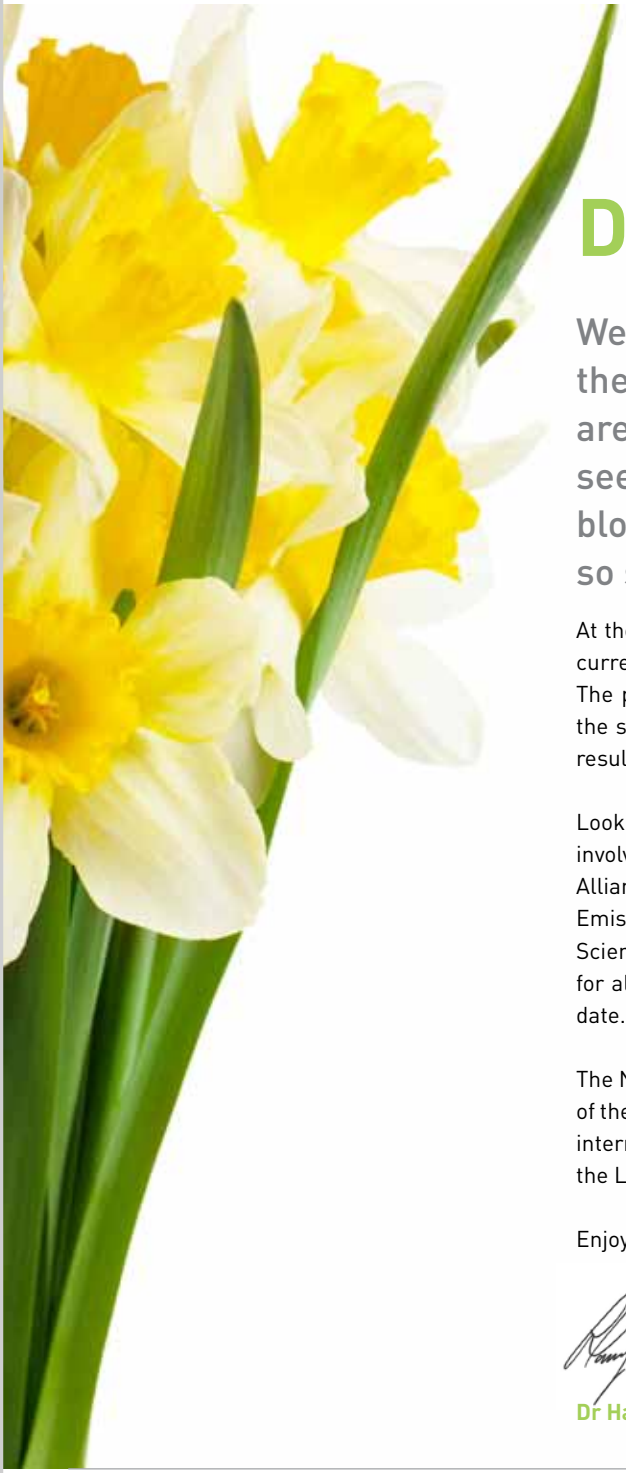
August 2012

# 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 seventh issue of the NZAGRC newsletter. The days are getting longer, the nights don't seem so cold and the daffodils are blooming here in Palmerston North, so spring must be approaching.**

At the end of June we celebrated the close of the second full year of the NZAGRC and are currently hard at work finalising our Annual Report and Highlights 2011/12 documents. The past financial year was another busy one for the Centre and I'm pleased to say that the science programmes are progressing well, milestones are being achieved and usable results, outputs and publications are emerging from the research.

Looking forward to 2012/13, it is likely to be another eventful year. In addition to our involvement in a number of scheduled overseas workshops to support the goals of the Alliance and the second round of the New Zealand Fund for Global Partnerships in Livestock Emissions Research, the NZAGRC will undergo a formal science review in early 2013. The Science Leadership Team has already started preparations for this process and the aim is for all involved to be fully prepared and rehearsed well in advance of the February review date.

The NZAGRC continues to administer the LEARN and GRASS fellowship schemes on behalf of the New Zealand government. If you are a researcher who is interested in increasing your international linkages, I would encourage you to look at the information on page 9 or visit the LEARN website (www.livestockemissions.net)

Enjoy reading,

**Dr Harry Clark**

# Upcoming events

| Event | Date | Location |
|---|---|---|
| Indonesia ICARD conference on Livestock Production and Veterinary Technology | 1 – 4 October | Bogor, Indonesia |
| Training Workshop on GHG Flux Measurements | 8 October | Porto Alegre, Brasil |
| International Symposium on Integrated Crop-Livestock Systems | 8 – 12 October | Porto Alegre, Brasil |
| Second Global Conference on Agricultural Research for Development | 29 October – 1 November | Punta del Este, Uruguay |
| Global Research Alliance Livestock Research Group meeting | 1 – 2 November | Punta del Este, Uruguay |
| Australia Dairy Science Symposium | 13 – 15 November | Melbourne, Australia |
| AAAP Animal Science Congress | 26 – 30 November | Bangkok, Thailand |
| NZAGRC Science Review & Workshops | 18 – 22 February | Palmerston North, NZ |

*If you have an upcoming event that you'd like us to profile in Release or on our website, please contact us at enquiry@nzagrc.org.nz*

# Global Research Alliance update

## Update from the Alliance Council Meeting

**The Alliance Council met for the second time from 5 to 7 June 2012 in Saskatoon, Canada. Twenty-two of the thirty-three Alliance member countries were represented at the meeting.**

The Research and Cross-Cutting Group Co-Chairs were invited to present to the Council an update of their groups' activities over the last 12 months. After an overview summarising all of the Groups was presented, each Group then provided a summary of its work plan and activities to date. The session concluded by a number of general challenges facing the research groups being outlined: these include ensuring a coordinated effort across the Groups, widening their reach and effectiveness, ensuring effective communication, and ensuring an inclusive approach that benefits all.

Four partners of the Alliance were also present at the meeting: Consultative Group on International Agricultural Research (CGIAR), Inter-American Development Bank (IADB), Inter-American Institute for Cooperation in Agriculture (IICA), and the World Bank. Each partner presented their views on links and collaboration opportunities to the Council. After each presentation there was an opportunity for the Council to discuss with each Partner how they may work with the Alliance.

Outcomes from the meeting:

- New Zealand handed over the Chair of the Council to Canada (Jamshed Merchant, Assistant Deputy Minister, Agri-Environment Services Branch, Agriculture and Agri-Food Canada)
- Uruguay was confirmed as Vice-Chair of the Alliance Council


Hayden Montgomery (Secretariat, NZ); Paul Stocks (shown in the picture as Chair, New Zealand) handing over the reins to Jamshed Merchant (shown in the picture as Vice Chair, Canada)

- Brazil was confirmed as Co-Chair of the Croplands Research Group
- New Zealand continues as the Alliance Secretariat
- Alliance Communications Policy was finalised and adopted by Council
- Alliance Secretariat to participate as observer on the Stakeholder Advisory Board of the Agriculture Food Security and Climate Change – Joint Programming Initiative (FACCE-JPI)

Punta Del Este in Uruguay is the location for the next meeting of the Livestock Research Group (LRG); which is set to start on the afternoon of the 1st and continue through the 2nd November 2012.

Visit the Global Research Alliance website to download meeting reports and find further information about LRG activities www.globalresearchalliance.org

New Zealand Government

## Global Partnerships Fund open for a second round

**The New Zealand Fund for Global Partnerships in Livestock Emissions Research (the Fund) is a contestable international research fund set up by New Zealand in support of the Global Research Alliance on Agricultural Greenhouse Gases.**

The second round of the Fund opened on 25 June 2012 with NZ$15 million of available funding to support proposals up to three years in duration. The size of individual proposals is expected to be in the range of NZ$1 – 3 million over the three years.

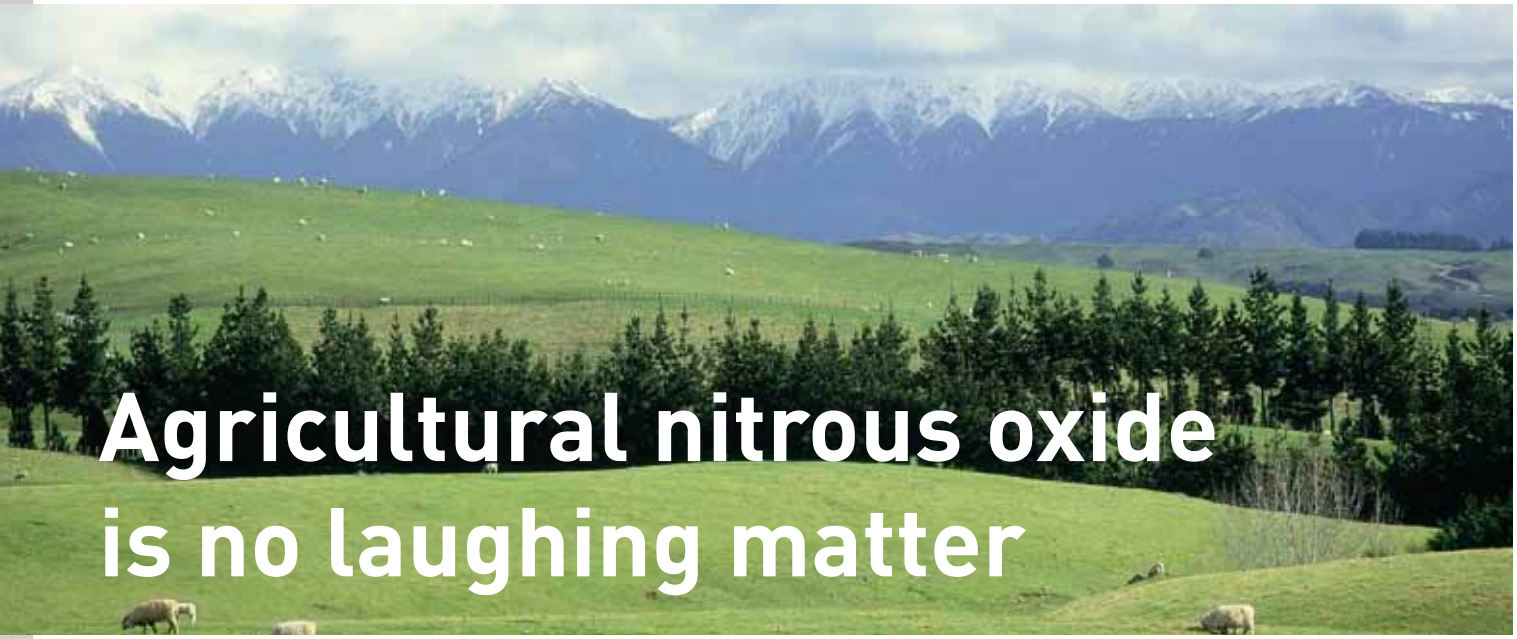
The Fund seeks proposals in response to a set of high-level research challenges in the areas of:

- Manipulating rumen function
- Reducing nitrous oxide emissions from soils in predominantly grazing livestock systems
- Manipulating the rates of soil carbon change in predominantly grazing livestock systems
- Improved information for farmer decision making in predominantly grazing livestock systems

The Fund is open to international scientists, and multi-stakeholder/country consortia bids are encouraged. International co-funding is expected. Projects can be led by a New Zealand participant or one from an Alliance member country but if the latter, must meet minimum New Zealand participation requirements.

The closing date for Expressions of Interest is 27 August 2012, 5pm New Zealand Standard Time.

For more information visit the Global Partnerships Fund website www.mpi.govt.nz/nzlivestockemissionsfund.



# Agricultural nitrous oxide is no laughing matter

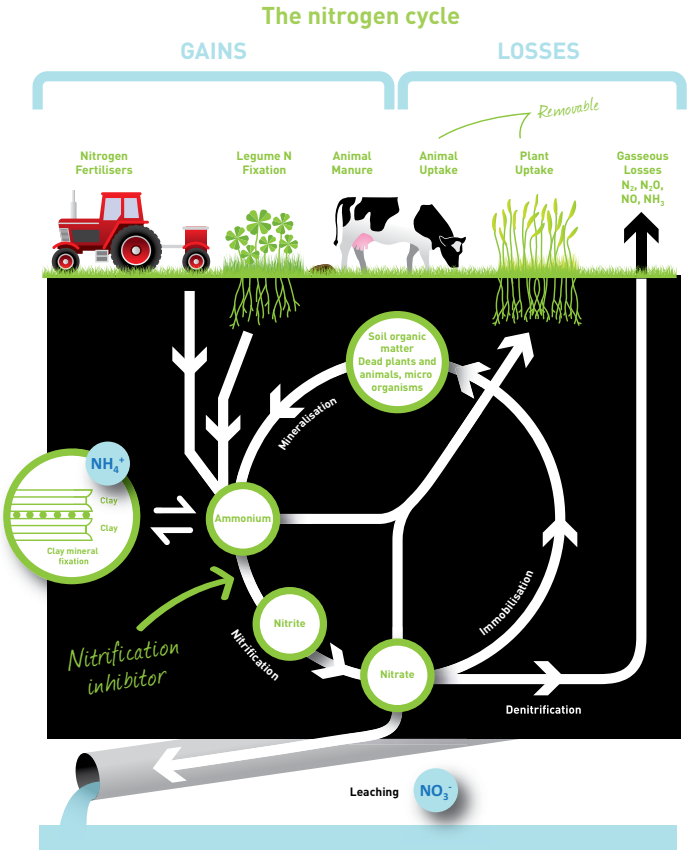
Nitrous oxide, commonly known as laughing gas, is a chemical compound with the formula $N_2O$. However, in the case of the environment, its presence is no laughing matter. $N_2O$ is a potent greenhouse gas (GHG) with a long-term global warming potential 298 times that of carbon dioxide ($CO_2$) and, in New Zealand, approximately 15% of total GHGs are $N_2O$.

Professor Hong Di (Lincoln University) and Dr Cecile de Klein (AgResearch) are jointly leading the NZAGRC $N_2O$ research programme. This seeks to reduce $N_2O$ emissions from agriculture and explore potential on-farm management options for these emissions. The research team are focussing on two key processes in the nitrogen cycle, nitrification and denitrification, with the aim of both discovering and developing ways to manipulate them to benefit the environment.

With respect to the nitrification process, the team is investigating the microbes involved at a detailed genetic level in order to see whether they could be inhibited by new molecules other than the already known nitrification inhibitors (such as DCD). Additionally, scientists are looking to develop improved protocols for the use of existing nitrification inhibitors. The key to this research is fully understanding the current effectiveness of these products and then ensuring application at their most effective times and forms.

The denitrification work also has discovery and developmental elements. On the discovery front, the team are exploring ways in which the $N_2O$ to nitrogen gas ($N_2$) step in the nitrogen cycle can be accelerated. There is an appreciation that gaseous N losses from denitrification cannot completely be avoided and that some nitrogen will be emitted to the atmosphere. Let's therefore try to make sure that this N is lost in the most benign form: i.e. $N_2$ gas. $N_2$ makes up approximately 80% of the earth's atmosphere and has no detrimental environmental impacts. The developmental work in this area is focussed on utilising existing knowledge about soil moisture and its relationship with $N_2O$ to understand whether emissions can be reduced by farm management practices. There is already extensive scientific information which shows that there is a threshold level of soil moisture above which $N_2O$ emissions increase dramatically. Therefore, it may be possible to develop robust guidelines relating to when and where to apply fertiliser and graze livestock during different times of the year.

The following pages profile some of the NZAGRC-funded $N_2O$ work that was started in 2010. This includes some initial work which was conducted to investigate ways to reduce nitrogen inputs into the agricultural soil system.



# Important impacts for NZ inventory from urine concentration study

Most $N_2O$ emissions in New Zealand come from urine patches excreted onto soil by livestock. Whilst studying urine patches isn't everyone's cup of tea, Dr Cecile de Klein has just wrapped up a project that investigated the potential to reduce $N_2O$ emissions by diluting the nitrogen (N) concentration of urine. The results of which were somewhat surprising.

Urinating cows in the field. Photo courtesy of Stewart Ledgard and Amanda Judge

"Unfortunately, our trials showed that mitigation technologies that dilute livestock urine N concentration are not likely to decrease the total amount of direct $N_2O$ produced" states Cecile. "Whether you have twenty urine patches at 0.8% N or eighty patches at 0.2% N, the overall direct $N_2O$ emissions are the same." The results came as a surprise to the science team as early work related to fertiliser usage had suggested an exponential relationship between N concentration and $N_2O$ emissions. That is, at really high N concentrations, the scientists were expecting to see much more $N_2O$ emitted than expected from that emitted at low N concentrations. This suggested that if urine N concentrations could be decreased, without changing the total amount of urinary N excreted, overall direct $N_2O$ emissions would decrease also. However, this turned out not to be the case.

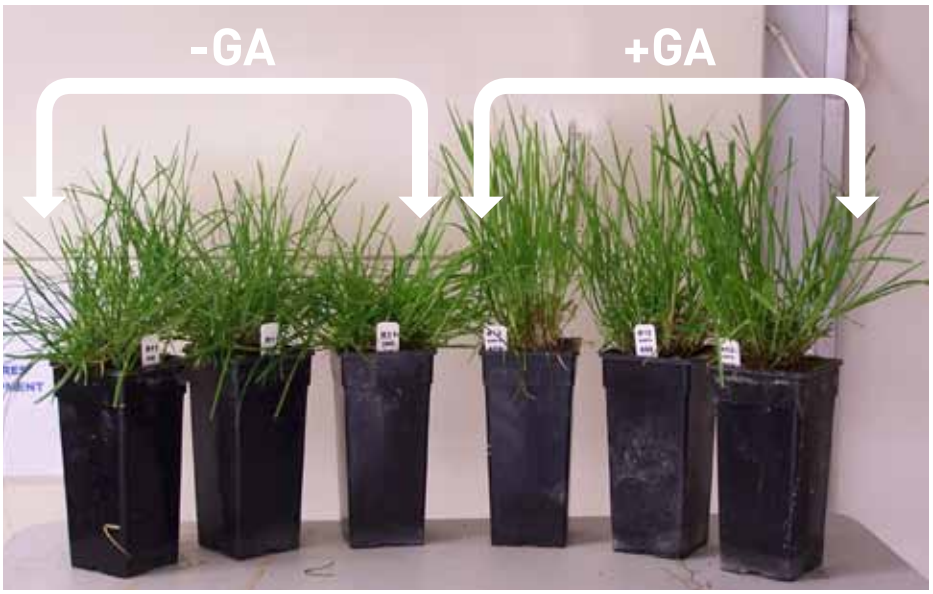
Cecile's findings have important implications for the NZ GHG inventory. One component of the current $N_2O$ calculation involves estimating the emissions from livestock waste deposited during grazing. Demonstrating a linear relationship between urine concentration and direct $N_2O$ emissions means that the constant figure currently used is appropriate and uncertainty in the current calculation can be decreased.

The results also mean that mitigation strategies that reduce the urine N concentration but don't reduce the total amount of urine N excreted, may have limited impact on reducing direct $N_2O$ emissions in New Zealand. For example, it has been shown that feeding salt to animals encourages the animals to drink more water. This results in lower N concentrations in the urine, but as the animal also urinates more often, the total amount of urine N is not different. Whilst the results mean that the direct $N_2O$ emissions may therefore not be affected by feeding animals salt, Cecile suggests that this practice may reduce N leaching, and thus indirect $N_2O$ emissions. However, this was outside the scope of this study.

"The only way to reduce direct $N_2O$ emissions is to reduce the total amount of urine going on to the soil" highlights Cecile. So what are the potential options to achieve this? One option is to manipulate feed intake so that animals receive a low N diet. This is difficult to achieve in the NZ pastoral system, however options such as maize silage are possible when the animals are off pasture. Additionally, work is underway to investigate the potential of pasture species that have high dry matter yields with low nitrogen content. This may be a potential mitigation option in the longer term, and current work on this front is profiled on the following page.

# Novel grass species with high dry matter production and low N content a possibility

Can we breed new pasture grass species which are able to produce high yielding plants with low N content? Dr Susanne Rasmussen (AgResearch) and her team have been conducting proof of concept research in this area and initial results show that this may be longer term option for future $N_2O$ mitigation.




It is well known that animals grazing pasture currently consume much more N than required, hence the large quantities that end up deposited on soil and the associated knock on environmental impacts. Susanne's team is focussed on exploring the hypothesis that novel pasture grasses could be developed that have the ability to produce more dry matter (DM) per unit of nitrogen (N) supplied. This would result in a lower N diet for livestock (with an N content more suitable for the animals), less N excreted on to agricultural soils and hence a reduction in $N_2O$ emissions.

There is a common assumption that grass growth is at all times resource (e.g. N supply) limited and that to increase grass growth, additional N needs to be added, generally by adding fertiliser. The NZAGRC-funded team have conducted studies using a phytohormone (gibberellin) to understand whether common perennial grasses are growing to their full potential at all times given the resources available.

The effect of N and gibberellin on the growth of approximately 2,000 ryegrass samples collected either in winter or summer from a 4 year old dairy pasture at Massey University was assessed. The results showed that at low N supply, the yield of biomass above a standard cutting/grazing height, after 4 weeks regrowth, was increased by gibberellin addition by 25%, while root biomass increased 80%.However, yield gains depended strongly on the duration of re-growth after defoliation and the season in which the plants were taken from the field. Highest yield increases due to gibberellin were seen in winter derived plants. These results clearly demonstrate the potential for stimulating ryegrass growth without adding more N. Although grass growth stimulation by gibberellin did not result in a reduction in N content in the herbage, less nitrogen would need to be applied on a pasture to produce a given yield, using gibberellin, than if the same increase in yield was to be achieved by adding N. And, the gibberellin stimulated plants may reduce releases of N to the environment by drawing down labile soil N.

The team are highly encouraged by these preliminary results and have already submitted two papers for publication. Future work involves understanding the mechanisms of how pasture plants control their response to environmental signals and establishing field trials to test environmental triggers of plant growth. The anticipated outcome is a future breeding programme for novel grass species which are able to achieve high dry matter production with low rates of N application when compared with current NZ pasture species.

# Investigating the role of plants in $N_2O$ emissions

$N_2O$ emission measurement units in a climate controlled plant growth cabinet

When we think about agricultural $N_2O$ emissions, the focus is generally on soil and the processes underway under the pasture. Dr Saman Bowatte (AgResearch) has been investigating the contribution of the plant canopy to pasture $N_2O$ emissions, but first his team had to develop some clever experimental contraptions to allow them to make their measurements.

Saman says that small scale laboratory experiments using flasks and chopped up grass leaves first gave the team the indication that plants themselves could be contributing to $N_2O$ emissions. On consulting the literature, they found a few papers investigating this phenomenon, but nothing looking at the New Zealand system. This NZAGRC-funded project allowed the team to explore the role of plants in NZ $N_2O$ emissions and whether they could determine any underlying mechanisms involved.

There are potentially three ways in which plants can emit $N_2O$: (i) directly from the leaves during nitrogen assimilation; (ii) through acting as a conduit by emitting $N_2O$ that is produced in the soil via the plant's transpiration flow; or (iii) through bacteria in the plant leaves involved in the $N_2O$ emissions. In order to investigate the processes in action, and separate emissions coming from leaves from those coming from the soil, new experimental units and protocols were required. Saman and his team worked extensively with both engineers and specialised glass blowers to perfect the final units and rigorous testing in controlled conditions was carried out prior to conducting any experiments.

The results generated from a study measuring the $N_2O$ emitted by ten different NZ grass species have proved to be very interesting. Firstly, the level of emissions varied between the different species. This may demonstrate potential for manipulation of $N_2O$ based on pasture species selection. Secondly, the $N_2O$ concentrations in the experimental units reduced in the dark, which means that the plants appeared to be absorbing $N_2O$ at night. This finding is significant as it shows the potential for underestimating emissions using the chamber technique i.e. when plants are held for periods of 1 hour in the dark.

The team also found emissions from cut leaf surfaces, indicating that the plant's transpiration flow is important in leaf $N_2O$ emissions. Therefore, the emissions from plants may be affected by how often their leaves are cut. Additionally, under a high ammonia environment (e.g. simulating a urine patch in a field) there were indications that the $N_2O$ was coming from the leaves, rather than from the soil through the plant.

# Can we decrease $N_2O$ emissions by manipulating denitrification?

*Left:* Neha Jha PhD student supported by Dr Edith Khaembah (Massey University) applying cattle urine treatments to field plots at Massey University Dairy Farm-4. *Middle:* Neha Jha collecting gas samples from Agee-jars for measuring soil denitrification rate at Landcare Research. *Right:* Soil samples treated with and without urine are incubated in Agee-jars in constant temperature room

**Professor Surinder Saggar (Landcare Research) is leading the discovery element of the NZAGRC-funded work on denitrification. Even though denitrification is the primary process of $N_2O$ production in pasture soils, there is still much more to understand about the controlling factors involved. Much denitrification research to date has focussed on reducing nitrate in wastewaters, wetlands, riparian buffer zones and waterways, rather than gaseous emissions into the atmosphere. However, with increasing concern about GHG emissions, scientific interest in the denitrification process is growing.**

"In an ideal world, we could reduce the amount of nitrate in the system to zero, by inhibitors or alternative technologies, and hence eliminate agricultural $N_2O$ emissions", says Surinder. "However, this is not currently possible and we need to acknowledge that nitrate is present in the system and work out how to remove it in its most benign form (dinitrogen, $N_2$). Not much research has been conducted on what to do once the nitrate is formed in soils or even what is happening in the denitrification process".

Research to date suggests that the diversity and functioning of soil microorganism communities responsible for denitrification vary depending on the soil conditions, management and environment. There are certain microorganisms which have the capacity to change nitrate into $N_2O$, and some which can change nitrate into the much more environmentally friendly $N_2$.

The team's experiments so far have shown that New Zealand dairy-grazed pasture soils have wide variations of denitrification enzyme activity (DEA), denitrification rate (DR), amounts of microorganism biomass present and $N_2O/N_2$ ratio. The key soil factors contributing to the differences in the amount of $N_2O$ produced, DEA and DR and $N_2O/N_2$ ratio included nitrate present, Olsen P, soil moisture, soil microorganism biomass and soil carbon status.

The next steps of the research will focus on understanding how soil, climatic and/or microorganism parameters affect the microorganism communities functioning and associated enzymes and how these can be manipulated. For example, $N_2O$ can be produced by several enzymes and microbial pathways but bacterial $N_2O$-reductase is the only enzyme capable of reducing $N_2O$ to $N_2$. Key enzymes identified in the denitrification process all have their own specific optimal working conditions. That is, some do their job most efficiently at high or low soil pH and soil water conditions, and others require the presence of other elements (e.g. copper) to work at all. Exploitation of these differences may provide potential routes for future $N_2O$ mitigation.

Learn
Livestock Emissions & Abatement Research Network

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

# Global Research Alliance Senior Scientist (GRASS) Award

## Supporting research in Agricultural Greenhouse Gases

The New Zealand Government, in support of the goals of the Global Research Alliance, is funding senior scientists from Alliance member countries to participate in an exchange programme to enhance collaboration and the building of mutually beneficial research partnerships between New Zealand and other Global Research Alliance countries.

### Focus areas

- Methane emissions from livestock and livestock wastes
- Nitrous oxide emissions from livestock wastes
- Enhancement of pastoral soil carbon sinks
- Integrated whole farming systems impacts at all scales as they relate to livestock emissions
- National inventory development as it relates to livestock emissions

### Eligibility

To be eligible, you must:

- Have a PhD or be a scientist with at least 5 years experience participating in/leading major projects that align to the priorities of LEARN, the Alliance or other relevant national strategies
- Demonstrate impact and leadership in your professional field
- Be able to contribute to scientific research and its application in your home region and the larger Alliance network, based on your networking record
- Work in collaboration with a New Zealand research organisation
- Be resident and normally employed on a permanent contract by a research organisation in an Alliance member country

### Funding

The exchange must be between 6 weeks and 6 months duration.

- Up to $30,000 for 6 months (pro rata for less than 6 months) will be provided to recipients to cover actual and reasonable living expenses
- Up to $5,000 will be provided for economy airfares and travel/medical insurance
- Up to $5,000 will be awarded for associated research costs

**For more details refer to the LEARN Website: www.livestockemissions.net or email the New Zealand Agricultural Greenhouse Gas Research Centre: enquiry@nzagrc.org.nz**

# Capability development

One of the key activities of the NZAGRC is to provide funding to students and early career scientists to increase scientific capability in the agricultural greenhouse gas emissions mitigation research area, and to boost international collaboration.

Dr Miko Kirschbaum (Landcare Research) would like to welcome Nicolas Puche to Palmerston North and the NZAGRC soil carbon modelling team. Nicolas arrived in New Zealand in April to accept a PhD position jointly supervised by Dr Kirschbaum, Prof. Mike Hedley (Massey University), Assoc. Prof. Louis Schipper (Waikato University) and Dr Mike Dodd (AgResearch). The Ph.D. scholarship is a further part of the collaborative relationship between Waikato University and Landcare Research, supported by the NZAGRC.

Nicolas hails from Toulon in the south of France and completed both his Bachelors (Electronics) and Masters degrees (Environmental Monitoring) at the University of Toulon. During his Masters degree, he completed two projects, the first in oceanography and the second related to arable cropping. He admits that electronics seems an unusual route into the environmental sciences, but points out that the physics and maths he learnt have turned out to be extremely valuable for monitoring and modelling work. After completing his studies, he worked at CESBIO in Toulouse for a year, and during this time, he developed the photosynthesis components of a water and greenhouse gases budgets model for crops.

Whilst at CESBIO, Dr Kirschbaum's advertisement for a PhD student caught Nicolas's eye. Linking agricultural greenhouse gas emissions with modelling work seemed to be an ideal opportunity for him to work in his chosen field of interest and learn about another country whilst doing so. Nicolas is currently facing a steep learning curve regarding the New Zealand pastoral agricultural system and its impacts on the soil. However, his robust knowledge of modelling has given him a solid background for his PhD project.

Despite coming straight to Palmerston North on his arrival in New Zealand, Nicolas has already managed to visit a number of other cities in the North Island and get out into the bush and go tramping. He says that the country's extensive tramping tracks and series of backcountry huts is very impressive. Nicolas is interested in completing some of the 'Great Walks", but acknowledges that with his current study schedule, unfortunately these will have to wait for the time being.

Nicolas Puche

Landcare Research
Manaaki Whenua

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