citations to each indexed article. SciVal is a research evaluation tool that allows an organisation to analyse institutional productivity and benchmark outputs.

Citation counts are merely a snapshot in time, as citations are constantly accumulating. The metrics below were downloaded from SciVal and Scopus on 15 March 2021. Publication and citation patterns vary considerably across subject areas. Therefore, when using publication counts or citation-based metrics, comparisons within subject categories are the most meaningful. To place our performance in a national context, we can compare Teagasc's performance with that of the eight Irish universities, within three relevant subject categories: the broad category of A – Agricultural & Biological Sciences, and two narrower categories B – Agronomy & Crop Science and C – Food Science.

Considering articles published in the period 2015 to 2020 and indexed in Scopus, we can make the following comparisons:

• Within category A – Agricultural & Biological Sciences: Teagasc consistently published the second highest number of articles in this category (Figure 1), and Teagasc had the second-highest overall citation count
• Within category B – Agronomy & Crop Science: Teagasc consistently produced the highest number of publications in this category (Figure 2), and Teagasc had the highest overall number of citations
• Within category C – Food Science: Teagasc consistently produced the highest number of publications in this category (Figure 3), and Teagasc had the second-highest overall citation count.

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

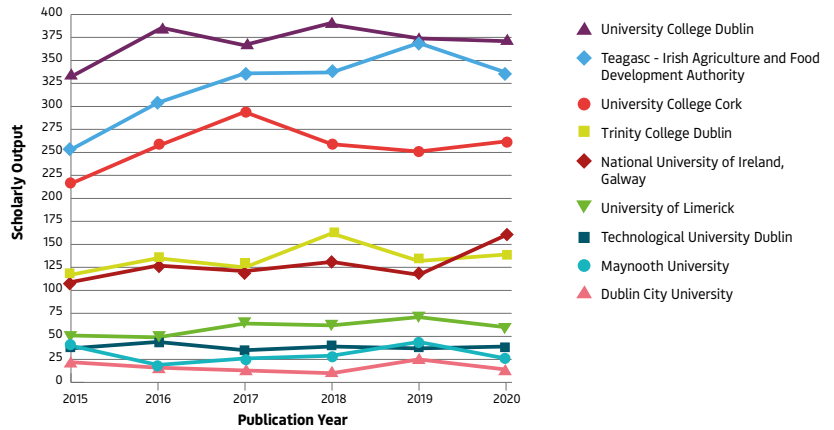**Figure 1: Number of papers by Teagasc and Irish universities that are indexed in Scopus category Agricultural & Biological Sciences (2015-2020).**
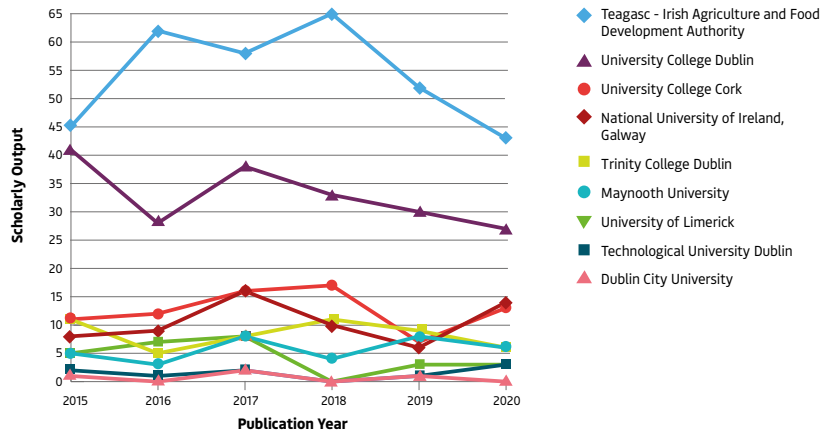

Figure 2: Number of papers by Teagasc and Irish universities that are indexed in Scopus category Agronomy & Crop Science (2015-2020).
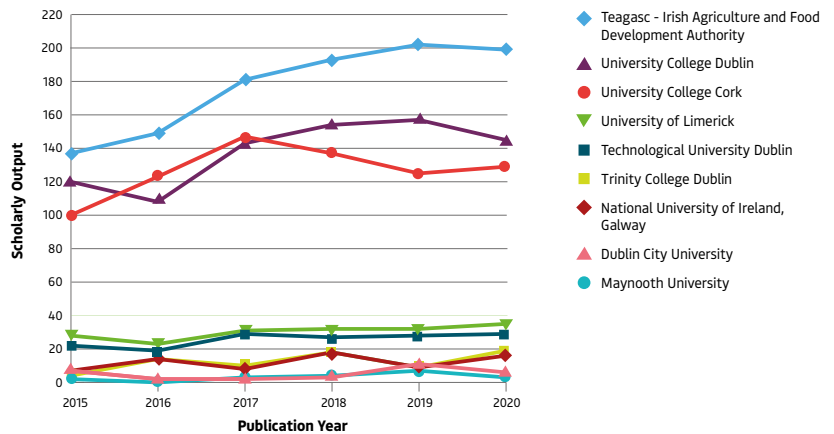

Figure 3: Number of papers by Teagasc and Irish universities that are indexed in Scopus category Food Science (2015-2020).
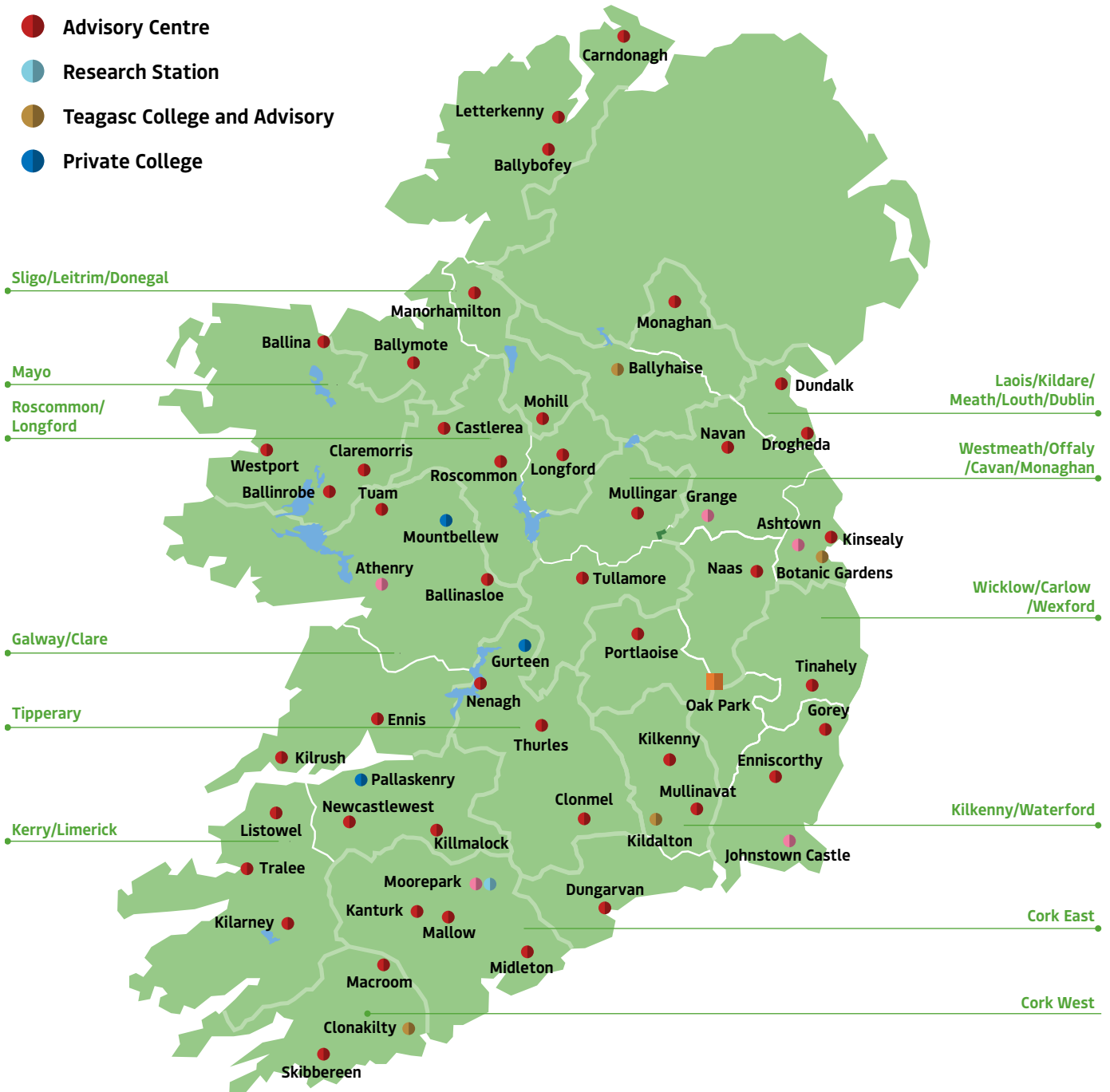
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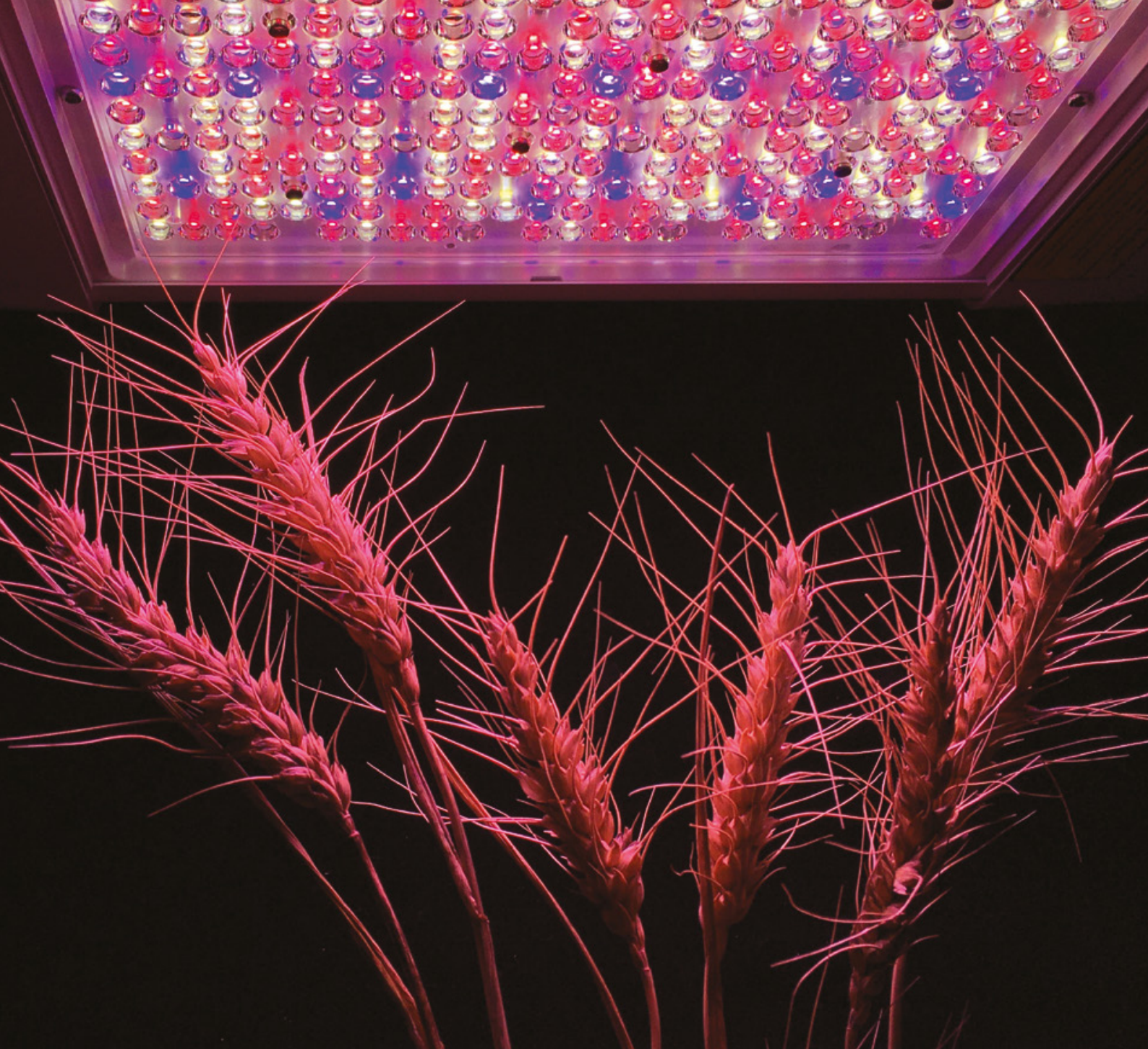- Head Office, Research Centre and Advisory
- Research Centre and Advisory
- Advisory Centre
- Research Station
- Teagasc College and Advisory
- Private College

Regions:
- Sligo/Leitrim/Donegal
- Mayo
- Roscommon/Longford
- Galway/Clare
- Tipperary
- Kerry/Limerick
- Laois/Kildare/Meath/Louth/Dublin
- Westmeath/Offaly/Cavan/Monaghan
- Wicklow/Carlow/Wexford
- Kilkenny/Waterford
- Cork East
- Cork West

Locations:
Carndonagh, Letterkenny, Ballybofey, Manorhamilton, Monaghan, Ballina, Ballymote, Ballyhaise, Dundalk, Mohill, Navan, Drogheda, Castlerea, Claremorris, Roscommon, Longford, Mullingar, Grange, Ashtown, Kinsealy, Westport, Ballinrobe, Tuam, Mountbellew, Tullamore, Naas, Botanic Gardens, Athenry, Ballinasloe, Portlaoise, Tinahely, Gurteen, Oak Park, Gorey, Nenagh, Ennis, Thurles, Kilkenny, Enniscorthy, Kilrush, Pallaskenry, Clonmel, Mullinavat, Newcastlewest, Kildalton, Listowel, Killmalock, Johnstown Castle, Tralee, Moorepark, Dungarvan, Kanturk, Mallow, Kilarney, Midleton, Macroom, Clonakilty, Skibbereen

Wheat grown under pink LED lights

"Scientists are continuously pursuing the ways to enhance the genetic gain in crop breeding, but generating new varieties is a lengthy process. One way to accelerate the research is through 'speed breeding', which shortens the breeding cycle by growing plants under LEDs for extended photoperiods (a plant's daily exposure to light).

Speed breeding significantly reduces the seed-to-seed cycle (generation time) for long-day or day-neutral crops. For example, wheat's seed-to-seed cycle takes around six months in a standard 16-hour photoperiod. While grown under LEDs lights for a 22-hour photoperiod, however, this can be achieved in around six weeks."

Photo and description by:
Dheeraj Singh Rathore, a molecular biologist with a broad interest in conventional and molecular breeding, genetic improvement and bio-stimulants.

Dheeraj's photo was named the overall winner of Teagasc's 2020 'Vision of Research and Innovation' image competition.