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In this issue

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Hello and welcome to Greenhouse in Agriculture's (GIA) latest research newsletter.

On the 17th March, Minister for Climate Change and Water, Senator Penny Wong, announced the Australian Government's detailed timetable for the introduction of a national emissions trading scheme. By December 2008 there will be a public release of draft legislation, with this legislation set to pass through parliament by mid-2009. By 2010 the Australian National Emissions Trading Scheme (ETS) will start.

Although initially agriculture is not included as a covered sector under the ETS, Senator Wong and the Minister for Agriculture, Fisheries and Forestry, Tony Burke, will "*begin discussions with agriculture sector leaders soon*". This is likely to set a timetable for agriculture's inclusion at some stage in the near future.

The GIA project aims to a) reduce uncertainty in estimates of emissions from agriculture and b) to deliver cost-effective options for the abatement of methane and nitrous oxide emissions from agriculture.

GIA research has already contributed to a significant reduction in the default emission factor for nitrous oxide in grains and pastures, from 1.25% of all nitrogen applied, to 0.3% for grains and 0.4% for pastures. This has significantly reduced the potential liability agriculture may face under an ETS. Further research is reported in this newsletter towards confirming even lower factors for grain cropping.

Our methane research is currently researching practical and cost-effective options available for farmers to not only reduce methane, but also improve productivity and thus provide a driver for on-farm adoption.

Now more than ever, this research is of critical importance to underpin sound policy development and prepare the agricultural industries with clear options, either in providing offsets, or to demonstrate abatement and meet any liabilities under an ETS.

Regards, Richard

Dr Richard Eckard

Science Leader, Greenhouse in Agriculture

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Victoria The Place To Be · GRDC Grains Research & Development Corporation · Australian Government Department of Climate Change · The University of Melbourne · Lilly · Dairy Australia

WA grain production emits lower soil N_2O emissions than international average

The coming growing season will mark the fourth and final year of the Western Australian (WA) Nitrous oxide (N_2O) research study based at the Cunderdin Agricultural College in the central grain belt of Western Australia. At the completion of the project, soil N_2O emissions will have been measured from two wheat crops, a canola crop and a lupin crop.

The WA N_2O research project was initiated by the Dept Climate Change (DCC), the Grains Research & Development Corporation (GRDC) and Department Agriculture and Food Western Australia (DAFWA) in 2004 to refine our understanding of the contribution of (Nitrogen) fertiliser applications to soil N_2O emissions. Our industry partners were concerned that the international default value for calculating soil N_2O emissions (at the time, 1.25% of N applied) was inappropriate for use under Australian growing conditions, and that the Australian grains industry could be unfairly penalised.

Two years down the track, N_2O emissions from the Cunderdin site have represented 0.02% of the N applied to wheat, and we expect a similar value for canola. Furthermore, our findings are consistent with those presented by DPI colleagues investigating N_2O emissions under various fertiliser and tillage practises Victoria.

Nitrous oxide emissions reported from the WA N_2O research study have not only been lower than those reported from other countries, but the timing of the losses has also differed from temperate climates. In a recently published article, we explain that a large proportion of the N_2O emissions in the first year of study were in response to summer rainfall, rather than the following N fertiliser applications during the growing season (Barton et al. 2008. *Global Change Biology Volume*, **14**: 177-192).

Figure 1. A nitrous oxide collection chamber at Cunderdin.

In subsequent years, greatest daily N_2O emissions have also tended to be following summer rainfall.

Findings from the WA N_2O research project have a number of implications for growers.

Firstly, it demonstrates N_2O emissions resulting from application of N fertiliser to land are likely to be lower from arable, cropping systems in south-western Australia than from our temperate climate counterparts.

Secondly, if we wish to further lower N_2O emissions from these grain growing areas we will need to adopt different strategies to those commonly promoted in other parts of the world. For example, it is often suggested that improving the timing of N fertiliser applications so as to better match crop demand will decrease soil N_2O emissions. Given that N_2O emissions have not increased following N fertiliser applications at the Cunderdin site, we would argue that these mitigation strategies may have limited value in the grain belt of south-western Australia.

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GIA Breeding: dairy farming in a changing climate

In late 2007 the Department of Primary Industries (DPI) Victoria Biosciences Research Division held a workshop to discuss the potential of dairy farming under climate change and determine the genetics research required to equip the industry for the future. Staff from DPI with expertise in dairy genetics and biotechnology, nutrition and pasture management, climate change and environmental biology and policy attended the workshop. Industry representatives from Australian Dairy Farmers, Dairy Australia, Genetics Australia and Victorian regional dairy farmers also participated. The final session for the day was facilitated by Susan Benedyka of the Regional Development Company.

Dr Richard Eckard, a joint appointment with the University of Melbourne and DPI introduced the day as GIA leader. Richard's presentation described the agricultural sectors impacts on climate change and the related physical effects of climate change for Australia. The influence of climatic changes on the dairy industry was presented by Robert Poole, Deputy CEO and Policy Director, Australian Dairy Farmers. The Research Director of DPI Animal Genetics and Genomics, Dr Ben Cocks spoke about the capabilities of DPI in animal breeding and genetics. Dr Amanda Chamberlain, Research Scientist, DPI Animal Genetics and Genomics, presented on the most recent animal breeding tool "genomic selection".

The facilitated session addressed three key questions:

- How will the dairy industry change in response to climate change?
- How might dairy cow genetics need to change to respond to climate change?
- What are the research questions we need to answer?

Following much discussion and debate three research priorities were identified:

1. Feed conversion efficiency (FCE)
2. Adaptability
3. Fertility

The top priority under any circumstances was FCE particularly if conditions became tough as a result of climate change. Adaptability to different environmental effects such as heat, stress, disease and nutrition was acknowledged as being crucial under a changing environment, and with fertility recognized as gradually declining for the past few decades and these must be rectified.

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GIA Mixed Farming Systems: results after a challenging season

The first year of comprehensive data collection of nitrous oxide emissions from crop legume rotation systems is nearing completion at Hamilton and Horsham using automated chambers (Figures 2 and 3).

Emissions from wheat crops at **Horsham** are being measured under the following treatments: with and without the Faba bean pulse (previously used in the crop rotation), without and with N fertilizer (50 kg/ha), and with and without supplementary irrigation. Winter wheat was planted into the stubble on 5 June 2007 and grown with Phosphorus (P) fertiliser. Supplementary irrigation was applied in early September to plots where N had previously been applied.

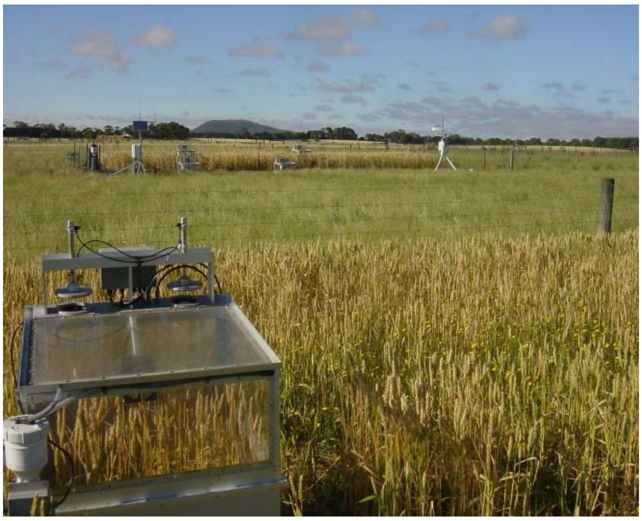
At **Hamilton** long term high and low (P) fertility pastures were direct drilled with wheat in late May 2007. This followed spraying to remove grasses in winter 2006 and the use of a knockdown herbicide prior to direct sowing into the resultant sub clover dominant sward.

The 2007 Wimmera rainfall was slightly less than the long term average of 411 mm (decile 4). There was a big rain event in late April with 77 mm in 2 days (decile 10), with further rain in May. The 2007 growing season rainfall was poor (decile 2), and the crops were stressed. The 2007 Hamilton rainfall was 800 mm compared with the long average of 684 mm, with 123 mm of the total falling in January.

The crops at both sites have been harvested and yields at Horsham were least for plants that had received N fertiliser but no irrigation (2.6 t/ha). Yield increased where no N fertiliser was applied (3.1 t/ha) and were greatest for the plants that received both N fertiliser and irrigation (3.6 t/ha).

The ranking was similar for total plant material (less grain), although the differences were not significant. Harvest index values were similar when no N fertiliser (0.34) or N fertiliser was applied without irrigation (0.33), and improved for the irrigated and N fertilised treatment (0.37). There were no treatment effects on 1000 grain weights or grain screenings. At Hamilton yields of 3.2 t/ha and 6.2 t/ha from the low and high fertility pasture respectively were achieved, with respective harvest indexes of 0.40 and 0.43. There was no effect of treatment on 1000 grain weight.

Figure 2. A nitrous oxide collection chamber at Hamilton.



Pulses of nitrous oxide emissions occurred after most significant rainfall events at both sites. At Horsham the highest rates of emissions occurred in April 2007, after the large autumn rain event. Prior to the rain event the soil was releasing approximately 0.4 g N_2O-N/ha. After 49 mm of rain fell on the site, the soil reached a peak average rate of emissions the following day of 8.9 g N_2O-N/ha. These emissions occurred while the soil was fallow, before N fertiliser was applied and the wheat was planted. Analysis of the data to examine the effect of the treatments and total emissions over the growing season is continuing.

At Hamilton the highest emissions occurred in August when 1700 g N_2O-N/ha was measured from the high phosphorus fertility plots sown to crop. For the same period the grazed high clover content and mixed pasture treatments, had measured emissions of 500 g and 200 g N_2O-N/ha respectively. This represented 35 to 55%

of the cumulative N_2O emissions from treatments over the period from sowing to the end of January 2008 (8 months). These high emissions occurred after periods when water was present on the soil surface.

Cumulative emissions from March 2007 at Hamilton indicate values from 500 to 3300 g N_2O-N/ha. The high fertility paddock sown to crop produced 3.3 kg N_2O-N/ha. The high fertility sub clover plot and the low fertility crop produced approximately 1 kg N_2O-N/ha for the year. The mixed pasture produced approximately half of this at 500 g N_2O-N/ha. These emissions are considerably higher that that recorded under lower rainfall conditions at Rutherglen (Vic), Horsham (Vic) and Cunderdin (WA), where annual emissions were in the order of 90 to 270 g N_2O-N/ha dependent on cultivation treatment and fertiliser management.

Measurements at both sites will continue for a further 12 months.

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Figure 3 A nitrous oxide collection chambers at Horsham.

GIA Farming System Analysis: modelling methane emissions

Methane production from the rumen is influenced by intake and diet quality, the higher the quality the lower the proportion of the energy intake that is lost as methane (Blaxter and Clapperton 1965). However, the main benefit of providing a high quality ration is through reducing the time taken to finish meat-producing animals to an acceptable weight and grade for slaughter, thereby reducing the total methane emission per unit of animal production.

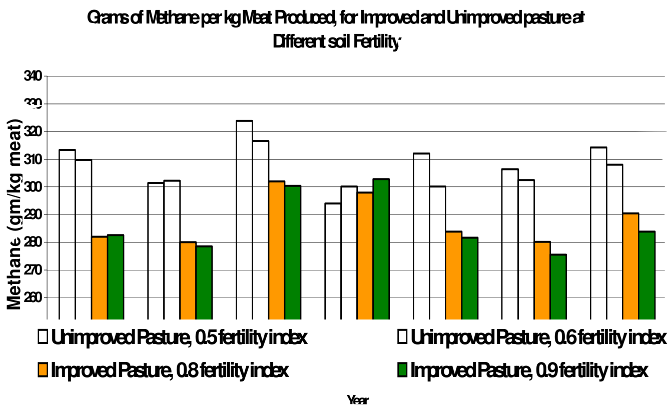
Steve Clark at DPI Hamilton is using GrassGro (a commercial computer software package, developed by CSIRO) to predict methane output from different pasture systems. GrassGro provides predictive outcomes (both biological and economic) for agricultural systems in a wide diversity of environments and uses the equations of Blaxter and Clapperton (1965) to predict methane output. Steve is examining methane output from the Long Term Phosphate Experiment (LTPE) and the EverGraze projects at Hamilton.

Initial results using simulations of the LTPE (Figure 4) show that pasture type and soil fertility influence methane production. GrassGro uses a scale of 0.5 to 1 to rate soil fertility, with 0.5 being a soil with very low Olsen P, with 1.0 being the highest rating, thus the lowest fertility paddocks on the LPTE were rated at 0.5, and the highest 0.9. For the years investigated, between 1979 and 1989, there was up to a 9% reduction in methane emissions per kg of meat produced due to pasture type and fertility.

Steve has also used the model to examine different supplements and because of differences in feed quality there can be nearly a 3 fold difference in the amount of methane released per kg of meat produced. Sheep fed lucerne cubes produced 940 g methane / kg meat, and sheep fed lupins produced 342 g methane / kg meat. Sheep fed silage were estimated to produce 677 g methane / kg meat, so there are large differences in methane output due to feed type.

The next step would be to obtain actual methane measurements from different grazing systems.

Figure 4. Effect of soil fertility and pasture improvement on methane emissions.



Ref:- Blaxter, K. L. and Clapperton, J. L. (1965). Prediction of the amount of methane produced by ruminants. Br. J. Nutr. 19: 511–522.

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GIA Methane: increasing fat can reduce methane emissions

GIA's DPI Ellinbank research team have been studying dietary strategies that can reduce methane (CH_4) emissions, profitably increase milk production and be practically implemented on farm.

Recently whole cottonseed was added to the diet of lactating dairy cows for five weeks over the summer period when pasture quality is generally poor in energy and protein content. Whole cottonseed (Figure 5.) is high in energy (14 MJ/kg DM), and protein (22% CP) and also contains about 22% oil and hence can improve the quality of the diet.

Figure 5. Whole cotton seed.

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%. Canadian research colleagues also examined the relationship between level of added fat and the reduction in CH_4 emissions using data from 17 studies with beef cattle, dairy cows and lambs. They found that for each 1% fat added to the diet CH_4 emissions/kg DMI were reduced by about 6%. This finding emphasised that the most important factor in reducing CH_4 emissions was achieved by adding fat to the diet.

If reductions in CH_4 emissions can be achieved from a variety of fat sources (eg. food processing industry waste) this provides some flexibility in implementing on farm strategies. Also from a life cycle analysis point of view accounting for the emissions generated from growing the crops and associated transport, using waste products would be more desirable than incurring additional emissions from cultivating oilseeds specifically to reduce methane.

The 2005 National Greenhouse Gas Inventory reports that total enteric CH_4 emissions from dairy cattle are 7266.21 Gg of CO_2 equivalents. If all these cattle were offered an extra 2% fat in their diet and achieved a 12 % reduction in CH_4 emissions, and assuming a carbon price of AU$35/tonne CO_2 equivalent, this abatement would be worth approximately $30.5M to the dairy industry, in a future emissions or offset trading regime. Figure 6 list a range of oil sources.

Figure 6. Potential and 'existing' sources of oils for livestock.

Item	% oil
Cooked potato chips	18
Soybean pollard	10
Ensiled grape marc (including tannin)	16
Brewers grains	8
Safflower meal	12
Palm kernel meal	10
Tomato pomace	15
Hominy meal	10
Bakery waste (dried)	13
Linseed meal	11
Citrus pulp (wet)	10
Naked oats	15
Sunflower seeds	58

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