WALSH FELLOWSHIPS SCHEME

TEAGASC WALSH FELLOWSHIP SEMINAR 2010

The Walsh Fellowship Contribution to the Food Harvest 2020 Vision of the Agri-Food Sector

ABSTRACTS

RDS, Ballsbridge, Dublin 4
Thursday, 11 November 2010

NDP
National Development Plan 2007 - 2013

RDS

teagasc
Agriculture and Food Development Authority

IFSTI

WELCOME

Prof. Gerry Boyle, Director

The 2010 Walsh Fellowships Seminar at the RDS, which is taking place as part of Science Week Ireland, is focused on acknowledging and highlighting the achievements of our postgraduate students as they near the completion of their theses.

The Walsh Fellowship Scheme provides opportunities for Teagasc to collaborate with universities and colleges on projects of relevance to the stakeholders in the agri-food sector. Equally important is the shared responsibility of preparing professionally trained people with either the capacity to contribute to addressing the serious challenges facing the sector or to take advantage of the great opportunities it can offer. Together we focus on research issues relevant to stakeholder's needs with high quality outputs based not only on the production of a thesis but also peer reviewed articles in scientific journals. In addition, we must ensure that the new knowledge generated will contribute to delivering growth in the sector.

It is against this background we have chosen the theme: "The Walsh Fellowship Scheme contribution to the overall vision for sector set out in the Department of Agriculture, Fisheries and Food recent publication Food Harvest 2020". This overall vision is summarised by three actions "Acting Smart, Thinking Green and Achieving Growth". Delivering this vision requires innovation or the use of new and existing knowledge to drive profitability and sustainability in the sector. It emphasises the importance for researchers to be increasingly cognisant of their role in supporting and delivering innovation. As we move through a difficult economic period, it has never been more important to demonstrate the economic return on the research investment. Innovation is central to achieving the ambitious growth targets set for the sector in Food Harvest 2020.

The continued support of the RDS for this event is appreciated and I would also like to thank the Institute of Food Science and Technology of Ireland (IFSTI) for their award to the best food science and technology presenter. Finally, I want to thank the Walsh Fellows for their contribution to our research programme and wish them much success in their future careers.

Professor Gerry Boyle,
Teagasc Director

WALSH FELLOWSHIPS SCHEME

ABSTRACTS

DECIPHERING THE INTENTION-BEHAVIOUR GAP IN HEALTH BEHAVIOUR RESEARCH: A FOCUS ON HEALTHY EATING BEHAVIOURS

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Unhealthy diets are associated with an array of non-communicable diseases such as coronary heart disease and hypertension. Healthy eating is often considered self-directed health behaviour where individuals are seen to contribute to their own well-being through adopting particular health enhancing behaviours and avoiding health compromising behaviours. Social cognition theory is one of the dominant research paradigms applied in attempts to understand the determinants of an individual's health behaviours. In particular this theory considers the cognitive, affective and behavioural aspects germane to understanding behavioural change. To date much of this research has focused on motivations or intentions to execute a health enhancing behaviour. However, it is recognised that good intentions do not always guarantee corresponding behaviours. This paper presents the results of an exploratory study which aimed to identify the social cognitive factors that underlie the transition from motivations to corresponding behaviour, commonly refereed to as the intention-behaviour gap. Twelve in-depth interviews were conducted on Irish adults and purposefully analyised using a content analysis approach. Discourse pertaining to failed and successful attempts to achieve dietary goals was identified and coded. Three significant transitional factors were identified. Planning, monitoring activities and self-efficacy were evident as central in translating behavioral intention into behavioral inaction. The findings correspond with the evidence presented in the social cognition literature. The next phase of the study will investigate hypotheses related to the intention-behavior gap by means of a quantitative survey. The output of this study is relevant for the agri-food and fisheries industry in view of the targets stipulated in the recent Food Harvest report. A focus on the post intentional phase of consumer behavior may be an astute marking strategy towards satisfying consumer preferences and, ultimately, achieving the objective of increasing value output by €3 billion by 2020.

TECHNOLOGICAL INNOVATION: INVESTING IN THE FUTURE SUSTAINABILITY OF THE IRISH FOOD INDUSTRY

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To promote industry sustainability and to catalyze links between publicly-funded knowledge providers and companies, the Irish government has invested significantly in food-orientated research and development. This project, based in Teagasc Food Research Centre, Ashtown, in conjunction with the Dublin Institute of Technology and University College Cork, aims to facilitate a greater understanding of the motivations and barriers influencing the decision by small and medium-sized food enterprises (SME) to invest in technological innovation, emanating from research conducted in publicly-funded organizations. A critical review of the literature was used to develop a framework for investigating the uptake of technological innovations from sources external to the company. In order to ground this framework within the specific context of the Irish food industry, a series of in-depth interviews were conducted with key food industry representatives (n=7). Building from the literature and exploratory interviews, a postal survey of Irish food SMEs was undertaken (n=399). A response rate of 31.8% (n=117) was achieved. An open innovation scale was constructed from measures of the perceived relevance of academia, support agencies and publicly-funded research. Results of one-way between-groups analysis indicated that companies which showed a propensity towards open innovation were more likely to have performed product [$F(1, 118) = 3.9$, $p = 0.05$] and process [$F(1, 111) = 9.3$, $p < 0.001$] innovations in the last three years. The proclivity towards open innovation varied significantly across sectors, with *the prepared-consumer goods* (M=3.92, SD=0.61) sector scoring a significantly higher open innovation mean than the *others* sector i.e. beverage, seafood and fresh produce (M=3.43, SD=0.57). The impact of company size and export status on open innovation scores was not seen to be significant. The Irish agri-food industry has significant potential to support export-led economic recovery by leveraging innovation and contributing to the development of the smart economy as outlined in the *Food Harvest 2020* industry vision. In line with this vision, it is hoped that the insights into the industry perspective on technological innovation, provided by this project, will help achieve the industry export target of €12 billion by 2020.

INVESTIGATION OF UNDERLYING FACTORS RELATING TO THE DEVELOPMENT OF A PINK DISCOLOURATION DEFECT IN COMMERCIAL CHEESE

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Cheese production in Ireland, the majority of which is exported (~€612m in 2008), has increased at a dramatic rate from about 80,000 tonnes in 1995 to 157,000 tonnes in 2009. However pink discolouration defects in ripened cheese have resulted in down-grading and loss of export markets. This defect is evident on the outer surface as a pink discolouration penetrating to a depth of 20mm in Cheddar-type cheeses or as a pink border at a depth of 15mm in rindless Swiss-type cheese. Defective samples show significantly higher redness (a*:0.36 v -3.57) and lower whiteness (L*; 70.79 v 76.41) values in comparison to control samples. Many factors (e.g. cheese redox potential, strains of lactobacilli, cheese pH, oxidation of tyrosine and bixin, etc.,) have been associated with the defect but specific factors responsible for the defect and the mechanism by which they work have yet to be defined. The colour compound partitioned with the water insoluble protein fraction of the cheese and was not soluble in solvents such as water, ethanol, methanol or acetone but was soluble in ammonium hydroxide and 6.6M urea. No compositional differences were observed between control and defective cheese. No molecular or structural differences were detected between control and defective samples as measured by Fourier transform infrared spectroscopy and hyper spectral imaging techniques or in oxidation-reduction potential and oxygen content. However, differences in patterns of bacterial cell viability and metabolic state were observed between control and defective cheese as measured by flow cell cytometry. Current analysis using mass spectrometry techniques is seeking to determine whether specific pigmented compounds such as melanin, possibly resulting from varying levels of bacterial tyrosinase activity on the free amino acid tyrosine, may be responsible for development of the pink discolouration. This work will contribute to achieving Food Harvest 2020 export target of €12b by 2020 by reducing cheese export losses to pink discoloration.

A QUALITATIVE EXPLORATION OF IRISH STAKEHOLDER OPINIONS AND VIEWS REGARDING FARM ANIMAL CLONING IN LIGHT OF US COMMERCIALIZATION

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Following the approval (Food and Drug Administration ruling in 2008) and subsequent adoption of farm animal cloning by livestock breeders in the United States, focus now shifts to Europe where the issue remains unresolved. Early indications are that the European approach will be to try to reconcile ethical, legal and social arguments from a diverse range of state and civil stakeholders. Given the increased global demand for dairy products and a growing shortfall in EU beef supply, the ability to clone superior farm animals may represent a competitive advantage for early adopters of the technology. With a focus on productivity and product quality through genetic advancement, Ireland may be in a position to benefit from cloning technology. This study, which looks at stakeholder opinion on the issue of animal cloning for food production purposes in Ireland, is an attempt to frame the likely policy debate and assess the prospects for the commercialization of the technology in the future. Using in-depth interviews, selected expert stakeholders from industry, academia and non-governmental organizations (n=19) were consulted for their opinions. The results indicated that formal discussion on the use and implications of animal cloning in food production had not occurred within participant organizations. Interviewees were also largely unaware of cloning developments in the agri-food industry elsewhere. While receptivity to the idea of cloning for food purposes varied among interviewees, the near-term prospects for this technology were largely viewed with skepticism. Technology development stakeholders suggested that animal cloning is a radical departure from conventional assisted reproductive techniques. Among participants that had favorable opinions on animal cloning, aspects such as cost, the ability to add value and consumer acceptance were identified as key determining factors. Overall, it is hoped that these findings will contribute to policy discourse and allow technology developers to assess the market potential of farm animal cloning as it pertains to the *Food Harvest 2020* vision of achieving growth. Further research in this project will examine the views of the Irish public with regards to farm animal cloning.

DETERMINATION OF ANTHELMINTIC RESIDUES IN MILK USING UPLC-MS/MS WITH RAPID POLARITY SWITCHING

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This paper reports the development of a new analytical UPLC-MS/MS method for determining the major classes of anathematic drug residues in milk. The method was validated according to Commission Decision 2002/657/EC criteria. The limit of detection of the method was typically <1 µg kg^{-1}. The performance of the method was successfully verified through participation in inter-laboratory studies. The method was accredited to ISO 17025 and applied to milk samples collected as part of official food inspection. This has resulted in the detection of low levels of flukicide residues, which has led to several veterinary products being restricted in dairy animals by regulatory agencies. In subsequent research, the technology has been used as a tool to investigate the fate and persistence of flukicide residues in milk. These studies helped identify the cause of residues in milk and generate new knowledge, which can support the establishment of safe withdrawal periods for flukicide drugs. The outcome of this research has been the improvement of the safety of Irish milk through the application of a new sensitive test method. The results from research can support the development of new veterinary medicinal products for the treatment of infections in dairy cows. This research will contribute to the 2020 Food Harvest Vision by underpinning Irish milk as a highly pure product, which will ensure consumer confidence and safeguard international investment in the sector.

THE GENETICS OF RESIDUAL FEED INTAKE IN BEEF CATTLE

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Improving feed efficiency within beef production systems is necessary to increase food production from a limited land base to meet the demands of a growing world population. Residual feed intake (RFI) is a feed efficiency trait and the objectives of this study were to (i) quantify the contribution of genetics to differences in RFI among animals, (ii) to elucidate the expected responses to selection for RFI in other performance traits and (iii) to identity potential early predictors of this trait. Data on bulls tested for feed efficiency for over 70 days at the National Beef Bull Test Centre in Tully, Co. Kildare were used along with commercial data on their relatives in Irish herds. Results showed that 45% of the differences in RFI among animals was due to their genetic makeup (i.e. heritability = 0.45). Selection for RFI is expected to improve muscling, animal value, carcass weight and conformation and reduce body fat. No expected deterioration in other performance traits, including reproductive performance or survival was evident, although selection for greater efficiency is expected to delay the age at first calving. The potential to identify early predictors of RFI based on linear type traits and certain DNA markers were evaluated; neither were good predictors. Selection for RFI, in order to reduce the cost of inputs without affecting the level of output in beef cattle, is feasible in Ireland.

TREATMENT OF DAIRY SOILED WATER USING AEROBIC WOODCHIP FILTERS

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The milking process produces dairy soiled water (DSW) that contains variable concentrations of nutrients. It is proposed that aerobic woodchip filters would decrease contaminant concentrations of nutrients in DSW, allowing re-use of water to wash down yards, thereby reducing water usage and environmental risks associated with land spreading. A laboratory-based study investigated woodchip as a filter medium. Subsequently, farm-scale filters investigated the system under operational conditions. Laboratory filters consisted of Sitka Spruce (Picea sitchensis) at three depths (0.5, 1.0, and 1.5 m) and two substrate loading rates (1 (S1) and 3 % (S2) suspended solids (SS)) (three replicates). Samples (100 ml) of influent and effluent from each filter were taken three times weekly. Average influent chemical oxygen demand (COD), SS and total nitrogen (TN) was 12,167 (±1,899), 10,000 and 235 mg l^{-1} (±56), respectively, for S1 and 34,418 (±4,995), 30,000 and 542 mg l^{-1} (±97) for S2. Average COD, SS and TN decreases of 95, 99 and 88 %, respectively, were achieved and the effect of depth was negligible. Based on these findings, three farm-scale (100 m^2) filters (1 m deep) were constructed and loaded at 3 l m^{-2} d^{-1} for 1 year, treating DSW from 300 dairy cows. Samples of influent and effluent (100 ml) were collected twice weekly from each pad and from the influent. Average influent COD, SS and TN was 5,027 mg l^{-1} (±1,739), 471 mg l^{-1} (±75) and 297 mg l^{-1} (±118) and average COD, SS and TN decreases of 65, 84 and 60 %, respectively, were achieved. Therefore, laboratory filters indicated that woodchip has potential as a filter medium to remove contaminants from DSW and farm-scale filters confirmed their effectiveness under operational conditions. The treated effluent can then be used for washing down holding yards. This would decrease fresh water use on farms and the risk of nutrient loss to water through land application. The findings of this research contribute to the Food Harvest 2020 vision by utilising natural resources and protecting the environment. It promotes the use of a low cost, minimal maintenance recycling system that can be integrated easily into an existing farm system.

THE FERTILIZER POTENTIAL OF DAIRY SOILED WATER IN TEMPERATE GRASSLANDS

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Soiled water is produced on dairy farms from the washing of milking plant and cow holding areas during the milking process. This study aims to characterize soiled water and its management on a group of 60 Irish dairy farms and then, through a series of experiments, identify and quantify the pathways of nutrients applied to grassland in soiled water. Despite its nutrient content, soiled water is typically perceived to be of little nutrient value and is generally managed as a farm waste. Its suitability as a replacement fertilizer was tested in a plot experiment on two contrasting grassland soils in Co. Cork, Ireland. Treatments consisted of four nitrogen (N) rates (0, 15, 22 and 30 kg N ha^{-1}) x two fertilizer types (inorganic fertilizer and soiled water) x two sites x nine application timings (Dec, Feb, Mar, Apr, June, July, Sept, Oct and Nov). There were four replicates. The mean N fertilizer replacement values (NFRV) for soiled water treatments were 72, 78 and 90% for 15, 22, 30 kg N ha^{-1}, respectively. The NFRV of soiled water at higher application rates increased for summer applications. Results indicate that soiled water offers the potential to increase herbage production and replace inorganic fertilizer throughout the grazing period (February – September), improving sustainability in grass based dairy production systems. This can contribute to the overall vision of the Food Harvest 2020 report by capitalizing on an available natural resource and improving environmental protection.

ENGINEERING DISEASE SUPPRESSIVE COMPOSTS FOR USE IN HORTICULTURE

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The European Landfill Directive (1999/31/EC) requires EU member states to reduce the quantity of biodegradable municipal waste (MSW) sent to landfill. A reduction to 35% of the 1995 quantity is required by 2016. To achieve this target in Ireland, 770,000 tones of MSW must be diverted away from landfill. Composting is one method of recycling biodegradable waste, which has received considerable attention. A wide range of composted MSW material is produced commercially in Ireland and the possible use of these materials in plant growing media or field application is of particular interest, especially their potential in suppressing plant diseases. This project investigated the suppressive properties of composted materials (COMs) on root rot diseases of horticultural crops. Fifteen COMs from different feedstocks were examined. It was identified that suppression of oomycete damping off diseases caused by *Pythium ultimum* and *Phytophthora erythroseptica*, could be suppressed by such materials. Evidence of suppression of root rot caused by *Fusarium oxysporum* was also detected. Investigations identified suppressive fungal and bacterial isolates present in the COMs examined. Fungi belonging to the genera *Aspergillus, Trichoderma* and *Penicillium* were identified as the most suppressive isolates. Isolates of the genus *Trichoderma* were further investigated and results identified several isolates with suppressive properties. One isolate, identified as *T. harzianum*, displayed the most promising tolerance to changes in environmental conditions. This isolate displayed the strongest production of diffusible anti-fungal compounds *in vitro* and characteristics of mycoparasitism. The isolation of such suppressive isolates raises the possibility of their use in engineered disease suppressive plant growing media and the possible development of a new outlet for composted MSW, as both a crop disease suppressant and a nutrient source. This will contribute to achieving the goal of aligning sustainability across the supply chain, one of the Think Green objectives in Food Harvest 2020.

INVESTIGATING THE CARBON BALANCE IMPLICATIONS OF ESTABLISHING BIOMASS CROPS

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European Union proposals envisage a 20% EU-wide cut in greenhouse gas (GHG) emissions by 2020 relative to 1990 levels, as well as a 20% contribution from renewable sources to the total energy mix. Land-use change to biomass production can contribute towards abating GHG emissions, with the additional economic benefit of reducing our dependence on fossil fuel imports. However, further information is required on the GHG emissions associated with biomass crop cultivation if the maximum mitigation potential is to be realized. Perennial grasses can provide a carbon-neutral fuel source, sequestering carbon in root biomass and soil carbon reservoirs. In this work, ecosystem carbon dioxide (CO_2) fluxes were measured on field-scale plots of *Miscanthus*, Reed Canary Grass and on permanent grassland, the original land-use type. Using the eddy covariance technique the balance between gross primary productivity (GPP) and total ecosystem respiration (R_{eco}), the two major determinants of the C budget, was assessed. Results from the growing season show that carbon uptake is related to leaf area index (LAI), with year-one Reed Canary Grass achieving high productivity early in the season and photosynthetic rates comparable to year-two *Miscanthus*. Although Reed Canary Grass is quite productive in the early establishment phase, the superior growth and biomass accumulation rates shown in mature *Miscanthus* crops would suggest greater carbon uptake in this crop over its life cycle. The output of this work will contribute to policy development that will underpin national strategies for mitigating GHG emissions and achieving the 20% renewable energy target. These will develop the "Think Green" focus in the Food Harvest 2020 vision.

A STOCHASTIC ANALYSIS OF THE DECISION TO PRODUCE BIOMASS CROPS IN IRELAND

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The Food Harvest 2020 Vision outlines the need for continued support of the bioenergy sector. However, land-owner concerns about the production and financial risks associated with growing energy crops may impede the actual rates of adoption. The uncertainty surrounding risky variables such as the costs of production, yield level, price per tonne and opportunity cost of land, coupled with their lengthy production lifespan, makes it difficult to accurately calculate the returns to biomass crops. A stochastic simulation model was used to estimate distributions of returns from willow and miscanthus in Ireland. The Net Present Values of various biomass investment options were simulated to ascertain the full distribution of possible returns. The results of these simulations were then compared using their respective Cumulative Distribution Functions and the investments were ranked using Stochastic Efficiency with Respect to a Function (SERF). The results show that while the distributions of investment returns for miscanthus are wider than those of willow, implying greater uncertainty, the distribution of willow returns is predominantly to the left of zero indicating that such an investment has an extremely high probability of generating a negative return. The SERF analysis shows that miscanthus generally has higher certainty equivalents, and therefore farmers may be more likely to invest in miscanthus rather than willow. The disparity in the level of risk is likely due to the superior yield potential, annual production cycle and cash flow profile of miscanthus compared to willow. The results will contribute to the design of appropriate policy mechanisms to incentives increased adoption of biomass crops. The research output will therefore assist in the stated aim of capitalizing on Ireland's natural advantages and resources in the 'Think Green' pillar of the 2020 Food Harvest Vision.

POSTER ABSTRACTS

TRANSMISSION AND MOLECULAR CHARACTERIZATION OF LISTERIA MONOCYTOGENES IN THE IRISH BEEF CHAIN

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Listeria monocytogenes can cause a wide ranging of symptoms from mild influenza-like symptoms to meningitis, septicaemia and infection in pregnant women leading to miscarriage. While beef has been linked to cases of listeriosis, few studies have tracked *L. monocytogenes* in the beef chain or assessed the clinical significance of strains transmitted by this vehicle. This study aimed to quantitatively track *L. monocytogenes* through the beef chain and to assess the virulence potential of isolated strains. Over a two year period, bovine hides (n=400) and their corresponding carcasses at pre chill (n=400) were sampled at a beef abattoir and ground beef (n=100) and ready-to-eat beef products (n=200) were sampled from retail outlets. All samples were examined for the presence and concentration of *L. monocytogenes* and isolates were characterized by stereotyping, antibiotic resistance profiling, virulence profiling and pulsed field gel electrophoresis (PFGE). *L. monocytogenes* was isolated from bovine hides (26%), carcasses (14%) and ground beef (29%) respectively. No *L. monocytogenes* was recovered from ready-to-eat products. The 1/2a, 3a serogroups were the most common on beef and also occur in human illness. Several isolates were multi-resistant to three or more antibiotics. The virulence gene *imo*2821, associated exclusively with virulent strains of *L. monocytogenes* was detected in 70% and 65% of hide and carcass isolates, respectively. PFGE profiling gave evidence of direct cross contamination from hide to the animals own carcass and also showed that contamination arose from other animals being slaughtered on the line. The study highlights the importance of beef as a transmission route for human disease causing strains of *L. monocytogenes* either directly via undercooked beef or via cross contamination in the retail and domestic environment. The results will contribute to the achieving growth theme in Food Harvest 2020 by providing information required for the design of systems to ensure safe added value beef products. This is necessary to achieve the targeted € 3b increase in value added output.

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DETECTION OF BENZIMIDAZOLE CARBONATES AND AMINO METABOLITES IN LIVER BY SURFACE PLASMON RESONANCE-BIOSENSOR

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A surface Plasmon resonance (SPR) biosensor screening assay was developed and validated to detect 11 benzimidazole carbonate (BZT) residues in liver tissue. The polyclonal antibody used in the benzimidazole carbonate assay was raised in a sheep immunized against a methyl 5(6)-[carboxypentyl)-thio]-2-benzimidazolecarbamate derivative. A modified Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) extraction method was developed to isolate benzimidazole carbonate residues. Benzimidazole residues were was extracted from liver using an acetonitrile extraction method. The assay was validated in accordance with the performance criteria described in 2002/657/EC. The biosensor assay limit of detection was calculated to be 32 µg kg^{-1}, the detection capability (CCβ) was determined to be 50 µg kg^{-1} and the mean recovery of analytes was in the range 77-132%. Biosensor assay performance was tested by analyzing liver tissue from animals treated with benzimidazole drugs and comparing the results with a UPLC-MS/MS confirmatory method. All non-compliant samples were identified using the biosensor assays.

ENHANCEMENT OF NUTRITIONAL STATUS OF REDUCED SODIUM CHILLED READY MEALS THROUGH INCLUSION OF SPICES

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Spices are rich sources of antioxidants and could be used to enhance the nutritional status of reduced salt ready meals while also compensating for any loss in flavor arising from salt reduction. Therefore we surveyed the antioxidant properties (using 5 methods) and the phenolic content of thirty spices commonly used in commercial ready meals. Of the spices surveyed clove demonstrated the highest antioxidant capacity in all the assays used. Cinnamon, pimento and spices of Lamiaceae family; rosemary, oregano, marjoram, sage, basil and thyme also had high antioxidant capacity. Further investigations focused on spices of the Lamiaceae family due to their high sensory score when used in the meals. This involved the identification of 38 phenolic compounds in the solid/liquid extracts of six Lamiaceae spices using LC-ESI-MS/MS. Other investigations focused on the development of novel extraction methods for antioxidant compounds from these spices using pressurized liquid extraction (PLE) in conjunction with response surface methodology (RSM) to optimize extraction temperature (66-129 □C) and solvent concentration (32–88% methanol). The antioxidant activity of the optimal PLE extracts was significantly ($p<0.05$) higher than solid/liquid extracts. The effect of drying method usually used for preservation of spices on the antioxidant activity of the spices was also examined. Dried spices had significantly ($p<0.05$) higher total phenolic (TP), ferric reducing antioxidant power (FRAP) and oxygen radical absorbance capacity (ORAC) values than those of the un-dried spices. The extracts of air dried spices showed the highest TP, FRAP and ORAC values among the extracts of dried herbs examined. The final step involved determining the antioxidant capacity of three chilled ready meals (chicken supreme, cottage pie and vegetable soup) after the addition of 0.1% rosemary, oregano and sage and monitoring antioxidant capacities during seven days of chill storage. Residual antioxidant capacity of meals with added spice was up to 75% higher than meals with no added spice, however, chill storage resulted in significant ($p<0.05$) decreases in the antioxidant capacity of both types of meals. The outcome of the work will contribute to achieving the goal (Food Harvest 2020) of enhancing SME outputs by reformulating healthy and value added products for the ready meal market.

THE EFFECTS OF DAIRY COW WEIGHT ON SELECTED SOIL PHYSICAL PROPERTIES INDICATIVE OF COMPACTION

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Animal treading in grassland ecosystems is known to affect soil and vegetation properties, which can influence agricultural system productivity. The main objective of this study was to establish the impact of cattle treading on a range of soil physical properties indicative of soil compaction under four soil moisture deficits (SMD; 0, 11, 14, 29 mm) with three Holstein Friesian cow weights (light – 389 kg, medium – 478 kg and heavy – 545 kg). Soil moisture deficit was calculated using archived and forecasted meteorological data supplied by Met Eireann and a SMD model. When the SMD was achieved, two cows of each weight were walked up and down grass plots (5 m × 2 m) five times in each direction. The experiment was a 4 × 3 factorial arrangement plus a control, set out in a block design, with four replicates per treatment. Bulk density (BD), total porosity, gravimetric and volumetric water content, penetration resistance and soil shear strength were measured, using standard methods, pre and post trampling. Data were analyzed using GLM in SAS. Soil moisture deficit was the main factor affecting changes in BD, soil shear strength, penetration resistance and total porosity. At SMD 0 mm, BD increased by 6.1% post trampling, whereas it only increased by 3.1%, 4.0% and 0.5% at SMD 11, 14, and 29 mm, respectively. Average BD was 2.3% greater immediately post trampling, and 4.6% greater in hoof marks. Penetration resistance was significantly greater following trampling by the heavy cow compared to the light or medium cow. There was no significant effect of cow weight on soil water content or BD. The results indicate that forecasted SMD can be used as a management input for rotational grazing systems to minimize soil compaction, and can therefore contribute to the Think Green Vision in Food Harvest 2020.

COMPARING ULTRASOUND WITH PLASMA PROGESTERONE TO DETERMINE LUTEAL STATUS OF DAIRY HEIFERS

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Where heifers have not been observed in estrus they may be presented to the veterinary practitioner to determine their pubertal status. With the advent of inexpensive ultrasonographic equipment this modality may have a role to play for this indication. Data were available from 1,671 heifers on 48 farms visited nine days prior to the mating start date. Blood samples were collected, plasma was harvested and progesterone (P_4) concentration measured using a validated time-resolved fluorescent immunoassay (AutoDELFIA, PerkinElmer, Finland) with a sensitivity of 0.01ng/ml. The presence of luteal tissue was recorded where an identifiable corpus luteum (CL) was visualized on scan or where the plasma P_4 concentration was $\geq$1ng/ml. Kappa values (*K*) were used to determine the degree of agreement between the two diagnostic techniques ($K \geq 0.8$=excellent level of agreement). In total, 74% of heifers had an identifiable CL and 42% of heifers had luteal phase plasma P_4 concentrations. This was a statistically significant but poor level of agreement (K=0.32; CI95=0.23-0.40, $P<0.001$) with moderate sensitivity (54%) but good specificity (90%). The P_4 data suggested that the majority of heifers did not have functional luteal tissue when sampled. This apparent contradiction may be explained by the ability of scanning, using a 7.5MHz transducer (less penetration, greater resolution), to detect non-functional CL (emerging or regressing). In conclusion, at a single examination, ultrasonography is a more reliable method of determining pubertal status than analysis of plasma P_4 concentration.

IDENTIFICATION OF THE NOVEL SINGLE NUCLEOTIDE POLYMORPHISMS IN THE BOVINE NEUROPEPTIDE Y5 RECEPTOR GENE AND THEIR PREDICTED ROLE IN PHYSICO-CHEMICAL CHARACTERISTICS OF THE RECEPTOR PROTEIN

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Background: Neuropeptide Y (*NPY*) plays a fundamental role in feed intake behavior and energy homeostasis in mammals. The neuropeptide Y 5 receptor (*NPY5R*), which is present on the neuronal cell surface, plays an important role in energy homeostasis by modulating the effect of NPY. Single Nucleotide Polymorphisms (SNPs) in the bovine *NPY5R* gene are likely to influence the function or expression of this gene in cattle. The objective of this study was to 1) identify SNPs in the bovine *NPY5R* gene and 2) predict their functional role in the protein product.

Result: Based on the multiple sequence alignment of 2.1 kb *NPY5R* genomic sequence, a total of 19 SNPs were identified. Of these SNPs, 4 were non-synonymous and 14 were synonymous. The nucleotide diversity in the coding, promoter and 3' untranslated region was $14.35x10^{-4}$, 8.74x10-4 and 9.77x10 respectively. One non-synonymous SNP (C1090T) introduces a stop codon that occurs in the third intracellular loop of the NPY5R molecule. This stop codon leads to a premature termination of the NPY5R peptide.

Conclusion: The SNPs identified in the regulatory and exonic regions of the bovine *NPY5R* gene, specifically those causing amino acid change and premature termination of the Y5 receptor protein and leading to alteration in the physico-chemical properties are likely to play vital physiological roles in the neuropeptide Y mediated energy homeostasis in cattle.

HOME PRODUCTION OF RUMINANT FEED: SIMULATION MODELLING OF COST AND EXPOSURE TO YIELD AND INPUT PRICE RISK

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Home production of winter feed provides an opportunity to reduce feed cost and reduce exposure to the increasing variability of purchased feed prices. The Grange Feed Costing Model was developed to facilitate comparison of the impact of management, market and biological factors on the cost of providing home grown feed to ruminant livestock. Stochastic analysis was used to ascertain the impact of yield and input price risk on the variability of feed cost for eight feed crops over a ten-year period. Intensively grazed perennial grass was the cheapest feed in this analysis. Yield risk was identified as the greatest single factor affecting feed cost variability. Purchased rolled barley was found to be a similar cost but lower risk option than the home produced equivalent. Feed crops incurring the greatest proportion of fixed costs and area-dependent variable costs, including bunker grass silage, were the most sensitive to yield fluctuations. The most energy input intensive feed crops, such as grass silage, both baled and bunker ensiled, were deemed the most susceptible to input price fluctuations. Maize silage was the most risky feed crop, with potential to be both the cheapest and the most expensive conserved feed alternative. Efficient utilisation of intensively grazed perennial ryegrass, with integrated silage harvests, and production of high yielding supplementary feed crops can provide a competitive advantage for Irish farmers seeking to efficiently and economically increase outputs. Knowledge of the yields and utilisation efficiency levels at which home produced feeds become economically preferable to purchased feeds will allow Irish farmers to select the most profitable feed strategy in an environment of increasing uncertainty of global feed prices.

DEVELOPMENT AND USE OF NUCLEAR MICROSATELLITE MARKERS (SSRS) FOR GENETIC DIVERSITY EVALUATION IN *MISCANTHUS* (PANICOIDEAE, POACEAE)

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Simple sequence repeats (SSRs) are powerful tools for both genetics and breeding studies in plants. SSRs combine many desirable marker properties including high levels of polymorphism, co-dominance, abundance in genomes and potential transferability to related species. We developed 19 nuclear SSR markers for *Miscanthus*, a genus of perennial C_4 grasses that has recently raised interest as a non-food crop for energy and fiber production. The genetic diversity of a collection of 164 *Miscanthus* genotypes and 14 related species of the subfamily Panicoideae have been characterized with these markers.

Total genomic DNA was extracted following a modified CTAB method. Total genomic DNA from the *Miscanthus sinensis* clone SW217 was used to construct a nuclear microsatellite enriched library. Two 96 well microtitre plates containing single positive bacterial colonies, one selected for the presence of TC_n, TG_n motifs and the second for the tetranucleotide $GATA_n$ motif, were obtained. The 192 clones were sequenced and SSRs were identified in the clones. 80 primer pairs were designed using the flanking regions of the nucleotide repeats. DNA was amplified through PCR and 30 primer pairs showing good amplification and possible polymorphism were selected. Forward primers were then fluorescently labeled to be used for automated genotyping and sized with GENEMAPPER ™ V4.0 software. 19 markers came out to be highly polymorphic and were used for statistical and phylogenetic analyses of the collection. Accessions could be clustered in three main groups, one of which includes mainly individuals of the species *M.* × *giganteus* and is clearly separated from the other two groups. Each group exhibits a high level of genetic diversity both between and within species.

EXAMINING THE PHYSIOLOGICAL AND GENETIC RESPONSE OF MAIZE TO LOW TEMPERATURE CONDITIONS

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Maize (*Zea mays*) is an emerging forage crop in Ireland. Maize is a C4 plant species originating in warmer climates. Low soil temperatures at early stages of crop establishment in spring are problematic under Irish climate conditions. Maize varieties with improved chilling tolerance have been developed and are on the market, but maize in Ireland is still widely grown on plastic and further varietal improvements are required to make the crop more economically viable. This study aims to investigate the genetic and physiological response of maize towards cold stress at early developmental stages. Of particular interest is the genetic response of developing maize roots to cold stress. Physiological experiments were carried out using twelve maize varieties to evaluate their behavior to cold stress. Maize varieties were germinated in Snijder Microclima environmental chambers fewer than two different temperature regimes in 24 hour-cycles and in dark conditions. Temperature regime 1 (control) was set up at 18°C for 16 hrs and 12°C for 8 hrs; Temperature regime 2 (cold stress) was set up at 12°C for 16 hrs and 6°C for 8 hrs. Root and shoot length was measured daily over a period of eight days post-germination. The mean root and shoot length for each genotype was used to determine whether genotypes differed in root and shoot length on the eight day post-germination under the two conditions. Genotypes differed significantly between control temperatures and cold conditions ($F < 0.001$) at this date, both in root and shoot length. The calculated percentage of growth reduction between the two conditions indicates the level of cold tolerance for the different varieties. The physiological experiments will be complemented by expression profiling to estimate the genetic response to cold stress. The breeding and release of more cold tolerant varieties will facilitate a more extensive growth of maize in Ireland.

FERTILIZER VALUE AND ENVIRONMENTAL IMPACT OF DIG ESTATE APPLICATION ON PERMANENT GRASSLAND

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Digestate from anaerobic digestion of biomass may be used as a fertilizer in agriculture. One option would be applying it to grass that is to be used as a biogas feedstock whereby agricultural nutrient cycles can be closed. However, as the digestate carries an active population of methanogenic micro-organisms, negative environmental impacts in the form of methane emissions are possible. The objective of this research is to quantify the fertilizer replacement value and environmental impact of digestate application in Ireland. The experiment is being conducted on long-term set-aside grassland at Teagasc, Oak Park, Carlow. Treatments include four levels of mineral nitrogen (N) fertilizer, four levels of digestate matched to the mineral N treatments, a combined mineral / digestate treatment and a control receiving no N fertilizer or digestate. The efficiency of N utilization from the mineral fertilizer and digestate by the grass was determined and the emissions of carbon dioxide, methane and nitrous oxide following application were measured. The first year results suggest that the “available” N in digestate less efficient for the support of plant growth than mineral fertilizer. However, digestate specific emissions of the three greenhouse gases per tonne of harvested biomass were found to be lower. The study is on-going. The results will contribute to the knowledge required in developing technologies and managements required to underpin nutrient efficiency and sustainability in the grass production and organic material recycling elements of the agri-food supply chain proposed in Food Harvest 2020.

LAND SPREADING DISTILLERY EFFLUENTS AND BIOSOLID WASTES ON MISCANTHUS X GIGANTEUS: IMPACT ON GROUND-WATER QUALITY

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The impact of land spreading organic wastes on the quality of groundwater's (GW) underlying plantations of *Miscanthus X Giganteus* was assessed. Biosolid waste (BSW) and distillery effluent (DE) were spread annually from 2007 to 2009 on six 0.117 ha treatment blocks of *Miscanthus X Giganteus.* Block treatment rates of 100% 50% and 0% were used, where the 100% rate represented the maximum permissible soil P-load. BSW was spread using a conventional slurry spreader; DE was spread using a purpose-built irrigation system. Prior to spreading, GW wells were sunk into each block to facilitate collection of GW samples. Samples were taken at the end of each month from October 2007 to October 2009, filtered to remove particulates and tested for pH and electrical conductivity. The samples were then tested at the Johnstown Castle Water Laboratory for NO_3^-, P, K, Cu, Cd, Cr, Pb, Ni, and Zn using AA and ICP spectroscopy. Crop and soil samples were collected from each block, on an annual basis, and concentration rates of the same species analyzed in GW were determined. Water table depths, soil densities, and site rainfall-rates were recorded. The mean concentration for each species was determined for the 25 month sampling period, and compared to Interim Guideline Values (IGVs) for GW as established by the Department of the Environment. Results show IGVs were not exceeded in any cases other than that of GW P, which exceeded its IGV by 186% in the 100% DE treatment block. Results suggest land spreading operations will need to take into account the possibility of P leaching to GW from sites where waste-spreading and soil-conditions give rise to the presence of a significant pool of mobile P.

FINE MAPPING OF BIOMASS YIELD QUANTITATIVE TRAIT LOCI (QTL) IN PERENNIAL RYEGRASS.

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Perennial ryegrass (*Lolium perenne* L.) is the main forage grass species in Ireland and farmers are aiming for a high biomass yield with good seasonal distribution. Biomass yield is a complex quantitative trait controlled by many environmental and genetic factors. In the context of a future agriculture with less cost inputs and a high demand for producing grass in a sustainable manner, the improvement of varieties using genetic tools is one of the solutions to achieve these objectives. In a precursor study, a genetic map of *L. perenne* was constructed based on an inbred-derived F_2 population using Amplified Fragment Length Polymorphism (AFLP) and Simple Sequence Repeat (SSR) markers. Three major biomass quantitative trait loci (QTL) have been found on linkage groups (LGs) 2, 3 and 7. This work focuses on the fine mapping of the QTL positions by mapping additional ryegrass SSR and Diversity Array Technology (DArT) markers. A total of 309 markers were added to the existing map increasing the map density from 7.5 cM to 3.7 cM. The QTL positions were recalculated for dry weight, fresh weight and dry matter data collected in the field and the greenhouse over two years. In accordance with the preliminary analysis, biomass QTL were localized on LGs 2, 3 and 7. The addition of markers permitted a reduction in the length of QTL intervals. To characterize the QTL regions, a screening of a *L. perenne* BAC library was performed using the markers flanking the QTL regions. The experimental approach of fine-mapping QTL positions combined with the information from the BAC library will benefit the dissection of the complex trait biomass yield and will contribute in the future to the identification of potential biomass-related genes.

N_2O EMISSIONS FROM LAND USE CHANGE INTO BIOENERGY CROPS

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Global warming, ozone layer thinning and resources depletion are urgent environmental issues mankind is facing. Land use change (LUC) for bioenergy production in Ireland may prove an environmentally sustainable and economically viable scenario. Our research aims to investigate the effect LUC has on nitrous oxide (N_2O) emissions and nitrogen cycling in the converted systems.

Three experiments were designed to facilitate this research: i) a long term field study of the N_2O emissions from two different energy grasses (Miscanthus, Reed Canary grass) cultivated on two contrasting soil types (poorly and well drained) converted from grassland to assess the sustainability of this land use change; ii) a short term outdoor lysimeter trial on the effect of ploughing technique and soil type on the N_2O emissions to evaluate the impact of this first step of land use change; iii) an indoor lysimeter trial using 15N tracer techniques to follow nitrogen cycling and losses in three grass systems (Miscanthus, Reed Canary grass, Rye grass) on a combination of soil types. The emissions in the first two years after LUC are characterized by the set of event based peak fluxes associated with agricultural practices (tillage, plant establishment). Ploughing emissions are soil specific and also depend on the ploughing technique used (conventional inversion tillage, reduced minimum tillage). Emissions post plant establishment are consistently low. Ploughing, as a first step of LUC, generates large N_2O fluxes therefore the importance of the appropriate agricultural practice and land choice is important. However the offset in future emissions on a long time scale should be taken into account as post establishment emissions are low (less/ no fertilization needed, longer plant life cycle). The LUC scenarios examined will contribute to the Think Green vision in Food Harvest 2020 by identifying possible options to achieving both national emission and renewable energy targets.

USE OF THE NITRIFICATION INHIBITOR DCD AS AN ENVIRONMENTAL TOOL TO REDUCE GHG EMISSIONS FROM CATTLE SLURRY

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There is an increased need for greater nitrogen efficiency in crop production in order to reduce production costs and reduce environmental emissions. Organic fertilizers such as cattle slurry have therefore received more attention recently to decrease chemical fertilizer usage. Extensive work has been carried out in relation to ammonia emissions from cattle slurry but little is known about slurry greenhouse gas (GHG) emissions. The objective of this research was to investigate the nitrification inhibitor dicyandiamide (DCD) to reduce the conversion of ammonium to nitrate thereby increasing nitrogen efficiency through reduced denitrification and nitrate leaching. Cattle slurry was applied in March, June and October each year at a rate of 33 m^3 ha^{-1} to grassland plots (3 x 2 m) arranged in a randomized block design at Johnstown Castle. Bandspread (BS) and splashplate (SP) spreading methods were simulated with and without DCD and a control treatment was used with a water equivalent of the slurry treatments giving five treatments in total. Emissions of nitrous oxide (N_2O) and methane (CH_4) were determined using the static chamber technique, by sampling frequently until background emissions were reached. In March N_2O emissions from slurry with DCD were reduced by 51% for splashplate and 50% for bandspread. There was no significant difference between spreading methods. Emission factors for slurry with DCD were 0.25% for SP and 0.18% for BS in March. In October slurry with DCD reduced emissions by 60% for splashplate and 192% for bandspread. Emission factors of DCD amended slurry in October were 0.14% for SP and 0.13% for BS. These figures are below the default emission value of 1% set by the IPCC. DCD significantly reduced N_2O emissions from the bandspread and splashplate application method treatments in March and October but not in June due to dry soil conditions. These results will contribute to the Think Green vision in Food Harvest 2020 by identifying DCD as a possible option to achieving national GHG emission targets.

SOIL COMMUNITY STRUCTURE: IMPORTANCE FOR SUPPRESSION OF AGRICULTURAL MICROBIAL PATHOGENS

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Animal manure and slurry are valuable resources that enhance many soil properties. However, these materials can contain pathogenic microorganisms to which humans and animals may be exposed under certain circumstances. Therefore it is crucial to identify the factors that affect pathogen survival in soil, in order to gain maximum agronomic benefits whilst minimising the threats to human and animal health. This research aims to elucidate the impact of soil communities on pathogen decline following environmental release. Initial work based on culture methods showed a significant effect of soil type and biology on the survival of *E. coli* O157. Microcosms consisting of sterile and non-sterile sand and clay soils were inoculated with known concentrations of the pathogen and destructively sampled over time. Growth was observed in sterile soil in the absence of a microbial community, whereas the pathogen declined in non-sterile soil due to microbial antagonism. A second, larger experiment is currently underway to show the effect of soil community structure on pathogen survival. A gradient of microbial diversity has been created through the inoculation of gamma irradiated samples with serial dilutions of field soil. These soils have been incubated for approximately one year to allow biomass stabilization, and microbial community phenotypes have been tracked by phospholipid fatty acid analysis (PLFA). Sub-samples have been inoculated with various microbial pathogens, namely *Listeria*, *Salmonella* and *E. coli* strains. The survival profile of these pathogens is currently being monitored and survival data will then be linked to soil community structure across the dilution series. It is hypothesized that greater persistence will be observed in samples with simple communities compared to those with more complex, diverse structures. This research will enable the identification of soil biological traits that could be manipulated through land management to enhance pathogen suppression in soil. The results will contribute to the Think Green and the Achieve Growth vision in Food Harvest 2020 by providing manure management guidelines that will reduce pathogenic risks to animal and human health.

N_2O EMISSION FACTORS FROM GRAZED GRASSLAND

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Agriculture can play a significant role in greenhouse gaseous emission inventories, particularly in Ireland which has a high proportion of agricultural land. In terms of global warming potential, nitrous oxide (N_2O) is 296 times more potent than CO_2 unit for unit. Nitrous oxide emissions are generated from soils through the biological processes of nitrification and denitrification which are influenced by environmental factors and management practices. This experiment was designed at the field scale, to compare N_2O emissions from two dairy stocking rates and fertilizer levels (INTensive 2.75 LU ha^{-1} and 258 kg fertilizer N ha^{-1} yr^{-1} and MODerately intensive 2.07 LU ha^{-1} and 131 kg fertilizer N ha^{-1} yr^{-1}). Nitrous oxide was measured twice per week, together with 5 consecutive days of sampling after each fertilizer application, from January to December 2009. The aim was to determine whether N_2O fluxes differed significantly between these derogation stocking rates over one complete farming year and to compare cumulative annual emissions (2009) of N_2O against the IPCC default emission factor (EF) of 1% of N applied. Net cumulative N_2O emissions were significantly different ($P < 0.05$) and were 1.96 ± 0.48 kg N_2O-N ha^{-1} yr^{-1} and 1.17 ± 0.51 kg N_2O-N ha^{-1} yr^{-1} for INT and MOD, respectively. Emission factors (expressed as % of fertilizer N applied) for the two treatments were 0.76% (INT) and 0.89% (MOD). These EFs are lower than those in the few existing Irish data sets, which may be partly because the fertilizer was applied on up to 9 occasions during the year, using a 'little and often' approach. As there are high levels of uncertainty about agricultural N_2O emissions this study will contribute to the Think Green vision in Food Harvest 2020 by adding to the information required for the design of robust national emission factors and for resetting the N fertilizer derogation rates in 2012.

FIELD MEASUREMENTS OF GREENHOUSE GASES AND AMMONIA EMISSIONS AFTER CATTLE SLURRY APPLICATION

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Agriculture in Ireland contributes 98% of total ammonia and 26% of total greenhouse gas emissions. Cattle slurry management is one of the key drivers of these emissions. In the context of the Food Harvest 2020 report, air quality and climate change are two key issues to be addressed by the Irish agri-food sector. Hence, this field study aimed at measuring the effects of land spreading of cattle slurry on ammonia volatilisation and greenhouse gases (N_2O, CO_2 and CH_4) emissions from a grassland soil.

Plots (2 m x 1.5 m) were established on a poorly-drained gley soil in a randomized block design. Four different slurries, either maize-based or grass-based with high (8%) or low (4%) dry matter (DM) content, were splash-plate or trailing-shoe applied at a rate of 33 m^3 ha^{-1}. These applications were carried out in April, July, August and September 2009 to provide a range of contrasting weather conditions. Three plots were also fertilised with calcium ammonium nitrate at a rate of 60 kg N ha^{-1} and no fertilised plots were used as a control. Continuous gaseous fluxes measurements were taken after fertilisation.

The results showed a significant impact of timing of application on nitrous oxide (N_2O) and ammonia (NH_3) emissions. Cumulative emissions of these two gases, for the first year of measurements, showed a reduction of gaseous nitrogen losses ($P<0.001$ for N_2O and $P<0.005$ for NH_3) when lowering slurry DM content. Switching from splash-plate to trailing-shoe application also reduced ammonia volatilisation ($P<0.05$), but the effect on N_2O was not clear. Finally, in terms of total greenhouse gases emissions, indirect N_2O emissions sourced from NH_3 losses comprised the largest proportion of land spreading emissions when slurry was spread in warm conditions.

Concerning gaseous carbon losses from the system, soil respiration was higher under warm conditions. Both carbon dioxide (CO_2, $P<0.005$) and methane (CH_4, $P<0.05$) were reduced when lowering slurry DM content, but soil respiration was increased when switching from splash-plate to trailing-shoe application ($P<0.005$). Last but not least, there was a substantial 'priming effect' in terms of carbon mineralization when slurry was applied and these CO_2 emissions dwarfed other greenhouse gases emissions over the measurement period.

ORGANIZATIONAL LEARNING AND TECHNOLOGY TRANSFER IN IRISH DAIRY FARMING

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Agriculture is an important industry for Ireland and within agriculture the dairy sector plays a prominent role. Teagasc promotes the competitiveness and innovativeness of agriculture through its knowledge transfer services: one activity within these services is the monitor farm programme (MFP). The MFP focuses on implementing key technologies (e.g., grassland or financial management) on Teagasc client farms. These farms have the central features of an organization: social structure, social actors, goals, technology and interaction with the environment. Therefore, it is appropriate to apply the concept of organizational learning (OL) to the learning processes underpinning knowledge transfer to these farms. The methodological approach is a case study of dairy monitor farms, investigating technology transfer through three main activities: discussion group meetings (DG), private farm demonstrations (PFD – that is, only accessible to Teagasc clients) and open farm demonstrations (OFD – that is, accessible to non-clients). The objective is to determine the types of learning (such as through interaction, observation, doing and discussion) and technology (both hardware and software) that each activity facilitates. Drawing on the OL literature, organizational 'routines' are focused on as the medium for technology transfer since routines are useful in determining organizational behavior and learning. Therefore, MFP routine (MOR) replication by dairy farms will be investigated. Overall, the selection-adoption-retention process for replicating MOR will be investigated and the learning mechanisms (i.e. single- or double-loop) identified. In line with expectations, initial observations of MFP activities show that information exchange is taking place through interaction, observation and discussion. However, it has not yet been determined whether these types of learning are sufficient triggers for MOR adoption by the wider farming community. Although some activities – such as PFD and OFD – mainly present research based knowledge, it cannot be concluded that this is the only type of knowledge being transferred. In light of these issues, unstructured interviews will be conducted with a selection of farmers to identify whether single or double loop learning is taking place in the context of MOR replication as well as the corresponding types of knowledge (e.g., whether research based knowledge, local knowledge, or a combination of both) that is transferred. The results will contribute to achieving the act Smart theme in Food Harvest 2020 by assisting in the development of knowledge transfer processes to improve skills and maximize adoptions of best practice on farms.

USE OF GIS SPATIAL CLUSTERING ANALYSIS TO DEFINE A LANDSCAPE CHARACTER ASSESSMENT – TOWNLAND TO COUNTY SCALE

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Landscape character assessments are usually carried out on a county scale. The rationale for this study was to focus on the effect it would have if carried out at a townland scale. Recent typologies are based on GIS overlay of digital maps using spatial analysis and statistics to define landscape types. Co. Roscommon was chosen as a case study for this work as it had a relatively detailed Landscape Character Assessment (LCA) undertaken. Various datasets were collected and compiled in a database in Arc GIS. A townland database was created for Roscommon. This involved undertaking townland statistics. The percentage of each dataset in each townland was attained with the use of the field calculator in Arc GIS and Excel. The statistical programme STATA was used to undertake clustering analysis. The number of clusters is selected and then the Calinski/Harabasz pseudo-F index was used to determine the maximum number of truly discernable clusters. The distribution of the f-values was extremely close so a visual analysis was then carried out. The clusters were then assigned to the data they represent. The visual analysis was carried out to look at the change in clusters from 5 to 8. Cluster 8 was chosen as the cluster number to use due to the distribution of clusters. The cluster maps more than 8 were too fragmented. To name/define the landscape types, the function for bar charts was used in STATA. This was used to look at the other variables that are in each cluster. The landscape character type map was then created for Roscommon with the new devised names. This method has proved to be a beneficial approach to determining landscape types. It has enhances the already existing landscape types map in the Roscommon LCA by adding further detail about the types. The clustering map has been used to change the focus to determining the impacts on these landscape types of actions taken under the Rural Environment Protection Scheme (REPS) 4 options.

A STRUCTURAL ANALYSIS OF GREENHOUSE GAS EMISSIONS AND THE FOOD-SUPPLY CHAIN IN NORTHERN IRELAND

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International efforts to reduce the stock of greenhouse gases in the atmosphere often motivate national and regional policies that impact the economic system (directly and indirectly) while pursuing an abatement target. Policy design may be informed by determining how to reduce emissions in such a manner that induces the smallest shock to the economy. Given the importance of agriculture and food-processing to the Northern Ireland economy, this research identifies the structural relationships most strongly linked to greenhouse gas emissions in the food-supply chain. Sensitivity analysis is conducted using linear programming and an input-output table for Northern Ireland based on data from the year 2005. The results allow for an ordered ranking of technical, demand, and emission-intensity coefficients. This is accomplished by calculating an elasticity measure indicating how sensitive economy-wide emissions are to changes in a particular coefficient using the framework developed by Morán and Gonzales (2007). The approach allows for distinguishing between activities that influence emissions from the supply-side, demand-side, or by linking the two. This is compared to a multiplier approach, whereby direct and indirect emission multipliers are calculated by sector. The identification of the most significant structural relationships in terms of emissions provides insight for policy, particularly that intending to foster technological change.

A 2005 AGRICULTURE-FOOD SAM (AGRIFOOD-SAM) FOR IRELAND

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This paper describes the construction of the AgriFood-Social Accounting Matrix (SAM) for Ireland for the year 2005 and gives a complete representation of all flows in the economic circuit and can be used as a tool to analyse the inter-sectoral linkages of the Irish economy, the income distribution of households, or to explore the impact of exogenous changes in exports, different categories of government expenditure and investments. The 2005 AgriFood- SAM for Ireland documented here makes use of the newly published 2005 Input-Output Tables and uses the 2005 National Farm Survey to disaggregate the agricultural sector. Another unique feature of the AgriFood-SAM is the integration of individual household data which makes use of the link between the 2004-2005 Household Budget Survey and the NFS 2005. These new features facilitate the link of the AgriFood-SAM with the NFS at micro level for the purpose of micro-simulation analysis. Therefore, in the 2005 AgriFood SAM for Ireland, 12 separate agricultural industries are constructed producing 13 commodities, 10 food-processing industries producing 10 commodities, thus providing greater detail about the downstream activities of the food system and its relationship with the agricultural sectors and the household sector is replaced by nine representative households constructed using the NFS 2004 and the HBS 2004-2005. To illustrate a use of the AgriFood SAM we simulate the effect of a reduction of 20% in GHG emissions from agriculture. According to the Teagasc FAPRI model this would require a reduction of 12.6 percent in the output of cattle in 2020, or a reduction in e183 million in the value of cattle output in that year. We estimate the knock-on economy-wide effects of this reduction in cattle output using our AgriFood SAM based on a 2005 economy database and the multiplier analysis. The results show that the reduction in cattle output has a much bigger impact in reducing the output of the beef processing sector how the overall change in factor income is divided between the different household and enterprise types. The majority of the loss occurs in urban households (including small towns) due to lost employment and profits etc. The next biggest hit is felt by farm households, principally cattle farmers) followed by enterprises and other rural non-farm households.

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