WALSH FELLOWSHIPS PROGRAMME

TEAGASC WALSH FELLOWSHIPS SEMINAR 2012

RDS, Ballsbridge, Dublin 4 :: Thursday, 22 November 2012

ABSTRACTS

teagasc
Agriculture and Food Development Authority

RDS

IFSTI

INTRODUCTION

Professor Gerry Boyle
Director of Teagasc

Over the years, Teagasc has effectively adapted the Walsh Fellowship Programme to meet the changing priorities of postgraduate training, the dynamics of research and research funding in Ireland, the changing employment prospects for graduates and Teagasc's own scientific priorities. During 2012, we continued with this process of change and adaptation, embracing an increased level of internationalisation of the programme, the introduction of new formats and the provision of formal structures for the development of supervisory skills amongst staff.

The New International Dimension

Science is becoming an increasingly global discipline and it is vital that our students are exposed to the best international science and research outside of Ireland. As a consequence, an increasing number of fellowships over the years have been undertaken with universities outside of Ireland. With a view to further broadening this international dimension, Teagasc awarded short-term overseas training grants in 2012 on a competitive basis to six current Walsh Fellows to spend short training periods in approved universities and research institutes.

The purpose of these awards is to strengthen the research training of Walsh Fellows, assist them in realising career objectives and develop their scientific capabilities by learning clearly-defined methods useful for their ongoing research. The initiative will also serve to strengthen Teagasc's own links with research teams in high quality overseas institutions.

New Fellowship Formats

This year saw the first full year of our new M.Agr. Sc Innovation Support Programme, which is being run in association with University College Dublin. This programme aims to equip graduates with the skills and knowledge to be effective in building the capacity of farmers to adopt new practices and technologies. The experience gained will equip the students for future roles in advisory services, technical consultancy and education delivery. The programme consists of taught modules, a research project on a particular knowledge transfer issue and practical experience in teaching and/or advisory work.

Also in 2012, we developed a new industry-based postgraduate programme which will offer an employment focused postgraduate experience different from the traditional academic focus. The scheme offers fellows the opportunity to complete a Masters or PhD degree while employed by a private company in the agri-food sector. The core of the educational scheme is a close and formalised partnership between an enterprise, Teagasc and a university on the implementation of a research project, which at the same time constitutes the subject in the training of a graduate at Masters/PhD level. In carrying out the research project, the fellow applies the knowledge and technology of Teagasc and the university to the benefit of the enterprise, which thereby acquires advanced knowledge and valuable technical skills.

Enhancing Supervisory Skills

Later this month, we will run a one-day training workshop for supervisors of Walsh Fellows facilitated by Prof Alan Kelly, Dean of Graduate Studies, UCC. This workshop is based on the common framework developed by Irish third-level institutions for the support of supervisors of postgraduate research students – "Developing an Institutional Framework for Supporting Supervisors of Research Students" (2012). This is an extremely important initiative for Teagasc and reflects emerging best practice internationally to provide formal structures for the development of supervisory skills amongst staff supervising PhD students. Many of our Irish third-level institutes are currently striving to establish formal procedures for the professionalization of supervision and the support of academic staff in this important element of their work. It is vital that Teagasc staff are also fully supported in this area of activity.

Conclusion

The Walsh Fellowship Programme has proved to be remarkably effective in meeting the training needs of young graduates and directing them into high-grade employment in industry, academia and the wider public sector. Through ongoing adaptation to the changing scientific and industrial environment, Teagasc will ensure that the Programme continues to address new challenges and opportunities as they arise.

TEAGASC WALSH FELLOWSHIPS SEMINAR 2012 **ABSTRACTS**

ORAL ABSTRACTS

The use of power ultrasound for accelerating the curing of pork

C. McDonnell[1], J. Lyng[2], J. Arimi[2], D. A. Cronin[2] and P. Allen[1]

[1] Department of Food Chemistry and Technology, Teagasc Food Research Centre, Ashtown, Dublin 15. [2] School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4.

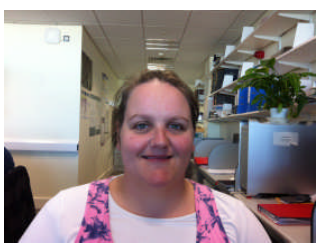
Meat curing is a time-consuming and labour-intensive process. Power ultrasound (US) may induce cell disruption through cavitation thereby increasing mass transfer. This study aims to assess whether US can accelerate the transfer of brine into meat and to establish its effect on meat technological parameters. Pork *M. longissimus thoracis et lumborum* samples were placed in a diffusion cell. Brine (6% NaCl) was placed on top of the samples allowing for unidirectional diffusion, and an ultrasonic probe was placed in the brine. A 3 x 3 factorial design was applied with ultrasonic intensities of 50, 75 and 100 W/cm^2 and treatment times of 10, 25 and 40 min. A non-sonicated cured sample acted as the control. Samples were analyzed for changes in NaCl content, moisture content, weight, pH, colour, texture profiles, cook loss and water-holding capacity. Differential scanning calorimetry acted as an indicator for protein denaturation and low-field nuclear magnetic resonance (LF-NMR) was used to assess water distribution and mobility. NaCl content (%) was increased by all ultrasonic treatments ($p<0.001$) compared with the control. Moisture content (%) was significantly increased by 100 W/cm^2 for 10 or 25 min ($p<0.05$). Decreased cohesion force ($p<0.05$) and gumminess ($p<0.05$) were evident in sonicated samples. There was no effect on the pH or the total colour difference of samples ($p>0.05$). Myosin denaturation occurred on the surface samples treated with the highest power input (100 W/cm^2 for 40 min), but this effect was not evident at a depth greater than 2 mm from the surface. No changes in water-holding capacity, water mobility or distribution were evident by centrifuge or LF-NMR analysis. Ultrasonic curing can assist in brine transfer, thus reducing processing times without any detrimental impact on the quality of the end-product.

The formation of an anti-cancer complex during *in vitro* and *in vivo* digestion of milk

L.M.Sullivan[1,2], J.J.Kehoe[1], L.Barry[3], M.J.M.Buckley[3], F.Shanahan[4], K.H.Mok[2] and A.Brodkorb[1*]

[1]Teagasc Food Research Centre, Moorepark, Fermoy, Cork. [2]Trinity Biomedical Sciences Institute, Trinity College Dublin. [3]Gastrointestinal Clinical Measurement Laboratory, Department of Gastroenterology, Mercy University Hospital, Cork. [4]Alimentary Pharmabiotic Centre, University College Cork.

Previously a complex that is lethal to tumour cells has been formed from two major milk components – the protein alpha-lactalbumin and the fatty acid oleic acid. It has been speculated that conditions for complex formation are similar to those found in the acidic digestive tract of infants. *In vitro* digestion methods mimicked the digestive tract of breast-fed infants; *in vivo* digestion was performed using adult volunteers who were fitted with naso-gastric tubes to allow gastric sampling. Samples were tested for structural changes during the digestion process, and bioactivity of the fractions was assessed. In both the *in vitro* and *in vivo* samples the required structural change occurred for complex formation. Results showed that under *in vitro* digestion conditions a complex that was active against cancer cells was formed. This complex was not formed under *in vivo* (adult model) conditions. Further investigations of the gastric contents using *in situ* visualization showed that the conditions within the stomach of adults were not adequate for complex formation, as a homogenous mixture was not seen. In conclusion, while the pH conditions within the stomach are favourable for the production of the complex, the mixing conditions are not sufficient for the complex to form.



Antimicrobial mediated alteration of the gut microbiota as a means of controlling weight gain

S. F. Clarke[1, 2], E. F. Murphy[4] , R. P. Ross[1, 3] , P. W. O'Toole[2, 3] and P. D Cotter[1, 3]

[1]Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork. [2]Microbiology Dept., University College Cork. [3]Alimentary Pharmabiotic Centre, University College Cork. [4]Alimentary Health Ltd., Cork.

The obesity pandemic has become one of the most prevalent health issues of our time, causing an ever-increasing burden on society. Recent studies linking the composition and function of the gut microbiota and obesity have led to large interest in this area. In a previous study by our group, we demonstrated that a reduction in weight gain in mice fed a high fat diet was attainable through manipulation of the gut microbiota due to administration of the antibiotic vancomycin, or the bacteriocin-producing probiotic *Lactobacillus salivarius* UCC118 (Bac^+). Nonetheless, it was noted that the benefits of these interventions were most dramatic early in the intervention period and were reduced over time, and in the case of the Bac^+ cohort, reduced such that the effect was no longer significant when the study concluded. Here we describe a retrospective DNA sequencing-based analysis of the murine gut microbial populations during the early stages of intervention and carry out a comparison with those present subsequently. The results revealed several inter-group and temporal differences over the six week period between microbial compositional analyses. In particular, it was apparent that vancomycin severely altered the gut microbial composition, relative to controls, at the early time point but that some recovery occurred in the subsequent six weeks. It was also revealed that, at this early time point, Bac^+ treatment resulted in the presence of significantly higher proportions of *Peptococcaceae* and significantly lower *Rikenellaceae* and *Porphyromonadaceae* relative to the gut microbiota of Bac^- -administered controls. This study offers support for the merits of utilizing antimicrobial strategies to target components of the gut microbiota and, in turn, obesity, and suggests that the targeting of specific microbial components using probiotics and other food bioactives could lead to beneficial effects over an even longer period.

Acceleration of cheddar cheese ripening using cell free extract of lactic acid bacteria entrapped in yeast

A.B. Yarlagadda[1, 2], M.G. Wilkinson[2], S. Ryan[1] and K.N. Kilcawley[1]

[1]*Department of Food Biosciences, Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork.* [2]*Department of Life Sciences, University of Limerick, Ireland.*

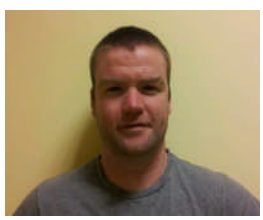
The ability to reduce the maturation time of Cheddar cheese without adversely affecting quality or shelf-life remains an important industrial objective. Enzyme entrapment has a wide range of potential applications, one of which is to enhance biochemical activity to direct and control flavour development in cheese. In this study, enzyme extracts were prepared from starter lactic acid bacteria (LAB) and entrapped in freeze dried attenuated *Yarrowia lipolytica* yeast. Yeasts were grown to high cell numbers and their structure altered using high pressure mechanical treatment. These cells were freeze dried to increase their permeability in order to enhance their capacity to absorb enzymes. Enzymes were entrapped by mixing freeze dried yeast with enzyme extracts under controlled conditions. Entrapment efficiency, yeast cell structure and stability were examined. Activities of key enzymes were enhanced in the entrapped yeast sample in comparison to yeast or enzyme extracts on their own. These novel entrapped enzymes were used in the production of pilot scale Cheddar cheese trials to accelerate ripening. Inclusion of yeast alone or yeast containing entrapped enzymes enhanced ripening. This study has shown that yeast cells can be used as a novel carrier of entrapped enzymes to boost flavour and shorten ripening time.

Dulse seaweed proteins and peptides: potential as heart health ingredients and their delivery in bread products

C. Fitzgerald*, E. Gallagher*, J. Prieto † and M. Hayes*

***** *Teagasc Food Research Centre, Ashtown, Dublin 15 .* †*School of Pharmacy, University of London, Brunswick Square, London WC1N 1AX, UK.*

Seaweed is an abundant, sustainable and underutilised resource found around the Irish coastline. The red seaweed *Palmaria palmata*, commonly known as Dulse, has a long tradition of consumption in coastal European and North American regions. *P. palmata* protein content ranges from 9- 25%. The enzyme renin plays an important role in blood pressure regulation and is the initial rate limiting enzyme in the renin angiotensin system (RAS). To combat hypertension, various stages of the renin angiotensin system (RAS) can be positively affected. This study isolated and characterised renin inhibitory peptides from *P. palmata*. Their inclusion in bread products was also assessed. The *P. palmata* protein hydrolysate generated inhibited renin by 41.89% (± 3.22) at a concentration of 1 mg/ml. Reverse phase- high performance liquid chromatography (RP-HPLC) was employed to enrich for renin inhibitory peptides. Fraction 25 (F_{25}) inhibited renin activity by 58.97 % (± 1.26) at a concentration of 1mg/mL. Novel peptide sequences were elucidated using mass spectrometry (MS) and the parent protein from which they were derived determined using MS in tandem with protein database searches. Microwave-assisted Solid Phase Peptide Synthesis (MW-SPPS) of the identified peptides was carried out and the renin inhibitory activities of the synthesised peptides determined. The peptide sequence IRLIIVLPILMA demonstrated considerable renin inhibitory activity giving an IC_{50} of 3.34 mM. Subsequently, the *P. palmata* protein hydrolysate was incorporated into bread to determine how the baking process and interaction with other ingredients of baked goods affected the bioactivity and functionality of the bread. Compared to a control, breads containing the hydrolysate showed significant changes in volume, crust colour and texture profiles, whilst not affecting water content or crumb cell number and size significantly.



Next generation DNA sequencing potentially uncovers the long sought-after cause of "pinking" in cheese

L. Quigley[1,2], J.J. Sheehan[1] and P. D. Cotter[1,3]

[1]Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork. [2]Microbiology Department, University College Cork. [3]Alimentary Pharmabiotic Centre, Cork.

Pink discolouration in cheese has been reported over many decades in a range of ripened cheeses across a wide geographical area. This discolouration can manifest itself in a number of ways, e.g. as patches at the surface or within the cheese block or as a uniform pink border occurring below the surface of the cheese block, resulting in down-grading or rejection of the product with consequential economic losses. The underlying cause of this defect has been the focus of considerable research and debate ranging from the suggested involvement of physicochemical factors to microbial reactions but, to-date, has remained elusive. To further investigate the possible involvement of microorganisms in this defect, we applied, for the first time, state-of-the-art DNA sequencing technology to gain an in-depth insight into the microbial content of pink discoloured cheeses. This strategy enables an assessment of the entire bacterial complement regardless of how difficult it is to grow these bacteria in the laboratory. Thus, we extracted total DNA directly from the discoloured area and from a corresponding area of a non-discoloured cheese. Following this, the DNA of bacterial 16S rRNA gene, which acts as a bacterial DNA fingerprint, was sequenced. We employed bioinformatic tools to reveal the bacterial population, which exposed the presence of a bacterium which was specifically associated with the pink discoloured samples. Following detection of this bacterium, we designed a quantitative DNA-based method to rapidly detect and quantify this bacterium. This approach, and the requirement of environmental samples from selected cheese manufacturing plants, revealed the presence of this microorganism within manufacturing facilities, in particular in hot water sources. Hence, by applying this ground-breaking technology we have identified, for the first time, the presence of a bacterium in cheeses, and associated manufacturing facilities, which may represent the cause of pink discolouration in cheese.

Monitoring changes in bovine lactoferrin over lactation which may influence bioactivity

N. O'Riordan[1,2], M. Kilcoyne[2], J. Q. Gerlach[2], J. O'Callaghan[1], M. Kane[2], R. M. Hickey[1] and L. Joshi[2]

[1]Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork. [2]Glycoscience Group, National Centre for Biomedical Engineering Science, National University of Ireland Galway.

Lactoferrin (LF) is a biologically important glycoprotein present in mammalian milk and has a range of important health promoting effects, including antimicrobial, antiadhesive, prebiotic, immunomodulatory and anticancer properties. Many of these properties can be attributed to the glycan chains which are attached to the LF protein. This study aims to monitor changes to these glycan chains over the course of lactation in bovine milk and predict how such changes affect LF's biological activity and value as a functional ingredient. A versatile lectin array platform was employed for this purpose. Clear distinctions between early and late lactation glycoprofiles were observed, with a higher level of overall glycosylation in colostrum samples. Anti-microbial sialic acid, fucose and other complex structures were highest in colostrum samples, while monosaccharide analysis revealed an increase in anti-infective oligomannose structures as transitional lactation progressed. Overall, lactoferrin glycosylation was found to be more complex in early lactation when compared to later in the lactation cycle, which may correspond to the extra protection required by the young mammal immediately after birth. The results from this study suggest glycosylated proteins such as LF and the immunoglobulins, may act as an initial immune system, passed from mother to calf through the milk, with their glycosylation evolving in tangent with the calf's own immune system and gut micro flora. Due to their differing glycoprofiles, LF from colostrum and from mature milk should be considered as two separate ingredients in products such as infant formula or functional foods.

New dairy 2020: the emergence of new entrant farmers to the Irish dairy industry

R. McDonald[1,2], K.Pierce[2], L. Shalloo[1], A. Macken-Walsh[3] and B. Horan[1]

[1]*Animal and Grassland Research & Innovation Centre, Teagasc Moorepark, Fermoy, Co. Cork.* [2]*School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4.* [3]*Tegasc Rural Economy & Development Programme, Mellows Campus, Athenry, Co. Galway.*

The objective of this mixed-method study was to describe the characteristics and expectations of new entrants to the Irish dairy industry and to subsequently evaluate alternative expansion strategies and the role of research technologies within these new businesses. The results of this research indicate that a young and highly-educated group of new entrants is establishing within the Irish dairy industry, with the majority converting from beef and mixed enterprise farms. Ninety-three percent of new entrants have at least two years of formal 3rd level agricultural education and intend to become relatively large scale and efficient milk producers post-EU milk quota abolition. The results provide further evidence that quota abolition is likely to result in increased milk production within the traditional milk producing areas in the south of Ireland. The Moorepark Dairy Farm Systems Model was used to investigate a range of expansion strategies for new entrants and the results of this analysis indicate that, while expansion in milk production is necessary on new entrant farms to maintain profitability over time, EU milk quota super levy fines in the years pre-quota abolition and high capital and financing costs associated with expansion create significant business risk and cash flow deficits on these new dairy farms. In the final component of the study, survey and interview techniques were employed to qualitatively evaluate the challenges of new dairy farm development and the role of dairy research technologies within these new businesses. The results indicate that while new entrant dairy farmers are adopting the relevant grazing and animal breeding technologies adequately, the lack of understanding of financial technologies, in particular, is of concern within highly debt-financed farm businesses where stringent financial control and cash flow monitoring are essential.

Effect of rubber covered slats on the welfare and behaviour of group-housed sows

J.A. Calderón Díaz[1, 2], A.G. Fahey[2] and L.A. Boyle[1]

[1]Pig Development Department, Teagasc Animal and Grassland Research & Innovation Centre, Moorepark, Fermoy, Co. Cork . [2]School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4.

Lameness is a major production disease of pigs and flooring is a risk factor. Constraints on the use of bedding mean that fully slatted floors predominate on Irish units. This project evaluated the effect of rubber flooring on the welfare of sows using a multidisciplinary approach incorporating health, behaviour and performance indicators. These indicators were firstly compared between group and individually-housed sows on concrete flooring. Although differences in claw health between the housing treatments were minimal, group-housed sows had poorer locomotory ability, suggesting that lameness will increase once the national herd switches to group housing in 2013. A longitudinal study on a commercial farm revealed that sows on rubber (RUB) slats were at lower risk of lameness, swellings and wounds on the limbs compared to sows on concrete (CON) slats. However, they were at higher risk of claw lesions such as toe overgrowth, heel-sole crack and white line disease. Nevertheless, fewer RUB sows were culled due to leg problems; they had more piglets born alive and were less likely to crush piglets during lactation. Our work also confirmed the preference of pregnant sows for a comfortable place to lie. When sows had access to rubber flooring, they spent more time in the rubber area and were more likely to lie there compared to sows in pens without rubber flooring. We found few carry-over benefits of housing on rubber during pregnancy on postural behaviour in the farrowing crate. There were no differences in the number of attempts, latency or time to lie-down between RUB and CON sows. Our work also showed a detrimental effect on claw health of the fully slatted floors used in farrowing crates irrespective of the flooring type during pregnancy. This project illustrated that rubber flooring could help to overcome problems with lameness associated with group housing and can increase sow productivity.

Agronomic performance and competitive hierarchies of perennial ryegrass cultivars sown in mixtures and monocultures

V. Griffith[*†], T. J. Gilliland[†§], M. O'Donovan[*], D. Hennessy[*] and M. McEvoy[*].

[*]*Teagasc Animal and Grassland Research & Innovation Centre, Moorepark, Fermoy, Co. Cork.* [†]*Queen's University, Belfast, Northern Ireland.* [§]*Agri-Food Biosciences Institute, Plant Testing Station, Crossnacreevy, Belfast, BT5 7QJ, Northern Ireland.*

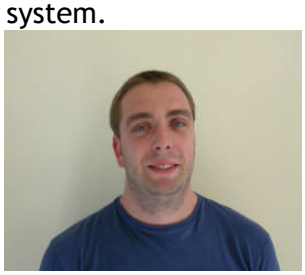
Perennial ryegrass is the most important grass species in Ireland, accounting for 95% of all forage seed sold. Perennial ryegrass cultivars are evaluated in national recommended list trials as monocultures, but retailed to farmers as cultivar mixtures. There is a limited amount of information available to farmers on the interactions that occur in seed mixtures. The study investigated the effects of mixing three perennial ryegrass cultivars on the agronomic performance of the sward in comparison to the performance of the components grown as monocultures. The competitive hierarchies between cultivars within mixtures were investigated using the genetic differences between cultivars to identify the proportion of each cultivar in the sward canopy. The mixtures were examined under a simulated grazing and a conservation management. The performance of mixtures, both in terms of dry matter yield and dry matter digestibility, tended to fall within the range of the component cultivars performance. There was no synergistic response between the cultivars. Including cultivars that have become outclassed in mixtures limited the performance potential of the mixed sward. The investigations into the competitive hierarchies in mixtures showed cultivar proportions could change by 30% ($P<0.001$) from the sown proportions. The changes only occurred where a competitive advantage rested with one cultivar in the mixture. The larger plant size of the tetraploid cultivars tended to shade the smaller diploid cultivars. The tetraploid cultivar never completely suppressed the diploid cultivar due to the diploid plants populating the spaces between the tetraploid plants. A competitive equilibrium developed in the first year post sowing and persisted into the second year. Cultivar construction at farm level should be based on cultivars from the national recommended list as their agronomic performance has been tested in field trials. Cultivars can be selected for specific requirements at farm level based on their performance in the national recommended list trials.

Genome-wide associations for carcass traits in Irish Holstein-Friesian cattle

A. G. Doran[1,3], C. J. Creevey[1] and D. Berry[2]

[1.] Teagasc Animal and Grassland Research & Innovation Centre, Grange, Dunsany, Co. Meath. [2.] Teagasc Animal and Grassland Research & Innovation Centre, Moorepark, Fermoy, Co. Cork. [3.] Molecular Evolution and Bioinformatics Unit, Biology Department, NUI Maynooth, Co. Kildare.

Genome-wide methods have been identified as the foremost approach to fully investigate polygenic traits such as disease susceptibility, health and growth. The aim of this study was to unravel the genetic architecture influencing growth and carcass characteristics using phenotypes of four carcass traits; carcass weight (CWT), carcass fat (CFAT), carcass conformation (CONF) of progeny, as well as cow carcass weight (CULL). Two genome-wide association approaches were performed on data from 1,061 Irish Holstein-Friesian artificial insemination bulls. The first approach included SNPs individually in a linear mixed model. Following adjustment for a false discovery rate of <5%, the number of SNPs associated with each trait were 2, 25, 496 and 48 for CWT, CFAT, CONF and CULL, respectively. The second statistical approach used a Bayesian mixture model. This method allowed the incorporation of prior knowledge about the distribution of SNP variances and effects. SNP posterior probabilities (PP) for each trait were calculated using alternative prior distributions of the proportion of SNPs that were associated with each trait. Investigation of PP and the occurrence rate of SNPs across priors found 12, 7, 12, and 16 SNPs for CWT, CFAT, CONF and CULL, respectively. Bovine genes within a 500kb region up and downstream of SNPs found significant using the Bayesian method were identified and mapped to their human orthologs (hg19). The R package GOseq, without the correction for gene length bias, was used to identify significantly over-represented KEGG pathways. A number of pathways were found to be significantly over-represented; these included Jak-STAT, p53 (both CWT) and PPAR (CFAT) signaling pathways. A number of quantitative trait loci have been identified for each trait using both statistical methods. Results from this study have identified a number of genes and key molecular processes involved in growth and carcass traits. Additionally, results may also be used to increase accuracy of selection if included in a genetic evaluation system.



The economic impact of *Food Harvest 2020* on employment in Ireland

C. Miller [1,2], A. Matthews [2], T. Donnellan [1] and C. O'Donoghue[1]

[1] *Teagasc, Rural Economy & Development Programme, Mellows Campus, Athenry, Co. Galway.* [2] *Department of Economics and Institute for International Integration Studies, Trinity College Dublin.*

Food Harvest 2020 (FH2020), the Government's strategy for the sustainable growth of the Irish agri-food sector, set specific targets for growth in the sector relative its size in the period 2007-09. The linkages between the various sectors of the economy can be mapped using a social accounting matrix model used in this paper to study the potential job creation of FH 2020 in the context of the current recession. This paper focuses on the four main growth targets in FH2020, namely those for milk, beef, sheep and pigs. The job creation arising out of FH2020 targets will depend, to a degree, on future employment intensities as measured by the level of employment per million euro of output. Three alternative scenarios are simulated: (i) Scenario 1 makes use of the average employment intensities given by the ratio of employment to output; (ii) Scenario 2 makes use of zero marginal employment intensities for the agricultural sectors while keeping the average employment intensities in the other non-agricultural sectors as before; (iii) Scenario 3 makes use of a mixed version of Scenarios 1 and 2 according to the findings reported in the *Annual Review and Outlook for Agriculture, Fisheries and Food* . Using the three different employment intensity scenarios, it is found that a minimum of 18,989 jobs, a maximum of 38,430 jobs and an intermediate numbers of 24,719 jobs would be created in the economy as a result of achieving the four main volume targets in the FH2020. Scenario 3 (the intermediate scenario) can be interpreted as the most realistic in terms of how it tries to deal with the limitations of the modelling framework in the context of the shocks that are defined.

Investment and financing constraints in Irish agriculture

C. M. O'Toole*, T. Hennessy* and C. Newman**

**Teagasc Rural Economy & Development Programme, Mellows Campus, Athenry, Co. Galway. ** Department of Economics, Trinity College Dublin.*

The objectives of this research are to investigate the factors which influence farmers' decisions to invest in machinery and equipment on their farm holdings. Drawing on the international research in the area, the focus is on a number of key drivers of investment decisions, namely:

- The profitability of invested capital;
- Access to finance to invest;
- The effect of policy supports and direct payments;
- The nature of the different farming systems;
- The size of farm holdings; and
- The age of the farm operator.

One particular aspect that we focus on is how the recent financial crisis affects farmers' investment decisions. This is particularly important given how the banking system in Ireland has essentially collapsed and access to finance has deteriorated across the economy. We also focus on the role of policy supports on investment in Irish agriculture. One particular research topic considered tests whether decoupled subsidies better enable farmers to get access to bank lending to use for investment. Using all farms included in the National Farm Survey over the period 2005-2010, the research investigates whether the CAP decoupled subsidy payments improve access to investment financing by altering the risk profile of farm earnings. This proposition is tested using up-to-date investment modelling techniques which draw on international best practise. We find that decoupled subsidies do improve access to finance for investment and the result is robust in respect of a number of recognised checks and testing procedures. The effect is greater for farms who experience greater difficulties in accessing finance (medium-sized farms relative to large farms and middle age and older farm operators relative to younger farmers). This evidence suggests that over and above the direct effect on production indicated in previous research, decoupling affects farm investment through financial channels.

Estimating population size and trappability of badgers at large spatial scales: implications for TB management

A.W. Byrne * †, S. Green ^, J. O'Keeffe$, D.P. Sleeman†, S.W. Martin ‡ and J. Davenport †

** Teagasc Rural Economy & Development Programme, Mellows Campus, Athenry, Co. Galway. † School of Biological, Earth and Environmental Science, University College Cork, Ireland. ^ Teagasc, Food Research Centre, Ashtown, Dublin 15. $ School of Veterinary Medicine, University College Dublin. ‡ Department of Population Medicine, Ontario Veterinary College, University of Guelph, Ontario, Canada.*

The large-scale management of zoonotic diseases in wildlife, through vaccination or population control, requires estimates of the proportion of the target population that can be reached. Estimates of population size and trappability inform vaccine efficacy modelling and are required for adaptive management during prolonged vaccination campaigns. An analysis is presented of mark-recapture data from a badger tuberculosis (TB) vaccination study. This study is the largest scale (755km^2) mark-recapture study ever undertaken with this species. A mean badger population size of 671 (SD: 76) was estimated using a closed-sub-population model (CSpM) based on data from capturing sessions of the entire area and was consistent with a separate multiplicative model. Population densities derived from the CSpM estimates were low (0.82-1.06km^{-2}), but broadly consistent with previous reports for an adjacent area. Mean trappability was estimated to be 34-35% per capture session across the population. By the fifth capture session, 79% of the adult badgers caught had been marked previously. Multivariable modelling suggested significant differences in badger trappability depending on location, season and age-class at capture. Live-trapping efficacy can vary significantly amongst sites, seasons, age, or personality, hence monitoring of trappability is recommended as part of an adaptive management regime during large-scale wildlife vaccination programmes to counter biases and to improve efficiencies. Low trappability during single capture sessions affects the likelihood of effective vaccine deployment by reducing vaccine coverage. Multiple capture sessions of badger populations will be required for future TB-vaccine campaigns to improve vaccine coverage, which potentially will reduce TB prevalence within the host population and ultimately reduce interspecific spillback transmission to cattle herds.

Understanding the adoption of soil testing on Irish farms

E. Kelly, *†, K. Heanue * and C. O'Gorman *†

*Teagasc Rural Economy & Development Programme, Mellows Campus, Athenry, Co. Galway. †Dublin City University School of Business (DCUBS),Glasnevin, Dublin 9.

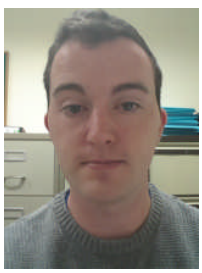
Informed by the evolutionary economic theory of the firm, this research examines how the managerial capabilities of the farmer and the routines of the farm influence the adoption of a practice. Specifically, the research seeks to understand the adoption of a key land management practice, soil testing, and how that practice is incorporated into a specific management capability, nutrient management. The research uses a mixed methods approach. It uses a binary logit model to analyse data on the use of soil testing from a nationally representative survey of Irish farms. The extent of soil testing by farmers and the characteristics of farmers and farms using soil tests are identified from this quantitative analysis. Qualitative interviews illustrate the actual use of soil test information and the implementation of a wider suite of land management practices by farmers. This qualitative data provides in-depth knowledge on the farmers' nutrient management capabilities and the routines used on the farm. The research contributes to our understanding of the adoption of a key decision-making tool-soil testing. It does this by contextualising the adoption decision by illustrating how practices are incorporated into routines of the farm through existing capabilities.

ICT- the future of communicating with extension service clients in Ireland

C. Byrne[1], P. Wims[2] and P.Maher[3]

[1]Teagasc, Naas, Co. Kildare, [2] University College Dublin, Belfield, Dublin 4, [3]Teagasc, Oakpark, Co. Carlow.

Information and Communication Technology (ICT) developments across the world have advanced rapidly with wider availability of information dissemination devices at reduced costs. This allows commercial enterprises such as farming to access relevant business information in a more efficient and effective way. Previous research indicates Irish farmers as lagging behind both the national and international population in terms of ICT adoption in regard to computer and internet usage. Teagasc, as an extension service, must understand the information-seeking behaviour and the current media use patterns of farmer clients in order to successfully engage with them. This study seeks to evaluate current usage of ICT by Irish farmers and analyse how Teagasc can engage with new ICT to better communicate with clients. Research is being conducted on the barriers to adoption, as well as identifying and assessing new forms of ICT applications for use in the farming sector which will aid the future development of customised tools and strategies to increase the uptake and usage of ICT by farmers. A detailed survey of Irish farmers is currently in progress. Preliminary results (n=209) indicate that approximately 90% of farmers surveyed have a computer in their homes in 2012, of which 65% indicated its use for farm business. A third of those surveyed indicated that they had a Smartphone, which may in the future open up new ways of communicating information to farmers. Early indications from farmers surveyed suggest that ICT usage is strong within Teagasc discussion groups.

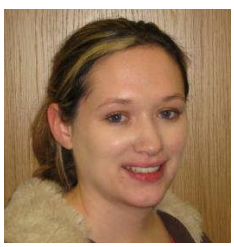


Phosphorus source and mobilisation potential of agricultural headwater ditch sediments

M. Shore [1, 2], P. Jordan [3], P-E. Mellander [1], M. Kelly-Quinn [2] and A.R. Melland [1]

[1]Agricultural Catchments Programme, Teagasc, Johnstown Castle, Wexford.
[2]School of Environmental and Biological Sciences, University College Dublin, Belfield, Dublin 4. [3]School of Environmental Sciences, University of Ulster, Coleraine, N. Ireland.

The Good Agricultural Practice measures implemented since 2006 are designed to minimise nutrient loss from farms to waterways. Farm ditches are ubiquitous across Ireland and provide a hydrological link between farms and downstream surface waters. The potential of farm ditch bed sediments to mobilise and release biologically significant forms and concentrations of phosphorus (P) was investigated. Phosphorus source potential was characterised in soils, bed and bank sediments from two agricultural sub-catchments using Mehlich3-P (M3-P), the degree of P saturation (ratio of M3-P/ (M3-Fe+M3-Al)), total P and water-soluble P tests. The potential for soil and sediment P to become physically mobilised was also characterised using the DESPRAL test. Physico-chemical parameters that may control P forms and content in sediments and soils were explored. The mean degree of P saturation of ditch bed sediments was less than an environmental threshold of 25 %, suggesting bed sediments were not at risk of releasing soluble P at concentrations which may cause eutrophication in the overlying water column. The soluble P content of bed sediments was similar to that of the surrounding field soils and higher than that of bank sediments. Whilst soils were richer in soluble P than sediments when mobilised by the Despral test, sediments were more dispersive and a similar or higher concentration of particulate P was mobilised from bed sediments than soils. Correlation analysis indicated that soluble P in ditch waters may be attenuated by M3-Al in sediments in both sub-catchments and that aggregation of sediments by organic matter may reduce the potential for particulate P mobilisation. The data suggest that these ditch sediments are unlikely to release biologically significant concentrations of soluble P but may supply particulate P to the water column and downstream receiving environments during event flows.

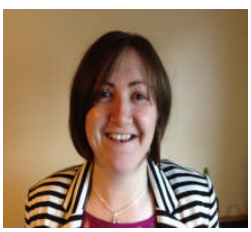


Utilizing the soils nitrogen supply potential for efficient grass production

N.T. McDonald [a,b], C.J. Watson [b,c] , R.J. Laughlin [c] , S.T.J. Lalor [b] and D.P. Wall, [b]

[a]Teagasc Crops, Environment & Land-Use Programme, Johnstown Castle ,Wexford. [b]School of Biological Sciences, Queen's University Belfast, Belfast, N. Ireland. [c]Agri-Food and Biosciences Institute, Newforge Lane, Belfast, N. Ireland.

Current grassland nitrogen (N) fertiliser recommendations in Ireland do not account for the differences in soil N supply potential. This "one soil fits all" N fertiliser recommendation system has the potential to under- or over-estimate N fertiliser requirements for target grass yields.This study aims to develop a soil N test to predict soil N supply across a range of Irish soils types. This will enable the differentiation of soil types based on their N supply through N mineralisation processes, and ultimately facilitate the prescription of soil specific N fertiliser advice. To fulfil the study objectives, a series of experiments was established; initially laboratory studies evaluating various soil N tests, followed by microcosm studies to validate the laboratory findings, and finally field studies to calibrate the results on two contrasting sites. The laboratory studies found large differences in potentially mineralisable N between the soil types (92.17 to 723.08 mg NH_4^+-N kg^{-1}), and showed that the Illinois soil N test (ISNT) was the best rapid predictor of soil N supply through N mineralisation. The results from the microcosm experiment, conducted in a controlled environment facility, showed that the ISNT by itself, was a poor predictor of grass DM yield and N uptake, as it does not account for residual soil mineral N in the soil (R^2= 0.44). However, the combination of the ISNT and a test measuring the oxidised component of soil mineral N (TON), gave a good prediction of grass DM yield (R^2=0.66) and grass N uptake (R^2= 0.72). The field studies show large temporal variability in soil N supply over the growing season and the periods when N supply is not sufficient to meet grass N requirements. This work shows the potential for new soil-specific N recommendations to increase N fertiliser use efficiency.



POSTER ABSTRACTS

A by-product from the Irish fruit processing industry as a novel ingredient in gluten-free bread

N.L. O'Shea[1,2], L. Doran[3], E. Arendt[2] and E. Gallagher[1]

[1] Food Chemistry and Technology Department, Teagasc Food Research Centre, Ashtown, Dublin 15. [2] Department of Food and Nutritional Sciences, National University of Ireland, Cork. [3] National Food Imaging Centre, Teagasc, Moorepark, Fermoy, Co. Cork.

This study aimed to utilise the nutritious by-products of food processing, focussing in particular on the Irish fruit-processing industry. By-products of fruit processing are documented to have a high quantity of healthy compounds (e.g. minerals, dietary fibre and bioactive compounds). However, they are still under-used in the food industry as a potential low-cost, functional ingredient. Orange pomace (OP), a by-product of orange juice processing was dried and milled and included in a gluten-free bread recipe as a novel, healthy ingredient. To optimize the bread formulation, a mathematical design was initially created; three variables were identified from preliminary tests: water (85-100% flour weight [FW]), fibre (0-8% FW) and proofing time (35-100 minutes). A response surface design (D-optimal) was created. Twenty combinations of the three variables were developed. Error was assessed based on five combinations repeated twice; an optimal formulation was calculated from the design. Extensive studies relating to batter rheology, baking properties, texture profiling, microscopy, sensory and nutritional characterisation were undertaken. Due to the high level of starch in gluten-free bread, hardness is a key problem, therefore texture and moisture were analysed two hours after baking and a full analysis (texture, moisture and fibre) was carried out 24 hours after baking. Orange pomace (OP) addition effected crumb hardness ($p<0.001$). Breads containing OP retained more moisture after 24 hours; this correlated with improved texture results. Optimisation of the formulation was based on high values for OP addition and low values for hardness. The optimized formulation was calculated to contain 5.5% OP, 94.6% water and a proving time of 49 minutes. The measured responses compared favourably with the predicted responses. Rheology results illustrated that orange pomace improved the robustness of the gluten-free batter ($p<0.05$) and decreased the occurrence of starch gelatinisation ($p<0.01$). Orange pomace-enhanced breads retained more moisture and had a softer crumb texture 24 hours post-baking. Also, dietary fibre levels in optimised breads were increased from 2g/100g to 4g/100g.This study highlighted how "waste" streams from Irish food processing may be utilised in a novel, functional way.

Altered physical and biological characteristics of heat-denatured whey protein hydrolysates

I.B. O'Loughlin[1,2], B.A. Murray[1], P.M. Kelly[1], R.J. FitzGerald[2] and A. Brodkorb[1]

[1] Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork. [2] Life Sciences Department, University of Limerick, Limerick.

Whey proteins are rich in bioactive peptides, but the predominantly globular nature of the native proteins makes for greater challenges when it comes to their hydrolysis by commercially available enzymes. It is well known that protein structural change, e.g. aggregation, can be brought about through denaturation. However, this study examined the effectiveness of heating whey protein isolate (WPI) as a means of improving the rate of enzymatic hydrolysis as well as the characteristics of the resulting peptides. Denaturation of whey proteins was monitored by electrophoresis, viscosity, particle-size, insolubility, and surface hydrophobicity. The protein components in WPI showed differences in their aggregation behaviour and subsequent rate of proteolysis. A novel approach was applied through the use of microscopy, both light and confocal laser scanning, to monitor aggregate disintegration during hydrolysis. Hydrolysis of heat-treated WPI dispersions required shorter enzymatic incubation times than the non-heat-treated control ($P < 0.001$). This study demonstrated altered free amino acid contents compared to the non-heat-treated control. Mass spectroscopy allowed for differences in the peptide profiles to be related to certain proteolytic cleavage points. The alteration of the conformational state of the whey proteins to generate aggregates results in greater susceptibility to certain proteolytic activities. This investigation emphasised the substantial effect that induced-protein aggregation can have on enzymatic hydrolysis leading to novel functional foods.

Fat absorption in the gut – can milk proteins change it?

S. Le Maux[1,2,3], L. Giblin[3], T. Croguennec[1,2], S. Bouhallab[1,2] and A. Brodkorb[3]

[1] INRA, UMR1253 STLO, 65 rue de Saint Brieuc, F-35042 Rennes, France. [2] Agrocampus Ouest, UMR1253 STLO, 65 rue de Saint Brieuc, F-35042 Rennes, France. [3] Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork.

Recent studies suggest that nutritional properties of food are not only affected by its composition but also by its structure. At molecular level, food structure involves protein structure and interactions between food compounds. Whey proteins, a valuable by-product of cheese making, are known to bind various kinds of small molecules (ligands) such as fatty acids, which may modify the nutritional properties of whey protein/ligand complexes. To investigate this hypothesis, the interaction of one selected essential fatty acid, linoleate (C18:2), with bovine ß-lactoglobulin (ßlg), and the impact of those complexes on biological activity *in vitro* were studied. We showed that ßlg can bind linoleate in two different sets of binding sites. Moreover, binding of linoleate induced the formation of aggregates of ßlg, which allow us to understand the mechanism of complex formation. Intestinal-like Caco-2 cells were used to simulate the human gut and to assess *in vitro* bioaccessibility. Complex formation of ßlg and linoleate significantly reduced the bioaccessibility of the fatty acid compared to free fatty acid. In addition, the complexed protein was digested faster *in vitro* than in its free form. Therefore, it is proposed that ßlg and its digested products may act as a molecular carrier for fatty acids such as linoleate and delay their absorption in the gut, thereby changing the overall kinetics of nutrient uptake. This knowledge could open the door to design new food products with optimised structure and biological properties.

Bioactivity guided fractionation, isolation and characterisation of plant secondary metabolites from bitter melon (*Momordica charantia*) fruit, fenugreek (*Trigonella foenum- graecum*) seeds and dandelion (*Taraxacum officinale*) roots

O. Kenny[1, 2], T.J. Smyth[1], P. McLoughlin[1], D. Walsh[1], D. K. Rai[1], N. P. Brunton[1] and C. M. Hewage[2]

[1]Department of Food Biosciences, Teagasc Food Research Centre, Ashtown, Dublin 15.
[2]UCD Conway Institute of Biomolecular and Biomedical Research, School of Biomolecular and Biomedical Science, University College Dublin, Belfield, Dublin 4.

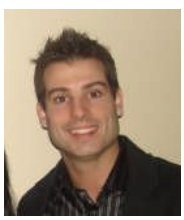
Plant secondary metabolites are a structurally diverse classification of organic compounds. Unlike primary plant metabolites, these are often restricted in their distribution amongst plant species. Regarded as the biologically active components in many traditional medicinal plant remedies, as well as acting as precursors for many modern-day synthetic drugs, their study and use as protective dietary constituents in the risk reduction of various disease states has evolved over time. The present study reveals how *in vitro* bioactivity guided fractionation of extracts from plant tissues of bitter melon (*Momordica charantia*), fenugreek (*Trigonella foenum-graecum*), and dandelion (*Taraxacum officinale*) has led to the isolation and characterisation of secondary metabolites exhibiting antioxidant, antimicrobial and antihypertensive properties. A range of extractions was performed based on polarity and size. Extracts were screened for antioxidant activities using *in vitro* assays. Antimicrobial Minimum Inhibition Concentration (MIC) screening studies were carried out against various food pathogens, while the antihypertensive properties of extracts were also determined using a Renin Inhibitor Screening Assay Kit. Extracts demonstrating good bioactivities were subjected to further fractionation and bioactive profiling by various chromatographic techniques. Antioxidant screening confirmed the dandelion ethyl acetate extract to possess the highest antioxidant activity (IC_{50} 33 μg/ml), while fractions of this extract reported IC_{50} values as low as industry based standards (7.5 μg/ml). Antimicrobial screening revealed groups of bitter melon and dandelion ethyl acetate derived fractions exhibiting a bactericidal effect against *B. cereus*, *S. aureus* and MRSA strains. Preliminary results have also shown a significant reduction in renin enzyme activity for bitter melon and dandelion dialysed methanol hydrophilic > 3.5 kDa (78% and 62%) extracts. A total of 28 phenolic compounds from fenugreek, 22 from dandelion, 21 from bitter melon and an antioxidant triacylglyceride, also from bitter melon, were identified and quantified using UPLC-MS, ESI-MS, NMR and LC-NMR techniques. Further characterisation of individual bioactive components is ongoing at present.

Increased adherence of B*ifidobacterium longum* subsp. *infantis* to HT-29 cells following exposure to the predominant milk oligosaccharide, 6' sialyllactose.

D.Kavanaugh [1,2,4], H. Slattery [1], J.A. Lane [1], M.Clyne [3,4], M.Kane [2,4], L.Joshi [2,4] and R. M. Hickey[1,4]

[1]Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork. [2]National Centre for Biomedical Engineering Science, National University of Ireland, Galway. [3]School of Medicine and Medical Science, University College Dublin, Belfield, Dublin 4 [4]Alimentary Glycoscience Research Cluster, Ireland.

Bifidobacteria constitute up to 90% of the total colonic microflora within the first week following birth in breast-fed infants. The proportion of these bacteria is much lower in the flora of formula-fed infants. Several beneficial properties have been associated with the presence of bifidobacteria in the infant colon, such as inhibition of pathogenic organisms, modulation of mucosal physiology, barrier function and systemic immunologic and inflammatory responses. In this study, we tested the hypothesis that milk oligosaccharides may contribute not only to selective growth of bifidobacteria, but also to their specific adhesive and colonising ability. Human milk oligosaccharides (3'sialyllactose and 6'sialyllactose) and a commercial prebiotic (Beneo Orafti P95; oligofructose) were assayed for their ability to promote adhesion of *Bifidobacterium longum* subsp. *infantis* (ATCC 15697) to human intestinal HT-29 cells. Pre-incubation of *Bifidobacterium longum* subsp. *infantis* (ATCC 15697) with 6'sialyllactose enhanced bacterial adhesion 4.7-fold. This bacterial response to 6'sialyllactose was decreased in the presence of lactose or following trypsin treatment. A combination of 6' sialyllactose with 3'sialyllactose significantly increased adhesion. Interestingly, the ability of 6'sialyllactose to increase adhesion appears unique to *B. longum* subsp. *infantis* (ATCC 15697) among the strains tested. The current findings demonstrate the potential of the predominant milk oligosaccharide, 6'sialyllactose, in enhancing the colonising ability of a typical infant-derived strain of bifidobacteria.



Influence of a 50-day dietary restriction on pregnancy per artificial insemination in beef heifers.

M.H. Parr[1, 3], P. Lonergan[2], A.C.O. Evans[2], J.F. Roche[3], T. Fair[2], M.A. Crowe[3], M.G. Diskin[1].

[1]Teagasc Animal and Grassland Research & Innovation Centre, Teagasc, Mellows Campus, Athenry, Co. Galway, [2]School of Agriculture and Food Science, [3]School of Veterinary Medicine, University College Dublin, Belfield, Dublin 4,

It has been hypothesised that follicle development in a period of negative energy balance (NEB), as experienced by the postpartum dairy cow, could be affected by undesirable metabolic changes, and may contain a developmentally incompetent oocyte with an impaired potential to establish a pregnancy To address the potential impact of NEB on oocyte quality, the objective of this study were to establish (i) the concurrent, and (ii) the carryover effects of a 50 day (d) period of dietary restriction on pregnancy per artificial insemination (P/AI) in heifers. A total of 156 reproductively normal, two year old beef heifers with an initial (mean ± SEM) live weight and body condition score (BCS) of 581 ± 4.4 kg, and 3.45 ± 0.05, respectively, were used across four replicates. Heifers were randomly assigned to either a (i) control feed intake group (C, n=68, 1.3 times estimated maintenance energy (M) requirements for 50 d; start = d 0) or (ii) restricted feed intake (R, n=88, 0.65 M for 50 d). Following the 50-d differential dietary treatment period, all heifers were fed a 2 M diet until the end of the study. Liveweight and BCS were recorded on d 0, 14, 21, 28, 35, 42, 50, 57 and 90. Concentrations of NEFA, beta hydroxy butyrate (BHB), urea and glucose in plasma were measured on d 0, 14, 28, 35, 42, 50, 57 and 90. Oestrus was synchronised using two injections of prostaglandin $F_{2\alpha}$ (PGF2α) administered on d 37 and 48 respectively. Heifers were artificially inseminated (AI) on d 50-52 using frozen thawed semen from one high fertility bull. Pregnancy was determined by ultrasonography 30 d after AI. Following pregnancy diagnosis, all heifers were injected with PGF2α to induce luteloysis and allow return to oestrus. All heifers were inseminated again on d 93-95 and P/AI was determined 30 d later. Liveweight, BCS and metabolite data were analysed using the Mixed procedure of SAS for repeated measures ANOVA with terms for day, treatment and replicate and their interaction included in the model. Pregnancy per AI was analysed by Fisher's exact chi-square. During the first 50 d of differential feeding, heifers on the R diet lost more weight (70.5 ± 2.8 *v* 5.8 ± 2.1 kg, respectively; P<0.001)) and had greater BCS loss (0.45 ± 0.03 *v* 0.05 ± 0.03 units respectively; (P<0.001)) than heifers on the C diet. In the period whilst heifers were on 2 M, the R heifers gained more weight 79.6 ± 2.5 *v* 49 ± 2.6 kg respectively (P<0.001) and had greater BCS gain 0.38 ± 0.03 *v* 0.18 ± 0.03 units respectively (P<0.001) than heifers on the C diet. A treatment x day interaction was observed for NEFA (P<0.001), BHB (P<0.01) and urea (P<0.05) on d 14, 28, 42 and 50 respectively. Concentration of glucose remained unchanged in both treatment groups. Pregnancy per AI (C: 69%, R: 72%, P>0.05) was similar following AI at d 50. However, following AI at d 93, (C: 64%, R: 80%, (P=0.03), P/AI was lower in C heifers. There was no evidence that a dietary-induced 50 d period of NEB had any concurrent or carryover effects on P/AI in heifers despite an elevation in systemic concentrations of NEFA.

Cattle slurry nutrients: content, assessment and variability

P.B. Berry[1,2], D. Wall[1], J. Quinn[2], P. Frost[3] and S.T.J. Lalor[1].

[1]Teagasc Crops, Environment & Land-Use Programme, Johnstown Castle, Wexford.
[2]School of Biological Sciences, Queen's University, Belfast, Northern Ireland.
[3]Agri-Food and Biosciences Institute, Hillsborough, Co. Down, Northern Ireland.

The nutrient concentration of cattle slurry is variable within and between farms. This makes its incorporation into a fertiliser management plan difficult. Laboratory analysis is the most accurate method for assessing the nutrient concentration, but this is time-consuming and is only as representative as the sample taken. Complete agitation of the tank is required before a representative sample can be achieved using conventional (bucket and rope) sampling methods. This limits the scope for laboratory analysis results to be available for use in a timely manner. Tube sampling is a method of sampling a tank without the need for agitation, and can be performed a number of weeks before land spreading, therefore allowing adequate time for results to be returned from the laboratory. Results of this study showed no significant difference in the dry matter (DM) and nutrient concentration of cattle slurry between tube sampling and bucket-and-rope sampling methods, indicating that the tube sampler is a viable option for sampling unagitated slurry tanks. This study also investigated the extent to which cattle slurry characteristics such as DM and nutrient concentration are affected by farm system and animal factors. Results from 75 samples from commercial farms showed that farm system and animal factors had little effect on the DM and nutrient concentration of cattle slurry and that DM is the most useful predictor of nutrient concentration. A survey of discussion groups showed that farmers are generally unaware of on-farm quick tools for predicting the nutrient concentration of cattle slurry. However, farmers agreed that the slurry hydrometer was a useful method for predicting the slurry DM and nutrient concentration of cattle slurry thus improving the efficiency with which cattle slurry is currently used in fertiliser management plans.

Transferring *Populus* resources to *Salix* reveals high levels of variation in lignin biosynthesis genes

A. Perdereau[1,2,3], T.R. Hodkinson[1], C.T. Kelleher[3] and G.C. Douglas[2]

[1]Botany Building, School of Natural Sciences, Trinity College Dublin. [2]Teagasc, Kinsealy Research Centre, Malahide Road, Dublin 17. [3] National Botanic Gardens, Glasnevin, Dublin 9.

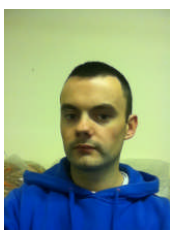
The characterisation of genetic variation is a key process in breeding and conservation programmes and allows the analysis of genotype/phenotype interactions. Little is known about the levels of variation in lignin or other wood-related genes in *Salix*, a genus that is being increasingly used for biomass and biofuel production. The lignin biosynthesis pathway is well characterized in a number of species, including the model tree *Populus*. This project aimed to transfer the genomic resources already available in *Populus* to its sister genus *Salix* to assess levels of variation within genes involved in wood formation. Molecular analyses on 27 gene regions were undertaken in 40 *Salix* species. Twelve of these regions were then sequenced. Basic Local Alignment Search Tool (BLAST) searches of the resulting sequences showed the close similarity of these *Salix* sequences to *Populus*, confirming homology of the primer regions and indicating a high level of conservation within the wood formation genes. However, all sequences were found to vary considerably among *Salix* species, mainly as Single Nucleotide Polymorphisms (SNPs) with a smaller number of insertion-deletions. Between 10 and 31 SNPs per gene region were discovered within *Salix* (from 16 to 102 SNPs per kbp). This variation is sizeable, but not unexpected, as it is based on interspecific and not intraspecific comparisons. The variation is comparable to interspecific variation in *Populus*. The SNP markers will be useful in characterising the levels of variation in *Salix* germplasm for genes involved in wood formation.

The effect of crop establishment system on the nitrogen use efficiency of cereal grain crops in Ireland

J.Brennan [ab], T. McCabe.[b], R. Hackett[a] and P.D.Forristal [a]

[a]*Teagasc Crops, Environment* & Land-Use *Research Programme, Oakpark, Co Carlow.* [b] *School of Agriculture, Food Science and Veterinary Medicine, University College Dublin, Belfield, Dublin 4.*

The effects of minimum tillage on soil properties have been well-documented. However, the effect of establishment system on the nitrogen status of a crop is not as conclusive, and appears to vary considerably with climate. The objective of the trials described here was to determine the effect of plough-based and min-till establishment systems on the N uptake patterns of winter wheat and spring barley throughout the growing season. Results showed that winter wheat performance varied considerably between seasons. In year 1, the min-till treatment had the greatest N uptake as the crop developed. However, cultivation system had no significant effect on grain yield or total N uptake at harvest. In year 2, the plough treatments had a higher nitrogen uptake and a significantly higher grain yield and total N uptake than the min-till at harvest. Straw incorporation had little effect in both seasons. The spring barley also varied with season, but not as much as the winter wheat. In year 1, the spring min-till establishment method performed poorly compared to the other establishment methods, with a lower nitrogen uptake and reduced total N uptake and grain yield at harvest. The plough-based system achieved the highest total N uptake and grain yield. All four establishment systems performed similarly in year 2, with no significant difference in total N uptake or grain yield. These field experiments indicate that the performance of winter wheat and spring barley establishment systems is season-dependent and the plough-based system remains the most reliable establishment method.

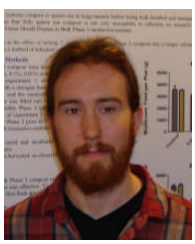


Characterisation of *Trichoderma aggressivum* infection in bulk phase 3 mushroom compost

M. O'Brien[*†], K. Kavanagh[†] and H.M. Grogan[*]

[*] *Horticulture Development Dept., Teagasc Food Research Centre, Ashtown, Dublin 15.*
[†]*Dept. of Biology, National University of Ireland, Maynooth, Co. Kildare.*

Compost Green Mould Disease is caused by the fungus, *Trichoderma aggressivum*. It is a fast growing mould which produces abundant green coloured spores when mature. Since it was first identified in the 1980s, it has been responsible for severe green mould epidemics throughout the mushroom-growing world, including Ireland. Initially it was associated with in-situ spawn-run systems in bags, blocks, shelves and trays. However, since the early 2000s it has also appeared in many Bulk Phase 3 composts around the world. No research has been done to understand how *T. aggressivum* behaves in the Bulk Phase 3 system of compost production. Significant compost mixing occurs when large tunnels of compost are being emptied and transported to growers and this may leave the compost vulnerable to infection. This study looked at the effect of mixing *T. aggressivum*-infected compost into healthy uninfected Bulk Phase 3 compost at the end of spawn-run, at rates of between 10 and 0.01% w/w. The effect of supplementation at the end of spawn run was also investigated. Our research shows that an infection rate of as low as 0.01% w/w of *T. aggressivum*-infected compost can reduce mushroom yield by up to 50% and that the extent of loss was related to the proportion of infected-compost added. Supplementation had no impact on the effect of *T. aggressivum* on yields. These results highlight the potential for good quality Bulk Phase 3 compost to become infected with *Trichoderma* Green Mould during tunnel emptying and bulk handling operations.



Integrating an innovation broker into a problem-solving innovation system

C. Ryan*†, K. Heanue* and F. Devitt†

*Teagasc *Rural Economy & Development Programme, Mellows Campus, Athenry, Co. Galway* †*Department of Design Innovation, National University of Ireland, Maynooth, Co. Kildare*.

Mastitis imposes substantial costs on the Irish dairy sector. One approach to tackling the problem is CellCheck - the national mastitis control programme. The success of CellCheck rests on dairy industry stakeholders working together. The activities of CellCheck may be viewed as creating a problem-solving innovation system. An innovation system approach is a systemic intervention to problem solve. It is a platform where different actors come together to address innovation challenges. Innovation brokers are required in conditions where suboptimal levels of interaction and networking exist and where reforms are mediated by the context in which they are embedded. There is ample evidence on the functions undertaken by an innovation broker but few examples exist in the literature of the process that is required to establish a broker in an innovation system. This research addresses that gap in the literature by exploring the development of the broker role in CellCheck. The study uses a case study approach, drawing on non-participatory observation methods and semi-structured interviews. The aim is to study the real-time development of an innovation broker, with an emphasis on how a broker emerges and begins to operate in practice. In an attempt to initiate the type of interaction and coordination among trained service providers and farmers that characterises successful innovation systems elsewhere, CellCheck has identified eight regional coordinators who could fulfil a brokering role. These regional coordinators are employed by milk processors. However, early research findings illustrate how the ideal functions required of an innovation broker might be frustrated, in reality, by the day-to-day context within which the regional coordinators work.

Spatial modelling of the expansion of Ireland's dairy sector to 2020: greenhouse gas emissions outcomes

E. Grealis[12], C. O'Donoghue , R. Fealy[2] and R. Fealy[1]

[1] Teagasc Rural Economy & Development Programme, Mellows Campus, Athenry, Co Galway. [2]National University of Ireland, Maynooth, Co Kildare.

Ireland's agricultural sector has been earmarked for significant expansion in the medium term under *Food Harvest 2020*. A 50% increase in output has been targeted specifically for the dairy sector. Ireland has also made significant commitments to reduce national greenhouse gas emissions by 20% within the same time-frame. With agriculture accounting for almost a third of Ireland's reported emissions, effective abatement strategies and improved efficiency measures will be required if both these policy objectives are to be achieved. Spatial information at the micro level enables the assessment of the impacts of these measures on farm households and on local emissions taking into account regional variations. Specifically examining the dairy targets, this study models the expansion of Ireland's dairy sector by dynamically simulating the weighted National Farm Survey forward to 2020 and presents emissions outcomes for a number of expansion scenarios. Informed by price projections from the FAPRI-Ireland model, entrants and exits from the sector are modelled together with projections for changes in yield, intensity of production and the land base, delivering a number of future herd number scenarios. Each scenario is disaggregated using the SMILE-NFS spatial microsimulation model, with resultant emissions outcomes for each scenario presented at the electoral district level. The availability of information on spatial emissions will help inform mitigation strategies for 2020 and beyond, allowing policy makers to identify spatial opportunities for emissions savings.

An assessment of the potential for online/electronic-based resources in agricultural training

D. Deegan[1], P. Wims[2] and T. Pettit[1]

[1]Teagasc Kildalton Agricultural College, Piltown, Co. Kilkenny. [2]School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4.

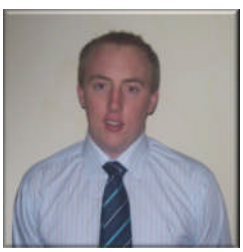
New technological developments have the potential to improve and assist students' level of understanding in existing programmes and also allow for equal access for students who require adapted and innovative forms of teaching in order to succeed in education. This research project aims to assess the potential for online/electronic-based teaching in agricultural training, an area which thus far has been unexplored, but which has the potential to expand and improve on an already successful agricultural educational system in Ireland. An online pilot was created to highlight issues and problems in relation to e-learning in a 'live' situation. This aided in the development of online materials, which will be tested in an educational setting and will allow for recommendations to be developed on how online learning can be incorporated in agricultural training. Pre, post and re – testing will be carried out. Attitudes and behaviours of students and teachers in relation to ICT in general, e-learning and technology-enhanced learning are also addressed. E-learning is described as a new pedagogy of learning. Well-designed educational approaches that appropriately apply technology are said to stimulate active learning, critical thinking, and problem-solving. An important implication for Teagasc is to ensure that more young farmers are engaging in a high level of agricultural education. E-learning offers the possibility of increasing the effectiveness of agricultural education through supporting and training young farmers (students) with varying needs and abilities.

An examination of the use of profit monitor/financial tools by tillage farmers

J. Irish [1], M. Wallace [2] and T. O'Donovan [3]

[1] Teagasc Crops, Environment & Land-Use Programme, Oakpark, Co. Carlow. [2] University College Dublin, Belfield, Dublin 4. [3] Teagasc, Kildalton College, Piltown, Co. Kilkenny.

Analysis of enterprise costs and margins can be facilitated by a range of financial tools such as the Teagasc eProfit Monitor. To examine the use of financial tools by Teagasc tillage clients, a survey consisting of 41 qualitative and quantitative questions was administered to one hundred Teagasc tillage clients in the south east. The average farm size was 146 hectares. The breakdown of farmer age was: 15% < 35, 31% 35 - 44, 26% 45 - 54, 21% 55 - 64 and 7% >65. 80% of the farmers had received an agricultural qualification; 20% had some level of off-farm employment and 38% engaged in farm machinery contracting; 33% are members of tillage discussion groups and a further 7% had previously been in a discussion group but are no longer members. Two-thirds of farmers calculated crop margins using pen and paper, with very few using computer applications. This is despite the fact that 52% of those questioned rated themselves as being experienced or advanced at using a computer and 17% stated that they use their computer for farm planning or budgeting. The number of respondents using eProfit Monitor is very low in comparison to the numbers that are aware of it: 7% and 70% respectively. Farmers cited their Teagasc advisor as their main source of advice for crop production decisions, but accountants were the predominant source of financial advice. Awareness of key Teagasc financial tools was quite high, but actual usage of most of them was very low. Farmers are more willing to use the financial tools which require the least effort, such as the Crop Costs and Returns Book. Robust benchmarking of performance is hampered by the lack of uniform and comprehensive recording of farm data. Overcoming the gap between awareness of a financial service and its adoption by farmers can be addressed by improved knowledge transfer techniques, such as increased participation in discussion groups.



An assessment of the potential for a grass budgeting service for beef farmers

A.O'Brien[1,2], P. Kelly[3] and K. Pierce[2]

[1]Teagasc, Kells Road, Kilkenny. [2]School of Agriculture & Food Science, University College Dublin, Belfield, Dublin 4. [3]Teagasc, Kildalton Agricultural College, Piltown, Co Kilkenny.

The objectives of this research project are to identify the barriers preventing beef farmers from grass budgeting; to establish the services that need to be provided to successfully increase and maintain grass budgeting on beef farms; and to identify any support that Teagasc advisors require to facilitate these services. Two existing beef grass budgeting groups in Wexford and Waterford were surveyed to investigate the benefits that members feel are associated with group membership. Ninety-four beef discussion group farmers in the South East of the country also completed a survey which aimed to assess their willingness to participate in a grass budgeting service. Future work will involve case studies to gain a more in-depth knowledge of grass budgeting practices on farms and identify barriers to grass budgeting on beef farms. Teagasc beef advisors will also be surveyed to establish if they require any additional training to facilitate such a service. Preliminary results from the survey of the grass budgeting groups indicate that all of the farmers found grass budgeting to be a worthwhile practice on their farms. Since joining the group, 75% of the farmers increased days at grass, 57% increased the stocking rate and 57% decreased fertiliser use. The average estimate for savings made as a result of grass budgeting was €4,000. The survey of the discussion group farmers not grass budgeting found that 69% would be interested in participating in a grass budgeting group and that 67% would be interested in a grassland mentoring service. (This is where an experienced grassland manager makes regular visits to a farmer who requires help in grassland management). The results from the grass budgeting group surveys have shown on-farm improvements and savings associated with membership of a grass group. The survey of the discussion group farmers has shown that there is a demand for both grass budgeting groups and a grassland mentoring service.

Nutrient management: 'getting the balance right'

T. Doherty [1], T. Cummins [2] and P. Murphy [1]

[1] *Teagasc Crops Environment & Land-Use Programme, Johnstown Castle, Wexford.*
[2] *Soil Science Department, University College Dublin, Belfield, Dublin 4.*

Aggregate results of over 100,000 agronomic soil-tests by Teagasc show that soil P and K fertility status has been declining during the period 2008-2012, indicating that current nutrient management practices on farms require investigation and improvement. A survey of farmers was conducted to develop an understanding of awareness and practices in Nutrient Management (NM) on farms. A total of 375 responses were collected from 22 counties. Results showed that 25% of farmers don't have a NM plan, and those that do say that the main reason is to enable them to calculate a whole-farm fertilizer allowance for cross-compliance rather than for agronomic benefits. Teagasc advisors were also surveyed on their attitudes and experience to NM activities. Results from 145 responses, from every county, indicate that the majority of soil samples are taken for compliance rather than agronomic reasons. The advisors requested simpler user-friendly NM tools to facilitate more adoption of NM for agronomic purposes. A comprehensive case study survey of 50 farms is in progress to determine the NM practice on a subset of intensive farms. To maintain high quality produce and high levels of production, as well as maintaining good environmental practice, nutrient management will be the key to unlocking the issues and improving the level of the soil nutrient status. The surveys showed differences in attitudes based on age, location and enterprise. Farmers engaged in more intensive farming enterprises had higher regard for the benefits of NM. Bridging the gap between advice given to farmer and NM practice on Irish farms through improved knowledge transfer is where the improvements can be made. Improved NM delivery methods and tools, along with training sessions and discussion group meetings, will be the main drivers of improved NM efficiency and thereby help fulfill the objectives of Food Harvest 2020.

An assessment of the potential of drystock discussion groups as an extension tool

M. Moran [1], J. Kinsella [2] and A. Murray [3]

[1]Teagasc, Drumboy, Mohill, Co Leitrim. [2]School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4. [3]Teagasc, Ballybofey, Co Donegal.

This study set out to determine the reasons for farmer involvement with drystock discussion groups and the potential that such groups may have as an extension tool for the Teagasc advisory service. It surveyed members of nine drystock discussion groups, comprising 142 farmers, located in the North West Region of Ireland, and collected data on farmers' knowledge and attitude in relation to grassland management, animal breeding and financial analysis, as well as their level of practice adoption of same. Seventy-one per cent of respondents reported that the main reason they joined the discussion group was to "learn from other farmers", while 16% indicated that they became members because of the €1,000 incentive provided. 39% of farmers who had joined drystock discussion groups in 2012 through the Beef Technology Adoption Programme selected 'Didn't know they existed' as the reason they had not joined groups previously, and 29% selected as the reason that 'They didn't know enough detail about them'. The results also indicated that farmers' involvement in their discussion groups resulted in higher level of knowledge on, and adoption of, key aspects of grassland, animal breeding and financial management. They also reported that their attitudes were more positive to new and improved practices. Thus far, the study highlights the important role drystock discussion groups play in improving farmers' knowledge, changing attitudes and helping to adopt new improved practices and ultimately strengthening productivity, which contributes towards the Food Harvest 2020 target of 20% increase in beef output.

Contract heifer rearing and related support services within the Munster region

C. Kelly[1], T. O'Dwyer[2] and D. O'Connor[3]

[1]Teagasc, Killarney, Co Kerry; [2] University College Dublin, Belfield, Dublin 4, [3] Teagasc, Moorepark, Fermoy, Co Cork.

Future milk production will be largely dependant on the efficient transfer of resources between exiting farmers and those wishing to expand production. Growth opportunities are anticipated for Irish dairy farmers post-quota abolition, but this may be limited by the availability of land suitable for milk production and heifer rearing. The aim of this study is to identify a means whereby Teagasc can supply an effective support service to farmers desiring to enter, or maintain involvement in, contract heifer rearing agreements. The study has four objectives: 1) assess the impact service providers have on decision-making by farmers currently involved in contract heifer rearing; 2) gain an insight into the operation of contract heifer rearing in the Munster area and to gauge its persistence as an enterprise in the Irish farming environment; 3) determine the current knowledge pertaining to contract heifer rearing arrangements amongst Teagasc advisory staff; 4) examine the role of service providers/ knowledge brokers in contract heifer rearing operations abroad. A case study method is being used to address objectives 1 and 2 and a survey is being used to address objective 3. Objective 4 will be addressed through a literature review. The early indications are that a secure directory of available heifer rearers and interested heifer owners could have beneficial effects. There are also early indications that 'practical know-how' pertaining to the benefits and issues regarding contract heifer rearing can be improved greatly through increased exposure to practical working examples, i.e. case studies at local level. The assembled case studies will add a 'first-hand account' knowledge resource to the previous knowledge base.

An assessment of learning by agricultural students during practical learning periods

N. Mc Kiernan *, J. Breen ** and T. Pettit***

**Teagasc, Ballyhaise Agricultural College, Ballyhaise, Co. Cavan. **School of Agriculture and Food Science, University College Dublin, Belfield, Dublin 4. ***Teagasc Kildalton Agricultural College, Piltown, Co Kilkenny*

To determine the attitudes, preparations and backgrounds of students prior to practical learning periods and to evaluate the outcome of their learning during practical learning periods, the current study carried out a pre- and post-practical learning period survey with all level 5 FETAC agricultural students within the six agricultural colleges in Ireland. The main advantage of producing a pre- and post-PLP survey is that it allows us to compare students' attitudes to the PLP before and after completing the programme. Results from the pre-PLP survey found that 14.4% of students felt that they could have been better prepared by their college prior to the PLP. This figure grew to 23.3% in the post-PLP survey. Also in the pre-PLP survey, students ranked getting the chance to apply the husbandry skills they had studied in a real farm environment as their top priority. Results from the post-PLP survey showed that students felt they had learned on average 1.9 new skills each during their PLP. They felt that they had improved on at least seven existing skills each during their PLP. Also when the students were asked to rank from 1-6 what they thought was the most beneficial aspect to their overall agricultural learning experience, the majority, approximately 42%, ranked knowledge gained from the practical learning period as number one. It is envisaged that the findings from this study will have important implications for the design of future agricultural education and training in Ireland. Ultimately, this study will contribute to innovations that will enhance learning outcomes and improve the operation of the Teagasc practical learning programme.

Identifying the success factors of milk production partnerships with an emphasis on new entrant/parent partnerships

L. Dooley[1], B. Roche[2] and D. Stead[3]

[1,2,]Teagasc, Moorepark, Fermoy, Co. Cork. [3] University College Dublin, Belfield, Dublin 4.

Milk production partnerships were introduced to Ireland in 2002. Currently, this is the only type of formally registered partnership available to Irish farmers. Ten years on, 620 such partnerships are operating nationally, comprising around 6% of dairy farmers in the country. Farm partnerships fall broadly into two groups: one group involving parents and new entrant sons and daughters; and the second involving at least one dairy farmer with one or more other farmers. New entrant-parent partnerships currently comprise two-thirds of all the registered milk production partnerships in Ireland. This study's objectives are: (a) to identify the success factors and challenges in Irish farm partnerships, with a focus on new entrant/parent milk production partnerships; (b) to determine and demonstrate the benefits and costs that farm partnerships have brought to new entrants and the family; (c) to create a profile of the type of farmer best suited to being in a farm partnership; (d) to provide user-friendly information on the success factors and challenges in establishing and running a farm partnership in Ireland, in particular by creating a checklist for farmers starting or thinking of starting a farm partnership. All milk production partnerships must register through the Teagasc registration office. Sixty questionnaires surveys are being conducted from a random sample of established new entrant-parent partnerships from the Teagasc register along with five detailed case studies of new entrant partnerships, also randomly selected from the register. Results to date have indicated a lack of awareness of partnerships and their benefits, thereby showing that clear information is needed to help inform potential farm partnerships. Personality clashes have been identified as potential causes of a breakdown in partnerships. The success factors identified to date are an improvement in work/ lifestyle balance, facilitating farm transfers and an improvement in skill sets.

Contact Details:

Teagasc Head Office
Head Office, Oak Park, Carlow
Tel: +353 (0) 59 9170200
Fax: +353 (0) 59 9182097
Email: info@teagasc.ie

www.teagasc.ie

NDP
National Development Plan 2007 - 2013

teagasc
Agriculture and Food Development Authority

SCIENCE WEEK 2012