Greenhouse in agriculture

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Introduction

Both sugar cane and wheat are used for bio-ethanol in Australia.

GIA Project Leader: Richard Eckard

More and more we are seeing that it is not the Physical aspects of climate change that will affect the agricultural industries in first instance, as much as the Policy and Peripheral issues that we need to be aware of.

What do we mean by this?
Well we know that our climate is getting warmer and some areas may get drier, but farmers have been dealing with these extremes for many years and, to some extent, are continually adapting to a changing and variable climate – this we call autonomous adaptation.

However, Policy decisions like an Emissions Trading Scheme by 2012 and the proposed Climate Change Bill in Victoria, targeting 60% reductions in greenhouse gas emissions by 2050, are likely to have a far greater impact on agriculture in the short term.

In addition, it is Peripheral issues like biofuel production which may provide new opportunities for the grains industries, but threaten grain supplies to dairy, poultry and feedlots production. Other obvious peripheral issues is consumer perceptions and the debate in the media around product labelling to include Food Miles – i.e. the greenhouse gas emissions associate with transporting produce around the world.

In this rapidly changing environment there will be almost as many new opportunities as there may be threats, and it is important for the agricultural industries to ensure that:
a) They are as informed as possible of the Physical, Policy and Peripheral issues around climate change, but also that
b) They are adequately represented in negotiations to ensure that threats are minimised and opportunities maximised.

---------- NEW GIA PROJECTS ----------

GIA welcomes three new projects recently funded by DPI Victoria under the theme "Future farming systems to meet the

challenge of greenhouse emissions and climate change".

Chambers at Hamilton on newly sown crop

GIA Nitrous Oxide: "A world first with TDL"

Project Leader: John Graham

The mixed farming project is progressing well with both the Horsham and Hamilton sites now set up and measuring emissions. At Horsham we are examining emissions from fertilized and unfertilized cropping systems, with effects of irrigation being tested later in the season. The instrumentation at both sites is working well with good data being generated.

At Horsham ground breaking technology is being used to measure nitrous oxide emissions, with new automated chambers being connected to a Tunable Diode Laser trace gas analyser system (TDL), a world first. All measurements are currently being done on newly sown crop, and as the crop has only recently germinated it is too early to confirm any treatment effect, however peaks due to diurnal variation in nitrous oxide can be seen.

The Hamilton site is a little different to the Horsham site, as measurements are being made on both a mixed sward and a clover dominant pasture (as a component of a legume/crop rotation) on both high and low fertility paddocks. A section of the high clover component has just recently been direct seeded to wheat, and nitrous oxide emissions from the crop/legume rotation system are being measured.

At Hamilton a Fourier Transform Infra-Red gas analyser (FTIR) is being used for gas analysis. Data collected at Hamilton up to sowing is showing spikes in nitrous oxide emissions due to rainfall, and also slightly increased emissions resulting from the higher fertility pastures. The data from both sites is only very preliminary, but indicates that the technology at both sites is working.

Cropping treatments at both sites have been sown, seeded conventionally into a previously cropped site at Horsham, and direct drilled into pastures that had never been cropped before at Hamilton, on the long term phosphate site.

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GIA Methane: "Monensin – can we get a "win-win" dose rate?"

Sulfhur Hexafloride (SF6) measurement technique

Project Leader: Chris Grainger

The focus of the Methane team's research is to test technologies that can be used to reduce methane emissions using three main criteria. Firstly they must reduce methane emissions from dairy cows. Secondly they must result in profitable effects on milk production and thirdly the technologies must be feasible and able to be implemented on dairy farms.

A technology currently being tested is monensin, which has been widely used for bloat control, often via a controlled release capsule. Monensin is also used as an additive to grain-based

supplements to increase efficiency of feed conversion as well as and bloat control.

In a recent study at Ellinbank researchers examined the effects of monensin, using controlled-release capsules on methane emissions from cows and on milk production. The cows were fed on ryegrass pasture and grain in the spring and limited pasture, pasture silage, hay and grain in the summer/autumn period. Cows received one capsule in early spring and another capsule about 130 days later in the summer period. Milk production responses were measured over 200 days, 100 days after the insertion of each of the two capsules; a 5% increase in milk solids production was achieved. The increased milk production resulted in an $8 profit from each capsule, based on milk prices at the time of the study. However, at the dose rate of monensin delivered by the capsule there was no reduction in methane emissions from the cows.

We do know from other work done overseas with beef and dairy cattle that if the dose rate of monensin is doubled, equivalent to giving each animal 2 capsules, a 10% reduction in methane emissions can be achieved. So in spring 2007 we plan to do a dose response study to see if we can find a "win-win" monensin dose that will give us a profitable increase in milk, but also reduce methane emissions from the cows. In the proposed study in spring we will deliver the different dose rates of monensin in the feed supplement. If we can get a "win-win" dose rate then monensin will be a technology that meets our three criteria for a successful technology to reduce methane emissions from dairy cows and will make a worthwhile contribution to reducing greenhouse gases from agriculture.

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Team member, Carolyn Bath, extracting the rumen sample for analysis

GIA Genomics: "Uncovering the secrets of the rumen"

Project Leader: Dadna Hartman

Ruminants are dependent on anaerobic fermentation mediated by microbes to digest their plant feed. The microbial species that have developed in the rumen over millions of years interact in a complex manner to play an essential role in ruminant nutrition. Of particular interest are the methanogens, due to the role methane plays in global warming and the fact that animals loose ingested energy as methane. Yet, the complex biotic communities that reside in the rumen, the rumen biome, remain to date largely unknown.

Random DNA sampling methodologies have been recently applied to entire microbial populations, enabling vast legions of unseen microorganisms and their gene complements to be described. Such advances in genomics, metagenomics, can be applied to the rumen allowing the inventory of the vast microbial complement and would be expected to capture the majority of the important genomes.

Our team aims to undertake a metagenomics analysis of the rumen microflora. This strategy will greatly expedite our knowledge of the rumen composition and enable the development of research diagnostic tools for the analysis of rumen composition and its relationship to key issues that affect farming systems. The rumen metagenome information will directly enhance many ongoing programs in animal production

within the Department of Primary Industries (DPI), particularly those associated with the abatement of methane from dairy cattle.

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GIA: Farming System Analysis "Methane Emissions from Different Farming Systems"

Aerial photo of the EverGraze and Long Term Phosphate project sites DPI Hamilton

Project Leader: John Graham

This project will use the GrassGro and DairyMod models and information from existing farming system projects to model methane outputs from livestock grazing the various systems.

As we are all aware, agriculture in Australia is the second largest emitter of greenhouse gasses, producing around 16% of Australia's emissions. Methane, predominantly from ruminants, accounts for 65% of those gasses. Any information that will allow us to devise abatement strategies to lower these emissions will be invaluable. The models will utilise information from three grazing system projects to project methane output per head, per hectare and per unit of finished product.

The EverGraze project at Hamilton has been established to examine different pasture species across the landscape, in terms of water use, water use efficiency and production. The pasture species being examined, and chosen as the most appropriate for recharge, slopes and low lying areas of the landscape, include established perennial grass species as well as newly developed grasses and also novel pasture systems (Chickory, Lucerne and Kikuyu). Modelling will be used to estimate methane emissions from sheep and cattle grazing these systems.

In addition, information from the long term phosphate project (LTPE), where extremes in fertiliser application and stocking rates have been evaluated over the past 30 years, will also be used to model methane output. GIA's Mixed Farming System's project is currently measuring nitrous oxide emissions on this site.

DairyMod will be used to estimate methane output from the 30/30 dairy farmlet systems project that is currently evaluating forages and perennial pasture systems.

The projected methane output derived from this modelling process will be used to define benchmarks in terms of greenhouse gas emissions for the different grazing systems, and define likely areas of future opportunities for improvement in terms of mitigation in grazing systems.

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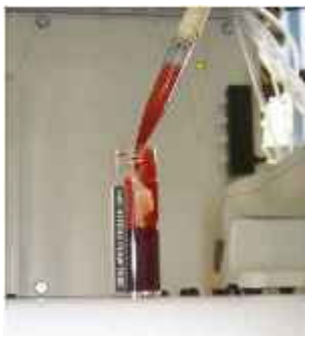
GIA: Breeding "The future for dairy farming"

Project Leader: Mike Goddard



DNA tests will be performed from a simple blood or tissue sample

The effects of climate change on the Victorian dairy industry are hard to predict but could be very severe. Several farming systems might emerge as the industry responds to this challenge. The aim of this new project is to provide the technology that enables farmers to select the system that suits them best as the effects of climate change become clear and to aid in the development of farming systems that will reduce greenhouse gas emissions whilst maintaining productivity.

The project will develop a DNA test that will be used to estimate the lifetime profitability of bulls and cows under different farming systems, particularly high and low levels of nutrition as well as temperature. A second aim of the project is to develop a test that could be used to predict whether a cow is a high or low emitter of methane.

The work will be led by Professor Mike Goddard, bringing together expertise from DPI-Attwood and DPI-Ellinbank,

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Western Australia: "A connection with biofuels"

David Gatter explaining the construction of the chambers to Debra Donovan

Project Leader: Louise Barton

The Western Australia (WA) nitrous oxide team has commenced its third year of measurements. Canola was sown at the Cunderdin site on the 24th May, on the back of limited opening rains. The crop has since received 94 mm (up until 3rd August), with further rain needed. The outlook for the region remains positive, and the group still has its collective fingers crossed that further rain will fall over the coming months.

The nitrous oxide emission data collected from Cunderdin will be used to assess greenhouse gas emissions from the production of biofuels from canola. Dr Wahidul Biswas from the Centre of Excellence in Cleaner Production at Curtin University will use 'life cycle assessment' to calculate greenhouse gas emissions from pre-farm, on-farm and post-farm activities related to biofuel production. Overseas studies have indicated that on-farm nitrous oxide emissions, resulting from the N fertiliser applications, may limit the usefulness of biofuel as an alternative fuel source. However, extrapolating overseas findings to Australia is difficult as current research suggests Australian on-farm nitrous oxide emissions are much lower than those from European farms.

David Gatter left the WA nitrous oxide team at the end of July to take up a position in the Horticulture Group at the Department of Agriculture & Food Western Australia. David has been with the group since it was first formed, and successfully set up and maintained the automated chamber equipment at the Cunderdin site for over two years. David spent 3 weeks training Debra Donovan on the use of the equipment before he left, and continues to stay in contact. Debra graduated from the University of British Columbia, and has recently immigrated to Australia. David's commitment to maintaining the field equipment has provided the group with over two years of continuous nitrous oxide data from a rain-fed crop in a semi-arid region–a world first. We wish David all the best in his new position, and welcome Debra on board!

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Zoe Loh calibrating the open-path lasers.

Emissions from Australian Beef Feedlots

Project Leader: Deli Chen

Project team: Zoe Loh, Tom Denmead, Robert Edis, Julian Hill, Stephanie Muir, Richard Eckard, The University of Melbourne
David Griffith, Bai Mei, Travis Naylor, University of Wollongong
Sean McCinn, Agriculture and Agri-Food Canada

Measurement techniques, such as chambers, commonly used to document greenhouse gas fluxes from land-management practices are generally not applicable in livestock production systems where greenhouse gases are often emitted from (approximate) point sources or non-uniform area sources. Instead, our team is pioneering new techniques for determining greenhouse gas fluxes from Australian beef feedlots, on a field scale in a large collaborative project, 'Greenhouse gas emissions from Australian beef cattle feedlots' jointly sponsored by Meat and Livestock Australia (MLA) and Australian Greenhouse Office (AGO).

We use a non-disruptive micrometeorological approach coupled to two open-path spectroscopic techniques to measure line averaged concentrations of carbon dioxide, methane, ammonia and nitrous oxide. Tunable diode lasers are commercially available for measuring methane and ammonia, whereas the open-path FTIR (measuring all four gases simultaneously) has been built in-house at the University of Wollongong. A backward Lagrangian stochastic (bLS) model of atmospheric dispersion is used to estimate greenhouse gas fluxes. Atmospheric mixing is simulated on the basis of temperature and pressure measurements along with wind statistics provided by a 3 dimensional sonic anemometer. The bLS model then predicts the ratio of a gas concentration at a particular location within the plume, to its source emission rate (C/F)sim. The emission rate is determined by measuring the gas concentration at the defined location and dividing this by the ratio (C/F)sim.

Measurements are made biannually (winter/summer) at typical feedlots in the north and south of the continent, allowing seasonal and climatic variations to be investigated. Now into our second year of measurements, we are accumulating the data necessary to update the livestock emissions accounting in the National Greenhouse Gas Inventory. The preliminary data (summer measurements) indicates methane fluxes are in the range of 110 to 170 g/head/day, 120 to 250 for ammonia and very low for nitrous oxide (<3).

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GIA: Communications "Demand for research high"

Project Leader: Traci Griffin

Garnaut Review keynote speakers -Land Management, Agriculture and Forestry Forum

Demand for information about emission measurement and abatement research on agricultural systems has been exceptionally high in recent months. Developments like the Commonwealth Government's proposed Emissions Trading Scheme, the new Office of Climate Change for Victoria and the Garnaut Review have increased demands from a range of government and industry agencies seeking better understanding about agriculture's emission profile and the potential for or limits

to abatement to inform debates and support decision making.

Primary producer and community groups have also increased demand for information via presentations at forums or enquiring for assistance to calculate farm based emissions and explore abatement options. Recent highlights include:

Garnaut Climate Change Review: Recently the Review held a national forum to explore ways Land Management, Agriculture and Forestry will interact with climate change. As a keynote speaker Richard Eckard provided an excellent presentation titled "The Abatement Challenge for Agriculture", an overview of relevant research across Australia, including; sources and types of emissions, and opportunities and challenges for abatement. Further information and presentations are available at www.garnautreview.org.au.

Research forum: Non-CO2 greenhouse gas fluxes in Australian-New Zealand landscapes – Held in Melbourne in May the forum was well attended by a range of researchers from Australia and New Zealand, providing an excellent opportunity for networking and sharing of research. A selection of papers from this forum will be published in a special edition of the journal Plant and Soil.

New Project Sheets: Description sheets for GIA's Methane and Mixed Farming Systems projects are now available on GIA website: http://www.greenhouse.unimelb.edu.au/.

Up Coming Events:
o Greenhouse 2007: Sydney: 2nd to 5th October, see http://www.greenhouse2007.com
o Greenhouse Gas & Animal Agriculture Conference 2007: Christchurch New Zealand. 26th to 30th November, http://www.confer.co.nz/ggaa2007/

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