Auckland Dairy School Seminar Day

Monday 9th February, 2015

The University of Auckland

Lecture Theatre OGGB5, Level 0, Owen Glen Building

Judging Panel

Dr Judith O'Brien, Deputy Director Development, Biological Sciences
Mark Burgess, Director of the Institute for Innovation in Biotechnology (IIB)

Presentations

(15 min talks, 5 minutes questions)

Photo courtesy of LIC

Welcome to the first Auckland Dairy School Seminar Day. We very much appreciate the efforts of the students who are presenting their work, and the partner companies and supervisors for their support. Our aim is to make this a highlight of the dairy research year. We are particularly keen on fostering a student led culture, where students can present and discuss their work and build the networks important in a professional career. If you are interested in joining the student committee, please contact Nicole Bennett (nicolehbennett@gmail.com)

We have recently put up the dairy school website and would appreciate feedback on its content.

www.dairy.auckland.ac.nz

Please don't hesitate to contact me if you have any ideas that will advance the school, or if you need any more information about the schools activities.

Professor Russell Snell
Director, The Joint Graduate School in Dairy Research and Innovation
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9.30am **Mostafa Rahnama (PhD)**
Faculty of Science, School of Biological Sciences - AgR Laboratory
Supervisors: Damien Fleetwood/Philip Harris (UoA)/Richard Johnson (AgR)

Topic: Studying the velvet gene *velA* in *Epichloë festucae* to dissect the molecular interaction between fungi and forage plants

Abstract

Epichloë endophytes form a host specific symbiosis with agriculturally important cool-season grasses and by producing different alkaloids protect them from a range of stresses. In New Zealand using novel strains of *Epichloë* annually contributes around $200 million to the New Zealand economy. Agricultural applications of *Epichloë* include protecting pastures against insect pests, increasing cows' grass digestion rate, and using as a bird deterrent for airports, golf courses, kiwifruit orchards and vineyards. Although ecological aspects of the interaction between *Epichloë* and its plant hosts has been well studied, currently very little is understood about these interactions at the molecular level. This study aimed to dissect the *E. festucae*/perennial ryegrass (*Lolium perenne*) interaction by functional analysis of the conserved regulatory protein VelA (*velA* gene). Infection of perennial ryegrass with an *E. festucae* mutant deleted in *velA* caused rapid plant death suggesting that VelA has a role in regulating *E. festucae* interactions with its host. VelA also influences cell wall characteristics of *E. festucae* as shown by checking its growth under cell wall stress. Transcriptome analysis of wild type vs. *ΔvelA E. festucae* revealed a range of candidate genes potentially involved in plant interaction and cell wall metabolism under VelA regulatory control. Functional analysis of some of these genes is in progress. It is expected that by understanding the molecular basis of the endophyte and host plant symbiosis, we will be able to extend the use of beneficial endophytes to other crops.

10.00am **Sangeeta Patel (PhD)**
Faculty of Engineering, Chemical and Materials Engineering
Supervisor: Prof. Wei Gao (UoA)

Topic: Sorption of endocrine disruptive chemicals on to bone char derived from waste cattle bones

Abstract

New Zealand has an agro-dependent economy with dairy and meat processing industries being the prime movers of the industry as well as major export earners. At $11.32 billion, dairy products were the top export earner for 2012 followed by Meat products at $5.25 billion. Fruits and Wine also figure among the top 10 export earners.

New Zealand being a small country with limited resources, intensive farming is followed with extensive use of inorganic fertilizers, herbicides, pesticides and fungicides. A field survey conducted in the Waikato region by Landcare Research indicated that, effluents from dairy farms could contain up to parts per billion (ppb) levels of endocrine-disrupting hormones even after oxidation pond treatment. Recently, the Horticultural properties have been recognized to be potentially contaminated sites in New Zealand and are now included in the Hazardous Activities and Industries List (HAIL), prepared by the Ministry for the Environment. Mitigating the risks imposed by these agrichemicals and estrogens from dairy farm effluent discharge is important for a sustainable growth of our dairy, meat and horticulture industry. This can be done by developing a viable and cost-effective onsite treatment plant.

Usually activated carbon is considered to be a versatile sorbent as it can be used for several applications. Though it has been efficiently used in adsorbing these agro-based contaminants, its scope is getting limited as they are expensive, non-selective and involve higher operating costs. Therefore, low cost materials are being explored for their adsorption efficiency.

In recent times, animal bone char which consists of a poor crystallite structure is been proposed for adsorption. Cattle bones are a readily available by product from abattoirs and slaughterhouses in large quantities. The usual disposal methods of these bones are incineration or burial in large pits.

Using bone char, as a filtrate media is easy as it does not clump when exposed to water. Adsorption is a helpful option, as it does not require any external power source or pressure to operate. Apart from surface area it also has a desirable surface chemistry to attract pollutants towards it. Also the regeneration is very easy and can be done by heating the bone char at a temperature of 300-4000C for few hours.

Being readily available, a twofold advantage is being proposed i.e. the animal bones can be safely disposed by using them for water treatment via adsorption. This inexpensive material will make dairy farmers willing to use this for onsite treatment.

10.20am Sam Beechener (PhD)

AgResearch

Supervisor: Dr Neels Botha (AgR)

Topic: How co-innovation impacts on scaling

Abstract

Making the transition to a global agri-food system that strikes the required balance between protecting the environment and improving productivity is highly complex. The combined challenge of feeding the world's growing population while responding to changing eating habits against a background of climate change uncertainties represents a wicked problem. That is, a problem characterised by multiple causes, wide-ranging impacts and uncertain outcomes. Business-as-usual is not a sustainable option and although the agri-food sector has a track-record of innovating in response to change, such is the complexity of this combined challenge that new ways of responding have to be found.

These issues are brought into especially sharp focus in New Zealand where the agri-food sector is striving to boost output while at the same time living-up to the 'clean and green' image portrayed in markets at home and around the world. One potential way of addressing this challenge is the co-innovation approach that is being piloted as part of the country's five year Primary Innovation Programme. Co-innovation has evolved in response to increasingly globalised supply chains. Typically, these involve a wide-range of stake-holders with diverse expertise and potentially conflicting stances that must be accommodated if lasting solutions to complex problems are to be found. In practice, co-innovation represents a collaborative approach to problem solving that requires mutual trust and a shared commitment to learning to be established between stakeholders. In this way, co-innovation seeks to develop, deliver and scale solutions where scaling includes scaling-up, for example from farmers to policymakers, and scaling-out, for example from famers to catchments. How co-innovation impacts on scaling, however, is not well understood and will be the focus of this study.

This project will consider, firstly, what co-innovation means to stakeholders in the dairy, beef and sheep sectors. Then secondly, through the application of the Multi-Level Perspective, the study will focus on interactions between the niche and regime levels to explore the impacts of co-innovation on scaling. Thirdly, evidence will be sought with respect to the wider generalisability of findings beyond New Zealand. Since this PhD is based at the University of Edinburgh and co-funded by AgResearch, New Zealand, and SRUC, Scotland, with specialist input from Wageningen in Holland, there is an interest in exploring how the findings from New Zealand relate to livestock farming in Northern Europe and vice versa.

10.40am **Mallory Crookenden**
DairyNZ
Supervisor: Dr John Roche (DairyNZ)

Topic: Neutrophil function is impaired during the early post-partum period in dairy cows

Abstract

There is a high incidence of infectious and metabolic disease in the period immediately post-calving. Susceptibility to disease during this period is likely due to physiological stress associated with the metabolic demands of lactation. We also know that calving has a negative effect on the immune system and lowers maternal 'immunocompetence'. The effect of parturition on neutrophil function is of particular interest due to the vital role neutrophils have in the innate immune response against pathogens that cause infectious disease. We hypothesised that neutrophil dysfunction occurs around the calving period and this will be evident by altered neutrophil gene expression around parturition. To determine this, we collected neutrophils from five time points during the calving period and investigated expression of genes involved in neutrophil recruitment into tissue. Samples were collected at one week pre-calving, day of parturition, and post-calving at weeks 1, 2, and 4. Genes involved in adhesion, including L-selectin (*SELL*) and the integrins, *ITGAL*, *ITGAM*, *ITGAX*, and *ITGB2,* and extracellular matrix adhesion (*LGALS8* and *TLN2)* all demonstrated differential expression ($P < 0.05$) over the transition period. This indicates that neutrophil adhesion is altered over the calving period and provides insight into changes in neutrophil function that may increase susceptibility to disease during this time.

11.20am Tania Law (PhD)

Faculty of Science, School of Biological Sciences
Supervisor: Mathew Littlejohn (LIC)

Topic: Causative Gene Discovery in Bovine Dairy Traits

Agenda

Milk is composed of a complex mixture of lipids, proteins, carbohydrates and various vitamins and minerals to support the growth of the developing neonate. In *Bos taurus*, the composition of milk shows continuous variation across individuals, which has shown to be partly attributable to genetics. In particular, the lipid and protein composition of bovine milk show high levels of heritability, and many studies have highlighted quantitative trait loci (QTL) for these traits on a number of bovine autosomes. Of these, a QTL for milk fat percentage (among other traits) has been mapped consistently to the centromeric region of bovine chromosome 14.

Diacylglycercol acyltransferase 1 (*DGAT1*), has been identified as the gene underlying this QTL. DGAT1 encodes an enzyme which plays an important role in the synthesis of mammary triglycerides, catalysing the reaction of diacylglycerol and fatty acyl-CoA to form triglycerides. A non-conservative amino acid substitution lysine to alanine at 232 (K232A) as a result of a 2bp substitution in exon VIII of the DGAT1 gene has been demonstrated as the causative variant. As an amino acid substitution, the mechanism of the variant is widely assumed to derive from enzymatic differences between the two DGAT1 isoforms, with recombinant DGAT1 bearing the 'K' allele shown to have enhanced activity over the 'A' allele in in vitro studies.

However, we report strong differences in the expression of DGAT1 transcripts between K232A genotypes in liver, fat, and lactating mammary tissue. We propose that this effect derives from the status of K232A as a predicted exon splice enhancer, showing that, in addition to increased enzymatic activity, the 'K' allele is associated with increased conversion of precursor mRNA to mature mRNA, and also modulates the production of an alternatively spliced RNA isoform. Although the impact on DGAT1 protein abundance for these effects is unknown, we propose that the major impacts on milk composition elicited by the K232A polymorphism may, at least in part, derive from these expression-based mechanisms.

11.40am Thomas Lopdell (PhD)

Faculty of Science, School of Biological Sciences
Supervisors: Mathew Littlejohn (LIC)/Russell Snell (UoA)

Topic: eQTL for Milk Traits in Cattle

Abstract

eQTL are associations between the genotypes of an animal and the expression levels of its genes in a particular tissue. This study seeks to link eQTL from the lactating mammary glands of dairy cattle with milk production phenotypes by correlating SNPs from eQTL with pQTL, to assist in finding causative genes which influence milk production. This technique has found both previously known and putative novel causative genes.

12.00noon Wei Yang (PhD)

Business School, Department of Economics
Supervisor: Basil Sharp (UoA)

Topic: Evidence of Social Interaction Effects on the Relationship of Nutrient Loss on Farm and Farm-level Nutrient Management Practices in New Zealand-A Spatial Approach

Abstract

Dairy farmers' decisions on nutrient management practices (NMPs) may be influenced by the neighbouring farmers, who are geographically close, and/ or the farmers in the same dairy groups, who are socially close. This papers aims to use a spatial analysis approach to explore the relationship between nutrient loss and NMPs, and to investigate whether or not social interactions between farmers may influence this relationship considering heterogeneous farm characteristics in New Zealand. The social interaction effects are modelled in terms of a spatial weights matrix capturing neighbouring farmers' impacts as well as a social weights matrix capturing the influence from farmers participating in the same dairy groups. With the analysis of a farm-level sample data, results show that lower nutrient loss are correlated with good NMPs, including wintering off cows, fencing off stocks and complying with regional effluent regulation. Notably, neighbouring farmers' decisions have no evident influence on the nutrient loss and NMPs relationship, but significantly positive spillover effects are observed from farmers participating in same dairy events. This indicates that encouraging farmers to participate in dairy activities/ groups may improve farm-level NMPs and facilitate the sustainable development of the New Zealand dairy industry.

12.20pm **Elisa Lam (PhD)**
Faculty of Science, School of Chemical Sciences
Supervisor: Yacine Hemar (UoA)

Topic: The effect of high pH on the physico-chemical properties of skim milks treated with transglutaminase

Abstract

Milk is a complex biological fluid comprising of water, milk fats, and solids-non-fats including carbohydrates, proteins, minerals, organic acids and miscellaneous, distributed between the aqueous phase and casein micelles. Native casein micelles at pH ~6.70 comprise of ~94% total caseins and ~6% inorganic components present as colloidal calcium phosphate (CCP). These native casein micelles are stabilised predominantly by the balance between electrostatic and hydrophobic interactions and the presence of CCPs. However, during alkalinisation, the physico-chemical properties of casein micelles and milks are affected. When the pH of the milk system is increased to the alkaline range (pH ~8 to 10), the protein-mineral equilibrium between aqueous phase and casein micelles is shifted, leading to the disruption of casein micelles. Possible reasons for the disruption of micelles can be due to modification in the ionisation state of proteins and alteration in kosmotropic ionic content (i.e., calcium and inorganic phosphate) in the aqueous phase of milks. To prevent the disruption of casein micelles during alkalinisation, transglutaminase (TGase) was added to crosslink peptide-bound glutamine and lysine residues on caseins in the micelles. Hence, this work aims to investigate the changes in physico-chemical properties of casein micelles in milks induced by alkalinisation, and compare these properties with those treated with TGase. The findings of this research can provide better understanding on the milk components such as proteins involved in the milk system and how they react at alkaline pHs. This will help shed light on the exact structure of casein micelles, which still remains not fully elucidated. From an industrial view point, the dissociation of casein micelles by high pH (and subsequent pH cycling), in combination with the use of TG, might be exploited to tailor the manufacture of novel dairy products and dairy ingredients.

12.40pm Stephen Waite

Department of Engineering Science, Auckland Bioengineering Institute
Supervisors: Dr Vinod Suresh (ABI)/Dr John Cater (UoA)/ Dr Garry Waghorn (DairyNZ)

Topic: A Computational Model of Rumen Structure and Motility

Abstract

A major challenge for the New Zealand dairy and sheep farming sector is the need to improve animal productivity while maintaining and enhancing sustainability. Improvements in feed conversion efficiency, mitigation of disorders such as bloat and reduction of methane emissions (which represent a loss of bioavailable energy) will have significant economic and environmental payoffs. Previous work focusing towards these goals has looked at issues such as animal intakes, diet chemical composition and digestibility, inhibiting methanogenesis and understanding variation between animals. Little attention has been given to the physical aspects of digestion in the ruminant forestomach (rumen) – breakdown of feed, mixing of rumen contents and outflow rates of digesta – and how they are influenced by rumen size and structure. Yet there is evidence that differences in rumen size and outflow rates are correlated with methane production and feed conversion efficiency. The aim of this research is to develop a computational model that incorporates anatomical structure and muscular contractions to describe the physical processing of feed in the rumen. This model will then be combined with existing simulation models of rumen microbial chemistry and nutrient utilisation to produce a fully process driven model of rumen digestion. In this talk I will describe the progress towards the development of the model. To model the geometry, excised sheep rumens were plaster cast while submerged within a buoyancy fluid and the surfaces were laser scanned. Data clouds from the scans were used to create a three dimensional surface mesh of the rumen. This mesh can then be used within a computational fluid dynamics (CFD) environment to simulate rumen contractions that drive mixing and outflow of digesta. To determine the mechanical properties of rumen tissue for simulating contractions uniaxial tension tests were performed on samples of rumen tissue at different locations and orientations. Histological studies were also performed to visualise the distribution of muscle and collagen within the rumen wall.