DEPARTMENT OF
PRIMARY INDUSTRIES

Greenhouse in Agriculture

Newsletter No 11 October 2008

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Introduction

Richard Eckard, DPI Victoria and The University of Melbourne

In the past few weeks a number of us have been privileged to be part of one of the largest collaborative research developments seen in Australia. In response to the call from the Department of Agriculture, Fisheries and Forestry (DAFF) for expressions of interest, under the $46.2 million Australia's Farming Future - Climate Change Research Program, rural research corporations and scientists, representing most State governments, CSIRO and universities, have spent significant time in meetings and teleconferences planning large collaborative submissions to DAFF. Many of these consortiums were initiated through the Climate Change Research Strategy for the Primary Industries (CCRSPI).

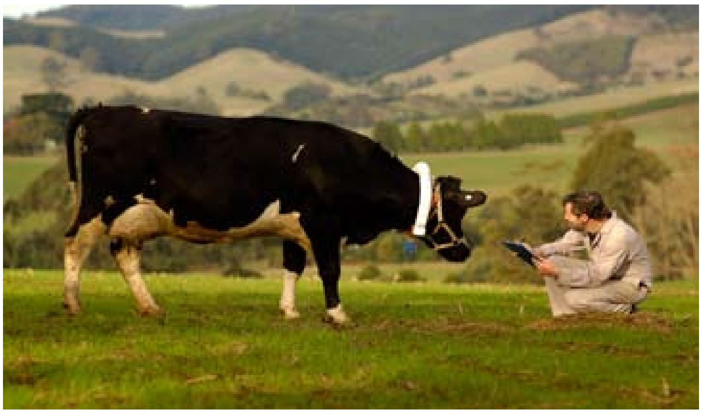
While this is very optimistic for the research community, what this has also highlighted is the magnitude of the task in the timescale required, relative to the actual capacity and capability available; with research capacity being relatively depleted through historical funding cut-backs.

However, bigger questions still remain, like should we be imposing additional costs on our agricultural sector when they are facing climate change and the current drought? A predicted global food shortage means we need to dramatically increase and not place new restrictions on food production. On the other hand, we are seeing record world food prices with many analysts predicting sustained price increases into the foreseeable future, meaning that our farmers may at last be paid equitable prices for their produce.

Never before has the research community been faced with a challenge as great as this, demanding that we drop institutional barriers and work in nationally collaborative consortia to deliver on-farm technologies that deliver win-win abatement of methane and nitrous oxide, in a whole farm systems context, while also improving profitability and resilience, meeting world demand and in a changing climate.

This is what the Greenhouse in Agriculture collaborative partners seek to achieve through their research.

Richard Eckard
GIA Project Leader



Investigating rumen genomics for emission reductions

Carolyn Bath, DPI Victoria

Ruminants are dependent on microbes to digest their plant feed via anaerobic fermentation. As a result of this fermentation, methane is produced by other microbes found in the rumen – known as methanogens. To get a better idea of the different microbial species present within the rumen, and the genes that they encode, researchers in DPI Biosciences Research Division (BRD) have carried out a metagenomic study on the rumen of the cow, which enables an analysis of the entire microbial population within the rumen.

A metagenomic library was created and sequenced using the 454 GS-FLX platform at Victorian AgriBiosciences Centre in Bundoora – the first of its kind in Australia. Sequence analysis of the library provided information about the diversity of microorganisms (for example the methanogens), and the genes present. Less than 0.1% of genomic sequences in the dairy cattle rumen match published sequences, revealing a unique and complex microbial community. Of the sequences, 1% show homology to the Archaeal domain. Within this group, a large range of different methanogens were identified, which are likely to contain previously unknown species.

The rumen metagenome sequencing results will now be used as the basis to develop a rumen specific microarray, a tool that will facilitate a previously unachievable analysis of the rumen microflora in response to different stimuli (ie. analysis of feed effects or comparison of high and low methane emitting cows). Through these studies we can better understand the process by which methane is produced by ruminants, leading to methods that mitigate its production, and subsequent reductions in greenhouse gas emissions from our livestock.

Currently researchers in BRD are building on this work with a project funded by DPI and the Geoffrey Gardiner Dairy Foundation Ltd., in metagenomic and microarray studies to improve the feed conversion efficiency of dairy cattle.

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Chewing the fat for less gas

Chris Grainger, DPI Victoria

Methane is a potent greenhouse gas and ruminant livestock are large contributors to Australian agriculture's greenhouse gas inventory.

DPI Ellinbank researchers have been studying dietary strategies that can reduce methane emissions, profitably increase milk production and can be implemented on farm.

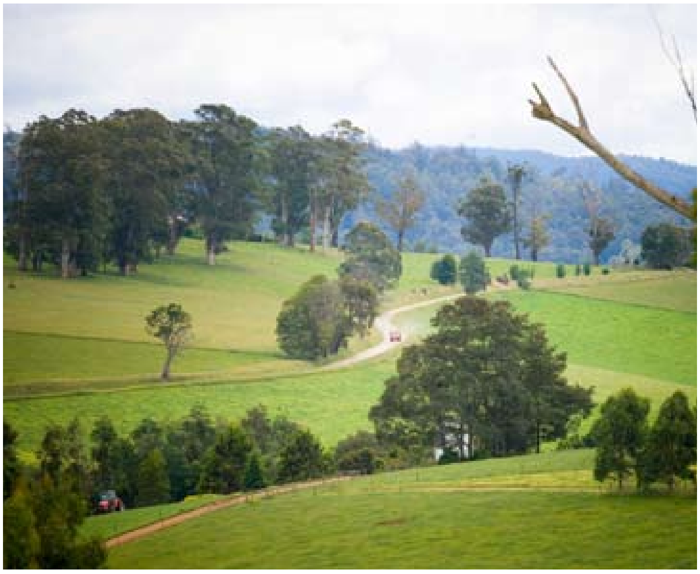
In summer 2007, researchers began to trial whole cottonseed in the diet of lactating dairy cows for five weeks when pasture quality was generally poor in energy and protein content.

Whole cottonseed is high in energy (14 megajoules/kg dry matter), and protein (22% crude protein) and also contains about 22% oil and hence can improve the quality of the diet.

Adding an additional 3.3% fat to the diet resulted in a profitable 16% increase in milk solids production and a reduction in methane emissions per kg milk solids of 21%.

Follow up work in autumn 2008 examined the effect of feeding whole cottonseed for 12 weeks to see if the reduction in methane persists. Results indicate that the effect of the whole cottonseed persists quite well up to 12 weeks which means that it is a viable strategy for reducing methane in the long term.

DPI Ellinbank's Canadian research colleagues also examined the relationship between level of added fat and the reduction in methane emissions using data from 17 studies with beef cattle, dairy cows and lambs.



They found that for each 1% fat added to the diet methane emissions per kg dry matter intake were reduced by about 6%. That finding emphasises that the amount of added fat is the most important factor in the reduction in methane emissions achieved by adding fat to the diet.

If reductions in methane emissions can be achieved from a variety of fat sources this gives some flexibility in implementing this strategy on farms.

Some of these sources could be waste products from the food processing industry and, from a life cycle analysis point of view, which takes into account the emissions generated from growing the crops and from transport, this would be more desirable than incurring additional emissions from the cultivation of oilseeds specifically for reducing methane. Future work will test some of these alternative fat sources such as brewers grains and hominy meal (a co-product of dry maize milling). We will also be trialing a dried micro-algal extract that contains high levels of omega-3 fatty acids that could have human health benefits in addition to reducing methane emissions.

The 2005 National Greenhouse Gas Inventory reports that total enteric methane emissions from dairy cattle are 7266 Gg of carbon dioxide equivalents.

If all these cattle were offered an extra 2% fat in their diet and achieved a 12 % reduction in methane emissions, and assuming a carbon price of AU$35/tonne carbon dioxide equivalent, this abatement would be worth approximately $30.5 million to the dairy industry in a future emissions trading or trading regime.

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Local data vital when calculating emissions from wheat production

Louise Barton, The University of Western Australia

Agricultural grain production results in the net production of greenhouse gas (GHG) through the use of fertilisers, herbicides and farm machinery. The greenhouse gases of primary interest are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). A holistic approach that accounts for all GHG gases is needed when calculating the global warming potential of wheat production.

'Life cycle assessment' (LCA) is an internationally recognised method for calculating GHG emitted from production systems. The assessment compiles the inputs and outputs during production, and in turn evaluates their potential environmental impacts (e.g., GHG emissions). This has the advantage of identifying the environmental impacts of all production stages, rather than focusing on a single GHG or production activity (e.g., seeding, fertiliser application).

In the last newsletter, we reported soil N_2O emissions resulting from nitrogen (N) fertiliser application were lower at a cropped site in the central grain-belt of Western Australia than those reported from other countries; and significantly less than the international default value. In a published article, we have investigated if the magnitude of these soil N_2O emissions affects our calculation of GHG from wheat production (Biswas et al. 2008. Water and Environment Journal, 22, 206-216).

Utilising our local N_2O field-based data, rather than the international default value (1.0%), decreased the total GHG emitted from wheat production in the central grain-belt of Western Australia. Specifically, emissions decreased from 487 to 304 kg CO_2-equivalents per tonne of wheat delivered to port. Our choice of N_2O data also changed the relative contribution of each gas to the total GHG. Using the local N_2O data, we found CO_2, CH_4 and N_2O contributed 75%, 3% and 22%, respectively, to total GHG emissions; with CO_2, emitted from fertiliser production and application, accounting for a large proportion (62% of total) of the GHG emissions. By contrast, using the international N_2O default value saw CO_2, CH_4 and N_2O contributing 52%, 2 % and 46%, respectively, to total GHG emissions; with soil N_2O emissions from applying urea to land the greatest source of emissions (36%) followed by CO_2 emissions from the production of urea (24%).

Research team: Daniel Carter (Department of Agriculture and Food WA), Louise Barton (The University of Western Australia) and Wahidul Biswas (Curtain University of Technology).

Findings from the Western Australian N_2O research project have a number of implications. The study demonstrates the importance of utilising locally derived data, when calculating GHG emissions and developing mitigating strategies, for agricultural production systems. Furthermore, our findings indicate decreasing GHG from the production and application of urea will have a significant impact on GHG emission from grain production. We recommend utilising regionally specific data for soil N_2O emissions, rather than international default values, when assessing GHG from agricultural production systems.

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Mixed Farming Systems - reduced emissions

John Graham, DPI Victoria

Both of the GIA Mixed Farming Systems project sites are into their second year of measuring nitrous oxide (NO_2) emissions from cropping systems. This year at Horsham measurements of emissions are from three different systems:

- Canola with 50 kgN (Nitrogen)/ha as urea fertiliser side-banded at planting
- Field peas with no addition of nitrogen fertiliser, and
- Un-grazed medic pasture with no addition of nitrogen fertiliser.

The Hamilton site is measuring emissions from wheat direct drilled into a sub clover dominant pasture, and from a mixed pasture, both treatments being on either a high fertility (~35 mg kg-1 Oslen P [0-100mm]) or low fertility soil (~5 mg kg-1 Oslen P [0-100mm]) soil. The mixed pasture on the high fertility site comprises a sub-clover phalaris/perennial ryegrass mix, and the pasture on the low fertility site consists predominantly of annual grasses and weeds with some sub-clover.

Whilst the high fertility crop treatment at Hamilton last year produced high emissions of over 3.0 kg N_2O-N/ha/year, compared to emissions of 0.7 kg N_2O-N/ha/year for the mixed pasture, emissions this year have been low in comparison, with the high fertility crop having only a total of around 0.4 kg N_2O-N/ha recorded to date. This has been due to the fact the soil moisture has not reached the high levels of last year.

The emissions from the Horsham site last year were much lower than those from Hamilton, ranging from 0.09 to 0.27 kg N_2O-N/ha/year. This year emissions have also been relatively low.

The Horsham site, July 2008

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From single animal to whole herd measurement

Francis Phillips, The University of Wollongong

The Centre for Atmospheric Chemistry at the University of Wollongong has developed an open path FTIR spectroscopy system to measure gaseous emissions from grazing animals and cropping systems. The prototype of the system was previously tested at the DPI Ellinbank and Kyabram Centers to measure methane emissions from dairy cows. The success of these tests resulted in funding from Department of Climate Change to further develop the system, increasing sensitivity while decreasing the reliance on liquid nitrogen and increasing portability.

In April this year the new system was operated at the DPI Ellinbank Centre, participating in the trial to asses the impact on methane emissions by adding whole cotton seed to the diet of dairy cows (C. Grainger GIA Newsletter, March 2008). The trial was conducted over several weeks, with the University of Wollongong team participating in the final 3 day measurement period, when the open path system operated in parallel to the DPI SF6 technique. While, for operational reasons, the measurement period for the OP-FTIR system was limited, results from the OP-FTIR system compared very favorably with that from the SF6 methodology.

Whereas the SF6 tracer technique measures a 24 hour average emission from individual animals, the OP-FTIR tracer technique measures a herd average emission with a time resolution of up to 3 minutes. The OP-FTIR system has been developed to fill a technology gap in methane measurements. While calorimetric chambers and the SF6 tracer technique allow for individual measurements on a smaller group of animal over limited time periods, the OP-FTIR system can measure a herd average emission rate for larger numbers of animals over extended periods.

Dairy cattle and the FTIR Spectroscopy system.

The OP-FTIR system consists of a FTIR spectrometer coupled to a telescope and a reflector which is placed up to 250m from the spectrometer. The system is positioned upwind from the animals so the wind carries emissions from the downwind animals though the infrared beam between the spectrometer and the reflector. The system routinely measures methane, carbon dioxide, nitrous oxide and ammonia. At Ellinbank a tracer gas, released close to the animals, was used to define the atmospheric turbulence and convert the measured gas concentrations to an emission rate.

In November this year, in collaboration with AgResearch and Landcare Research New Zealand, the team will participate in a trial to measure methane emissions from steers at Aorangi Research Farm, Palmerston North New Zealand. A number of measurement techniques will be employed, giving an excellent opportunity to compare measurement methodologies.

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Quick Bits and Diary Dates

NEW Greenhouse in Agriculture website

GIA recently relaunched its project website with a fresh new face and improved access to content. The website includes research project details, publications, a photo gallery and decision support tools, including the very popular on-farm greenhouse emission calculators.
www.greenhouse.unimelb.edu.au

The Livestock Emissions and Abatement Research Network (LEARN)

Established in November 2007, LEARN is an international research network focused on improving the understanding of greenhouse gas emissions from livestock agriculture. The objectives of LEARN include;

- To improve understanding, measurement and monitoring of non-CO_2 greenhouse gas emissions from animal agriculture at all scales;
- To facilitate the development of cost effective and practical greenhouse gas mitigation solutions.

LEARN encourages research collaborations for the exchange of data, people and joint projects that contribute towards continuous learning and knowledge development.
www.livestockemissions.net

Carbon Pollution Reduction Scheme (CPRS)

Development of the CPRS continues. Next phase is the release of draft legislation in December, to be followed up by a consultation phase over the December – February period.

Firm indications of the Federal Government planned medium-term trajectories for CPRS are due by end of 2008. The Department of Climate Change CPRS webpage has a timeline for the development of the CPRS and other details about the scheme.
www.climatechange.gov.au/emissionstrading/index

Upcoming Conferences

- *2008 Carbon Farming Expo and Conference*

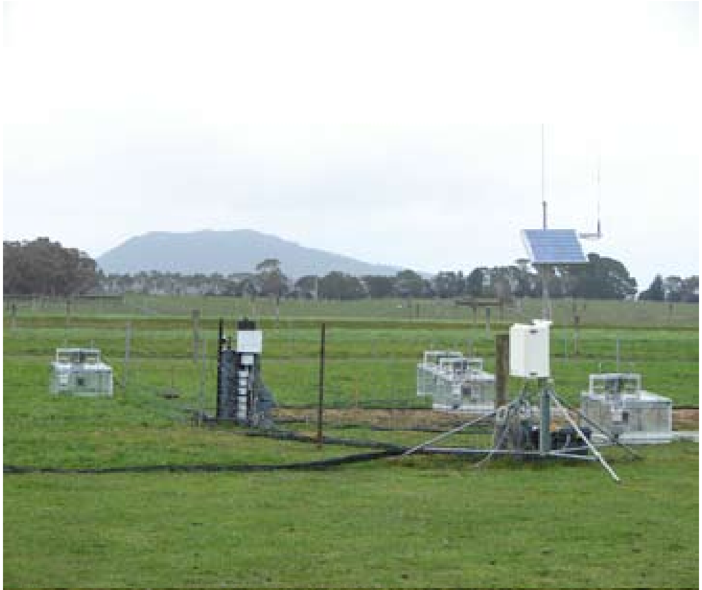
November 18th and 19th. Orange Function Centre, Orange NSW. www.carbonfarming.net.au

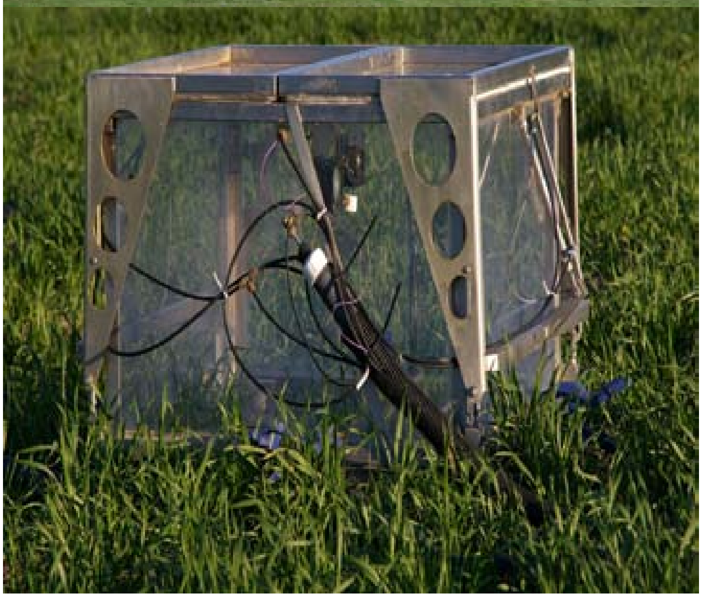
- *Greenhouse 2009. Climate Change and Resources*

March 23rd to 26th 2009. Burswood Entertainment Complex, Perth Western Australia. www.greenhouse2009.com

- *Climate21. Agriculture and Food Futures*

March 27th 2009, Burswood Entertainment Complex, Perth Western Australia.
www.agric.wa.gov.au/content/lwe/cli/climate21





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