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Harnessing innovation in horticulture

Foods for heart health
Improving farm safety
Sheep 2015

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Irish Horticulture in 2015

I recently came across a 1999 Teagasc document entitled: *What will the agri-food industry look like in 2015?* The report identified what the expected drivers of change up to 2015 would be, including:

- increased globalisation on the back of more liberal world trade;
- increasing consumer demands for assured food safety;
- increasing consumer awareness about environmental sustainability in the food chain;
- an ageing population leading to more interest in the health attributes of food;
- a growing market for functional foods; and
- a more dynamic consumer market for convenience foods and niche products.

It was predicted that the number of horticulture producers would reduce, and that the scale of remaining operations would increase.

Today, when I look across all the sectors in horticulture, it is clear to see these predictions have become a reality. In fact, I would argue that, in 2015, these drivers are still as relevant but that the pace of change is accelerating. Today, in Ireland, 88% of fresh produce is retailed through multiples that have widened consumer choice through international volume purchasing arrangements. However, the international food chain is a complex web. Geo-political disturbance has recently exposed the supply chain; Irish mushrooms were recently in very high demand in the UK as some European ports were effectively closed.

So, how do Irish horticultural producers maintain viability in the face of competitive forces? Horticultural businesses need to increase scale and efficiency to produce higher volume with a lower unit cost. The Teagasc Horticulture Development Department, which supports the sector, is responding to this more specialised and capital intensive sector. New state-of-the-art facilities are in the construction phase at Teagasc Ashtown Research Centre, Dublin, where the department will continue to contribute to the development of Irish horticulture. In this horticultural special edition of *TResearch*, we preview some of the current research and technologies that are already addressing the needs of the sector.



Dermot Callaghan,
Head of the Horticulture
Development Department at Teagasc.



Acknowledgment
Helen Grogan, Horticulture
Development Department, guest
edited the horticulture special
section.

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Gairneoireacht na hÉireann in 2015

Tháinig mé le déanaí ar cháipéis Teagasc 1999 dar teideal *What will the agri-food industry look like in 2015?* (Cén bhail a bheidh ar an tionscal agrairbhia in 2015?) Aithníodh sa tuarascáil na rudaí a measadh a bheadh ag tiomáint na n-athruithe chun cinn go dtí 2015. Orthu siúd bhí:

- Domhandú méadaithe mar aon le córas trádála domhanda níos liobráláí;
- breis éilimh ó thomhaltóirí maidir le sábháilteacht dhearbhairthe bhia;
- méadú ar fheasacht tomhaltóirí faoi inbhuanaitheacht chomhshaoil sa slabhra bia;
- daonra atá ag dul in aois a chuirfeadh suim níos mó i dtréithe sláinte bia;
- margadh atá ag fás ó thaobh bianna feidhmiúla; agus
- margadh tomhaltóra níos dinimiciúla do bhianna áise agus táirgí nideoige.

Bhí sé á thuar go dtiocfadh laghdú ar líon na dtáirgeoirí gairneoireachta agus go dtiocfadh méadú ar scála na n-oibríochtaí a bheadh fágtha.

Nuair a bhreathnaím ar na hearnálacha gairneoireachta go léir inniu is soiléir gur fóraíodh an tairngreacht sin. Go deimhin, ba mhaith liom a mhaíomh go bhfuil na tosca sin fós ábhartha is go bhfuil dlús faoi luas an athraithe. Sa lá atá inniu ann in Éirinn, díoltar 88% de tháirgí úra trí shiopaí ilbhrainte a thugann rogha níos leithne do thomhaltóirí trí shocrúithe ceannaigh idirnáisiúnta ar an mórchóir. Mar sin féin, gréasán casta is ea an slabhra bia idirnáisiúnta. Bhí tionchar ag an suaitheadh geopholaitiúil ar an slabhra soláthair le déanaí; bhí an-éileamh ar bheacáin na hÉireann le déanaí sa Ríocht Aontaithe toisc go raibh roinnt calafort san Eoraip beagnach dúnta.

Mar sin, cén chaoi ar éirigh le táirgeoirí gairneoireachta na hÉireann inmharthanacht a choimeád ar bun i bhfianaise na bhfórsaí iomaíocha? Ní mór do ghnólachtaí gairneoireachta scála agus éifeachtúlacht a gcuid frontar a mhéadú chun níos mó táirgí a chur ar fáil ar chostas aonaid níos ísle. Tá an Rannóg um Fhorbairt Gairneoireachta Teagasc, a thacaíonn leis an earnáil, ag freagairt do riachtanais na hearnála seo atá níos speisialaithe agus níos déine ar chaipiteal. Tá áiseanna nua úrscothacha á dtógáil ag Ionad Taighde Bia Teagasc i mBaile an Ásaigh, Baile Átha Cliath, áit a leanfaidh an rannóg ar aghaidh ag cur le forbairt ghairneoireacht na hÉireann. San Eagrán speisialta gairneoireachta seo de *TResearch*, tugaimid réamhamharc ar chuid den taighde agus de na teicneolaíochtaí trína bhfuil aghaidh á thabhairt cheana féin ar riachtanais na hearnála.

Dermot Callaghan,
Ceann na Rannóige um
Fhorbairt Gairneoireachta,
Teagasc

Admháil
Ba í **Helen Grogan**, aoi na Rannóige
um Fhorbairt na Gairneoireachta,
a chuir an chuid speisialta seo faoi
ghairneoireacht in eagar.

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David Meredith



David Meredith is a Senior Research Officer in the Agrifood Business and Spatial Analysis Department (Rural Economy Development Programme) based in Teagasc's Ashtown Research Centre. David's current research programme covers three broad areas, including evolution of the rural economy and, related to this, restructuring of the farming sector. Working in close collaboration with John McNamara, the third research area focuses on farm occupational health and safety. Though covering a variety of issues, David's research is thematically linked by the concern of understanding geographically differentiated outcomes to common policies and processes. David's current work, on agricultural restructuring, comprises projects that are funded through the Research Stimulus Fund (Department of Agriculture, Food and the Marine). Working with colleagues across a number of Teagasc programme areas and in the universities, David is engaged in a range of projects exploring the changing structure of farming, farm households and land use. He is the principal investigator on the Profitable Dry Stock Enterprise Development (ProDSE) study, which assesses the diverse nature of dry-stock production and the subsequent need for targeted initiatives to support the development and enhanced viability of cattle enterprises. David is also contributing to three other Research Stimulus Fund studies as a work-package leader. His work on the Land Markets project evaluates the attitudes of potential farm successors to land mobility; with regard to Join2Farm, he is assessing the characteristics and spatial distribution of those farmers that are more favourably disposed to joint farming initiatives; and on the IdealHNV project he is evaluating changes in the demographic structure of farm households and socio-economic change in areas with higher levels of high-nature value farmland. For many farm households, agricultural restructuring has meant that they are increasingly dependent on off-farm sources of income. David has undertaken, and led, research in this area since he joined Teagasc in 2001. His research on rural socio-economic change was extensively used in the report of the Commission for the Economic Development of Rural Areas. David is currently supervising two Walsh Fellowships concerned with this research area; one explores the evolution of rural labour market areas and their labour activation requirements, while the second evaluates the basis of both farm and non-farm household resilience. David is a member of the Royal Irish Academy's Geoscience and Geographical Sciences Committee and was recently appointed to the selection committee responsible for evaluating applications to implement the LEADER programme (2015-2021). David completed his PhD in 2012 (NUI Maynooth), has a MLitt (1998) and BA (1995) from UCD and received a Higher Diploma in Statistics from TCD (2014).

APC Microbiome Institute launched



Pictured (left to right) are: Fergus Shanahan, Director, APC Microbiome Institute; Mark Ferguson, Director, SFI; Sally Cudmore, General Manager, APC; Simon Coveney, TD, Minister for Agriculture, Food, and the Marine and Defence; and Frank O'Mara, Director of Research, Teagasc.

APC, the national centre for excellence in food and medicine research, recently announced the creation of 50 additional hi-tech jobs in Cork. The APC is one of Science Foundation Ireland's national centres for research and it represents a partnership between UCC, Teagasc and Cork Institute of Technology (CIT). Since its foundation in 2003, APC has made several seminal contributions to the field and was ranked second in the world by Thomson Reuters for its area of science. In recognition of the significantly increased scale of APC activities and the importance of microbes in health, UCC has recognised the Cork scientists with the designation of institute. The APC, formerly known as Alimentary Pharmabiotic Centre, will now be named APC Microbiome Institute.

Rural Development Conference

Teagasc Rural Development Conference attendees heard how the Irish economy is in recovery phase now, with over 80,000 new jobs created in the past two years. Growth in the small- and medium-sized food enterprises (SMEs) is identified as being very important to deliver jobs in the future, particularly in rural areas. One of the key challenges for food SMEs, identified by the Commission for the Economic Development of Rural Areas (CEDRA) report, is the development of export pathways to exploit the higher potential on overseas markets.



Pictured (from left to right) at the Teagasc Rural Development Conference are: Bill Ashton, Rural Development Institute; Ricky Conneely, Teagasc; Paul McCarthy, Full Health Medical; Cathal O'Donoghue, Teagasc; and Pat Daly, Head of Food Industry Development, Teagasc.

Food authenticity

Teagasc and safefood, in association with Queen's University Belfast, jointly hosted a seminar entitled 'Food Authenticity – Protecting your business from food fraud' at Teagasc Food Research Centre, Ashtown, recently. The event attracted over 100 people from the food processing and retail industries, along with regulators, policy makers and enforcement agency representatives. The seminar focused on the potential for fraudulent activity in the food supply chain and the lessons that can be learnt from what's happened before. The tools and techniques by which industry can protect itself and its customers from fraudulent activity, and ensure the authenticity of food, were also addressed.



Pictured (from left to right) are speakers at the seminar: Peter Whelan, FSAI; a EUROPOL representative; Ita White, Teagasc; Lynn Patterson, LP Associates; David Hammond, Eurofins; Gillian O'Connell, Musgrave Retail Partners Ireland; Pat Wall, UCD; Gerry Downey, Teagasc; James McIntosh, safefood; and Chris Elliot, Queen's University Belfast.

Post-doc programme launched

Teagasc has launched a new Post-Doctoral Development programme that is designed to provide professional development for post-doctoral researchers. This programme will prepare Post-Doctoral Fellows for a variety of career options, whether in academia or in industry.

Speaking at the launch Frank O'Mara, Director of Research, Teagasc, said: "Participants on the programme have access to a range of development opportunities to equip them with the necessary skills for the next stage of their career. It will open more doors for them in the future as they pursue their careers in science."

This Post-Doc programme, which was developed by Teagasc in collaboration with University College Cork (UCC), University College Dublin (UCD) and the Agri-Food Advanced Professional Development team, is the first structured Post-Doctoral training and development programme in Ireland.

The development programme is being delivered by UCC, led by Alan Kelly.

CommBeBiz

CommBeBiz – a Horizon 2020 project that aims to speed up transfer of knowledge from bioeconomy research projects to business, social innovation and policy – recently launched its online platform for European researchers working in food, fisheries, agriculture, forests and biotechnology.

As the central hub of the CommBeBiz project, the platform will enable researchers to join a community promoting two-way engagement and interaction, from meeting and networking to sharing information with other researchers and stakeholders. Members will have access to tailor-made and targeted activities for training, testing, match-making, and enhancement of EC-funded bioeconomy research projects. It's free to register (<http://www.commbebiz.eu>) and a host of resources will be available, including: a library building, over time; project briefs; webinars; innovation catalogues; expert blogs; training events; and videos. Teagasc is a partner in this project alongside MINERVA Communications, UK; PRACSIS SPRL, Brussels; and EBN, Belgium.

Moorepark open day



Also pictured is Sean Sherlock, TD, Minister of State at Department of Foreign Affairs (with Special Responsibility for ODA, Trade Promotion and North South cooperation), with Jane O'Connor, an intern at Teagasc Food Research Centre Moorepark from UCC, and Pauline Dunne, Killowen Yogurts. Killowen Yogurts' products were developed in association with Teagasc.



Some of the massive crowds at the recent Moorepark 2015 Irish Dairying – Sustainable Expansion open day.

Teagasc new Foresight project

Teagasc recently launched a new Foresight project, which will cumulate in the release of a report next March. The primary aim of the Foresight Project is to identify the key technologies that have the potential, over the next 20 years or so, to underpin competitiveness, sustainability and growth in the Irish agri-food and bioeconomy sector. A secondary aim is to provide a comprehensive and well-researched source of evidence for policy decisions relating to Teagasc's future science and technology programmes.

Major job potential in Irish bio-economy

Speaking at the launch of a new report on the Economic Impact of the Irish Bio-Economy, Cathal O'Donoghue, Teagasc Head of Rural Economy and Development Programme highlighted the impact of Ireland's bio-economy on local communities. "Due to the fact that bio-economic sectors locate much of their inputs in Ireland, and because they employ relatively more people per unit of output, when these sectors increase their sales and in particular their exports, they generate a greater impact on the economy.

"Of the 162,000 jobs in the bio-economy in 2010, there were an additional 45,000 jobs elsewhere in the value chain. As much of the bio-economy is located in rural areas, this impact can have a particularly strong effect on rural job creation."

The analysis utilises the Bio-economy Input Output model (BIO), which studies the links between bio-economy sectors, which incorporates the agriculture, food, forestry and marine sectors, and the wider economy. This model was developed, by the Socio-Economic Marine Research Unit (SEMRU) of NUI Galway and the Rural Economy and Development Programme of Teagasc, in association with the Marine Institute, under Beaufort Award and Teagasc funding, to assess the output and employment multipliers of public policy initiatives. It builds upon the CSO's national more aggregated Input-Output table and previous work by Alan Matthews of Trinity College. The model was used recently to support strategic planning in the recent Food Wise 2025 strategy for the Agri-Food Sector. The strategy targets the creation of an additional 23,000 direct and indirect jobs in the agri-food sector all along the supply chain from primary production to high value added product development.

Crops open day



Teagasc Researcher Liz Glynn, talks to attendees about spring barley disease control at Teagasc's Crops and Sprayers Open Day in Oak Park this summer.

Irish growers produce some of the highest crop yields in the world but, given our climate, significant inputs are required. This requires the tailoring of fertilizer inputs to soils and crop needs. In addition, each year farmers invest €80 million in crop protection products for weed, pest and disease control on their farms.

The open day focused on assisting farmers in choosing and applying these products most effectively. The event was organised in association with the *Irish Farmers Journal*.

TV science series

Teagasc is once again contributing to science programming in RTÉ. Scheduled to be broadcast this autumn, Teagasc researchers will feature in two episodes of a new and updated series of *The Science Squad*, one on gut health and another one on water.



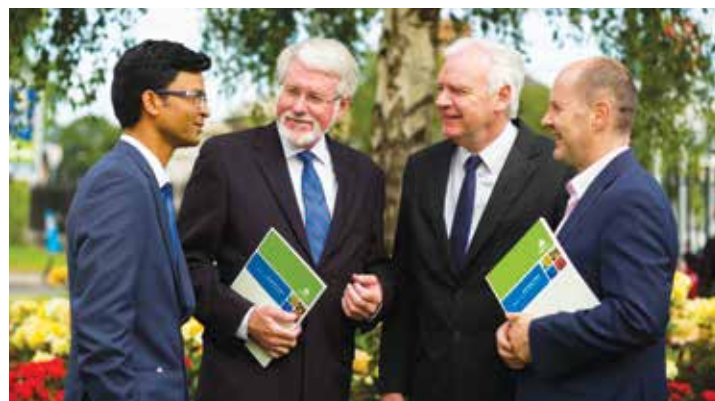
Presenter Jonathan McCrea with Teagasc's Sophie Sheriff and Daire Ó hUallacháin on location at Teagasc Johnstown Castle Crops, Environment and Land Use Research Centre.

Leadership in Sustainable Land Use

Teagasc researchers Rogier Schulte, Gary Lanigan and Stuart Green recently co-hosted a combined visit of the Northern Ireland Land Use Expert Working Group and the Colombia Climate Law School (New York), to showcase Ireland's many initiatives on sustainable land use. This included demonstrations of the Carbon Navigator and Bord Bia's Origin Green programme, as well as visits to the Devenish Drowth Farm and Glanbia's Open Source Sustainability Programme (shown in photograph), followed by a visit to the Dunleer Catchment, hosted by the Teagasc Agricultural Catchment Programme.



Nutramara conference



Pictured at the NutraMara Conference in the RDS (from left to right) are: Brijesh Tiwari, Teagasc Food Research Centre, Ashtown, with Torger Børresen, Technical University of Denmark, Declan Troy, Director of NutraMara, Teagasc, and Jason Whooley, Bio-Marine Ingredients Ireland Ltd. NutraMara, the Marine Functional Foods Research Initiative, is a programme established through funding from the Marine Institute and the Department of Agriculture, Food and the Marine, for the identification and development of novel bioactive ingredients for functional foods, from marine-derived resources.

Global Food Security Forum



At the Annual Teagasc-RDS Food Security Seminar, Yenesh Gebresilasie (Teagasc Walsh Fellow), Waga Dersseh (Teagasc Walsh Fellow) and Uta Priegnitz (Wageningen University and Research) presented the outcomes of the Chencha project on Sustainable Potato Production in the Ethiopian Highlands. The Chencha project is a collaboration between Teagasc, Wageningen University and Research, Vita, University College Dublin, the International Potato Centre (CIP) and the Ethiopian Institute for Agricultural Research.

Economic and environmental sustainability

In September, the BioÉire consortium hosted its first seminar in the Teagasc College of Amenity Horticulture, National Botanic Gardens, Glasnevin. The seminar was attended by representatives across policy, academic, state and semi-state organisations and provided an opportunity to contextualise BioÉire's current research activities. It also provided input for its market-development project, with outcomes from this workshop feeding into the process of developing a coherent, national bioeconomy strategy for Ireland. "This strategy is needed to help us to review and ultimately change, how we produce, process and recover biological feedstocks," according to Maeve Henchion, BioÉire project coordinator.

The development of a bioeconomy in Ireland, producing biofuels, biofertilisers, biochemicals and bioplastics, is considered to be particularly plausible given its abundant natural resources, thriving agriculture and marine sectors, growing forestry development, well-respected food industry and renowned research and development capabilities. At the European level, the bioeconomy is estimated to provide employment for some 21.5 million people, with a market worth approximately €2 trillion.

Advances in knowledge and technologies

Teagasc, in association with UCD and the ASA, recently held a conference on Advances in Knowledge and Technologies for Agriculture. Discussing the conference focus, Frank O'Mara, Director of Research, Teagasc, said: "This conference highlighted relevant new technologies under development by Teagasc and UCD that already have, or will soon bring benefits to farmers and the industry. These technologies have come about through investment in research and development. Teagasc and UCD scientists collaborate on many of these and other research projects, and this pooling of expertise is important in delivering world-class research." The proceedings are available on the Teagasc website.

Walsh Fellow Accolades

Crop Soil Agronomy Science

Sara Vero, a Teagasc Walsh Fellow based at Johnstown Castle and registered with NUI-Galway, recently featured in the prestigious CSA News (US) magazine. Sara also won the prestigious 2015 Robert Luxmoore Student Travel Award bursary, which is specifically aimed at students conducting research in soil physics. She will use this bursary to attend the US Tri-Society (American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America) conference in Minnesota in November. Sara will present her work on soil time lags.



QUB award

Congratulations to Michael Dineen, a Teagasc Walsh Fellow based at Teagasc Moorepark and registered with Queen's University Belfast (QUB), who recently won first prize (for first-year students) in the postgraduate seminar in Molecular Biosciences at Institute for Global Food Security at the University.

AFBI post-grad awards

Well done to Teagasc Walsh Fellows Claire Guy, Teagasc Moorepark, winner of the best poster presentation (Grass growth, structure and morphology of tetraploid and diploid swards sown with and without white clover during the winter) and Mary Harty, Teagasc Johnstown Castle, winner of the best oral presentation (Effects of fertilizer form on yield, uptake and direct and indirect nitrous oxide (N₂O) emissions from grassland) at the recent Agri-Food and Bioscience Institute (AFBI) post-graduate symposium, held recently at AFBI Hillsborough.

Overseas training award

Eleven Teagasc Walsh Fellows recently received funding to carry out a portion of their research overseas. This year's overseas training award scheme will enable Fellows to travel to universities and research institutes in Europe (France, Scotland, Northern Ireland, Germany, Holland and Switzerland), Canada, the US and New Zealand.

TEDx

Congratulations to Teagasc Walsh Fellow (and Teagasc Fulbright Scholar recipient) Ruairi Robertson, who was selected to speak at the TEDxFulbright event in Los Angeles in September. For more see: <http://www.tedxfulbright2015.com/>

Developing strategies to improve farm safety



Improving the safety record of farming represents a considerable challenge. Assessments indicate that the majority of farmers could improve farm safety by further participation in activities where this topic is addressed, such as a discussion group.



Improving farm safety presents a considerable challenge in Ireland and internationally. Teagasc and the Health and Safety Authority (HSA), in association with the Farm Safety Partnership Advisory Committee to the HSA, operate a preventative initiative to assist farmers with occupational safety and health (OSH). The principal aim of the initiative has been to develop a risk assessment (RA) format, assist farmers with its completion and assess its utility. Devising and assessing effectiveness of new approaches has been a key objective of the initiative and an outline of these are described in this article. A recent Teagasc/HSA/University College Dublin study describes these assessments fully (McNamara, 2015).



Challenges of improving farm safety

Ireland has approximately 130,000 farms with about 400,000 persons at risk. The farming population is widely dispersed and farms deploy a wide range of facilities/equipment and use farm practices with many potential hazards.

A number of factors combine at the same time/place to cause an accident. In Ireland, fatal farm accidents are associated with farm vehicles/machinery (60%), livestock (17%), being crushed (13%), drowning/suffocation or poisoning (7%) and falls from heights (3%). Securing farm safety requires development and control of both the physical and organisational elements of a farm, so, ongoing OSH management by farmers is crucial to prevent accidents.

Models for improving farm safety

The Transtheoretical Model of Change (TMC) or 'stages-of-change' model is the predominant model in the field of voluntary behaviour change in OSH. This model indicates that a person moves through the following stages to achieve sustained behaviour change: pre-contemplation; contemplation; preparation; action; and maintenance. Slater (1999) aligned the principal theories related to purposive

communications to gain behaviour change with the TMC. This suggests that media approaches be used initially to gain contemplation with the approaches of the Theory of Reasoned Action (TRA) and Social Cognitive Theory (SCT) to be subsequently used to gain adoption. The TRA and its follow-on theory, the Theory of Planned Behaviour (TPB), indicates that behaviour uptake is influenced by intention. This is in turn influenced by 'attitude', 'subjective norms' (a person's belief about how persons they respect view the behaviour in question) and 'perceived behavioural control' (a person's perception of their capacity to perform the behaviour). SCT relates to the influence of the social and tangible environment on adoption.

Irish farm safety initiatives

The principles of prevention that underpin Irish law, together with some key farm OSH initiatives, are now described.

Principles of prevention

The Safety, Health and Welfare at Work Act (SHWWA) 2005 in Ireland, in common with the EU OSH Directive, is based on the 'Principles of Prevention' approach. This advocates a hierarchy of controls prioritising avoidance of risks, combating risks at source, adaptation of work to individuals, the replacement of dangerous articles, substances or systems with less dangerous ones, all of which are collective protective measures. These are followed in the hierarchy by organisational measures such as provision of consultation, training instruction and supervision – which are individual measures. Examples of collective measures implemented in Irish agriculture include specification farm infrastructure in State schemes, pesticide control and livestock breeding for docility. However, a recent Irish study (McNamara, 2015) concluded that influencing individual farmers' OSH management capabilities has a disproportionately large influence on farm OSH implementation compared to employment sectors where the hierarchy of controls can be fully implemented.

Media usage

Considerable ongoing use is made of media and communication strategies to inform and motivate farmers towards farm safety adoption in Ireland. Studies have indicated that virtually all farmers



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Patrick Griffin, Senior Inspector, Policy, HSA.
James Phelan, formerly School of Agriculture, UCD; current HSA board member and Chair Farm Safety Partnership
Jim Kinsella, Senior Lecturer, School of Agriculture, UCD
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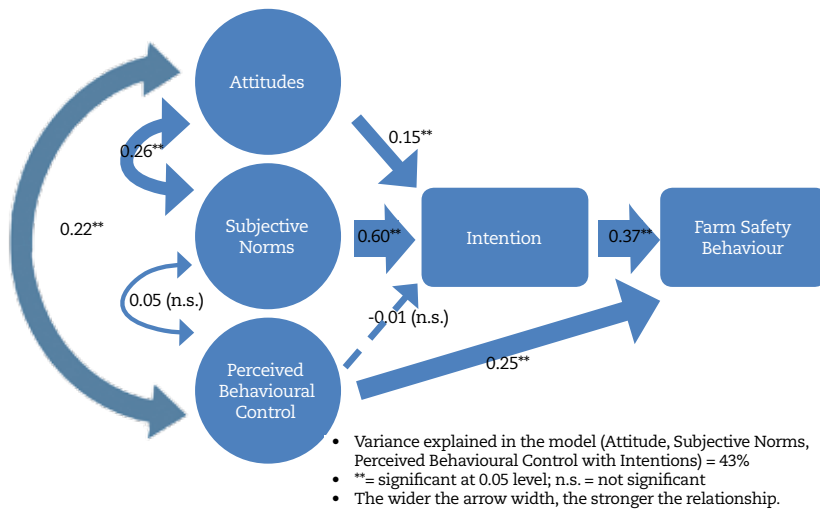


Figure 1. TRB Model among Irish farmers related to farm safety (Source: HSA, 2014).

are aware of the SHWW legislation and of farm safety as an issue needing attention. The challenge is to move from awareness to gain increased OSH adoption. This recent Irish study (McNamara, 2015) also indicates that to be effective, communication strategies must precisely reflect the issues causing accidents. For instance, the importance of PTO safety appears to be getting through, with no fatalities in the five year period to 2014; however, deaths due to being struck or crushed by farm vehicles has increased dramatically in recent years.

Risk assessment approach

The SHWW Act 2005 allows the use of a sector-specific RA format under an approved code of practice. These documents have been prepared and assessed for the agriculture sector as part of the HSA-Teagasc Prevention Initiative. They provide a basis for converting legal requirements into a practical format to assist with OSH implementation, and can be found at http://www.hsa.ie/eng/Your_Industry/Agriculture_Forestry/. The Teagasc National Farm Survey found that by the year 2011, 55% of farmers nationally had completed the RA, while 22% had completed half-day training on its completion. Follow-up research (McNamara, 2015) found that farmers filled the document to a limited extent and, on average, about 40% more controls were specified by those who attended training.



Farmer discussion groups participation has been shown to increase farm technology and practice adoption.

Farmers (57%) who implemented the controls they specified in the RA had a significantly higher percentage of farms with satisfactory OSH standards. The study concluded that, while the RA completion has positive utility, more comprehensive approaches such as discussion groups should be considered to support its use.

Discussion Groups

Farmer discussion groups (also referred to as knowledge transfer groups) participation has been shown to increase farm technology and practice adoption (Hennessy and Heanue, 2012). A recent HSA-commissioned TRB study among Irish farmers (HSA, 2014) has shown that ‘social norms’ (0.6) was reported as the predominant influencer of farm safety adoption intention followed by ‘perceived behavioural control’ (0.25) and ‘attitude’ (0.15) (Figure 1) with a higher figure indicating a higher relationship between variables. Notably, the co-efficient for ‘social norms’ was higher than for other TRA/TRB (about 0.25) studies related to farms safety, conducted abroad. This suggests that discussion groups have considerable potential to assist Irish farmers with farm safety adoption. Under the current Department of Agriculture, Food and the Marine Knowledge Transfer Programme, farmer participation in a discussion group is incentivised, while inclusion of farm OSH at groups is specified. Currently, Teagasc, the HSA and UCD jointly plan to assess the effectiveness of this approach through a PhD Walsh Fellowship study.

Summary

Improving the farm safety record of farming in Ireland and internationally represents a considerable challenge. In Ireland, significant development and assessment work is being undertaken to make progress with this issue. While the RA approach has shown positive utility, assessments indicate that the majority of farmers could improve farm safety by further extension approaches where this topic is addressed – such as participation in a Discussion Group.

Acknowledgments

Patricia Murray, Organisational Psychologist, HSA who, with Mr Pat Griffin, Senior Inspector, HSA, coordinated development and implementation of the HSA (2014) study.

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Sheep 2015



Teagasc Director, Gerry Boyle photographed with Mairéad McGuinness, who performed the official opening of Sheep 2015, with some members of the Organising Committee and representatives of the sponsor. Pictured left to right are: Philip Creighton, Teagasc; Fergal Morris, MSD, sponsor; Mary Newman, Zoetis, sponsor; Gerry Boyle, Director, Teagasc; Stephanie Fitzgerald, Musgrave-SuperValu, Sponsor; Michael Diskin, Teagasc; Mairead McGuinness, Member of the European Parliament; Darren Carty, *Irish Farmers Journal*, Organising Committee and sponsor; Alex Evans, University College Dublin, Organising Committee; Jonathan Forbes, Kepak, main sponsor; Declan Fennell, Bord Bia, Organising Committee; and Tommy Kelly, FBD, sponsor.

Michael Diskin outlines the main take-home messages of Sheep 2015.

Sheep 2015 was held in Mellows Campus Athenry on June 20, 2015 and attracted an attendance of 13,000. While there were many commercial and sheep breed exhibitors present, Teagasc had major research and technology transfer exhibits and workshops organised on a village basis each with a number of practical 'take home' messages.



Michael G. Diskin,

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Importance of grass

The ability to grow grass in Ireland makes grass Ireland's greatest natural resource. Our knowledge of grass growth and utilisation has greatly increased in recent years. Discussions on grass budgeting, optimal pre- and post-grazing heights are now common on dairy farms. The same principles are equally valid for sheep production. The grassland exhibit concentrated on demonstrating optimal pre- and post-grazing grass heights for lamb production and the alternative ways of rejuvenating pastures by reseeding, fertilisation, liming and weed control. Grass measurement and budgeting allows more accurate decisions and pre-empts potential grass surpluses and deficits occurring.

Sheep breeding

The Sheep Breeding Village, which involved both Teagasc and Sheep Ireland, covered a number of new and exciting topics, including genomic selection, genetics of health traits, the use of AI and embryo transfer as well as practical demonstrations on ewe and ram pre-breeding examinations and use of Euro-Star evaluations.

The recently imported New Zealand Texel and Suffolk ewes generated much interest. Over the past decade, New Zealand had made significant genetic gain for a number of commercially important traits. The imported ewes were selected from the top 10% of their respective breed in New Zealand and will now be compared with genetically elite Irish Texel and Suffolk sheep, which are currently being sourced in Irish flocks.

Hill sheep

The Scottish Blackface breed accounts for approximately 22% of the 2.5 million ewes in Ireland. The majority of these Blackface sheep are maintained on hills or marginal land that is not suited to other sheep breeds or other farm enterprises. The majority of the hill breeds are bred pure with an emphasis on producing flock replacements for retention or for sale. Profits from these hill sheep enterprises is very much

dependent on prices obtained for lambs sold. A large proportion of these lambs become available for sale annually from August onwards. Many hill lambs are sold to lowland finishers and reappear in the spring as hoggets. The results of recent Teagasc studies and options to improve the marketability and profitability of store-hill land, cross-bred lambs were presented and discussed with producers. The Teagasc Store Lamb Calculator, which examines the impact of changing a number of key variables on gross margins from finishing hill lambs, was launched.

Flock health

Flock health and spending thereon is the second largest variable cost on Irish sheep farms. This exhibit concentrated on abortion, internal parasites, lameness, quarantine procedures and flock biosecurity as well as anthelmintic resistance. In Ireland, as in all sheep production countries, there is evidence of widespread resistance to a number of classes of anthelmintics used. Therefore, it's important that sheep producers know the effectiveness of the products they use. Over 3,000 drench tests have been carried out as part of the Sheep Technology Adoption Programme (STAP). Based on 2014 results, only 52% of anthelmintic treatments administered as part of this STAP task were effective against strongyle worms with significant differences in efficacy between product types. Benzimidazole was effective in only 29% of cases; levamisole in 56% and macrocyclic lactone in 71% of cases. Therefore, it is important to know the 'anthelmintic status' of the flock

Research–Demonstration Farm

The Research–Demonstration Farm was established in 2011 to investigate the effect of stocking rate and ewe prolificacy on: lamb output per hectare; feed requirements/budgets of the different systems; pasture growth and utilisation; and overall systems profitability. Three years' data is now analysed. On average each increase in stocking rate by two ewes/ha has resulted in a 58kg increase of lamb carcass per hectare. Increasing prolificacy by 0.2 lambs per ewe has resulted in an extra 51kg of lamb carcass per hectare. The combined effect of increasing both was an increase of 109kg of lamb carcass per hectare. On average, increasing the stocking rate by two ewes per hectare increased gross margin by €65/ha. However, increasing the number of lambs weaned per ewe by 0.2 lambs resulted in a €166/ha higher gross margin with the combined effect of increasing both resulting in a €221/ha increase in gross margin. Over the first three years of the study a combination of 12 ewes/ha and high prolificacy 1.8 lambs per ewe joined with the ram, produced the highest gross margin.

Science village

Visitors to the Teagasc Science Village saw cross-sectoral sample of the broad range of Teagasc research activities but with a particular emphasis on drystock and sheep farming. Displays included interactive exhibits on animal health, fertility and nutrition, as well as grass breeding and grassland management, forestry and farm financial planning. Information on new Teagasc-led innovations was provided, as well as up-to-date results of a number of large Department of Agriculture, Food and the Marine-funded on-farm research studies. The work displayed as part of this exhibition was designed to underpin and further develop many of the practical demonstrations and innovations presented in other technical villages

and stands. Teagasc researchers and postgraduate students discussed their work and many stands were of particular interest to students studying agricultural science and associated science subjects at secondary and third level.

Health and safety

A total of 30 farm accident deaths were recorded on Irish farms in 2014 with a further six deaths recorded up to the end of May 2015. The farm death rate in 2014 accounted for 55% of all workplace deaths while just 6% of the workforce is employed in agriculture. These startling statistics must motivate all to cut the level of tragedy, pain and suffering associated with farming. Risk assessment and removal of hazards along with safety training are key approaches to make farming a safer activity. Teagasc, in association with health promotion professionals, also actively promotes health practices. A recent national study indicated that farmers, as an occupational group, have the highest mortality and disability rates. In particular, behaviour-related chronic diseases, including cardiovascular diseases and cancer, occur at heightened rates among farmers. Again, education and training are key to addressing this.

Education

The significant education exhibit dealt with all of the options available to people interested in a career in agriculture or agricultural science with all of the main providers present. Typically, 3,500 students undertake full-time training on Teagasc further education and its IT-linked higher education programmes annually. Courses are now more specialised and enterprise-focussed. The School of Agriculture and Food Science in University College Dublin offers level-8 degree programmes across the entire food chain

Acknowledgements

Sheep 2015 was organised by Teagasc, UCD, the Department of Agriculture, Food and the Marine, the *Irish Farmers Journal*, Bord Bia and Sheep Ireland. It was supported by Kepak, Musgraves/SuperValu, MSD, Zoetis, FBD and Germinal.



Sheep breeder Fintan Thornton of Tynagh, Co Galway, with his grandson attending 'SHEEP2015', the major National Sheep Open Day hosted by Teagasc at Athenry.

Soil status and protection



A Teagasc event for the International Year of Soil 2015 (World Reference Base training course hosted by Teagasc).

Recently, in this, the International Year of Soils, 75 stakeholders, who deal with soil daily at different geographical, institutional and societal levels, got together in Teagasc's Johnstown Castle estate. They discussed a common subject: what are the key priorities for soil protection and research in Ireland? Francesca Bampa reports the outcomes of this soil status and protection workshop.

A new thinking on the role and functionality of soils in securing sustainable development and food production in our society is emerging. International and European institutions such as the FAO and the European Commission are pushing, through the International Year of Soils 2015 campaign, the concept of soils as critical to deliver the functions and ecosystem services that enable life on Earth. In this context, better knowledge of Irish soils would allow for a sustainable agri-environmental economy to be maintained.

Even though binding soil legislation is missing both at European and national level, many policies indirectly contribute to sustainable soil management in Ireland. In the past 15 years, many research projects have added knowledge to the national picture. An

example is the Irish Soil Information System, co-funded by the Environmental Protection Agency (EPA) and Teagasc, which was launched last September 2014. A range of stakeholders from policy makers, governmental representatives, researchers, education officers and local authorities to farmers, parks and wildlife managers and gardeners are interested in the outcomes of the research and policies relating to soils. However, thus far, there has been no coherent framework to guide these stakeholders. In response, the 'Soil Status and Protection' project has evaluated state-of-the-art soil research in Ireland. In March, 75 of these stakeholders gathered to give their soil research insights, together with European and international visiting scientists.



Stakeholders of soil quality during the Soil Status workshop.

Francesca Bampa, post-doc of SOIL STATUS project, Teagasc, Crops Environment and Land Use Programme, Johnstown Castle
Lilian O'Sullivan, SQUARE project, Teagasc, Crops Environment and Land Use Programme, Johnstown Castle
Rogier Schulte, Leader of Translational Research on Sustainable Food Production, Teagasc, Johnstown Castle
Rachel Creamer, Lead Researcher, Soil Quality and Classification, Teagasc, Crops Environment and Land Use Programme, Teagasc, Johnstown Castle

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A Teagasc event for the Internal Year of Soil 2015 (World Reference Base training course hosted by Teagasc).



Multi-functional role of soils – example of a soil supporting primary productivity and carbon sequestration.

Managing soil: do you have enough information available?

Twelve panellists were invited to discuss the issue: 'How to move forward: what are the key priorities for soils in Ireland?' The main research gaps identified correlate with the functionality of agricultural soils in: primary productivity; water purification and regulation; carbon cycle and storage; provision of functional and intrinsic biodiversity and provision and cycling of nutrients. While the amount of soil data and information available to support policy has increased greatly, the main contemporary research gap now pertains to the integration of this into a consistent framework.

Monitoring soils

Twenty-six stakeholders focused on the development of a national monitoring campaign for soils. The session opened with a keynote address from Reece Hill on soil mapping, soil-landscape interpretation, soil description, sampling and monitoring, exemplified by the soil quality monitoring programme of the Waikato Regional Council he established in New Zealand. In the subsequent discussion, participants agreed that forthcoming monitoring network designs should: build upon existing data and systems in place; be able to track and respond to temporal changes over time; include as many parameters as possible, as the major cost is visiting the sites; and be flexible to include further parameters to support future policies at national and EU level (e.g., microbial activity).

Educating and raising awareness on soils

The attendees agreed that the current Irish Leaving Certificate programme in Agriculture Science is unfortunately based too much on basic soil formation principles, which provides a sound basis to soil science, but does not explain the role of soils in terms of land management. William Considine, farmer, teacher and Irish Agricultural Science Teachers Association (IASTA) joint founder, focused on the role of education in contributing to understanding and management of land. Participants included: teachers from primary and secondary level; farmers; scientific policy officers from governmental national bodies; researchers; Irish charities; NGOs; private consultancies; environmental journalists; and soil supporters. The stakeholders agreed that there is a need for educational material that raises soil awareness using a common language, but differentiates based on educational levels (primary, secondary and third level) and audience languages (public and policy makers).

Summarising soil information: metadata

In this afternoon workshop, 15 stakeholders learnt from Einar Eberhardt (BGR) and Peter Mooney (EPA) about the implementation of the INSPIRE Directive in relation to soil (meta-data), specifically in the context of the Soil Status project. The subsequent discussion elucidated that the concept of metadata has a different meaning to different users and stakeholders. For example, metadata for objects could define research projects, research papers or reports, while metadata for data in the case of soil would be specified by the 'INSPIRE Data Specification Soil' protocol and be much more low-level in specification. Metadata is data in its own right. For many researchers and scientists this is an abstract concept and, as a result, there are currently limited software tool supports for metadata in soil science.

Take home message

As a summary of the panel discussion all the attendees agreed on the following keywords as representatives of the knowledge gaps that need to be addressed to better manage our land.

- Harmonised
- Monitoring
- Knowledge transfer
- Holistic
- Interpretation

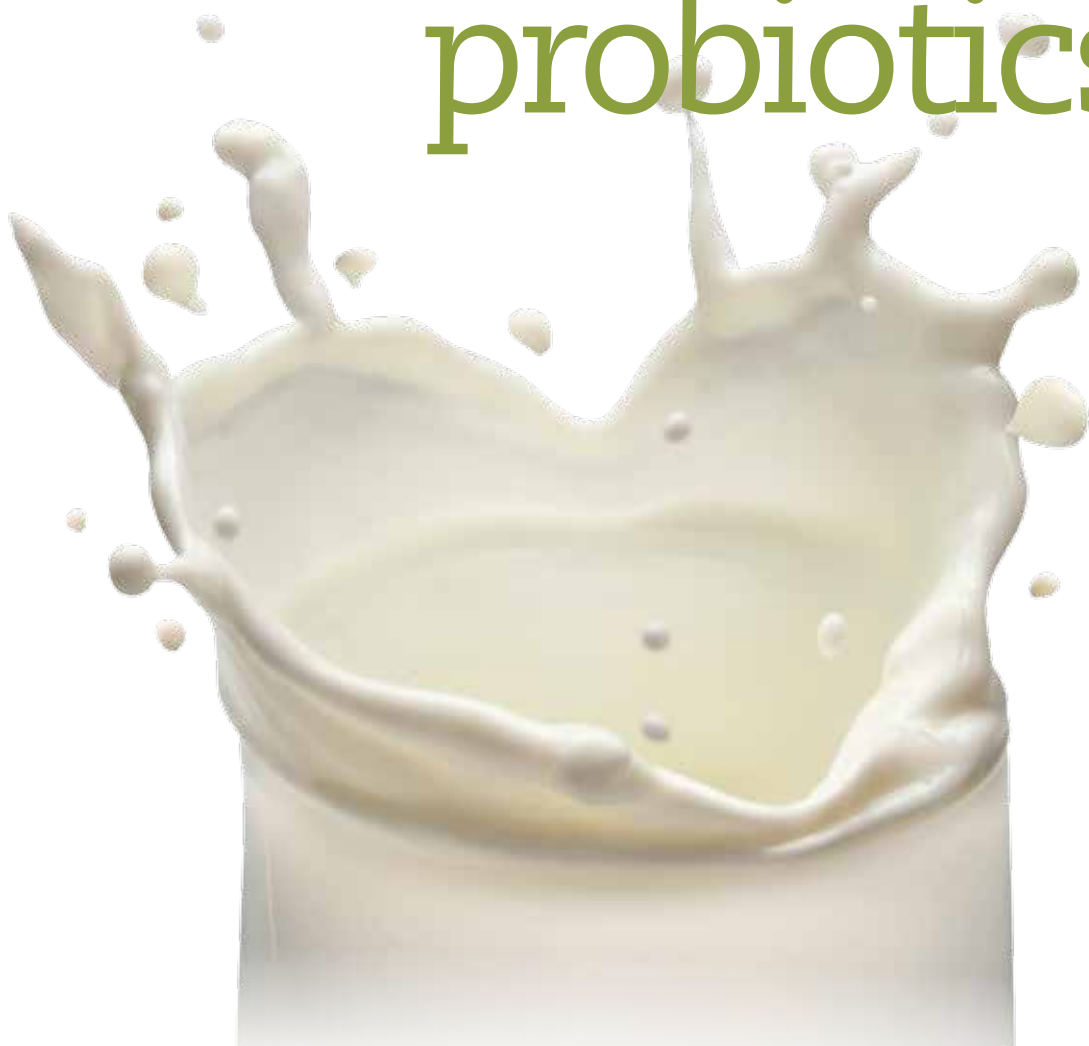
"The challenge is to get our own education and knowledge and to become our own scientists."

Acknowledgements

The project Soil Status and Protection was funded by the Environmental Protection Agency Research Programme. For contributing to the workshop as keynote speakers, the authors thank: Peter Mooney, Research Fellow, Environmental Protection Agency and Department of Computer Science, Maynooth University, Ireland; Einar Eberhardt, Senior Scientist, Sub-division Basic Information Groundwater and Soil, Federal Institute for Geosciences and Natural Resources (BGR), Germany; Reece Hill, Senior Soil Scientist, Waikato Regional Council, New Zealand and the current President of the New Zealand Society of Soil Science; William Considine, current farmer of Nicharee Farm, Duncormick, Co Wexford and former dairy farmer, pedigree beef breeder, teacher, joint founder of IASTA and council member of ASA; and Arwyn Jones, Senior Officer in Soil Issues, European Commission, Directorate General Joint Research Centre.

For more on the Soils Status and Protection project see: http://www.teagasc.ie/soil/soil_status/

Heart-friendly probiotics



Teagasc and UCC have developed heart-friendly probiotic dairy products as part of the APC Microbiome Institute.

DPC6426) with demonstrated cholesterol-lowering properties *in vivo*, which provides new opportunity for innovation in the development of cardioprotective foods. In particular, the technology is attractive to dairy-product innovation, for the development of reduced-fat yoghurt and cheese and also the beverage sector for heart-health products.

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Among the recommendations to avoid heart disease is the maintenance of normal blood cholesterol levels by ingesting a cardioprotective diet and, if necessary, via the use of drugs such as statins. Low consumer compliance with dietary recommendations, as well as the expense and side effects of drug therapy for many consumers, aligned with increased consumer acceptance of foods with additional health benefits, has led to an opportunity for functional foods in the heart health area. Ongoing research at Teagasc/UCC (under the APC Microbiome Institute) has led to the identification of a probiotic strain (*Lactobacillus mucosae*

Reducing CVD risk factors

Cardiovascular disease (CVD) is currently the leading cause of death and disabilities globally, with estimations that by 2030, CVDs will claim the lives of almost 25 million people annually. The morbidity and mortality associated with most CVD can be significantly reduced by addressing risk factors. Elevated plasma cholesterol is a validated risk factor for CVD and possibly some types of stroke. A 10% reduction in serum cholesterol in men aged 40 has been reported to result in a 50% reduction in heart disease within five years; the same serum-

cholesterol reduction for men aged 70 years can result in an average 20% reduction in heart-disease occurrence in the next five years. In Ireland, a 30% reduction in the heart disease death rate has been attributed to 4.6% reduction of the population mean for total cholesterol. A cardioprotective diet abundant in fruits and vegetables, whole-grain, dietary fibre and fish (rich in omega-3 PUFA) containing only small amounts of saturated fats, is recommended to manage blood cholesterol levels (American Heart Association).

Foods ingredients for heart health

Heart-health protective bioactive components in food, with recognised cholesterol-lowering activity include phytochemicals and soluble dietary fibre. However, there is a clear gap in the probiotic market for clinically-proven strains with proven lipid-lowering ability. The availability of such products would potentially have advantages for the food industry and, particularly the dairy industry, in that such cholesterol-lowering probiotic products may be produced in a cost-effective manner (milk fermentations) without changing current manufacturing equipment. They may also be suitable for application in low-fat foods (yoghurt, reduced fat cheese), where they would potentially confer technological advantages (improved rheology due to the presence of microbial soluble fibre produced during the fermentation process) to product quality, and the nutritional benefits of enhanced dietary fibre, thus also potentially contributing to gut health.

In ongoing research at Teagasc/UCC, a novel soluble fibre (exopolysaccharide [EPS]) producing *Lactobacillus* strain (*Lb. mucosae* DPC6426 of mammalian intestinal origin was identified (London et al., 2014a, Ryan et al., 2015a), which demonstrated potential to reduce serum cholesterol *in vivo* following ingestion (London et al., 2014b). We used the atherosclerosis-prone apoE-deficient mouse model, fed a high fat/high cholesterol diet for up to 24 weeks, which resulted in significant elevations of serum cholesterol and triglycerides. However, when these animals received, in addition, a dietary supplement containing live *Lb. mucosae* DPC6426, a statistically significant reduction ($p \leq 0.001$) in total cholesterol in serum and serum triglyceride ($p \leq 0.05$) was found, compared with unsupplemented controls. Furthermore, dietary intervention with *Lb. mucosae* DPC6426 resulted in significantly higher ratio of high-density lipoprotein (HDL) cholesterol to total cholesterol in serum and liver ($p \leq 0.05$); while significantly increased ($p \leq 0.001$) levels of faecal-cholesterol excretion were associated with daily administration of *Lb. mucosae* DPC6426 strain, compared with unsupplemented controls. Additionally, we have favourably benchmarked this cholesterol-lowering probiotic against commercially available cholesterol-lowering food ingredients on the market, including plant sterol

esters and oat beta-glucan. Furthermore, the *Lb. mucosae* strain is technologically robust and its use in dairy fermentations yields consumer acceptable reduced-fat yoghurt and cheese (London et al., 2015; Ryan et al., 2015b).

Potential for developing functional foods

Given the difficulties already experienced by the food and probiotic industries in getting approval for health claims, this research is aimed at the generation of scientifically sound evidence, based upon the health-promoting, cholesterol-lowering potential of *Lb. mucosae* DPC6426. The findings of this project are generating information leading to development of functional foods with potential cardioprotective properties. In particular, the technology should be attractive to Irish dairy companies, from both the 'lipids management' abilities of the strain, and the multifunctional effects of inclusion of the strain during dairy fermentations, such as low-fat yoghurts and reduced-fat cheese, and applications in functional foods and beverage sector for heart-health products.

Acknowledgements

This work was supported by the Department of Agriculture, Food and Marine, the European Community's Seventh Framework Programme (FibeBiotics), the Enterprise Ireland Commercialisation Fund and the Science Foundation Ireland-funded APC Microbiome Institute.

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Linking blackberry polyphenols to heart health



The Cardio-RUBUS project is currently investigating the beneficial effects of blackberry polyphenols on cardiovascular- and metabolic-health in Irish adults.

Many people associate blackberries (*Rubus species*) with youthful excursions to the countryside to collect bags of this delicious fruit for use in jams and pies. Ireland has a long tradition of growing blackberry fruits both traditionally as wild brambles and through commercial cultivation. Benefits of blackberries extend further than their delicious flavour; blackberries have a favourable nutritional profile. They are low in fat and kilocalories, while rich in dietary fibre, vitamin C, vitamin K and folate, and are also a rich source of antioxidant compounds known as polyphenols. With obesity on the rise and metabolic disorders such as diabetes endemic in Irish society our cardiovascular health has never been more at risk. Factors such as high blood pressure, high cholesterol levels, obesity, poor dietary quality, smoking and a sedentary lifestyle can all contribute to the development and

progression of cardiovascular disease (CVD), our most common cause of death in Ireland (Irish Heart Foundation, 2015). Research shows that increased consumption of fruit and vegetables, which are rich in polyphenols, is associated with reduced risk of CVD. In addition, favourable effects of berry consumption on blood pressure and blood cholesterol have been reported (Erlund *et al.*, 2008). However, there is a need for dietary studies to identify levels at which blackberry polyphenols are physiologically effective, as findings on health effects associated with blackberry consumption are limited.

The Cardio-RUBUS project is currently investigating the beneficial effects of blackberry polyphenols on cardiovascular- and metabolic-health in Irish adults and focuses on the development and characterisation of a novel polyphenol-enriched blackberry beverage, which will be subsequently tested for efficacy in the Cardio-RUBUS dietary intervention study. The Cardio-RUBUS project is coordinated by University College Cork (UCC) with Teagasc Food Research Centre, Ashtown, as its project partner. These research activities have adopted a stepwise approach and will provide robust scientific data to substantiate the effect of blackberry polyphenols on cardio-metabolic health outcomes.

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Dietary intakes of polyphenols

Dietary intakes of polyphenols occur at varying levels within a variety of foods. It is important to establish the sources and level of polyphenol consumption in the diets of Irish adults and children, particularly for the development of polyphenol-enriched functional foods. This research is currently underway at UCC and is led by Mairead Kiely, Jacqueline Lyons, Clara Heneghan and Alice Lucey. It focuses on incorporating food composition data on polyphenols from the eBASIS (BioActive Substances in Food Information Systems) database with Creme Global Food software, supporting the generation of dietary exposure estimates for polyphenol compounds in the Irish population.

Functional polyphenol-enriched blackberry beverage

A polyphenol-enriched blackberry beverage has been developed by food scientists, Seamus O'Mahony and Noirin Kelly at UCC. This blackberry beverage will support the Cardio-RUBUS dietary intervention study and has undergone extensive stability testing, nutritional profiling and sensory evaluation.

This functional beverage has undergone in-depth polyphenol characterisation, which will continue throughout its shelf-life. This research is led by Dilip Rai and Ciaran Fitzgerald at Teagasc Food Research Centre, Ashtown, using advanced analytical techniques (i.e., liquid chromatography-tandem mass spectrometry) to identify and quantify the predominant polyphenolic compounds found within the beverage. The main polyphenols in blackberries include anthocyanins (these pigments are responsible for the rich violet colour of the berry), phenolic acids, ellagitannins and flavanols.

Dietary intervention study

Dietary interventions are required to support claims of a cause-and-effect relationship between berry polyphenols and health outcomes. The Cardio-RUBUS dietary intervention, a carefully designed, double-blinded, placebo-controlled randomised crossover study is currently ongoing at the Human Nutrition Studies Unit at UCC and is led by Alice Lucey, Mairead Kiely and Clara Heneghan. This dietary intervention study is testing the physiological efficacy of the polyphenol-enriched blackberry beverage on cardiovascular- and metabolic-health outcomes, including blood pressure and blood lipids in adults at increased cardiovascular risk. This study will provide novel scientific data to substantiate the effect of blackberry polyphenols on cardio-metabolic outcomes, a necessary requirement within the food industry for the submission of a Health Claim to the European Food Safety Authority.

Impact of increased consumption

The impact of including the Cardio-RUBUS polyphenol-enriched blackberry beverage in the habitual diet of Irish adults will be examined through the use of modelling statistics. Such estimations are crucial to inform the food industry how best to place the final product in the beverage market. This research is led by Clara Heneghan, Mairead Kiely, Alice Lucey and Jacqueline Lyons at UCC.

Opportunities for dietary intervention

Food-based dietary interventions are central to healthy aging, indicating a clear need and market opportunity to develop novel foods with proven benefits for cardiovascular and metabolic health.

Cardio-RUBUS undertakes a 'farm-to-fork' approach, integrating food research and enterprise to enable the development and characterisation of a functional blackberry beverage. This beverage is currently being tested for physiological efficacy in Irish adults and will provide robust scientific evidence on the effects of blackberry polyphenols on cardio-metabolic health. Thus, if successful, the Cardio-RUBUS project will open up a substantial market opportunity to develop novel functional foods with proven health benefits using one of Ireland's most treasured native fruits.

European project links

The Cardio-RUBUS project is strongly linked to the ongoing BACCHUS Project, an EU-funded FP7 project, which is investigating the beneficial effects of dietary bioactive peptides and polyphenols on cardiovascular health in humans. The BACCHUS Project is coordinated by the Institute of Food Research (IFR), Norwich, UK, with UCC as project partners. BACCHUS examines the effect of European nutrition and health-claims regulation on food innovation among small and medium-sized enterprises in Europe (<http://www.bacchus-fp7.eu/>). Cardio-RUBUS is also linked to EU COST Action POSITIVE: Interindividual variation in response to consumption of plant food bioactives and determinants involved, and specifically addresses variations in bioavailability and physiological responses to consumption of plant food bioactives in relation to cardio-metabolic endpoints (www.cost.eu/COST_Actions/fa/Actions/FA1403), where Dilip Rai is a member of the Management Committee.

Acknowledgements

The Cardio-RUBUS project is funded by the Department of Agriculture, Food and the Marine under the FIRM/Stimulus/CoFoRD programme.

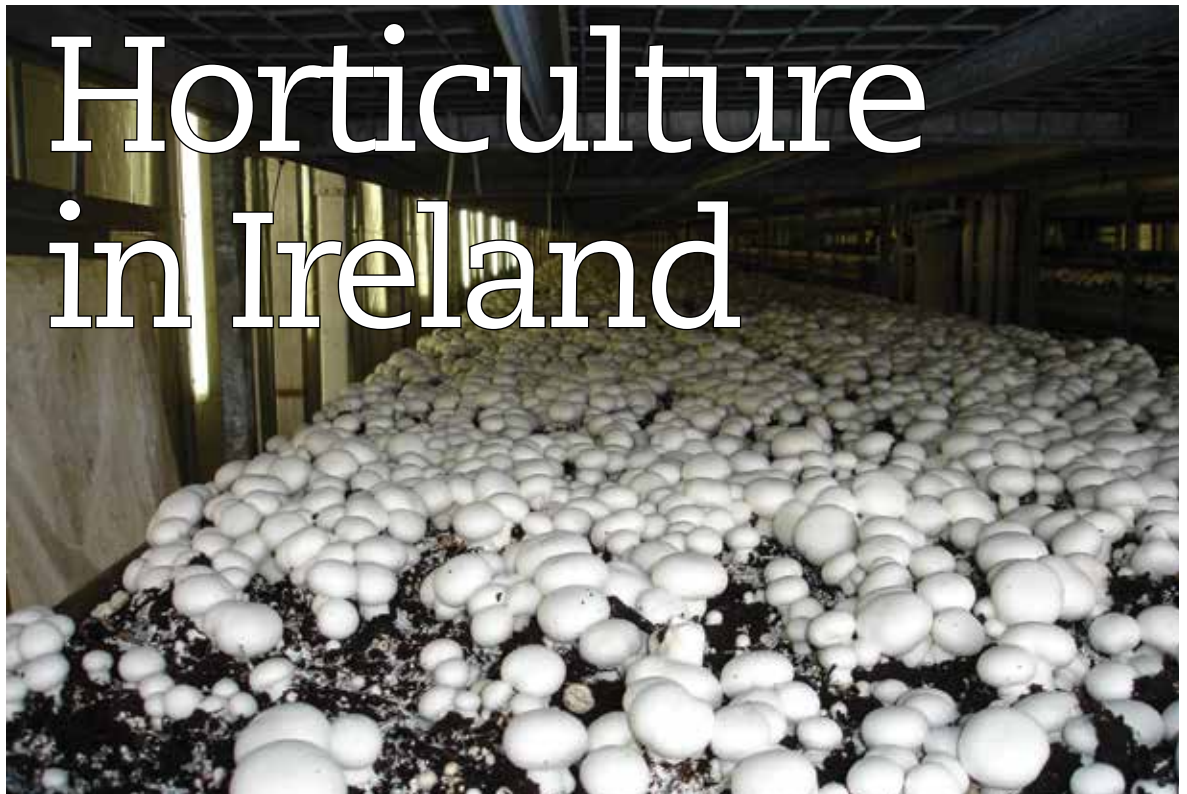
The Cardio-RUBUS research consortium consists of: Mairead Kiely (PI); Alice Lucey (Project Coordinator); Jacqueline Lyons (Co-PI); Seamus O'Mahony (Co-PI); Clara Heneghan (PhD student) and Noirin Kelly (MSc student) from UCC; and Dilip Rai (Co-PI) and Ciaran Fitzgerald (RO) from Teagasc Food Research Centre, Ashtown.

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Horticulture in Ireland



Stephen Alexander, Teagasc Horticulture Development Department Specialist in Vegetable Crops reviews the early years in State support for horticultural research and advice, which paved the way for where we are today, supporting a modern, progressive and efficient sector.



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Horticultural research in Ireland in the modern era dates from the foundation of An Foras Taluntais/ The Agricultural Institute (AFT) in 1958. AFT was set up in the aftermath of World War II under a Marshal Aid programme to carry out agriculture and food research. Under its tutelage, a horticultural research station was set up in 1959 at Kinsealy, Co Dublin, around the same time a research facility for soft fruit opened at Clonroche, Co Wexford and a centre for top fruit opened at Ballygagin, in Co Waterford. Kinsealy Research Centre, under the able direction of Dr David Robinson, was to establish itself at the forefront of the development of Irish horticulture in the ensuing decades.

In 1980, the agricultural advisory service and agricultural colleges amalgamated with the creation of An Chomhairle Oiliúna Talmhaíochta/ The Agricultural Training Council (ACOT) with Dr Tom Walsh at its head. A new, specialised service, aimed squarely at the commercial grower, was launched at Warrenstown College in June 1985 and charging for advisory services was introduced in 1987. Although

working in separate organisations the researchers and advisers maintained close links. The research generated at the stations was disseminated by the advisers and adopted by the growers.

Modernisation

Over the years, much valuable research was carried out at the research centres. The modernisation of vegetable production started with the development of a vegetable processing industry by the likes of Erin Foods, a subsidiary of the Irish Sugar Company, and Batchelors. The research team at Kinsealy swung into gear to develop production protocols that spanned varieties, nutrition, mechanisation, weed control



Glasshouse production (175ha) covers a wide range of protected crops with the main ones being strawberries, tomatoes, lettuce and peppers.



Artist's impression of the new facilities at Ashtown.

and best practice in pest and disease control. The establishment of AFT coincided with the development of the apple industry in the south east and in an effort to support this initiative they opened up a research station at Ballygagin near Dungarvan. Over the years, pioneering research was undertaken in apples and other top fruit before the station was closed in 1982.

But the jewel in the crown of horticultural research was the development of the mushroom industry on the back of sterling work carried out at Kinsealy in the 1970s and 1980s. It involved the development of new composts, based on straw and poultry manure, and a new growing system based on polythene bags of compost in insulated tunnels. This kick-started the development of what is now Ireland's leading horticultural industry, with a current output of €133 million per annum, 75% of which is exported to the UK. The mushroom industry has continued to progress since the early days and it is now a highly automated and technologically advanced sector.

Change

Another change occurred in 1988 with the amalgamation of AFT and ACOT into Teagasc. This finally merged advice, research and education into one body; but it came at a price – a 43% cut in the new



Crop of Brussels sprouts. Vegetable growing is an important component of the horticultural industry.

organisation's budget meant staff numbers fell from 2,300 to 1,400. The redundancies hit horticulture hard with big staff losses in both advisory and research roles. Over the following years, the downward trend continued through retirements, recruitment embargoes and non-replacement of staff. With the arrival of the Celtic Tiger there was some hiring of new staff in the early 2000s, which unfortunately was negated by the ensuing crash from 2008 onwards.

Challenges and opportunities

There are currently 12 people employed in the Horticultural Development Department, which includes a mix of advisers, researchers, technicians and farm staff, providing research, extension and training for the horticultural industry, which is worth over €300 million (Table 1). The team support a modern, progressive sector, which has many challenges ahead but also opportunities for innovation and expansion, as demonstrated by the range of current activities described in the following pages.

A bright future

The future of horticulture within Teagasc bodes well. Dermot Callaghan takes on the role of Head of Horticulture in Teagasc this month and gives his view on the place of horticulture in Ireland's agri-food industry in the editorial on page 3. A new Horticulture Technology Centre is being constructed on the Ashtown Food Research Centre campus and it will comprise an education and training centre, laboratories, glasshouse, polythene tunnels and a mushroom research unit. This development has the potential to support the revitalisation of training and support services to the sector. And, most importantly, will allow Teagasc to continue the proud tradition of State support for the development of the horticultural industry.

Table 1. Horticultural output

Enterprise	Value €'000	
	2013	2014
Mushrooms	121,522	133,172
Protected crops	82,008	85,334
Field vegetables	59,725	61,060
Nursery stock and other sectors	38,163	40,814
Outdoor fruit	7,691	9,758
Bulbs, outdoor flowers and foliage	4,496	5,857
Total	313,605	335,995

Advances in mushroom science – viruses and *Trichoderma*



Mushrooms on shelves

Severe outbreaks of *Trichoderma* green mould and Mushroom Virus X disease across Europe in recent years led to these topics being investigated as part of a three-year, EU-funded project, MushTV. Research on both topics has resulted in important new information for the industry, which is summarised below.

Mushroom viruses new to science identified

Since the late 1990s, new virus diseases, with serious economic consequences, have been a sporadic problem for the mushroom industry across Europe caused by what became known as Mushroom Virus X. These viruses have been correlated with brown discoloration of white mushrooms (Brown Cap Mushroom Disease), as well as crop delay symptoms. Recent research, as part of EU funded project MushTV (www.MushTV.eu), has expanded our knowledge and understanding of the viruses involved. Mushroom Virus X is a complex of a large number of viruses. The use of next generation sequencing (NGS) technology has revealed the sequences of 19 different viruses in diseased samples, 16 of them are new to science, all are distinct and likely to have very different biologies. They have been classified into existing and new clades. Laboratory studies have shown that it is difficult to infect fungal cells *de novo* with viruses, which suggests that the original infections of the 19 viruses may be ancient events. Even disease-free

mushrooms can have up to 12 viruses leading to the paradigm that low virus presence may be 'the norm'. The virus causing Brown Cap Mushroom Disease has been identified as *Agaricus bisporus* Virus 16 (AbV-16) and it contains five unique viral RNA elements. The levels of these viruses are low in symptom-free mushrooms but increase 1,000 fold to cause the brown discoloration symptom. The reasons for this abrupt change in virus titre are not fully understood.

Viral-host interactions

Multiple virus infections found in the mushroom give rise to the concept of numerous viral-viral and viral-host interactions. Evidence has been found of both synergistic and antagonistic viral-viral interactions. Viral-host interactions have also been detected. The host, the mushroom, responds to viral infection by decreasing the activity of nutritional genes, which could explain why, in some cases, the crop can be delayed. The presence of an active viral infection also triggers down-regulation of viral defence mechanisms.

New diagnostic test developed

The sequences of the viruses have been used to develop a new detection test, which is so highly sensitive that it can detect the presence of virus in mushroom compost before the crop is produced. This test can be used as an early warning system for the industry.

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Discoloured mushrooms due to Brown Cap Mushroom Disease (AbV-16).



Impact of green mould on production.



Mushroom compost in Phase 3 tunnel at AFBI with no visible green mould.

Mechanisation exacerbates *Trichoderma* green mould

Compost green mould in mushroom production is caused by the fungus *Trichoderma aggressivum*. It can result in 100% yield loss, affecting both growers and compost producers. Mushroom compost is increasingly bulk-incubated in large tunnels (80-200 tonnes) producing what is termed 'bulk Phase 3 compost'. Tunnels are emptied mechanically using winches and conveyors and, as a result, the compost undergoes several mixing processes between the incubation tunnel and the mushroom growing shelf.

The technologically advanced bulk Phase 3 system has many controls in place to ensure the compost is protected from contamination but several outbreaks of green mould, associated with bulk-handled compost, highlighted gaps in our knowledge on how the mould develops and spreads within this system. One of the MushTV objectives was to characterise the growth of *T. aggressivum* in the bulk incubation system, using the experimental scale incubation tunnels at AFBI Loughgall.

Localised infection

A series of experiments were conducted where *T. aggressivum* was artificially introduced into the back of a bulk incubation tunnel. At the end of the incubation period the *T. aggressivum* mould was not visible in the compost but testing indicated that it was confined to a small area of the tunnel around the infection site (approx. 1m diameter). The majority of the compost in the tunnel was healthy and produced a normal crop yield, while yields from the infected zone were reduced by 24-100%. Thus, we know that a single *T. aggressivum* infection only affects a small amount of compost in a tunnel.

Compost mixing spreads infection

In a second series of experiments, when compost was subjected to all the standard mixing processes typically associated with emptying the tunnel, filling transport vehicles, and offloading onto shelves at the farm, the initial localised area of infected compost became mixed with a greater volume of compost. Rather than diluting the effect, our replicated trials showed that the yield from all the compost in the tunnel was now reduced by 80-100%. Furthermore, contaminated equipment was also shown to cross contaminate otherwise healthy compost when the uncleaned equipment was used to empty compost from two new tunnels, with yields reduced by up to 100%.

Vulnerability of bulk Phase 3 highlighted

These important results highlight how vulnerable bulk Phase 3 compost is to cross-contamination during tunnel emptying, transportation and delivery on farms. They reinforce the importance of implementing very stringent hygiene and cleaning procedures before and after all operations to minimise the impact of this potentially devastating mushroom pathogen.

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Agronomy blueprints for cut foliage production



Ornamental Brassica.

Andy Whelton, Ornamentals Specialist in the Horticulture Development Department, outlines agronomy research trials taking place at Kildalton College in Kilkenny, and on growers' holdings, to underpin production blueprints for the cut foliage sector.

Effective technical and research support is proving vital to the development and success of the relatively new cut foliage enterprise in Ireland. Given the exacting market requirements for the continuity of supply of top-quality cut foliage, Teagasc is developing agronomy blueprints for the production of ornamental and minor forest species as part of ongoing research and applied extension work on growers' holdings in Wexford and Kerry and at Kildalton College. The delivery of uniform stems of suitable length and spray form can only be achieved when optimum plant density is coupled with best management practices of pruning, nutrition, pest and disease control. Current cut foliage research, thus, aims to identify these exacting requirements for a range of species.



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Plant density and weed control

While extensive, low density planting systems of 2,500 trees/ha have proved to be satisfactory in meeting the specifications for key tree species like *Eucalyptus* and *Pittosporum*, recent work on the more shrubby species such as *Brachyglottis* and *Viburnum* suggests that they should be planted more intensively on beds at high density (16,000 plants/ha) to deliver the necessary stem length and quality sprays.

Controlling weeds in such high density plantations is particularly challenging and the move away from reliance on chemicals is becoming an important aspect of production. Given Ireland's year-round weed growth, the solution to this problem is unlikely to be achieved easily, but Teagasc-funded work is evaluating the use of mulches as a sustainable means of weed control for the future.

Pruning

Most plant species flower at a particular stage in the season but vegetative growth is more desirable in cut foliage production. Research is aimed at preventing the flowering phase and inducing vegetative growth. Techniques such as altering pruning time and nutrition levels for different plant species is helping to deliver product in high volumes at the key demand periods like Christmas and Valentine's Day. A recently completed MSc by Catherine Gavin in Kildalton College has provided essential information on optimum pruning treatments for *Ozothamnus* – a core foliage species for the Christmas market. Pruning young plants to 50cm frameworks in early spring prevents flowering and results in high yields of suitable stem length and quality.

Pests and diseases

When ornamentals are planted in large stands they become much more susceptible to pests and diseases. Sustainable control measures fostering environmentally friendly methods are now advocated under the Sustainable Use of Pesticides Directive, thus, integrated crop management is a major cornerstone of the current research programme in Teagasc.

A few years ago, the blue gum psyllid – a green-fly-like pest of *Eucalyptus* and other foliages – caused



Planting Ornamental Brassica trials.

serious damage to the foliage sector. With good research support, this problem was rapidly cleared up by the release of a tiny parasitic wasp, *Psyllaephagus pilosus*, a biological control method, which is still in use today. Dorothy Hayden of Teagasc Botanic Gardens is completing a PhD researching the biological control of a *Eucalyptus* leaf beetle that threatens the viability of *Eucalyptus* cut foliage as it renders the foliage unsalable. The technique involves the use of another parasitic wasp, *Enoggera nassau* (see *TResearch* 2014, Summer, p9).

The success of biological control techniques allows for the elimination or reduction of chemical pest control measures in crops. Pest monitoring and the development of trapping technologies are



Evaluating sustainable weed control methods.



The striking red leaves of Photinia are in big demand in the floriculture market.

important aspect of the work being carried out in Kildalton and on growers' holdings in the southwest and is an area that is going to require greater attention in future work programmes. Real-time pest information is needed by growers so they can be more targeted and sustainable in their use of pesticides, using chemicals only when needed.

Protected crops and continuity of supply

Kildalton College lecturer, Grainne McMahon and Andy Whelton, Teagasc Ornamentals Specialist have been undertaking trials on developing production protocols for the continuity of supply of 'foliage fillers', which aim to supply foliage to meet supermarket demand for product in the off-season to compliment the main production period. This provides Irish producers with a clear market advantage. Using protective structures for early and late season cropping, coupled with a range of varieties and pruning regimes, production blueprints have been developed for the bouquet fillers *Solidago* and Ornamental Brassica – two species currently being scaled up by growers in the industry. Flower crops such as Peony roses and scented stock are currently the focus of agronomy work that aims to provide the Irish industry with a suite of production blueprints for products demanded by a discerning developing market, and which is currently under-supplied both at home and in other EU countries, therefore offering potential for growth.

Collaboration with Kildalton College

An added benefit of the collaborative work between Teagasc Kildalton and the cut-foliage sector is that it provides an opportunity for students to experience this exciting new market-led sector of commercial horticulture in Ireland, which is beginning to offer opportunities in several different areas for graduates.

Acknowledgment

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Innovative plants for cut foliage



Andy Whelton, Teagasc Horticulture Development Department Specialist in Ornamentals, takes a look at the screening work carried out on new species of ornamental plants, which are being used in the expansion of the fledgling new cut foliage industry.

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Cut foliage is a new term to many people. It describes the decorative branches cut from a wide variety of trees, shrubs and perennials for use in bouquets and other flower arrangements. Worldwide demand in developed countries is increasing and the prospects for continued expansion of the small Irish industry for export markets are very good. Twenty-five growers currently export cut foliage worth over €4 million, providing much needed employment in harvesting and processing in rural parts of Kerry, Wexford and Waterford.

Innovative new lines

The mild, relative frost-free climate in southern Ireland is ideal for growing lush, premium foliage, however, buyers and customers are constantly looking for innovative new products displaying different textures, colours and scents for a discerning and competitive market. At Kildalton College in Kilkenny, the Teagasc Horticulture Development Department screens and evaluates a wide range of ornamental plants to identify potentially interesting 'new' foliage lines, with support from Bord Bia and foliage processors Forest Produce Ltd. The aim is to identify foliages that give value to a bouquet in terms of 'fill' and 'uniformity' and they are evaluated from a physical and market perspective. While 'green' is the predominant colour of commercial cut foliage, coloured and scented species that reflect seasonality, especially autumn, are sought after by the market. Species showing potential include *Hypericum* and *Rosa*, which provide a range of coloured berries and rose hips for the late summer/



autumn period. Other species generating market interest are new cultivars of well-known garden plants such as *Weigela* and *Pittosporum*, bred for their purple/black stemmed foliage. These species are currently undergoing post-harvest tests in conjunction with processors – a necessary research step before a species can be released to the industry. The first commercial plantings of a long stemmed scented Rosemary species will take place in 2016 for use in an innovative scented bouquet range, a trend that is increasing.

Ongoing research

Breeding research in Teagasc by Gerry Douglas has led to a variety of *Hebe* with desirable features for the foliage industry, which will enter agronomy trials next year. The scope of trialling and evaluation is enormous as it includes not only attractive exotic species but also forest species (e.g. Larch, Hemlock, moss) and native plants (e.g. Bog Myrtle – *Myrica gale*). A new clone of *Myrica gale* is showing promise after one season in trial and has potential for production on organic soils in marginal areas, provided it passes the rigorous agronomy and market evaluations being carried out by Teagasc.



Cut foliage display.

Expansion and growth

With increasing demand for large volumes of top quality and innovative cut foliage for export markets, especially at peak periods like Christmas and Valentine's Day, continued research and development is essential to ensure the sector can expand and grow to meet that demand.

Funding

This work is funded by Teagasc, Bord Bia and Forest Produce Ltd.

Precision irrigation for strawberries



Dr Eamonn Kehoe, a soft fruit specialist based at Teagasc, Johnstown Castle, Co Wexford, describes an ongoing project at Kinsealy Research Centre aimed at controlling strawberry irrigation using a sensor-driven control system.

weather conditions and set the controls accordingly. Results, therefore, depend on the grower's experience, attention to detail and intuition, which can often be misleading.

Precision irrigation systems

The current method of irrigation in strawberry crops (and many other horticultural crops) does not give optimal control. There are two approaches that can be used to improve the situation. One is that of direct measurement, where some type of sensor is used to measure the moisture status of the growing substrate. This then sends a signal, which controls the irrigation system. The other method of control is indirect, where the water used by the crop is calculated using a mathematical model of evaporation with the input of climate data, such as solar radiation, temperature, wind speed and humidity.

Currently, we are investigating the direct measurement approach in research trials at Kinsealy. Soil-moisture sensors (SM 150's- Delta-T Devices) were selected as the moisture-status sensor. The sensor measures the percentage volumetric water content *in situ* using Frequency Domain Reflectometry (FDR) and it consists of two short probes, which can be easily placed into the growing substrate (peat or coir etc.). Each sensor is wired back to a data logging unit (GP1 Data Logger-Delta-T Devices) and a portable PC, running a data interface, is used to connect to the data logger(s). This allows the user to set up the sensor control parameters and the overall irrigation control parameters.

The Irish soft fruit industry continues to boom

The Irish berry sector continues to be one of the most challenging, rewarding and profitable sectors of Irish horticulture. High-quality berries, very favourable trends in population growth and healthy eating habits should help to drive the sector forward. The shining star continues to be the strawberry, which dominates approximately 92% of the Irish-grown berry market.

As the strawberry industry has expanded, so has the demand for resources like water and nutrients. In the future, it is possible that all water and nutrients used in glasshouse and tunnel-grown crops may have to be recycled and reused. This type of legislation already exists in the Netherlands for example. Most strawberry crops are now grown under protection, in peat substrates in modules (bags) or containers. In this system there is a small reservoir of water available to the plant, thus making irrigation necessary. On most farms this is provided by way of a drip-line irrigation system. Most of these systems are automated with a timer being used. Growers still have to monitor a number of crop-growing factors and anticipate



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Strawberry trial in Kinsealy research centre.

There are three irrigation threshold treatments in the current experiment. Each threshold is based on the percentage volumetric water contents as read by the sensors. Irrigation is kept between a lower and a higher setpoint. The three thresholds used were as follows: 40-45%, 45-50% and 50-55%. These levels correspond to a below-average, average and above-average irrigation treatment (control).

How do the moisture sensors work?

When the plant takes up water or water is lost by evapotranspiration, the substrate dries out. Moisture levels are continuously recorded by the sensors. The software control programme (Delta-T), tests the moisture status of the sensors every 15 minutes. Taking the 40-45% irrigation treatment as an example, the sensor calls for irrigation once the moisture level in the substrate drops to the 40% setpoint. It does this by triggering an electrical relay (switch) through the GP1 data logger. This, in turn, controls the irrigation pump and solenoid valves, thus starting the irrigation cycle. When the water level reaches the 45% setpoint the sensor detects this, the irrigation is stopped and the cycle begins again. The 45-50% and 50-55% treatments operate in a similar fashion, giving a more precise control of the irrigation of the crop.

Expected benefits

The main aim of the project is to develop an automated irrigation control system for substrate-grown strawberry crops. So far in the experiment the control system has worked very well. The sensors cover a wide measurement range and they are fast, reliable and user friendly. They are also very affordable. It is envisaged that this irrigation control system will be used on commercial farms in Ireland and growers are encouraged to adopt the system on a small scale to begin with.

The use of a precise irrigation control system also has many other benefits. These include a saving in water use and consequently fertilizer use, which will reduce costs. The percentage of Class 1 fruit quality should improve as growers are not trying to determine irrigation levels themselves, especially in rapidly changing weather conditions. There should also be fewer incidences of plant diseases due to a more optimal growing environment. Ultimately, the system should lead to improvements in efficiency and productivity on the



SM 150 moisture sensor in situ in growing trough.

farm (e.g. input costs and labour costs reduced).

This is one of a number of control systems that could be used in protected strawberry production and could also potentially be used in many other areas of horticultural production. The industry is continually searching for innovative ways to improve efficiency and productivity on the farm and more precise control systems are being developed with this in mind. The use of more powerful algorithms in control systems and the use of artificial intelligence (AI) in such systems could become more commonplace in the future.

The aim is to have increased productivity and efficiency on the farm by the scientific control of difficult daily operations, at the same time using less human input.

Funding

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Strawberry picking in progress. Black drip line irrigation tubing is also visible.

Improving strawberry tray-plant production in Ireland

Dr Eamonn Kehoe is a soft fruit specialist based at Teagasc, Johnstown Castle, Co Wexford, and he describes research at Kinsealy Research Centre which has led to strawberry tray plant enterprises in Ireland.

The fruit growing season in Ireland has changed fundamentally over the last decade. In the past, the strawberry season lasted from June to July. Today, through new technology the season has been extended from March to November. The strawberry industry has grown by over 270% over the last 15 years and is now worth an estimated €37 million.

In the past, most of the strawberry plants grown in Ireland had to be imported and there were often problems in relation to plant disease levels, stock quality and cost. With the extension of the growing season, Irish strawberry propagators had limited supplies of plants to meet demand from the expanding protected strawberry sector. Research was undertaken to establish and test a 'tray plant' production system for the Irish strawberry propagators who wished to set up such units to satisfy the increasing demand.



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Tray plant research

As a result of this research, new strawberry 'tray plant' nurseries have been set up in Ireland to supply the home market. Plants are 50% cheaper to produce compared to imported material. Consequently, tray plant imports have been cut by at least 30% and it is also hoped to develop an export market. During the course of the research, total yields for cv. Elsanta

exceeded 600g of fruit per plant each season. Fruit and plant quality characteristics were excellent and fruit yields and quality were outstanding, being equal to or better than those seen in more advantageous climates.

Added benefits

Strawberry tray plants also offer many advantages over soil-grown, 'bare-root' plants. Runners and cuttings are grown mostly in peat-based substrates, reducing the risk of infection by soil-borne diseases to a minimum. Plant nutrition can be controlled completely, plants can be more easily lifted during frost and wet conditions and the roots remain intact in comparison to bare-root plants. This improves plant storability and establishment after cold storage. These benefits of Irish-grown tray plants are leading to an increase in productivity and efficiency on the fruit farm.

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Improving raspberry production in Irish conditions



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A project currently underway in Teagasc Ashtown aims to test the concept of a 'one year planting' for raspberry production in Ireland.

Currently there are 24 hectares (ha) of raspberry cultivation in Ireland, mostly under protection, with a farm gate value (fgv) of €2.7 million. Although the primary fruit crop in Ireland is strawberries (185ha, €35 million fgv), raspberries are increasingly popular and in demand, attracting a higher price (€9/kg) than strawberries (€5.18/kg). Raspberries, therefore, offer potential to growers who want to diversify. Most raspberry production is from long-term, multi-year plantations (either in soil or pots) and they require labour to prune and train expansive growth every year. The concept of utilising a plant for a single harvest is common practice in strawberry production, leading to increased yields and decreased costs. A project is currently underway in Teagasc Ashtown to test the concept of a one-year planting for raspberry production in Ireland.

Two raspberry varieties are being evaluated, 'Tulameen' and 'Glen Ample', which have complementary cropping patterns that provide fruit over a broad time frame. Although other factors such as substrate type, irrigation scheduling and pest control are also being investigated, this report focuses primarily on fruit yield.

Preliminary results

Preliminary results have shown that 'Tulameen' yielded strongly early in the season, while 'Glen

Ample' yielded more consistently throughout and had overall higher yields (1.31kg fruit per cane versus 1.05kg per cane). This was a result of both higher fruit numbers per cane and a higher average weight per fruit. Total average yield for the season to date is 1.18kg per cane, which is close to the pre-experiment yield target of 1.2kg per cane. Stomata are the pores found on the surface of leaves. They play a key role in the loss of water via transpiration and CO₂ uptake for the use in photosynthesis. Stomatal conductance is the measurement of this gas exchange and is an indicator of plant water stress and growth. The variety 'Tulameen' had an average seasonal reading of 145mmol/m²/s compared to of 204mmol/m²/s for 'Glen Ample'. Future work will explore the relationship between fluctuations in stomatal conductance and yield.

Conclusion

Since the pre-experiment yield target of 1.2kg fruit per cane is likely to be achieved, an economic analysis will now be conducted to assess the comparative financial return utilising the one-year approach as opposed to the more common multi-year approach.

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Nutrition potential of biowaste composts



Cabbage plants growing in compost amended soil

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Under the European Landfill Directive, the amount of biodegradable municipal waste (BMW) going to landfill must not exceed 427,000 tonnes by 2016, with full diversion targeted for 2020.

Ireland is on course to achieve these targets, which are laid out in the European Landfill Directive (1999/31/EC). However, currently there is more than 800,000 tonnes of biodegradable municipal waste (food, garden, catering and commercial organic wastes) generated yearly, requiring treatment and, ultimately, a productive end-use. Composting is likely to be the most cost-effective form of treatment for these materials; however, a large proportion of this treated

material is still returned to landfill. Composting reduces the volume of this material by approximately 90% and prevents the breakdown process becoming anaerobic, reducing the amount of phytotoxic compounds being produced, while also significantly reducing the amount of greenhouse gases emitted.

Composting has a pivotal role to play in closing the 'organic loop' – returning valuable organic matter and plant nutrients to soil. To date, due to their high organic matter and lime content (2-11% dry matter), composted biowastes have primarily been considered as soil conditioners. However, their significant nutrient content, such as phosphorus and potassium, as well as calcium and sulphur, which are important for successful vegetable crops (Table 1), means they also have a value as a fertilizer. Using

Table 1: Differences in nutrient content of four categories of composted waste.

Composts	CaCl ₂ DTPA mg/L				
	Mean	NH ₄ -N	NO ₃ -N	P	K
Biowaste	Mean	19	321	40	1,404
Composted manures	Mean	2,418	74	103	7,378
Green waste	Mean	3	107	35	1,290
Anaerobic digestate	Mean	51	204	9	1,154

composted wastes as fertilizers has been problematic however, due to the heterogeneous nature of composts made from diverse waste sources (feedstocks) and the subsequent unpredictability of nutrient availability, due to a poor understanding of the effect of the primary feedstock on nutrient release. Within this study composted wastes from Ireland and other European countries were analysed to ascertain the optimal usage for these materials, based on their compositional characteristics and primary feedstocks.

Compost stability

In order for a composted waste to be marketed as a 'compost' (and used in horticulture/ agriculture), it must fulfil a number of criteria. An important criterion is that it must be 'stable', that is, the material is no longer microbiologically active. Under Irish standards, a material must have an oxygen uptake rate (OUR) value of 13 (units: mmol O₂/kg OS/h) or less to be considered stable. It is hypothesised that unstable composts (>13) would immobilise nitrogen when applied to a growing media or soil, however our studies indicate that such a rigorous standard may not be as appropriate for field crop application. Biowaste composts used in this study with stability levels of 15-25 displayed no nitrogen immobilisation during plant growth studies, indicating that where composted wastes are destined for field crops it may be possible to increase the stability standard required without negatively impacting plant growth. This would decrease the time and cost of the composting process and in turn reduce the cost of these materials to growers.

Nitrogen availability

Carbon/nitrogen (C/N) ratio is commonly used as a descriptor of compost quality, but also as a means of predicting nitrogen (N) availability. Increasingly modern composting methods are producing composts with a C/N ratio of less than 16, as composts with a C/N ratio greater than 14 will potentially result in N immobilisation. Under the current legislation, composts with a C/N ratio <10 have a predicted availability of N of 15%, and those with a C/N ratio of 12.5 have a predicted availability of N of 17.5%. However, this approach was largely developed for organic materials of a homogeneous nature, such as spent mushroom compost. As the materials from waste sources are far more heterogeneous, it was found that both

g/kg				mg/L	
Total N	Total P	Total K	Carbon	Ca	S
21.5	7.9	8.3	311.4	1,0575.6	1,088.8
30.4	14.3	31.4	426.1	5,287	2,645.6
20.9	2.8	8.3	278.1	7,900	161.9
27.4	4.2	8.5	235.1	9,386	37.4

neural detergent fibre (NDF) and lignin content were more accurate in predicting N availability from these materials (Table 2). The ability to more accurately assess N availability will allow for the development of more agronomically useful application rates, which can account for the low availability of N from these materials. Overall the availability of N from composted biowastes is low (approximately 8% of total N) and commercial production practices would require the application of an inorganic N source. Plant growth experiments indicated that once the compost is moderately stable, plant uptake of N from inorganic sources was not affected.

Phosphorus availability

In general, the plant uptake and availability of phosphorus (P) from composted wastes from growth experiments was higher than expected, and compared favourably with single super phosphate (SSP). While composted animal manures had the highest availability of P, there were no significant yield differences when biowastes were applied, on the basis of their total P content to plants whose P fertilizer was applied as SSP at a comparable rate. This finding suggests that instead of applying composts on the basis of their nitrogen content, which is largely unavailable to the plant, we should give more consideration to the P content of composted wastes.

In addition to the benefits described above in terms of nutrient recovery, applications of 5-10t of compost per hectare per year have been shown to balance the yearly impact of intensive cropping systems, with long-term compost application increasing soil C content. The full utilisation of composted wastes can help maintain sustainable intensive cropping systems.

Table 2: Nitrogen uptake results correlated with NDF, lignin and C/N ratio.

	NDF (%)		Lignin (%)		C/N Ratio	
	R ²	P value	R ²	P value	R ²	P value
Harvest 1	0.81	<0.01	0.74	<0.01	0.17	>0.05
Harvest 2	0.83	<0.01	0.91	<0.01	0.01	>0.05
Harvest 3	0.64	<0.01	0.79	<0.01	0.02	>0.05

Funding

This work was supported by funding from the EPA STRIVE scheme.



Healthy vegetables

The varieties of fruit and vegetables that are grown are chosen for many reasons: customer preference, yields, disease resistance, but perhaps, soon, they could also be selected for their health properties?

With increasing concern over the falling nutritional quality of some fruits and vegetables and continuing debate over general health claims of particular agronomic practices, there may be a commercial opportunity for growers to select varieties based on the content of specific health-promoting compounds known as ‘bioactives’. As part of the Irish Phytochemical Food Network (IPFN), several varieties of carrots, broccoli and onions were grown over a two-year period and assessed for specific bioactive compounds before and after minimal processing. The overall aim of this work is to provide Irish growers and companies with the knowledge to optimise primary production and processing of vegetables to create healthy and convenient products.

Falcarinol is a polyacetylene found in carrots where its primary function is to protect against fungal diseases, but it also has been linked with anti-cancer properties. The content of Falcarinol and several other polyacetylenes within different carrot varieties was assessed. Total and individual polyacetylene concentrations varied significantly. Total polyacetylenes ranged from 104 to 701µg/g dry matter, with three wild Irish carrot species (obtained with thanks from HRI Warwick, UK) returning the highest values. The range of values from current commercial varieties ranged from 104 to 361µg/g dry matter, with the content of Falcarinol ranging from 34 to 164µg/g dry matter (Figure 1). These data, and those for other vegetables, indicate that there is sufficient variation within commercial varieties to allow growers to select varieties for increased content of a specific bioactive compound of interest. However, consumer research is increasingly indicating that products, specifically fruit and vegetables, need to focus marketing on more than just health, and also promote other attributes, such as convenience.

Investigations into the effect of minimal processing indicated that removing the outer skin of the carrot with a brush had less effect on polyacetylene content than peeling. Also, how carrots were prepared (shredded, batons, discs, cubes) had a significant effect on the retention of polyacetylenes: shredded carrot displayed the largest decrease while carrot cut into batons retained the same polyacetylene levels as unprocessed carrots. When stored in modified atmospheric packaging, carrots maintained or increased their polyacetylene content over a 15-day period. The output of this work could allow growers

and processors develop new vegetable products based around health and convenience.

Acknowledgments

The authors would like to acknowledge the contributions of Dr. Ingrid Aguilo and Ms. Corina Abreu.

Funding

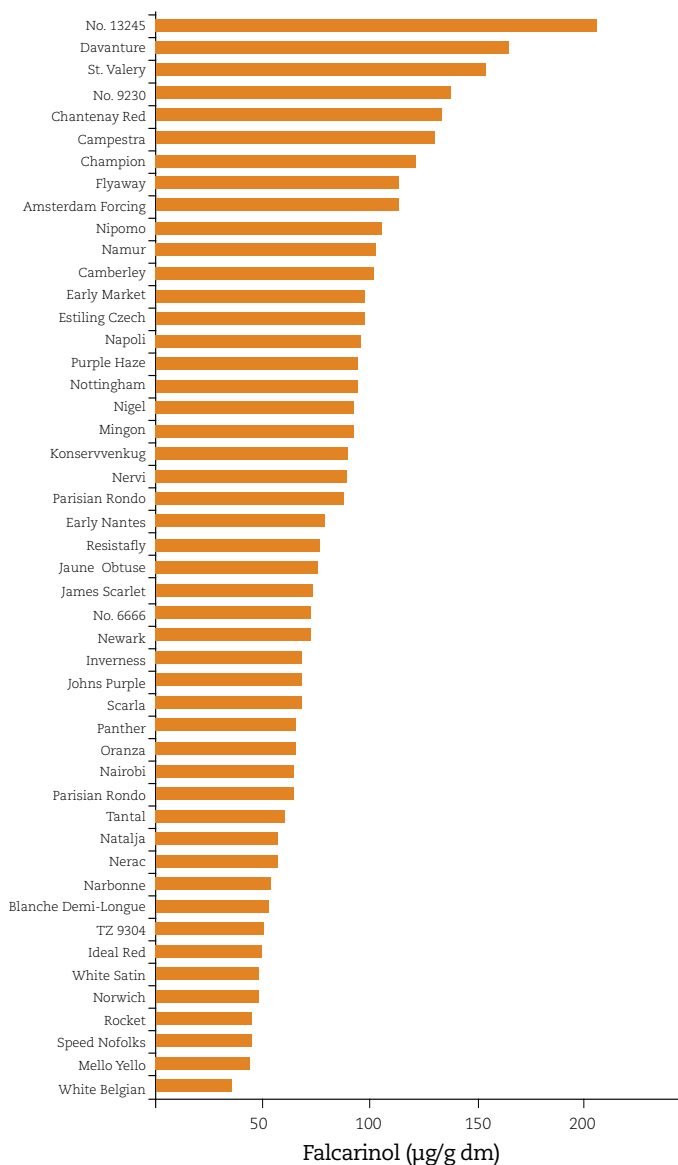
This work was funded by the Department of Agriculture, Food and the Marine under the Food Institutional Research Measure.



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Figure 1. Falcarinol content of commercial and heritage carrot varieties grown in a single year.





Consumer acceptance of phytochemicals as functional food ingredients

With many consumers failing to consume the recommended five portions of fruit or vegetables a day, Teagasc and colleagues from the Irish Phytochemical Food Network investigates consumers acceptance of functional food ingredients to help increase intake.

Dietary guidelines to consume at least five portions or 400 grams per day of fruit and vegetable exist because of the multitude of health benefits these foods confer, as well as a reduced risk for many diseases such as cancer and heart disease. It is the phytochemicals naturally present in fruit and vegetables that confer these health-promoting properties. Hence, an effort to increase the content of these naturally occurring phytochemicals in a person's diet seems logical. Recommendations to increase consumption of fruit and vegetables have achieved some success but most consumers still have intakes well below recommended levels. Therefore, other approaches, with potential to increase consumption of phytochemicals, warrant investigation. One such approach is extracting the beneficial phytochemical from the fruit or vegetable for use as a functional ingredient in other foods.

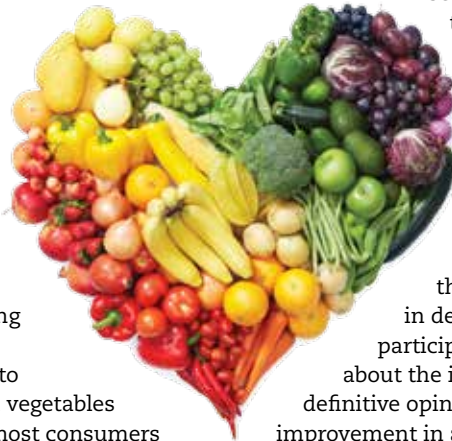
Qualitative research, in the form of focus groups, was undertaken to explore consumer preferences for varying delivery methods of phytochemicals in foods. Five focus groups were undertaken and consumers were presented with a picture of a hypothetical cheese containing glucosinolates – phytochemicals derived from broccoli – as a functional health ingredient. Discussions took place regarding acceptance, usage situations and understanding the benefits.

How do you like your phytochemicals?

In general fruit and vegetables were acknowledged as healthy and important in the diet by all participants. The perceived need for, and belief in the benefit offered, were associated with acceptance of the product. Parents of younger children viewed the concept favourably for children who would not eat

vegetables. Some also thought that the functional cheese would be of benefit to older consumers and those with an established illness. Younger groups did not perceive a personal need to consume disease-preventing foods. For some participants, especially females, the preference was to consume the beneficial ingredient as a supplement. Others showed a strong preference to consume the natural ingredient source (e.g. broccoli), rather than from any other source.

Within all of the groups there was a certain level of scepticism and many were unlikely to believe the benefit claim. Many indicated uncertainty about adding such ingredients to foods. However, there was some evidence of inconsistency in their thinking, as they held a positive view to the added ingredients contained in fortified milk. This suggests that familiarity is important in determining acceptance. Some participants wanted more information about the ingredient before forming a definitive opinion. There was a cautious improvement in acceptance of the ingredients following further clear and simple communication of the benefits and assurance that authorities, such as the European Food Safety Authority, would have to review and approve the health benefits of the ingredient before food producers could make a claim.



Recommendations

Overall, it appears that functional foods containing phytochemicals may be met with hesitation and caution by some consumers. Using established and accepted functional-food concepts may improve acceptance, e.g. the addition of phytochemicals to fortified milk. Furthermore, clear unambiguous communication of less familiar concepts such as phytochemicals and endorsement by trusted establishments, will be central to consumer acceptance.

Funding

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Integrating crop protection

As of January 2014, all growers are required to grow in a manner that is complementary to the principles of integrated pest management (IPM), which, in essence, means that crop-protection decisions should be considered in a prioritised order of: physical, cultural, biological and, finally, chemical.



Figure 1. Swedes growing under under bionet to protect against cabbage root fly.

The comparative lack of access to pesticides is an ongoing concern for Irish growers, who are often competing for market share against growers from jurisdictions with a greater availability of pesticides. Horticultural crops are often referred to as ‘minor crops’ at a European level, and because of the limited acreages involved, few new active ingredients are now developed or registered for the horticultural market. However, this continuing lack of access to pesticides, combined with increasing regulation and public opinion, has led to innovative practices being identified to combat pest, disease and weed problems. With few synthetic pesticides available, robust IPM strategies are being developed for many horticultural crops.

Delia radicum, the cabbage root fly, causes severe damage to transplanted Brassica plants, as its larvae feed extensively on the developing root system. As the availability of chemical control products for this fly has diminished in the last decade, growers have adopted alternative strategies. Many growers now use mesh covers on their crops (0.8mm) to keep the female flies from laying eggs at the base of the plants (Figure 1). This has also had the added benefit of protecting young crops from pigeon damage, which has noticeably increased in the last five years. There is also a favourable microclimate created under the nets, which can lead to quicker plant growth. However, this quick ‘soft growth’ can lead to a greater propensity to fungal diseases.

When growing crops under protection, in glasshouses or or polytunnels, there is the ability to modify the environment under protection for optimal crop growth, however, this environment is also favourable for pests, particularly insect pests.

Aphids, whitefly, thrip and spider mites attack most protected fruit crops, but they can largely be controlled by introducing beneficial insects, which feed on (Figure 2), or parasitise them (Figure 3). It is essential, however, that these ‘beneficials’ are introduced before pest populations become too high. In order to ascertain the optimal time to introduce these beneficials, growers invest significant effort and time monitoring for pests, particularly using coloured trapping cards (Figure 4). For pests, such as whitefly, it can be useful to intersperse crops with a plant such as aubergine, which is highly attractive to whitefly and is useful as a monitor plant for this pest.

While these systems are robust, there is a continual need to work on integrating them into the entire agronomic strategy. Recent research has shown that some predatory mites are adversely affected by certain fungicides, which reduce their ability to locate and kill two spotted mites. Therefore the use of these fungicides when there is high red-spider mite pressure is now avoided.



Figure 2. Adult hover fly introduced into a raspberry crop, whose larvae feed heavily on aphids.



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Figure 3. A group of raspberry aphids (*Amphorophora idaei*), one of which has a wasp larvae developing inside (circled).

As there is now increasing international trade in horticultural produce, the introduction of a new pest can challenge these IPM systems. Ireland is one of the last European countries where the spotted wing drosophila has yet to be reported. This small Asian fruit fly has spread from the Mediterranean to northern Europe in less than three years and is a major pest of soft and stone fruit, causing losses of over 70%, due to the fact that it lays its eggs in ripening fruit, as opposed to over-ripe fruit, which would be more normal for fruit flies (Figure 5). Teagasc, UCD and the Department of Agriculture, Food and the Marine have commenced a monitoring project using pheromone traps to provide Irish growers with an early warning system. Its arrival will be a severe challenge to Irish growers and will require re-evaluation of current IPM systems.

Even with the adoption of cultural, physical and biological techniques in the cultivation of most horticultural crops, there is a continuing need to improve these systems, both in protected and field crops. As described above, the pest population is continually evolving, therefore, it is essential that growers have the necessary, effective, modern pesticides available to use if required. The risk associated with growing horticultural crops, the high cost of production and demanding quality standards dictate that growers will sometimes need to resort to chemical options (which is an integral part of IPM), when other control options either fail or do not exist. A combination of legislative changes at European level, will likely result in the loss of 40 active ingredients and the probable loss of another 47 active ingredients used in crop protection in the near future. To put this in context for Irish horticulture, for major field crops such as *Brassica* species this would mean the loss of five of the nine registered insecticides, eight of the 14 registered fungicides and six of the nine registered herbicides. This has obvious implications for the development of pesticide resistance and highlights the



Figure 4. Yellow sticky trap used by carrot growers to monitor for carrot root fly (carrot root flies circled).

continuing challenges faced by growers, and also emphasises the increasing need to continue developing IPM strategies for horticultural crops, as well as continuing to evaluate and optimise them for Irish growing conditions.

Funding

This work is supported by Teagasc core funding and by the Department of Agriculture, Food and the Marine's STIMULUS funding programme.



Figure 5. Larvae of spotted wing *drosophila* emerging from a cherry.

Horticultural plant pathology



Inspecting a field of carrots for disease.



Brian McGuinness and Helen Grogan run the Horticultural Plant Pathology laboratory and report here on its diagnostic and research activities.



Plant disease diagnostics for the commercial horticulture sector is an important service. It ensures that growers know precisely what pathogens are affecting their crops so that they can take appropriate measures to control them. Plant pathology has been an important activity since the establishment of the Horticultural Research Centre at Kinsealy in 1959. With the imminent closure of the Kinsealy centre, plant disease diagnostic services are now available at the Ashtown campus, where the Horticulture Development Department has been relocated.

Problem samples are submitted by post or collected directly from the field by a network of experienced advisors and then analysed in the laboratory using microscopic and molecular methods. Symptoms may be caused by a number of things including fungal or bacterial pathogens, insect or other pests, chemical damage, nutritional deficiencies or weather damage. Often, a result can be returned within hours of sample receipt and, once the source of the problem is identified, qualified advisors can advise on an appropriate course of action.

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Shothole disease of *Prunus laurocerasus* (Laurel)

Laurel and its many cultivars, is one of the most popular protective hedge plants cultivated in Ireland today. It is also grown as a commercial crop for the cut foliage sector. However, the leaves suffer from 'shothole' disease, which is most commonly caused by the plant pathogenic bacteria, *Pseudomonas syringae* pv. *syringae*. Infected leaves develop small circular to irregular shaped lesions, 1-10mm in diameter. Within a few days, the lesions are excised, leaving small holes in the leaves that give the impression that they have been 'shot' with pellets, hence the name.

Shothole disease is a major problem for cut foliage growers as the leaves must be free of damage and blemishes of any kind to be acceptable. Anthony Twamley, a horticultural student at Dublin City University (DCU) and Teagasc, completed a final year research project this year on shothole disease. Anthony surveyed 19 *Prunus* cultivars in the grounds of the National Botanical Gardens, Dublin, to see if any showed resistance to shothole and might be suitable for the cut foliage sector. All plants surveyed showed some symptoms of shothole. The cultivar 'Polster' was the least affected, while the highest disease incidence was recorded for cultivars 'Rotundifolia' and 'Triomphe de Bordeaux', with average number of shotholes per leaf of 0.3, 5.2 and 16.4, respectively.

Controlled inoculation studies were conducted to



Anthony Twamley examining a laurel hedge for shothole.

more accurately evaluate levels of shothole resistance in the three cultivars – ‘Rotundifolia’, ‘Otto Luyken’ and ‘Ivory’ – using *P.syringae* isolate Ps7562 on detached leaves. The difference in disease response from the three cultivars was significant with only 8% of inoculation sites on ‘Ivory’ producing symptoms of infection, while 48% of inoculation sites on ‘Rotundifolia’ produced symptoms after just three days’ incubation. With a reliable inoculation method in place, further investigations into cultivar resistance can be continued.

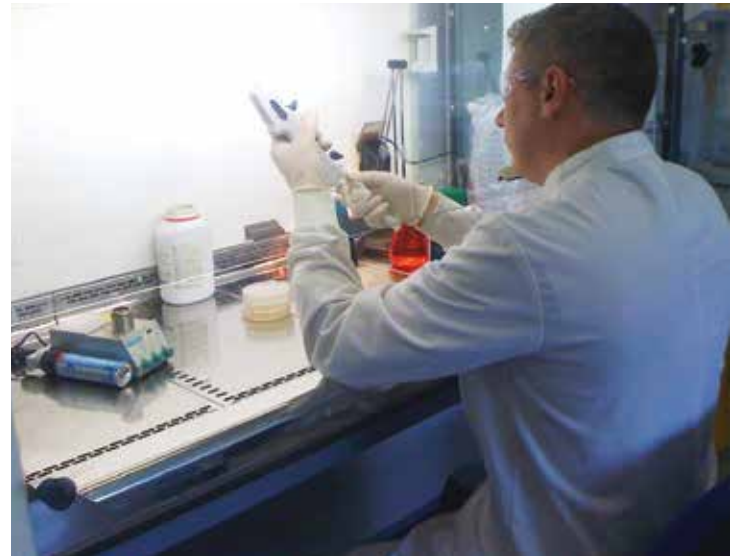
Leaf spot disease of *Escallonia*

An *Escallonia* fungal leaf spot disease came to the attention of the Kinsealy plant clinic in April 2006. It was described as having ‘*Septoria*-like structures with black pycnidia around a white central area and producing long narrow 4-celled spores’.

Since then, *Escallonia* leaf spot has become a significant problem for both the nursery stock industry and hedging suppliers, as *Escallonia* is commonly used as an ornamental boundary hedge. Research is being done by Brian McGuinness to characterise the disease, understand its epidemiology and identify potential control solutions as part of a research Masters at Trinity College Dublin, in collaboration with Trevor Hodkinson.



Severe leaf spotting on *Escallonia* leaves.



Processing of samples in the laboratory.

Taxonomic studies have identified that the disease is caused by a new species of *Septoria*, a major fungal genus with pathogens affecting many crops globally. Observational research has shown that once infection is established in the leaves in August, the disease spreads quickly. As rainfall increases, leaf wetness times are significantly longer, leading to a rapid increase in leaf spotting and release of fungal conidia. The disease progresses by rain splash from the base of the plant to the top, peaking in December. Diseased leaves senesce and die and by January, the normally evergreen shrub is bare. The disease quickly makes container-grown plants in the nurseries unmarketable leading to a high rate of rejection and plant losses. Fungicide trials are currently underway evaluating four chemicals and a biocontrol product for treating the disease. Both mature hedges and container-grown plants are included in the trials and results will be available early next year.

Cultivating the next generation of plant pathologists: science outreach

Over the years, Teagasc’s horticulture plant pathology laboratory has accommodated many doctoral, graduate and school students as part of its science outreach programme, encouraging young scientists to take an interest in plant pathology. Several have been quite successful in their endeavours. Kevin Howlett from Killester College of Further Education won an innovation award for his project on *Eucalyptus* Diseases in 2012. Kevin went on to study at Clonakilty Agricultural College in Cork and is considering a career in plant pathology.

Anna McEvoy from Greenhills College, Drogheda conducted the research for her entry to the 2014 BT Young Scientist of the Year at Teagasc’s horticulture plant pathology laboratory in Ashtown. Her project ‘The Aetiology of Bleeding Canker Disease in Horse Chestnut Trees’, won the Elan Student Award for excellence in 2014. She went on to represent Ireland at the 2015 Intel International Science and Engineering Fair (ISEF), held in Pittsburgh, and received first place in the Monsanto Company Award for innovation in Plant Science and Sustainability.

Funding

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Horticulture: technology transfer in practice



Irish and European mushroom growers and composters visiting a new farm in Poland.



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Communicating the benefits of Teagasc's horticultural research and advisory activities, and their application to the wider horticultural community, is a key objective of the Horticulture Development Department.

Transferring horticultural knowledge and technologies to commercial businesses takes many forms. Teagasc Specialist Advisors are constantly keeping abreast of the leading edge trends in their areas and passing this information on to growers via publications, newsletters, discussion groups, conferences, and workshops, as well as one-to-one conversations. Study tours and farm visits are organised to visit facilities where new technologies are already in place and where growers can see them in action. This provides hands-on opportunities to critically evaluate their potential for implementation on the home farm.

The Irish mushroom sector is one of the most advanced and successful in Europe. Mushrooms account for 46% of edible horticultural crops and Irish mushrooms have over 50% of the UK market.

Teagasc mushroom specialists have always been at the forefront of technology transfer to the sector and work closely with compost companies, growers, casing companies and all other industry stakeholders. While supporting the industry generally, Teagasc also have a direct relationship with CMP, Commercial Mushroom Producers, a producer organisation that represents 75% of mushroom growers in Ireland. A joint programme exists where the Teagasc specialist is embedded with CMP on a day to day basis. The most recent specialist, Dermot Callaghan (now Head of Department) has been involved in designing and delivering a package of technical services to grower members, who now have large scale, efficient and technology-driven businesses. He is supported by researcher Helen Grogan and her team at Ashtown. Technology transfer is organised on a routine basis, with farm walks, seminars, workshops and a biennial All Ireland and UK Mushroom Conference and Trade Show. This year the theme of the conference is 'Harnessing Innovation' and Chairman of the organising committee Dermot Callaghan, Teagasc, states "the conference reflects a progressive and innovative culture in the mushroom industry where entrepreneurial growers grasp every opportunity to increase efficiencies and maximise profit."



Study tour to California by Irish soft fruit growers in 2014.

A recent study tour to California by Irish soft fruit growers, organised by Specialist Advisor Eamonn Kehoe, in association with the Irish Soft Fruit Growers Association, resulted in a number of new varieties of strawberry and raspberry being grown here.

Andy Whelton, Ornamentals Specialist, has spearheaded the development of production blueprints for new-cut foliage species. Once protocols have been fine-tuned to market needs, he organises on-farm discussion groups to demonstrate the requirements of the crop to interested growers.

Fruit and vegetable growers need the most up-to-date advice on nutrient needs for productive crops and pesticide advice in the event of pest and disease problems. Stephen Alexander, Specialist Vegetable Advisor, is involved in updating key Teagasc publications such as *Major and Micro Nutrient Advice for Productive Agricultural Crops* and *Approved Pesticides for use on Vegetable Crops* when new information is available. Stephen also produced a *A Guide to Vegetable Growing* for the general public and is heavily involved in promoting horticulture at Bord Bia's Bloom in the Park every year.

Michael Gaffney, Researcher in Protected Crops and Integrated Pest Management, organises an annual protected crops conference to inform the sector of up-and-coming technologies identified



Stephen Alexander talking with a member of the public at Bloom.



Andy Whelton discusses agronomy requirements of *Hypericum* with cut foliage growers.

across the wider European horticultural industry. He also provides workshops and seminars on integrated pest management (IPM), a technique that works well in protected environments, but is reliant on the ability of growers to be able to identify key pests such as aphids, to accurately target biological, cultural and chemical controls effectively.

Two technology transfer events will take place in the coming months. In September, fruit and vegetable growers and food producers are invited to a seminar on 'Exploiting the Commercial Potential of Phytochemicals' and in October, the mushroom industry is invited to the '2015 All Ireland and UK Mushroom Conference and Trade Show'. Further details of both events can be found in our events section on page 40.



Growers learn how to identify aphids as part of an IPM workshop.

Events

SEPTEMBER

September 28-30

Co Wexford, Ireland

Catchment Science 2015

An international conference exploring the latest developments in catchment science and its application to the challenges facing farmers, policy makers and regulators. The conference is hosted by the Agricultural Catchments Programme in Wexford with two days of indoor sessions and a choice of field trips on day three. Contact: CatchmentScience2015@teagasc.ie

September 29

Department of Agriculture, Food and the Marine,
Backweston, Celbridge, Co Kildare

Phytophthora ramorum in Irish forests - workshop

This workshop will discuss the detection, epidemiology and control of *Phytophthora ramorum* and *P. kernoviae* in Irish forests.

Contact: josephine.brennan@agriculture.gov.ie

<http://www.eventbrite.ie/e/phytofor-detection-epidemiology-and-control-of-phytophthora-ramorum-and-p-kernoviae-in-ireland-tickets-18344491869>

September 30

Teagasc Food Research Centre, Ashtown, Dublin 15

Exploiting the Commercial Potential of Phytochemicals

This conference includes sessions on: Chemical characterisation of phytochemicals; Enriching food products with phytochemicals; Optimising levels of antioxidant phytochemicals in fresh-cut products; Exploring the commercial potential of potato peel waste; and Update on permitted health claims.

Contact: michael.gaffney@teagasc.ie

http://www.teagasc.ie/events/2015/IPFN-workshop-2015_Final.pdf

OCTOBER

October 13

Kilbrin, Co Cork

Research on 1st and 2nd Thinning of Conifers

Teagasc, as part of its forestry research programme, has established a new thinning trial in Kilbrin, Co Cork. The research is aimed at providing growers information about the effect of thinning on the growth and development of the forest crop and the optimum treatment to produce a commercial crop. It is possible that rotation ages could be significantly lowered on highly productive sites. Financial analysis indicates that a robust first thinning, close to marginal thinning intensity, yields the best return on investment, and if thinning is to be considered stands should be thinned early to offset the risks of windblow.

Contact: john.casey@teagasc.ie

<http://www.teagasc.ie/forestry/events/>

October 15 & 16

Hillgrove Hotel, Monaghan

All Ireland and UK Mushroom Conference & Trade Show 2015

The theme for the conference 'Harnessing Innovation' reflects the progressive and innovative spirit of the industry. The conference offers growers a unique opportunity to expand their knowledge base through exposure to the latest technology, and to network with other growers, composters and suppliers. The conference on October 15 will be followed by farm walks on October 16. Sponsored by Bord Bia.

Contact: dermot.callaghan@teagasc.ie

<http://mushroomconference2015irelandanduk.com/>

October 16

Clonmel Park Hotel, Clonmel, Co Tipperary

Soil Fertility Conference – Fertiliser for growth in grassland farming systems

This conference includes sessions on: National Soil Fertility; New Developments in Soil Fertility Research; and Soil Fertility Research into Practice.

Contact: david.wall@teagasc.ie/pat.murphy@teagasc.ie www.teagasc.ie/events

October 20

Cavan Crystal Hotel

October 21

Horse and Jockey Hotel, Thurles

Pig Farmers' Conference

This conference features a number of presentations covering a broad array of topics relating to nutrition, performance and animal health. It also features a research update on current projects and a poster session by students involved in the research programme at Teagasc, Moorepark. This provides attendees with the opportunity to meet with our researchers and students to find out more about the projects ongoing in the Pig Development Department.

Contact: Ciaran.Carroll@teagasc.ie

October 21-22

Killeshin Hotel, Portlaoise, Co Laois

Teagasc Biodiversity Conference

Teagasc is pleased to announce a conference titled 'Farmland Conservation with 2020 vision' and encourages submission of papers on relevant topics. This conference follows on from the successful 'Conserving Farmland Biodiversity' conference, which Teagasc organised in May 2011. The EU Biodiversity Strategy to 2020 aims to halt the decline of biodiversity and the degradation of ecosystem services. The Food Harvest 2020 strategy highlights the need to develop effective methods for biodiversity conservation, as part of the development of sustainable production systems. A key aim of this conference is to address how the agriculture sector has responded to these and other policy objectives, and how prepared the sector is for similar policy objectives post 2020.

Contact: daire.ohuallachain@teagasc.ie

www.teagasc.ie/events

NOVEMBER

November 8-15

Teagasc locations

Science Week

Teagasc proudly supports this initiative, which is coordinated by Science Foundation Ireland (SFI) Discover, the education outreach programme of SFI, by holding events at its research and education centres. The aim of Science Week is to promote the relevance of science, technology, engineering and maths (STEM) in our everyday lives and to demonstrate their importance to the future development of Irish society and to the economy.

The annual Walsh Fellowship seminar takes place during Science Week (November 12) at the RDS, Dublin. The annual seminar is a very important element of the training of Walsh Fellows and all Fellows nearing completion of their research are expected to make either an oral presentation or participate in the poster session.

Contact: catriona.boyle@teagasc.ie

www.scienceweek.ie

November 19

ExCeL, London

Second UK-Ireland Food Business Innovation Summit

The Institute of Food Research, together with Teagasc and in partnership with Food Matters Live, is hosting the second UK-Ireland Food Business Innovation Summit on November 19 at ExCeL, London.

Contact: ciara.mcdonagh@teagasc.ie

www.foodmatterslive.com

November 26

Crowne Plaza Dublin Airport Hotel

CANtogether final conference

This conference will look at the sustainability of Mixed Farming Systems from an environmental, economic and social perspective. Results of the Crops and Animals Together (CAN) EU FP7 project, which assessed the relevance of farming systems combining crops and animals to increase sustainability of farms and regions across Europe.

Contact: eimear.ruane@teagasc.ie

<http://www.fp7canttogether.eu/conference.php>

For a list of Teagasc's food industry training schedule (food safety, food law, animal welfare, quality assurance, microbiology, cheese making, calculating meat content, laboratory auditing) please see: <http://www.teagasc.ie/food/research/training/schedule.asp>
For presentations from previous Teagasc events see: <http://www.teagasc.ie/publications/>