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RELEASE



NEW ZEALAND
AGRICULTURAL GREENHOUSE GAS
Research Centre

The newsletter of the New Zealand Agricultural Greenhouse Gas Research Centre



Director's update

Welcome to the eighth issue of the NZAGRC newsletter. Spring is rapidly changing into summer here in New Zealand and I'm sure that everyone is looking forward to the end of year break.

During the university summer holidays, for the third year running, we are providing funding to promising young students to work alongside some of our Senior Scientists. We hope that their summers spent in the lab or the field will encourage them on to further study in the GHG mitigation area.

We submitted our Annual Report to MPI at the end of August and this is now available on our website, along with a shorter and more colourful "Highlights" document. Also on our website you can find the first three NZAGRC fact sheets. These are intended to kick off a series of factsheets, which will go progressively into more depth about agricultural greenhouse gases and potential

mitigation options. An overview of the fact sheets is presented on page 9.

Preparations for our formal science review in February 2013 are now in full swing. The recommendations from the science review will provide input into a wider assessment of the Centre to be completed by MPI by the end of 12/13. Alongside the formal science reviews NZAGRC-funded scientists have the opportunity to attend team workshops; these discussions are important and will be very valuable in helping to determine the next stages of the research programme.

The Global Research Alliance continues to keep the NZAGRC team busy. The Livestock Research Group, which I co-chair, had its annual meeting in Uruguay and endorsed a range of new projects. This includes a suite of regional capacity building activities, with a targeted project in south-east Asia and a workshop in Ghana.

Enjoy reading,

Dr Harry Clark

News

NZAGRC pipeline scholarship recipients, Cameron Shaw, Calvin Ball and Samatha Edgar, were honoured recently at the Annual Massey Agriculture Dinner. Cameron (pictured here with Vice-Chancellor Steve Maharey and College of Sciences Pro Vice-Chancellor Professor Robert Anderson) was deemed to be a worthy recipient of the Massey Agriculture Student of the Year award. In addition to his other extracurricular activities Cameron's NZAGRC-funded summer work, which resulted in co-authorship



on two papers, was highlighted as an excellent achievement.

We would like to welcome Dr Lora Hagemann to the NZAGRC team. She has been contracted to work closely with the Centre Director during 2013 to take up some of Dr Heather Went's duties whilst she is on maternity leave. Heather, the Centre Operations Manager, will be out for the year to welcome the arrival of her second child. Kate Parlane, the Centre Administrator, will be the first point of contact for any NZAGRC-related enquiries.





Global Research Alliance work programme moving forward

The Livestock Research Group (LRG) held its annual meeting on 1-2 November 2012, in Punta del Este, Uruguay. The meeting following a three-day meeting of the Global Conference on Agricultural Research for Development (GCARD), which aims to promote collaboration to increase agricultural production and food security.

The LRG reviewed progress of its work plan and decided on a range of new activities and collaborative research projects to accelerate discovery of mitigation options. Many of these projects are based on inputs from and led by kiwi scientists, reflecting the leadership that New Zealand is showing to advance agricultural mitigation research.

One key area of work by the LRG is to identify opportunities for increasing research capability and capacity around the world. To this end, workshops are being held in different world regions to scope projects and activities that would help improve understanding of livestock emissions and allow scientists to develop locally appropriate mitigation options. Recent activities have focused on projects

in south-east Asia and east and west Africa; future workshops and follow-up activities are planned for Central America and the Caribbean, and Eastern Europe. New Zealand through the NZAGRC is leading those activities together with several other Alliance member countries.

Much of the scientific work of the LRG is conducted through dedicated research networks. Four networks are already active; rumen microbial genomics, animal selection via genetics and genomics, manure management, and feed and nutrition. The recent LRG meeting also agreed to establish a further network on the links between animal health status and greenhouse gas emissions intensity. This network draws on the fact that healthy animals are generally more productive and thus have lower emissions intensity per unit of product. This new network is therefore seen as an important link between mitigating agricultural greenhouse gas emissions and delivering on broader objectives of food security and sustainable agricultural development. The LRG also agreed to explore the potential need for a dedicated research network on the role and management of grasslands with regard to livestock emissions. New Zealand, through

the NZAGRC, will help develop the scope of this potential network together with colleagues in Uruguay, Ireland and the United States.

Finally, a range of exciting new collaborative research projects were agreed, either for immediate implementation or to further develop their scope. These include the projects supported by the New Zealand Fund for Global Partnerships in Livestock Emissions Research, but also several new projects to further develop novel measurement methods, provide decision-support to farmers, and better understand the factors that influence the adoption of low-cost mitigation options on farms. In a promising interaction with global industry, a workshop will be held in the first half of 2013 to explore areas in which members of the Sustainable Agriculture Initiative (SAI) Platform could collaborate with scientific experts from LRG member countries.

A full updated work plan of the LRG will become available on the LRG website in early December (www.globalresearchalliance.org). More information on LRG activities can be obtained by contacting the NZAGRC at enquiries@nzagrc.org.nz.

Why do models matter?

The NZAGRC is funding the development and improvement of a number of agricultural greenhouse gas (GHG) related computer models. A question that sometimes arises is why? This question can be answered in several ways.

First, to comply with its international commitments, New Zealand has to produce an annual report of all human-induced emissions and removals of GHGs. This is known as the GHG inventory and includes a section on agricultural GHGs. It is impossible to actually measure all of the gases being emitted from NZ farms. So, the total value must be modelled as accurately as possible. Currently, NZ uses a Tier 2 methodology, which is based on multiplying the number of different types of livestock in the country by NZ-specific emission factors. This approach conforms to the IPCC good practice guidelines and is constantly being improved. The NZAGRC funded nitrous oxide modelling work is helping to ensure that the national inventory reflects the real on-farm situation.

Second, models can support on-farm decision-making. As GHG mitigation options are developed, models can

be used to understand and simulate the implications of different farm management regimes and explore how, and under what circumstances, GHG emissions could best be reduced without compromising farm productivity. Farmers and land managers can use models to aid on-farm decision making and enable them to select management options that produce the lowest GHGs possible. Models such as OVERSEER are already being used to assist farmers and their advisers to examine nutrient use and movements within a farm to optimise production and environmental outcomes. Better models that include GHG emissions can lead to better informed and balanced decision making.

Third, models can improve our understanding of the processes influencing GHG emissions. Biological and agricultural systems are complex and our understanding of what processes have the biggest influence on emissions is incomplete; models are often the only way unravel this complexity. Models generally focus on particular questions or processes, and they simulate some parts of the system in great detail while treating other parts in simpler ways. For example, models whose main aim is to understand nitrous oxide emissions may use a simplified representation of plant

processes, or the carbon cycle in general but have a detailed representation of nitrogen cycling in soils. In contrast, models whose primary focus is the carbon cycle may have a relatively simple representation of the nitrogen cycle, or not include it at all. The NZAGRC funded mechanistic modelling of rumen methane production work is an example of this.

By necessity, all models are a simplification and abstraction of reality. Knowing where and what to simplify and what to treat in detail is very much a question of 'horses for courses'. Making such judgements requires scientific insights as well as experience in their application. Having a variety of models allows us to compare the effect of different assumptions and approaches on the issues of concern, whether this is soil carbon, nitrogen, greenhouse gases, or any combination of those and other factors. Testing models through cross-comparison, where a set of models are provided with the same input data and their simulated outputs are compared (against each other, and against measurements) is one important approach of fostering on-going refinement of models, and to better understand their skills and limitations.

Digging deeper into nitrous oxide emissions



Dr Donna Giltrap (Landcare Research), Dr Frank Li, Dr Iris Vogeler, Josef Beutrais and Dr Rogerio Cichota (AgResearch)

Dr Iris Vogeler (AgResearch) and her team are using NZAGRC funding to “dig deeper” into the nuts and bolts of nitrous oxide component models to develop a better approach for New Zealand agriculture.

The team originally began looking at N_2O component models that could be linked into a whole farm model to predict GHG emissions as part of a larger SLMACC-funded project. When aligned NZAGRC funding was awarded to the team in 2010, it allowed the researchers to look much more closely at how the N_2O models were working and to spend some time identifying the best tool for the job.

“The Tier 2 approach that NZ currently uses for the N_2O inventory is pretty good”, says Iris, “but it doesn’t take any management strategies into account. Additionally, N_2O emissions change depending on a range of factors including soil types and climate conditions, so there’s a lot of room for improvement”. The team began by looking at a range of models from the literature and identifying which ones were most suitable for the pasture-based, grazing intensive NZ situation. Four process-based models were selected for further study. These are ones which aim to mimic all of the nitrogen-related processes occurring in the system

to predict factors such as N_2O emissions and N_2O/N_2 ratios. “These have given us plenty of parameters to look at and a good understanding of what is going on”, states Iris.

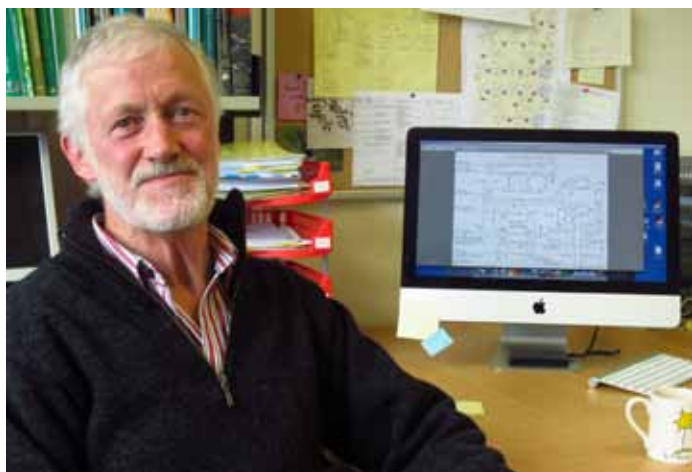
The team have also compiled a database consisting of huge datasets from around NZ which show land management regimes and the corresponding N_2O emissions. Using this database to test the models has led to the team focusing on DNDC and APSIM. These are both established models which have been refined and validated for NZ conditions. To date, neither model has proven to be superior for modelling N_2O emissions. Therefore, the next step of the project is to run sensitivity analyses to identify the best parameters for all of the processes involved in the nitrogen cycle and further refine the models.

The end goal of the project is to simulate ‘real’ data with reasonable accuracy. Not just total N_2O emissions, but how N_2O changes over time under different conditions. This will benefit both the NZ inventory and assessment of new mitigation tools. The final model could also be linked into whole farm models to allow farmers to understand the effect of different management regimes on their farm’s N_2O emissions.

Modelling soil carbon dynamics over short and long time frames

Professor Tony Parsons (Massey University) and Dr Miko Kirschbaum (Landcare Research) are both working to advance our understanding of the key processes that affect soil carbon storage in New Zealand's agricultural soils.





Professor Tony Parsons (Massey University)



Dr Miko Kirschbaum (Landcare Research)

Pastoral agricultural soils hold large quantities of carbon. Altering those carbon stocks could either partially compensate, or add, to the direct and indirect greenhouse gas emissions from agriculture. Our capacity to manipulate, and potentially increase, soil carbon stocks depends on how well we understand the fundamental processes that are taking place in the whole of the plant, animal, and soil continuum. Therefore, developing and using detailed process-based dynamic models that integrate all three components are the only way to simulate the effects of different management strategies on soil carbon. The goal is to assess whether it is possible to achieve high levels of food production while sustaining, and preferably increasing, soil C sequestration.

A number of grassland ecosystem models have been developed over the years, but few include all the important processes and interactions between plants, soils, and grazing animals, necessary for understanding and predicting soil carbon stocks. The NZAGRC supports work on two models, the Grassland Ecosystems Dynamics Model which has been developed out of the 'Hurley Pasture Model' ('HPM'), and the other is CenW, a development of the Century model. Essential new components have been added to these models to account for recent advances in understanding. Both models have already provided valuable insights into how we may be able to manipulate the GHG signature of productive grassland ecosystems. So far journal papers have been published that describe work on management impacts (2); prospects for using altered plant traits to affect methane emissions (3) and alter plant nutrient use

efficiency that could affect nitrous oxide emission and N release (2).

Tony is working with Dr John Thornley (originator of the 'HPM') revisiting many aspects of the fundamental biology behind assumptions in such models, and to encompass altered plant traits and more recent concepts of the role of soil micro-organisms in determining C and N the soil. Recent published work accounts for how lactating dairy animals, compared to dry animals, alter the cycling and fate of carbon and nitrogen, and the longevity of these in the different parts of the system. Results to date have demonstrated that the continual off-take of (notably) nitrogen in intensive, notably dairy, systems, leads to a reduction in both carbon and nitrogen sequestered in the soil, and that there is a limited capacity to compensate for this by applying additional fertiliser (N); these results match observed long-term observations/data. Tony is now focussing back on how modifying plant traits may alter soil microbial processes and the prospects for manipulating the grassland environmental footprint, under both the current and future climates.

Miko is focussing on whether changes in soil carbon observed over short time periods can be accurately simulated using the CenW model. The variability of soil carbon makes it generally difficult to measure changes in carbon stored in soils over periods of less than several years. This consequently makes it difficult to relate any observed changes to underlying environmental or management drivers. Daily measurements of gas exchange fluxes from whole paddocks using eddy-flux systems provide

an opportunity to overcome that limitation. This work is being done in collaboration with Louis Schipper's team at Waikato University who are recording the daily exchange of carbon dioxide between the atmosphere and grazed pasture/soils at the paddock level using eddy flux methodologies.

Matching the model output to observed data initially proved to be challenging, but has led to a number of new insights and the development of new approaches. For example, the carbon exchange of grazing systems, when viewed at a single paddock scale, is characterised by long periods with low rates of carbon gain through photosynthesis that turn into large short-term carbon losses during grazing events. Capturing these important periodic events, at this scale, is challenging for eddy-flux systems, yet is crucial for understanding and quantifying the net carbon exchange averaged over an entire farms system, and year. Correctly interpreting eddy-flux data can therefore only be done if the exact time of grazing events can be matched with wind speeds and directions to assess to what extent recorded fluxes correspond to particular grazing events. Once that can be satisfactorily resolved it will allow the full power of eddy-flux observations to be used to follow short-term changes in carbon balances for the entire system that would not be possible with traditional approaches.

In combination, Tony and Miko's work looks at both short term and longer term drivers of soil carbon change and the prospects to manipulate grassland systems and soil carbon stocks in the future.

Capability Development

We are proud to introduce five NZAGRC Pipeline Scholarships recipients for 2012/13. Typically November is when many students are winding down for the long summer break, however these scholars are enthusiastically preparing for a summer, an Honours year, or both, spent with their sleeves rolled up getting involved in cutting edge research. Massey University are still confirming their Honours Pipeline student/s for 2013.



MASSEY UNIVERSITY

Briar Davies

Briar has just finished the third year of her Bachelor of Science Degree majoring in Genetics and Microbiology. Her research project will involve a detailed genetic study of plant samples generated from experiments conducted to understand the potential for stimulating ryegrass growth without adding more nitrogen. She will be supervised by Dr Susanne Rasmussen at AgResearch. Briar is still considering her future options, but has a keen interest in combining her passions for Japanese culture and environmental science in her upcoming career.



New Zealand's specialist land-based university

Charlotte Johns

Charlotte is currently in the third year of her Bachelor of Science Degree majoring in Environmental Biogeosciences and looking forward to doing Honours in 2013. Her scholarship research will investigate the topic of nitrous oxide emissions from river systems under the supervision of Professor Tim Clough. Charlotte hopes that the skills learnt from her Honours Project will enable her to continue to progress in the area of environmental research science.



New Zealand's specialist land-based university

Britt Paton

Britt is in the 3rd year of a B.Ag Sci degree and is intending to do honours next year. Her scholarship research project looks at N loss from biochar that was placed under crop and grazed pastures 4 years ago. She will be examining the persistence of biochar properties within the soil over time and will be supervised by Tim Clough and Leo Condon. Britt is particularly interested in soil sustainability and feels this project will help set her up for a future in research within the Ag industry.



New Zealand's specialist land-based university

Anna Carlton

Anna is from a city background however she loves the outdoors and practical approach that Lincoln University offers. Anna is currently studying towards a BSc (Hon) in Soil Science. Her research will investigate the potential of lignite addition to soil to mitigate N₂O emissions under the supervision of Dr Brett Robinson. She has a keen interest in environmental science and how potential negative impacts associated with agriculture can be mitigated in a way that is both profitable and sustainable.



New Zealand's specialist land-based university

Jasmine Lochhead

Jasmine is currently in the third year of her Bachelor of Science Degree. Her NZAGRC scholarship will fund her Honours in 2013. She has an interest in the relationship between environmental protection and agricultural production. Her project on an aspect of greenhouse gas emissions from agriculture will be finalised shortly.

Introducing the first three NZAGRC fact sheets

The NZAGRC is proud to be able to showcase the first three fact sheets from the Centre. These are intended to provide a background and broader context to the work of the Centre and indeed the overall challenges that New Zealand faces with regard to agricultural greenhouse gases and climate change. Subsequent fact sheets will provide more detail on specific research areas aimed at understanding and reducing agricultural greenhouse gas emissions.



1. The Impact of Livestock Agriculture on Climate Change

There is robust scientific evidence that the climate is changing, and that most of the warming observed over the past 50 years is due to increasing greenhouse gas concentrations from human activities. This fact sheet summarises why, and how, livestock agriculture contributes to climate change, and why limiting the projected global increase in those emissions is seen as a key component of dealing with climate change.

With almost half of our emissions from agriculture, New Zealand is unique in the developed world. Understanding the global contribution of agriculture to climate change provides important context for New Zealand’s efforts to enable agriculture to continue to create wealth in a carbon constrained world.



2. Impacts of Global Climate Change on New Zealand Agriculture

Climate change presents multiple challenges to New Zealand. Some are direct – such as climatic impacts on domestic agricultural production, or domestic climate policies – but further, indirect impacts could come from overseas, via trade, such as climate-induced production shifts, global responses to greenhouse gas mitigation measures, consumer perceptions and reputational issues.

These international flow-on effects are complex and hard to quantify, but they are an important part of the overall picture. Many climate impacts and responses overseas – such as increased demand, higher returns, competitive advantage and smart marketing – could help to offset domestic weather impacts and emissions mitigation costs. This fact sheet summarises what we currently know about these multiple influences, and how they can inform New Zealand’s response to climate change.



3. Economic and Policy Implications of Alternative GHG Metrics

Agriculture emits a range of greenhouse gases. Evaluating the effectiveness of mitigation strategies requires a way to compare the contribution of individual gases to overall emissions. This is usually done by converting emissions of methane and nitrous oxide into so-called “carbon dioxide equivalents” using a simple multiplier.

However, there is more way than one to compare apples and oranges, and the same applies to different greenhouse gases. This fact sheet describes the most common equivalence metric, the Global Warming Potential, used by the UNFCCC and in the Kyoto Protocol. Alternative metrics exist though and could give very different weight in particular to methane. The fact sheet highlights the potential implications of alternative metrics – globally, and for New Zealand – for our collective efforts to limit greenhouse gas emissions and projected climate change at least cost.

Season's Greetings

from the New Zealand Agricultural
Greenhouse Gas Research Centre

All the best for a happy and
prosperous 2013



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