

February 2012

# RELEASE



NEW ZEALAND  
AGRICULTURAL GREENHOUSE GAS  
Research Centre

The newsletter of the New Zealand Agricultural Greenhouse Gas Research Centre



NZAGRC Science Leadership Team



NZAGRC International Science Advisory Group

## Director's Update

Welcome to the fifth issue of the NZAGRC newsletter. It's been a busy start to 2012 with the team coming back from the Christmas break straight into final preparations for our Annual Conference.

I'm happy to report that the Annual Conference and Science Planning Workshops, held in Palmerston North from 31st January to 2nd February, went very smoothly and weren't scuppered by a last minute change of venue. My thanks go to the Science Leadership Team (*above left*) for all of their assistance with this year's programme. Approximately 150 delegates attended the one day conference and 100 scientists were involved in reviewing and planning work for the coming year. It was encouraging to see the range of work underway and the passion generated when scientists get together to discuss their research.

We welcomed all of the NZAGRC advisory bodies to the Manawatu during the conference. It was great to catch up with our Steering Group, key stakeholders and international science advisors (*below left*) and to gain their input and feedback.

Additionally, NZAGRC staff continue to be kept busy working alongside MAF supporting the Global Research Alliance. New funding of \$2.9 million has recently been awarded to five programmes to specifically further the aims of the Livestock Research Group and build international collaborative research teams in a number of areas.

Enjoy reading

Dr Harry Clark

## Upcoming Events

Event	Date	Location
South-East Asia Capability Building Workshop	4-6 March	Bangkok, Thailand
IPCC WG III Second Lead Author's Meeting	19-23 March	Wellington, New Zealand
UNFCCC Workshop on GHG metrics	3-4 April	Bonn, Germany
Global Research Alliance Council Meeting	4-7 June	Saskatoon, Canada
International Symposium on Emissions of Gas and Dust from Livestock	10-13 June	St-Malo, France
INRA-Rowett Symposium on Gut Microbiology	17-20 June	Clermont-Ferrand, France
Dairy Solutions Symposium	20-21 June	Dublin, Ireland
NCCARF National Adaptation Conference	26-28 June	Melbourne, Australia
ISAG (International Society of Animal Genetics) Conference	15-20 July	Cairns, Australia
Australian Dairy Science Symposium	13-15 November	Melbourne, Australia

# Think globally, act locally

The key message from the NZAGRC 2012 Annual Conference



One hundred and fifty greenhouse gas (GHG) mitigation focused scientists, policy makers and industry representatives made the trip to the Travelodge in Palmerston North to attend the second Annual NZAGRC Conference. The conference provided an excellent opportunity to reflect on the international context in which New Zealand's agricultural GHG emissions research programme resides.

The day also included a wide range of presentations and posters covering research underway and how this may be applied on-farm in the future.

Dr Andy Reisinger, NZAGRC Deputy Director, opened the conference by presenting an overview of the global challenge to secure food supply in an uneven world and for a growing and increasingly affluent population, whilst maintaining environmental integrity. Bringing his focus to New Zealand, he emphasised that to allow sustained absolute reductions whilst supporting projected output growth, new technologies and practices are needed. This requires a multi-pronged effort that can expand existing options, develop new ones and creates and delivers tools for implementation. The NZ government has recognised the long term and global nature of the challenge and is providing dedicated research funding. Andy concluded by stating that the "journey will inevitably have many

twists and turns and some dead ends, but we are confident that it will deliver".

Four science sessions followed, covering methane, nitrous oxide, soil carbon and integrated systems research. Four speakers, including one leading international scientist, presented in each session. This provided an opportunity for delegates to hear the latest developments in areas outside of their regular sphere of interest. A number of the audience commented afterwards that they had gained new knowledge and some even experienced "eureka" moments.

John Hutchings, General Manager (Sustainability Policy and Carbon) at Fonterra provided a motivating summing up to the conference. In line with it being the start of the year, he provided his seven "wishes" for a more sustainable and efficient NZ agricultural sector: improvements in emissions efficiency; producers becoming

more aware of GHG issues; optimal research investment; trusted industry participation in policy making; cost effective management of liabilities; emission efficient production of milk; and all parties working together respectfully and collaboratively going forward. He highlighted that good progress was being made towards fulfilling a number of his goals already.

Returning to the opening comments made by Andy Reisinger, John quoted a recent article by John Vidal in The Observer ("The Future of Food", 22 January 2012) which suggested that science's answer to feeding an extra 2.5 billion people on the planet is a diet of algae, insects and meat grown in a lab. Whilst this may be one option, from a NZ dairying perspective "you can't go past milk!" So for the foreseeable future, the NZ research effort will continue to support local agricultural producers and industry's future goals, while keeping a close eye on how the research can be implemented globally.



# Mitigation of methane



Professor Jamie Newbold opened the session by highlighting the UK's reliance on importing meat products and hence their challenge with "protein security". This leads to a balancing act to increase local agricultural production without increasing GHG emissions.

The UK is investigating a range of mitigation strategies including: feeding high sugar grasses; high lipid diets involving additives such as high fat "naked" oats; and exploring natural compounds that can reduce methane. Professor Newbold made the key point that whilst compounds may be discovered which decrease methane significantly, they need to get into animals in paddocks to make a real difference. This isn't easy. One option may be to utilise the window of opportunity that exists when animals are closely monitored whilst pregnant and weaning. Could the rumen be programmed at this point to reduce methane emissions in later life?

Dr Peter Janssen provided an overview of New Zealand's current methane mitigation research, funded under the Pastoral Greenhouse Gas Research Consortium (PGgRc), NZAGRC and other MAF initiatives. The goals of these aligned programmes encompass developing vaccines and chemical inhibitors for methanogens, utilising animal breeding and providing low cost supplements to reduce the sector's methane emissions. Dr Janssen explained how the detailed study of methanogens and their genomic information funnels into product development.

Dr Ron Ronimus described in detail how his research team are using genomic information to look for novel non-toxic and environmentally friendly inhibitors of

methanogens. Their work involves: enzyme target identification; cloning and expression in *E. coli*; developing high-throughput compatible enzyme assays for screening compound libraries (including natural compounds); and determining/modelling methanogen enzyme structures to enable rapid computer-based screening of large compound libraries (up to 600,000). About 40 suitable inhibitory compounds have been identified to date and these will be tested against respective enzymes, pure cultures and in-rumen fluid-based assays before trialling in animals.

Dr Neil Wedlock concluded the session by describing the work towards a vaccine against rumen methanogens. He pointed out that vaccines have a long history of on-farm use by farmers, are generally safe and efficacious and can be manufactured at low cost. The goal of his research is to vaccinate animals to generate antibodies in their saliva, which would then pass into the rumen and decrease methanogen activity. As cattle produce a huge amount of saliva (98-190 L/day) this could prove a very efficient strategy. Proof of concept that antibodies can inhibit methanogen activity has been demonstrated, potential vaccine antigens have been identified and are currently being studied to confirm the lead candidates before proceeding to a testing regime.

Chair: Dr Tim McAllister  
(Agriculture and Agri-Food Canada)

- UK perspectives on methane mitigation research:  
Professor Jamie Newbold (Aberystwyth University)
- Manipulating rumen microbial processes to mitigate methane emissions in grazing systems:  
Dr Peter Janssen (AgResearch)
- Inhibiting rumen methanogens:  
Dr Ron Ronimus (AgResearch)
- Vaccines against rumen methanogens:  
Dr Neil Wedlock (AgResearch)

# Manipulating nitrous oxide producing processes



Dr Richard Eckard started the nitrous oxide session with a look at the current funding initiatives and research underway across the ditch in Australia. With new funding available shortly, most Australian science teams had spent their Christmas holidays writing grant proposals!

In the nitrous oxide space, work is underway to compile an emissions profile or “risk potential” map for the country and to move towards a tier 3 approach to their inventory. Dr Eckard highlighted that many of the known or potential carbon farming strategies to mitigate nitrous oxide emissions are not yet economically attractive. However, he noted that data from the fertiliser industry showed that about 20% of Australian farmers are using nitrification inhibitors once per year. He found this encouraging as there are no policy drivers in place to promote this practice yet.

Dr Cecile de Klein outlined New Zealand research to mitigate nitrous oxide emissions and showed how the NZAGRC programme mapped to different sections of the nitrogen cycle. She noted that whilst the Australian primary source of nitrous oxide is fertiliser, in New Zealand the focus is urine and dung from grazing animals. She said that proven products are available to reduce nitrous oxide emissions, but their cost currently is too high for widespread adoption. Dr de Klein also stated that whilst there is high variability in nitrous oxide emissions, this uncertainty should not be seen as a problem but should be exploited: “target the peaks to have the biggest impact”. Since moisture is a key factor in driving nitrous oxide emissions, this information could guide better on-farm decision-making regarding when and where to spread fertiliser and graze animals. N management could be

effectively linked to effluent management decision-making tools.

Professor Hong Di provided details on experimental work aimed at optimising the effectiveness of the nitrification inhibitor used most widely in New Zealand, DCD. Field trials studying the effect of animal trampling and DCD on nitrous oxide emissions have been carried out using a robotic hoof. The results showed that trampling increases emissions from wet soils significantly (more than doubling them), but the positive news is that DCD significantly reduced emissions even from trampled soils (>50% reductions). DCD was also effective in reducing indirect emissions (nitrate leaching) from winter runoff situations.

Building on the significance of soil moisture to influence nitrous oxide emissions, Tina Harrison-Kirk presented research to find the most relevant metric to describe wet soil. The ultimate goal of this work is to aid on-farm decision-making to minimise nitrous oxide emissions. Laboratory experiments conducted so far indicate that diffusivity may be the best metric for predicting emissions. Diffusivity can be estimated using easily measurable parameters like moisture content (MC) and bulk density (BD). Future work will investigate whether diffusivity is indeed the best metric across different soil types and whether there is a single metric value that is critical for nitrous oxide emissions.

Chair: Professor Keith Smith  
(University of Edinburgh)

- Australian perspectives on nitrous oxide mitigation research:  
Dr Richard Eckard  
(University of Melbourne)
- Reducing nitrous oxide emissions by manipulation of nitrification/denitrification processes:  
Dr Cecile de Klein (AgResearch)
- Manipulating nitrification to reduce nitrous oxide emissions:  
Professor HJ Di  
(Lincoln University)
- Influence of soil water status and compaction on nitrous oxide emissions from urine:  
Tina Harrison-Kirk  
(Plant & Food)

# Prospects for manipulating soil carbon



Professor Keith Goulding opened the session with a European perspective on soil carbon sequestration. He noted that many players have an interest in carbon, for a variety of reasons, and quoted from Louis Redshaw (Barclays Capital) that “carbon will be the world’s biggest commodity market and it could become the world’s biggest market overall”.

However, in the context of climate change and carbon sequestration, we should be looking for net transfers of carbon from the atmosphere to the land, not just a movement between land carbon compartments. Carbon sequestration in soils is reversible and each farm system has its limits. He highlighted that conversion of arable land to forest or pasture is genuine sequestration, but opportunities for this conversion are limited and the growing demand for food creates the pressure for conversion in the opposite direction. Professor Goulding concluded that our priorities should focus on good land stewardship including efficient use of N, reduced tillage and maintenance of “green” cover.

Dr Mike Beare presented research investigating the temperature sensitivity of soil organic matter (SOM) mineralisation in soils with different management histories. Climate change concerns have stimulated interest in this area, as loss of soil organic carbon induced by climate warming could provide a positive feedback and thus accelerate global warming. Work to date shows that different management histories showed a clear difference in SOM, with pasture having much higher levels than cropped and fallow soils. Sand and silt sized organic matter accounted for most of the losses and SOM mineralisation increased exponentially with temperature in these fractions.

Building on the issue of labile soil carbon, Professor Peter Millard outlined work looking at SOM turnover rates. His team has developed a measurement technique that enables the quantification of SOM fluxes in the field without disturbing the soil being studied. One of his key findings is that disturbance of soil causes rapid loss of labile carbon within less than 1½ hours. Based on these findings, he cautioned the audience to be careful when interpreting laboratory experiments.

Dr Susanna Rutledge concluded the session by describing research into net carbon exchange in grazed dairy pastures and the effect of alternative management practices on the carbon balance. The study uses an eddy covariance system alongside in-situ measurements and farm records at Scott farm (a DairyNZ research farm) and has been running since Dec 2007. The conclusions to date are that severe drought conditions and cultivation both resulted in net carbon losses, but the site recovered after these disturbances and on an annual time scale was a net sink for carbon dioxide (and thus most likely carbon). More recent measurements indicate that regrassing to a mixed sward may lead to enhanced carbon sequestration, but more research is needed in this area before a definitive answer about long-term effects can be given.

Chair: Professor Pete Smith  
(University of Aberdeen)

- European perspectives on soil carbon research:  
Professor Keith Goulding  
(Rothamsted Research)
- Temperature sensitivity of soil C mineralisation in soils of contrasting management history:  
Dr Mike Beare (Plant & Food)
- Environmental regulation of soil organic matter turnover:  
Professor Peter Millard  
(Landcare Research)
- Net carbon exchange in grazed dairy pastures:  
Dr Susanna Rutledge  
(Waikato University)

# Farming practices to reduce greenhouse gases



Dr Frank O'Mara opened the final session of the day with a reminder of the global importance of grasslands and pastoral meat and milk production. To feed the growing population, humankind would need to “sustainably intensify” and produce more food from the land already farmed.

Current research underway around the world is aiming to decouple agricultural GHGs emissions from this increasing food production. Dr O'Mara showed that there are already big differences in the amounts of food energy produced and accompanying GHG emissions in different regions of the world, therefore adopting existing best practices was an important part of the solution.

“If we are to achieve things never before accomplished, we must employ methods never before attempted”. This quote from Francis Bacon opened Dr Pierre Beukes presentation in which he described a 5-point plan to decrease GHGs and increase profitability from NZ dairy farms. He argued that the timing of on-farm decisions was key: “the difference between an average farmer and a good one is a couple of days”. Dr Robyn Dynes then delved into sheep and beef farming. Her model studies indicate that opportunities for improvement depend on how farms are currently performing, with the biggest gains possible for farms that are not currently high performers. One of Dr Dynes' key points was that lower ewe replacement rates have contributed to decreasing GHG emissions intensity per kg output, and farmers should be aiming to keep their ewes as productive as possible for as long as possible.

Dr Stewart Ledgard presented an overview of Life Cycle Analysis (LCA) with a focus

on the dairy industry. The LCA process has a product focus but a whole system perspective. It can be very valuable in identifying hot spots and how to address them. To date, most carbon footprinting has been carried out on the “average” farm, but researchers are now starting to look at farm-to-farm variability. Early analysis has shown that most variability can be explained by differences in management practices rather than the physical locations of farms. Dr Ledgard reminded delegates that LCA is a valuable tool to ensure new mitigation approaches result in an overall reduction in total GHG emissions and not just trading off one environmental issue for another.

Any farm model, inventory or life cycle analysis is only as good as the models used to understand emissions. It was therefore fitting that Dr David Pacheco provided the final science presentation of the day, focussing on modelling methane emissions from the rumen. Dr Pacheco's team have developed new equations to model rumen function and their work feeds into that of other researchers working in the methane mitigation space to ensure specific interventions can be reflected in whole farm models and to predict farm-level emissions. While the work was challenging, he reminded the audience that rumen methanogens have evolved to provide a valuable service and are not there just to annoy humankind!

Chair: Dr Peter Kuikman  
(Alterra, Wageningen UR)

- Pastoral agriculture's contribution to food and environmental goals:  
Dr Frank O'Mara (*Teagasc*)
- Improved farming practices: a cost effective method for GHG reduction:  
Dr Pierre Beukes (*DairyNZ*) & Dr Robyn Dynes (*AgResearch*)
- How life cycle assessment (LCA) can help farmers to decrease GHG emissions:  
Dr Stewart Ledgard (*AgResearch*)
- An improved enteric methane model:  
Dr David Pacheco (*AgResearch*)



# Delving into the detail



In addition to the speakers at the NZAGRC conference, a wide variety of posters adorned the venue. Twenty-seven posters in total were presented and these offered delegates a chance to delve into the detail of recent agricultural greenhouse gas mitigation research. For example, Dr Iris Vogeler (*pictured middle*) leads an NZAGRC objective team investigating improving agricultural nitrous oxide component modelling. In her posters, Iris presented

research related to compiling a  $N_2O$  database for NZ pastoral systems and modelling  $N_2O$  emissions from urine patches.

The prize for the furthest distance travelled to present a poster goes to Catherine Nakielny (*pictured right*) from Carmarthenshire in Wales. She profiled her work on the role of genetic productivity improvements to reduce the enteric methane emissions intensity

from the Welsh national sheep flock. Catherine is a Nuffield Farming Scholar and, as part of her scholarship, gets to spend eight weeks overseas. After networking in Palmerston North she was heading off to Auckland and then to Australia. After a disappointing summer in NZ, hopefully she got to enjoy some sunshine in Australia before heading back to the midst of a Welsh winter!

## Science in action



Following the conference, a number of delegates took the opportunity to tour a selection of the local research facilities. After a brief introduction to the GHG work being conducted at Landcare Research, Dr Julie Deslippe showed the group the soil microbiology lab and provided a very succinct explanation of how tiny amounts of DNA can be

extracted from bulk soil samples. The group then visited one of the analyser rooms to discuss the equipment and protocols used for measuring nitrous oxide emissions from experimental samples and field trials. The final stop at Landcare Research was Dr Chris Pratt's laboratory where he is investigating options for low-cost, floating, "biofilter"

covers for anaerobic ponds to mitigate methane emissions. After a quick walk down the hill, Dr Natasha Swainson showed the group around the NZ Ruminant Methane Measurement Centre (AgResearch, Grasslands). She is pictured here answering questions related to the sheep calorimeters.



# UPDATE

## New Zealand Government Funding in support of the Global Research Alliance



### New Zealand Government

The New Zealand Government (through MAF) has committed a total of NZ\$45 million over 5 years to support the work of the Global Research Alliance (Alliance) on agricultural greenhouse gas emissions. Most of this investment directly supports collaborative research projects intended to discover and develop new ways of reducing the greenhouse gas emissions intensity of agricultural and in particular livestock production. This NZ\$45 million is being distributed via a number of channels.

Following a competitive tender process, five projects designed to specifically support the activities of the Livestock Research Group of the Alliance, which NZ co-chairs with the Netherlands, have been awarded a total of NZ\$2.9 million. These projects, led by New Zealand scientists but made up of teams from Alliance countries, will undertake to:

1. Finalise a 'good practice guide' on the methodologies for chamber  $N_2O$  measurements from soils  
Contact: cecile.deklein@agresearch.co.nz
2. Establish and co-coordinate the animal selection, genetics and genomics network (ASGG Network) a global research network focusing on emissions mitigation through the genetic improvements of ruminants  
Contact: grant.shackell@agresearch.co.nz
3. Establish the Rumen Microbial Genomics Network (RMG Network) to better understand global rumen microbial genomics diversity  
Contact: Dr Adrian Cookson at RMG.network@agresearch.co.nz
4. Characterise the rumen microbial diversity through:
  - a. a taxonomy of rumen bacteria  
Contact: peter.janssen@agresearch.co.nz
  - b. a global survey of rumen microbial diversity  
Contact: gemma.henderson@agresearch.co.nz
  - c. the Hungate 1000 project to generate a catalogue of reference rumen microbial genomes  
Contact: Dr Bill Kelly at hungate1000@agresearch.co.nz

5. Improve the identification and selection of low emitting animals through the sharing of data and development of common measurement protocols

Contact: John.McEwen@agresearch.co.nz

MAF has also established an internationally competitive research fund with NZ\$25 million of the Alliance funding, called the Global Partnerships Fund in Livestock Emissions Research. This fund is truly international in nature as projects can be led by scientists from any Alliance country. Sixteen million dollars was available for the first round of the fund, which had a two stage process. Initial expressions of interest were assessed against a series of four targeted 'research challenges' and the highest rated projects were invited to submit full applications. The fund was heavily oversubscribed; of the 36 expressions of interest submitted in November 2011, 11 were selected to proceed to full application.

With a second round likely to be opened in mid 2012, there are several lessons to be learned for applicants thinking of applying to the next round.

1. Read the instructions and guidelines carefully and make every word count; the expression of interest form is brief and it is crucial that the information requested in each section is provided in a clear and concise manner
2. Ensure the project is clearly aligned to one of the four research challenges proposed, being distantly related will not suffice. Read the challenges carefully
3. The formation and development of new/existing partnerships is a core aim of the fund and researchers should look widely when forming research teams and not restrict membership to people they work with already
4. The science should be relevant, robust and fit for purpose
5. The proposals should succinctly outline the science methodology and clearly identify how data generated will be used to advance the search for mitigation solutions

Further information about the Global Partnerships Fund can be obtained from <http://www.maf.govt.nz/nzlivestockemissionsfund> or by contacting [andrea.pickering@maf.govt.nz](mailto:andrea.pickering@maf.govt.nz)

# Capability development

Funding capability development in the GHG emissions mitigation research arena is a key activity for the NZAGRC. Towards the end of 2011, the NZAGRC methane core programme welcomed two new faces to Massey University and the AgResearch labs in Palmerston North.

## Preeti Raju

Preeti joins the methane team from the Institute of Microbial Technology (IMTECH) in Chandigarh, India where she was working on the development of technologies for therapeutic proteins. She has a Masters degree in biotechnology from Chinmaya Degree College and a keen interest in recombinant proteins. Preeti's PhD project focuses on identifying alternative hydrogen utilisers under the co-supervision of Drs Gemma Henderson, Peter Janssen and Mike Tavendale (AgResearch) and Dr Jasna Rakonjac (Institute of Molecular Bioscience, Massey University). Preeti is climbing a steep learning curve whilst coming up to speed with the techniques and jargon used in the methane team. However she notes that she is finding picking up the new knowledge fun due to the friendly



Preeti Raju and Yang Li

people and the supportive environment. She is looking forward to spending the next three years in New Zealand.

## Yang Li

Yang recently moved to Palmerston North to start his PhD under the co-supervision of Dr Sinead Leady and Dr Graeme Attwood (AgResearch) and Dr Jasna Rakonjac (Institute of Molecular Bioscience, Massey University). Prior to the move, he completed a Masters degree in biochemistry from Otago University. The main focus of his PhD project is the investigation of rumen methanogen genomics. Whilst the area of

genomics is new to Yang, he is no stranger to cows, having spent his teenage years on a 120 hectare beef farm. He acknowledges that his family tended to spend more time fixing fences than looking after the cows though! Originally from Taiwan, which he remembers as highly polluted, Yang is enjoying being involved in research that aims to make a positive difference to the environment. He is also enjoying the "flat ground" and the great student atmosphere in his new working environment and has already taken the opportunity to pelt one of his co-supervisors with paintballs in his time away from his research.



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