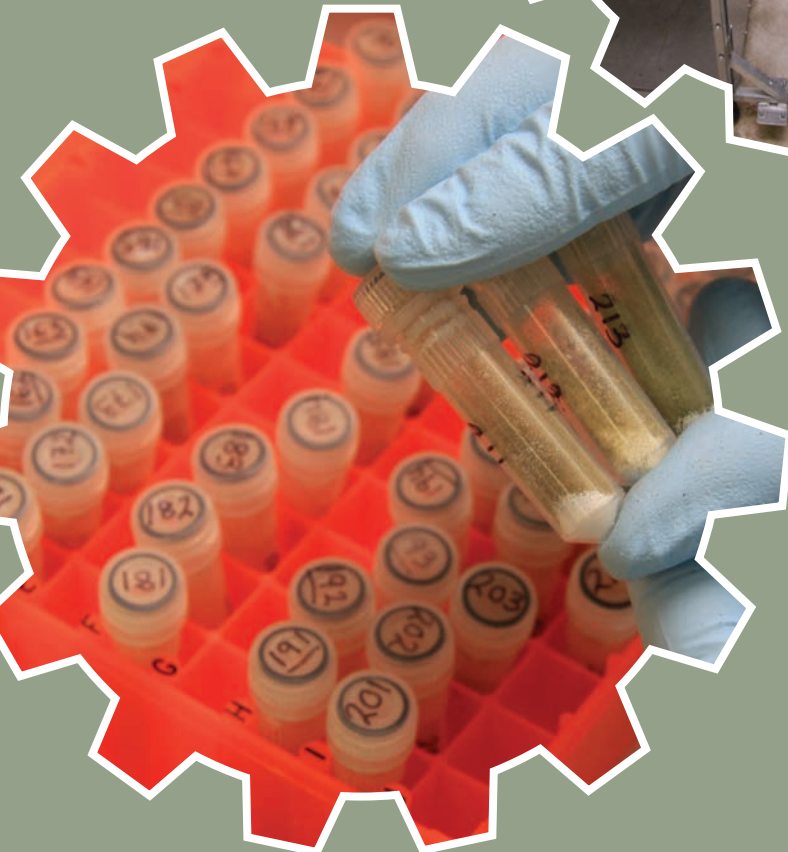# HIGHLIGHTS 2018

NEW ZEALAND
AGRICULTURAL GREENHOUSE GAS
Research Centre

OUR ROLE

THE NZAGRC BUILDING IN PALMERSTON NORTH

New Zealand's Government has set a target to reduce greenhouse gas emissions to 30 percent below 2005 levels by 2030.

OUR MISSION

To provide knowledge, technologies and practices which grow agriculture's ability to create wealth for New Zealand in a carbon-constrained world.

OUR VISION

To be an internationally renowned centre for research and development into agricultural greenhouse gas mitigation solutions.

The New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) is 100% government-funded by the Ministry for Primary Industries through its Primary Growth Partnership fund. The Centre is a partnership between the leading New Zealand research providers working in the agricultural greenhouse gas (GHG) area and the Pastoral Greenhouse Gas Research Consortium (PGgRc). It is a core component of the New Zealand Government's approach for addressing the reduction of greenhouse gas emissions from agriculture.

This includes New Zealand becoming: (a) a major investor in agricultural GHG mitigation research; (b) a world leader in finding solutions to agricultural GHG emissions via its domestic investment programme; and (c) a leader in international initiatives to advance the search for mitigation solutions and help ensure international treaties address agricultural GHG emissions in an appropriate manner.

The Centre is a science funder, has additional responsibilities for strategic research coordination and capacity building and leads New Zealand science input into international activities and policy processes in the agricultural GHG area. About NZ$48.5 million is being invested by the NZAGRC into research and development activities over ten years.

The NZAGRC is a "virtual" Centre and the research that it funds is carried out by researchers working in their own organisations and collaborating across organisations.

OUR GOALS

OUR RESEARCH PROGRAMMES

ADVANCE KNOWLEDGE AND UNDERSTANDING

- 12 papers published plus 15 papers submitted in 2017/18
- 30 scientific conference papers in 2017/18
- Valuable pieces of IP produced include methane breeding values for sheep, developments in the vaccine programme and a novel compound that reduces nitrous oxide emissions
- Comprehensive report prepared for the Government's Biological Emissions Reference Group summarising what farmers can do now to reduce emissions and future options scenarios

ENHANCE AWARENESS AMONG STAKEHOLDERS

- Close cooperation with the PGgRc is a key pathway for the Centre's interaction with industry stakeholders, assisting MPI to manage IP and enabling knowledge transfer
- Maintaining direct links with a broad range of other stakeholders including policy makers, farmers and other end users, the science community and the wider public
- Farm systems mitigation modelling for GHG reduction on Māori farms project started in December 2017 and finishes 30 June 2019

CONTRIBUTE TO POLICY

- Centre's relationship with MPI and other government departments continues to grow and strengthen
- On-going inputs into the GRA and other international initiatives
- National and international advisory roles including to the Parliamentary Commissioner for the Environment and Prime Minister's Chief Science Advisor.

DEVELOP SCIENCE CAPABILITY

- Six PhD students graduated during 2017/18
- Four undergraduate, three Masters and four PhD students currently studying
- Eight active or completed postdoctoral research projects under NZAGRC and GRA funding
- Balanced funding portfolio for research across methane, nitrous oxide, soil carbon and integrated farm systems

DEVELOP SCIENCE AND COMMERCIAL PARTNERSHIPS

- Leadership of science input into Global Research Alliance and coordination of Livestock Research Group with the Netherlands
- Two visits by scientists from overseas research organisations funded by GRA fellowships
- New research collaboration in Kenya established

MITIGATING METHANE EMISSIONS
(Joint programme with the PGgRc)

- Reducing emissions through small molecule inhibitors and vaccines and indirectly through feeding and changes in animal phenotypes

PLANTS AND GHGS

- Identifying and prioritising plant traits for low GHG emissions
- Mitigation practices to maintain soil carbon and reduce nitrous oxide emissions at paddock scale
- Defining the achievable soil carbon stabilisation capacity of New Zealand grassland soils

INTEGRATED FARM SYSTEMS

- Promoting profitable, practical and low GHG-emitting sheep, beef and dairy farm systems

MĀORI-FOCUSSED RESEARCH
(Aligned with Integrated Farm Systems)

- Assisting the Māori pastoral sector to increase resource efficiency and farm productivity while lowering GHG emissions

POLICY SUPPORT

- Conducting research and analysis to ensure that policy makers have current and validated science upon which to base their decision-making

CHAIR AND DIRECTOR REPORTS

CHAIR'S REPORT

Dr Peter Millard
Chair, NZAGRC Steering Group

DIRECTOR'S REPORT

Dr Harry Clark
NZAGRC Director

Over the past year the focus on environmental issues has continued to grow. Governments globally began ratifying the 2015 Paris agreement much earlier than anticipated, including New Zealand in October 2016.

Domestically the new Minister for Climate Change has been consulting on a proposed Zero Carbon Act, to be introduced in 2019, as the Government drives climate change policy towards low emissions and climate resilience. This framework supports the existing target for New Zealand to reduce greenhouse gas emissions by 30% below 2005 levels by 2030.

The NZ Government also plans to set a new emissions reduction target for 2050 and establish an independent Climate Change Commission.

The Interim Climate Change Committee with a supporting secretariat has been established, with Dr Harry Clark, NZAGRC Director contributing as a committee member and Dr Andy Reisinger, NZAGRC Deputy Director (International) as part of the committee secretariat. A key challenge for this committee is to develop evidence and analysis on how agriculture should be brought into the Emissions Trading Scheme. As New Zealand farms contribute 49% to the country's GHG emissions, changes will need to be made.

There are a number of science and policy challenges to be considered, particularly how to mitigate agriculture's emissions whilst still producing sufficient food to supply an expanding global population.

The emissions intensity of New Zealand agriculture per unit of meat or milk produced has declined on average by about 1% a year since at least 1990. However this has been more than offset by the increased overall product generated by the sector. While our farmers are making a contribution and making efficiency gains, it is not enough to counter the extra GHGs being produced overall.

New, practical, cost-effective mitigation technologies and practices will make a valuable contribution to Government strategies and subsequent action plans. International collaborations and alliances can help find lasting global solutions. Developing these approaches is the role of the NZAGRC alongside the joint industry/Government-backed PGgRc. Our efforts are a great example of Government, industry and researchers working together.

The NZAGRC is also working with the Biological Emissions Reference Group (BERG) and industry-led initiatives such as the Dairy Action for Climate Change. Key results in 2017/18 demonstrate that our science teams are getting closer to viable solutions to reduce agricultural GHGs.

Interest in mitigating GHG emissions from New Zealand agriculture has never been stronger and NZAGRC staff and researchers are playing key roles as new policy and industry-led initiatives are developed.

Reports from the Parliamentary Commissioner for the Environment and the Productivity Commission, and the planned introduction of a Zero Carbon Act with the possibility of agriculture entering the Emissions Trading Scheme, have put emissions from agriculture in the national spotlight.

NZAGRC funded research programmes are producing usable results, outputs and publications. We ensure outcomes lead to practical solutions, some of which are already happening at a pilot scale. For example, the impact of the low-emitting sheep research is currently being validated with elite breeders.

New work plans have been developed for the nitrous oxide, soil carbon, integrated farm systems and Māori programmes. A new programme, "Plants and GHGs", fully co-ordinates nitrous oxide and soil carbon research. The new integrated farm systems and Māori work plans involve working alongside relevant industry organisations and aligning strongly with their goals.

We continue to invest in capability building. Our scholarship programme with Massey, Lincoln and Waikato Universities provide opportunities for undergraduates to gain research experience and provides post-graduates with top-up funding to accelerate their work. We also provide support to PhD students in NZAGRC research programmes.

We work collaboratively with the PGgRc, MPI and a wide range of national and international organisations. Our administration of GRA funding on behalf of MPI ensures excellent coordination of New Zealand research with international efforts.

Highlights this year include my appointment to the Interim Climate Change Committee and Andy Reisinger's role as an Inquiry Director for the Committee's Secretariat. We completed a comprehensive piece of work for the Government's Biological Emissions Reference Group summarising what farmers can do now to reduce emissions.

Our original contract was to end on 30 June 2019. A one-year extension agreed with MPI will allow the NZAGRC to continue in its current form and level of funding to June 2020. We are working with Government and industry to develop priority research and technology actions for the next decade.

MAKING PROGRESS TOWARDS SOLUTIONS

Identifying mitigation solutions is a key component of the New Zealand Agricultural Greenhouse Gas Research Centre's Vision and Mission. The complexity of the problem means that it is a long-term goal.

Successfully reducing greenhouse gas emissions below a historical baseline will require progress in both direct and indirect mitigation options. Direct mitigations are those solutions that reduce absolute emissions per unit of substrate (e.g. feed, nitrogen). Indirect mitigations are those that arise as a result of general improvements in the efficiency of production (e.g. by improved animal genetics and feeding practices which will reduce emissions per unit of product but may increase absolute emissions per animal).

It is important that the new knowledge developed in NZAGRC funded/co-funded research programmes has a practical impact on the greenhouse gas emissions emitted from New Zealand agriculture.

The table below highlights some key outputs from 2017/18 and their envisaged impacts.

SCIENCE OUTPUT	EXPECTED IMPACT
The sheep breeding work has found: • Differences in methane emissions between sheep selection lines continue to persist with continued breeding. • The low methane sheep appear leaner. Prediction using molecular breeding values appears to be sufficiently accurate that, given a well-chosen training population, predictions could be made available to breeders. • Breeding sheep for low methane will neither increase nor decrease nitrogen excreta-related GHG emissions. • Some parts of the rumen microbial communities have been identified that appear predictive of methane yield. • Higher economic value in favour of the low lines appears to be an on-going trend.	Direct breeding for low emissions and selection via genomic markers or rumen microbial community analysis has the potential to reduce emissions from the sheep sector by up to 1% pa. The indication of leaner low emitting lines could be important for milk composition and for early life nutrition. B+LNZ Genetics Ltd are now testing the impact of the low emitting trait with elite breeders. This work is jointly funded by the NZAGRC and PGgRc.
Plantain appears to have a direct effect on nitrous oxide emissions. Results from detailed cattle studies show that at equal total nitrogen intake the quantity of urinary nitrogen excreted declines as the proportion of plantain in the diet increases above 15%. Preliminary results suggest that the lower nitrous oxide emission factors recorded with increasing proportions of plantain in the sward is most likely due to an effect of plantain itself on soil processes. An initial cattle trial suggest that plantain may also reduce methane emissions, but this result needs further investigation.	There is a growing weight of evidence from individuals that plantain can have a positive impact on nitrogen processes in animals and soils. The challenge now will be to integrate plantain into farming systems.
Analysis has shown that mid-infrared (MIR) spectroscopy can be used to identify the soil carbon stabilisation capacity and saturation deficit of different New Zealand grassland soils.	This technique may allow soil carbon measurements to be made from whole soil samples more quickly and more cost-effectively.
A study of the effects on soil carbon from high levels of supplementary feeding on a dairy farm showed that 13% of the imported carbon was stored as additional soil carbon during the three years of the study. Once soil carbon losses from growing these supplementary feeds using current practices is taken into account, the net impact on soil carbon may be minor.	Net carbon changes arising from supplementary feeding (e.g. maize) on dairy farms using existing management practices may be minor.
Successful demonstration that the urine from sheep consuming a novel compound delivered through a slow release device reduced nitrous oxide emissions in a controlled laboratory study.	Work is at an initial stage and more comprehensive trials are being planned.
Modelling farm system change on multi-enterprise Māori farming entities resulted in +/- 5-10% changes in GHG emissions, similar to previous modelling work. Land use change into forestry or horticulture had a much higher impact.	Mixing and matching the farm system and land use change at the whole business level has the potential to significantly reduce GHG emissions, while maintaining or enhancing business profitability.

METHANE RESEARCH PROGRAMME

PRINCIPAL INVESTIGATORS: DR PETER JANSSEN AND DR GRAEME ATTWOOD

The NZAGRC methane programme is jointly planned and funded in partnership with the PGgRc and aligns with existing MPI programmes funded through SLMACC and New Zealand funding in support of the Global Research Alliance on agricultural greenhouse gases. It aims to reduce emissions by directly targeting the methane producing methanogens through the discovery of small molecule inhibitors and vaccines and indirectly through feeding and changes in animal phenotype. The current objectives within the NZAGRC methane programme have made significant progress this year, with the sheep breeding programme getting closer to delivering breeding values to the national flock.

SHEEP BREEDING FOR LOW METHANE

The sheep breeding programme in 2017/2018 continued to build on developments from earlier years. High/low sheep lines continue to diverge and are currently on average 10% different for methane yield. The lines continue to segregate on maternal breeding worth with the low line favourable by ~$10 gross margin per mated ewe. However, breed proportion may play some role in the observed differences in maternal breeding worth so validation in other flocks with greater genetic diversity is required.

A trial with low and high methane yield selection line sheep fed cut pasture indicated consistent differences in methane per unit of intake across all four seasons, and excreted nitrogen was similar in two seasons, suggesting that breeding sheep for low methane will neither increase nor decrease excreta greenhouse gas emissions.

RUMEN MICROBES A POSSIBILITY FOR SHEEP SELECTION

Analyses of rumen microbial communities in ewe lambs measured multiple times on cut pasture and lucerne pellets suggest that rumen microbial community composition has the potential to be used to rank animals for prediction of methane.

LOW METHANE TRAIT LOOKS POSITIVE FOR MEAT AND MILK

Preliminary analysis showed that there are differences between the lines in fat and lean proportions of carcass. Additional detailed meat quality measures on a subset of ram lambs show that the low methane animals had no difference in intra-muscular fat and significantly higher branched chain fatty acids. This has potential positive implications not only for meat quality but also for milk quality and even for subsequent lamb growth in low emitting sheep.

Breeding values were estimated for PAC traits using both pedigree (eBV) and molecular or genomic information (mBV). A module to automate estimation of breeding values for the national flock has been developed in collaboration with Beef + Lamb New Zealand Genetics (B+LNZG).

IMPORTANT FINDING IN SHEEP VACCINATION TRIALS

During 2017/18, a sheep vaccination trial, including measurement of methane emissions, was conducted and all vaccinated animals produced antibodies against each of the 19 protein/protein fusions present in the mix of recombinant proteins. This is an important finding as anti-methanogen vaccines are very likely to contain multiple antigens.

The issues that arose with assay repeatability in the vaccine programme in 2016/17 have been addressed over the past year. The methanogen growth assay has been refined in order to ensure reliable testing of antibodies against candidate vaccine targets. New auxiliary assays (ELISA, Western blotting, flow cytometry) for measuring 'effectiveness' of antibodies produced against specific targets have been developed.

FEASIBILITY STUDY FOR METHANE CAPTURE

A feasibility study of a novel mechanism for capturing and breaking down methane was completed at the start of 2017/18. The aim of this study was to test the practicality of capturing methane emitted from housed cattle and stored animal waste, and injecting it in the soil for oxidation by methanotrophs.

Laboratory column studies showed the soils did not prime adequately to make removal of methane from housed animals practicable. NZAGRC funding is not continuing in this area.

INHIBITORS

NZAGRC involvement in the inhibitor programme did not continue in 2017/18. It is now solely funded by the PGgRc as the lead commercialising partner.

PLANTS AND GHGS RESEARCH PROGRAMME

PRINCIPAL INVESTIGATORS: DR CECILE DE KLEIN, PROFESSOR HONG DI, DR DAVID WHITEHEAD AND PROFESSOR LOUIS SCHIPPER

NZAGRC's former nitrous oxide and soil carbon work streams were combined into one programme this year. This ensures a strong overall framework, closer communication and full GHG analyses across the programme. The programme focusses on three key areas:

1. Identifying and prioritising plant traits for low GHG emissions;

2. Mitigation practices to maintain soil carbon and reduce nitrous oxide emissions at paddock scale; and

3. Defining the achievable soil carbon stabilisation capacity of New Zealand grassland soils.

INVESTIGATING PLANTAIN PROPERTIES

An animal feeding trial conducted in association with the Forages for Reduced Nitrate Leaching programme, investigating the ability of plantain to modify nitrogen processes in animals and soils, was a major focus this year. The aim was to assess the impact of increasing proportions of plantain in the diet on methane yield, nitrogen excretion in urine and dung, and nitrous oxide emissions. Preliminary findings include:

- a reduction in urinary nitrous oxide concentration with increasing proportions of plantain and associated reductions in nitrous oxide emissions from urine patches.

- differences in methane per kilogram of dry matter intake between the treatment groups. However, methane emissions were unusually high for the control group so these data need careful interpretation.

- nitrous oxide emission factors reduced with increasing proportions of plantain in the sward, most likely due to an effect of plantain plants on soil processes.

To further study the effects of plantain, a sward containing 60% plantain has been established at a Waikato farm. Carbon balances and nitrous oxide emissions have been continuously measured in comparison to a ryegrass/clover sward. Experiments have commenced to compare results to traditional chamber measurements at the plot scale.

IMPACT OF IMPORTING FEED

Parallel work at a nearby farm calculated carbon balances for three years for a farm with very high feed imports (about 12 tonnes dry matter or 5.3 tonnes of carbon per hectare, per year). The majority of the imported feed was converted back to carbon dioxide by cow respiration and decomposition of dung. Some of the imported carbon was also exported in increased milk production. Carbon balance measurements over maize are continuing at the site so that the carbon balance of feed production and importation can be completed.

POSITIVE RESULTS FOR NOVEL NITROUS OXIDE INHIBITOR

An initial study to determine the impact of a novel inhibitor was conducted in 2017/18. After 36 days urine from treated animals had 50% lower nitrous oxide emissions than untreated animals. This work will be expanded in 2018/19.

IRRIGATION EFFECTS MODELLED

The CenW model developed for Waikato farms was compared against three years of eddy-covariance data from an irrigated grazed pasture in the Canterbury region. CenW was used to compare three irrigation management scenarios: no irrigation (dairy grazed), real life irrigation (dairy grazed), and sheep grazing (no irrigation or fertiliser). This initial modelling demonstrated that carbon accumulation was maximised with about 1100mm of combined rainfall and irrigation.

DETERMINING LEVELS OF SOIL CARBON STORAGE

An experiment was designed and conducted using a novel 13C stable isotope method to determine how the stabilisation capacity and saturation deficit of different soils affects their ability to store more carbon. Research was also completed describing a rapid, non-destructive method based on mid-infrared (MIR) spectroscopy to identify the soil carbon stabilisation capacity and saturation deficit of different New Zealand grassland soils.

INTEGRATED FARM SYSTEMS RESEARCH PROGRAMME

PRINCIPAL INVESTIGATOR: DR ROBYN DYNES

During 2017/18 new work plans have been developed for both the sheep and beef and dairy components of the Integrated Farm Systems research programme out to mid 2019. These have been co-developed with significant input from Beef + Lamb New Zealand (B+LNZ) and DairyNZ respectively to ensure alignment with relevant industry investment, initiatives and extension programmes. Work is now underway on the research outlined below.

SHEEP AND BEEF

The sheep and beef part of the programme is designed to provide new insights into GHG emissions from the sheep and beef sector by assessing the drivers of emissions for at least 100 real sheep and beef farms, representing all 8 B+LNZ farm classes, to identify characteristics for reducing GHG outputs. The data set generated will be relevant to all sheep and beef farmers and will be used to develop a diversity of recommendations and pathways for the sector that are beyond 'averages'.

Data and analysis from this programme will be used to enable sheep and beef farmers to understand which mitigation approaches are most effective across a range of farm classes. Individual farmers will be able to identify with one or more of the modelled real farms to see how they got from A to B with their GHG emissions and use these strategies to develop their own pathway to a lower emissions future.

The new programme is also extending the work to date on two existing monitor farms – Highlands and Onetai Station. Aspirational mitigation options will be investigated (e.g. GHG at a collective level, carbon-neutral, integrated catchment management).

DAIRY

The dairy part of the programme involves the design of a cohesive and targeted communications and extension programme that provides the dairy industry with the information required to begin addressing its GHG emissions. The programme will build off and interlink with existing industry and Government initiatives, such as the Dairy Industry Action for Climate Change (DACC), a partnership between DairyNZ and Fonterra and supported by MfE and MPI, launched in mid-2017.

The NZAGRC has the capacity to build off the DACC and other existing initiatives and extension networks and provide dairy farmers, rural professionals and the wider dairy industry with a more comprehensive set of targeted resources to address GHG emissions. Building awareness, knowledge and confidence will position the industry well to respond to new policies being developed.

Results from previously-funded integrated farm systems research has been widely presented and reported in the rural media over the past year.

MĀORI-FOCUSSED RESEARCH PROGRAMME

PROGRAMME LEADERS: PHIL JOURNEAUX AND DR TANIRA KINGI

This project aims to improve the capacity of Māori farmers to improve their efficiency and productivity while lowering greenhouse gas emissions. Two Māori agri-business entities involving dairy, sheep and beef, forestry and horticulture are having their GHG emissions modelled including looking at how these emissions and profitability can be balanced at a business level.

In addition, the project investigates decision-making criteria and issues around introducing new GHG mitigation strategies and analyses any barriers to the uptake of such strategies.

HIGHLIGHTS

During 2017/18 the project has:

- Identified two multi-enterprise Māori operations, incorporating dairy, sheep and beef and forestry operations, willing to allow modelling of farm system and land use change to identify impacts of reducing GHG emissions.

- Following discussions with the trustees of the enterprises, carried out a range of modelling involving a range of farm system changes on both the dairy and sheep and beef farms, incorporating improving productivity measures as well as changes in stocking rate and animal production levels.

- Modelling has also incorporated change in land use, particularly increases in forestry development, as well as possible horticulture enterprises, and change in pastoral land uses, e.g. finishing deer, and dairy sheep.

The results of the modelling reinforced previous work that shows changes in farm systems generally have a limited impact on reducing GHG emissions (+/-5-10%) and a variable impact on farm profitability - some reduced farm profitability but those that concentrated on lifting animal performance often resulted in an improvement in farm profitability.

LARGE IMPACT OF LAND USE CHANGE

The largest impact on reducing GHG emissions was achieved via land use change into forestry. Both enterprises had targeted increased areas of forestry planting on their sheep & beef farms. Both enterprises also have an issue in that they have large areas of pre-1990 production forest, which cannot be claimed as an offset.

The horticultural enterprise considered (chestnuts) had a negative impact on GHG emissions and a positive inpact on profit levels, albeit restricted to the relatively-small size of the proposed plantings; 10 and 40ha respectively.

SIGNIFICANT REDUCTIONS IN GHG EMISSIONS POSSIBLE

Part of the aim of the project is to consider the impact of any changes at a whole enterprise level. Mixing and matching the various scenarios modelled indicates that significant gains in reducing GHG emissions (largely due to land use change) and some improvement in profitability is possible at the whole enterprise level. There is some variation however and no "magic bullet" answer.

RESEARCH TO SUPPORT POLICY

NZAGRC staff and researchers have completed a number of pieces of work to help provide scientific evidence to support policy development.

FUTURE EMISSIONS TRENDS AND MITIGATION OPTIONS

The NZAGRC made significant contributions to the work of the Government's Biological Emissions Reference Group (BERG) including reports on current and future options for reducing New Zealand farm emissions.

The Parliamentary Commissioner for the Environment (PCE), Simon Upton, commissioned the NZAGRC Deputy Director to write a special report to clarify the role of livestock-derived methane on global warming.

NZAGRC staff also provided advice for two other reports discussing options to reduce agricultural greenhouse gas emissions:

- The Productivity Commission's 2018 report on how New Zealand could transition to a low-emissions economy.
- A 2018 report by Professor Sir Peter Gluckman, the former Prime Minister's Chief Science Advisor, on mitigating agricultural greenhouse gas emissions.

OVERSEER® ALGORITHMS CHECKED AND NEXT STEPS AGREED

During 2017/18 an NZAGRC-funded project reviewed the GHG algorithms in the OVERSEER® nutrient budget model. This model has been recommended as the tool of choice for on-farm reporting of methane and nitrous oxide emissions. However, on-farm GHG reporting is reliant on full confidence in the GHG estimates being produced by the model.

The current algorithms and approaches for estimating on-farm methane and nitrous oxide emissions in OVERSEER® have been evaluated and the existing code has been systematically checked.

Recommendations from the project team have been documented and reported to a MPI/OVERSEER®/NZAGRC steering group. The objective leader met twice with the steering group during 2017/18 to discuss issues relating to GHG estimates, project progress and agree on next steps.

A meeting is planned for early 2018/19 to agree on the steps to address the recommendations of this project.

NZAGRC INTERNATIONAL DIMENSIONS

The New Zealand Government started the Global Research Alliance on Agricultural Greenhouse Gases (GRA) in 2009 to increase international cooperation and investment in agricultural research that mitigates the effect of greenhouse gas emissions. Nearly a decade on, 50 countries and 16 international and regional partners are now working together in the pursuit of this goal. It remains a key plank in New Zealand's work on climate change and agriculture, offering significant opportunities to build global research and commercial partnerships and strengthen domestic capability.

NZAGRC continues to co-chair the GRA's Livestock Research Group and providing strategic advice and support to MPI (which administers the GRA Secretariat and the Government's dedicated multi-million GRA budget). NZAGRC works closely with key GRA partners such as the Food and Agriculture Organization of the United Nations, the World Bank and CCAFS (the CGIAR's Research Program on Climate Change, Agriculture and Food Security) to deliver international and regional projects on behalf of the GRA and to raise awareness of the opportunities associated with low emissions livestock production.

NZAGRC led or supported a wide range of GRA activities during 2017/18 as well as continuing to negotiate and manage GRA research contracts on behalf of MPI. NZAGRC's GRA work involves five Centre staff along with external contractors. A dedicated GRA post-doctoral position will be created at the start of 2018/19 to engage with outreach work taking place in Africa.

NZAGRC organised and co-chaired the annual meeting of the LRG in mid-May 2018 in Ho Chi Minh City, Vietnam, involving representatives from 26 countries discussing research to reduce livestock greenhouse gas emissions. This included opportunities to inform the work of the Intergovernmental Panel on Climate Change (IPCC) and the UN climate change negotiations, which is establishing a work programme on agriculture.

The NZAGRC continues its active contribution of New Zealand specific expertise to the work of the Intergovernmental Panel for Climate Change (IPCC) including Bureau representation, the European FACCE-JPI and Horizon 2020 committees, and as a research partner for the international soil carbon research project, CIRCASA.

KEY ACHIEVEMENTS IN 2017/18 INCLUDE:

- A new research partnership opportunity through the GRA Council's establishment of flagship programmes on enteric fermentation, GHG inventories and soil carbon. NZAGRC's leadership of the enteric fermentation flagship has resulted in the establishment of two major global projects during 2017/18 – both involving New Zealand providers

- 23 contracts signed in support of the MPI's collaborative research investment opportunities

- Successful bid submitted in partnership with the Food and Agricultural Organization of the United Nations (FAO) to the Climate and Clean Air Coalition for work in Asia, East Africa and Latin America

- 10 GRA-funded projects completed with highlights including research into deep sequencing the rumen microbiome, using naturally-produced lovastatin to reduce methane emissions, researching whether animals selected for reduced feed intake produce less methane, and identifying new nitrification inhibitors

- Publication of the Hungate1000 report in Nature Biotechnology

- Working with CCAFS to develop much-needed resources for countries to use in strengthening their national greenhouse gas inventories for livestock emissions

- Working with FAO, drawing on CCAC funding, to deliver the second phase of a multi-country project on reducing enteric methane for food security and livelihoods

- Launching a major project with Indonesia to develop and implement a Tier 2 inventory for the beef sector

- Outreach in Africa to better understand countries' needs regarding MRV of livestock greenhouse gas emissions

NZAGRC GOVERNANCE

The NZAGRC is set up as a unit operating within AgResearch. The Board and Chief Executive (CEO) of AgResearch have ultimate responsibility for the NZAGRC. However, a Steering Group (SG) comprising a representative of each NZAGRC member provides advice and recommendations to the AgResearch CEO and Board on the operation of the NZAGRC. The NZAGRC Director reports to the AgResearch CEO and Board via the NZAGRC's Steering Group.

An International Science Advisory Group (ISAG) is convened regularly to monitor, advise and report on the NZAGRC's science quality and direction to the SG and NZAGRC Director as required. Input from PGgRc Board members via the SG provides guidance in relation to the needs of the industries that are intended to take up its research outcomes. The advisory roles of the ISAG and PGgRc Board are primarily in the areas of science quality, research direction and industry relevance.

A Māori Advisory Group (MAG) was established in 2011/12 to ensure that the research and development undertaken by the NZAGRC is relevant and accessible to all sectors of New Zealand society.
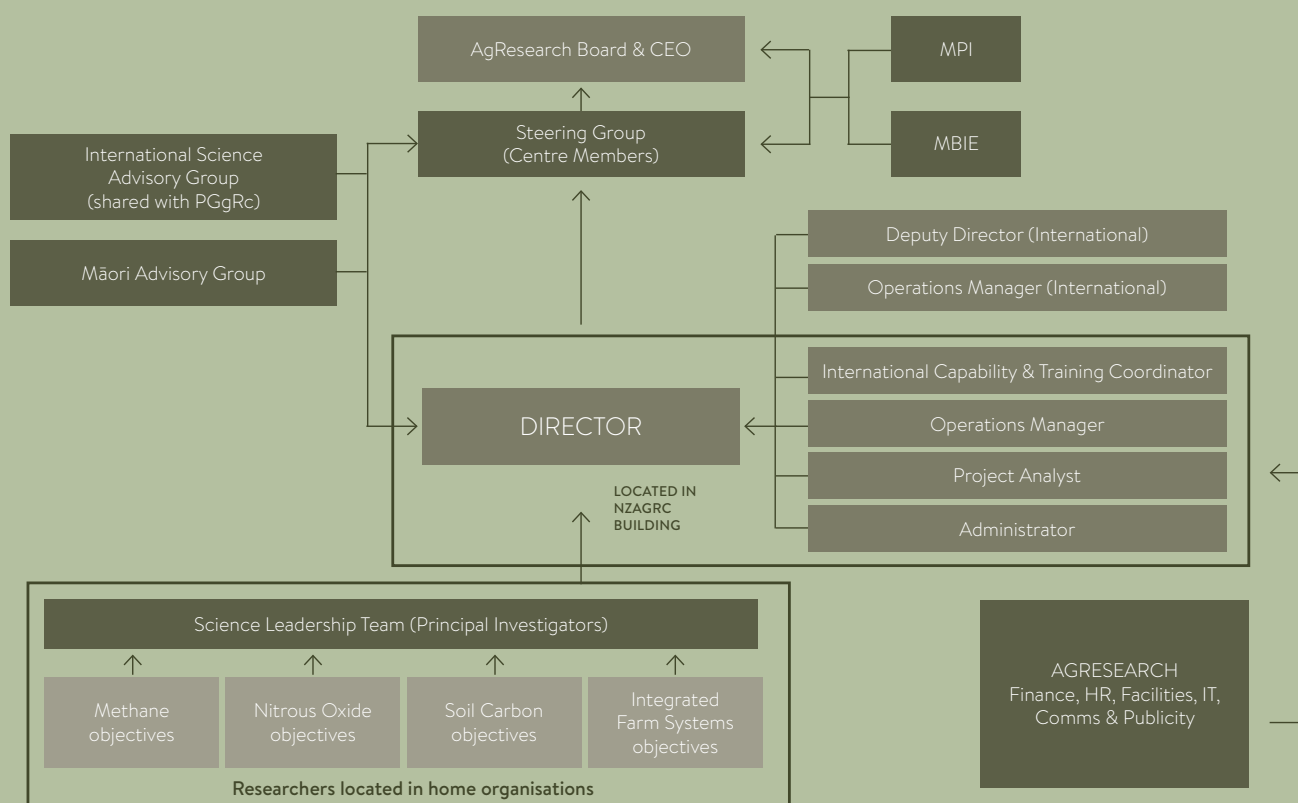
NZAGRC STAFF

NZAGRC STAFF

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Director

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Administrator

Trina Bishop (from Mar 2018)

Administrator

STEERING GROUP REPRESENTATIVES

Dr Greg Murison

Research Director

Dr David Burger

Strategy and Investment
Leader for Responsible Dairy

Dr Peter Millard (Chair)

General Manager Science

Kevin Hurren

Director, Research
Management Office

Prof Mike Hedley / Prof Peter Kemp

Professor Soil and Earth Sciences /
Head of School of Agriculture and
Environment

Dr Sam Dean

Chief Scientist - Climate,
Atmosphere and Hazards

Mark Aspin

Consortium Manager

Warrick Nelson

Operations Manager -
Sustainable Production

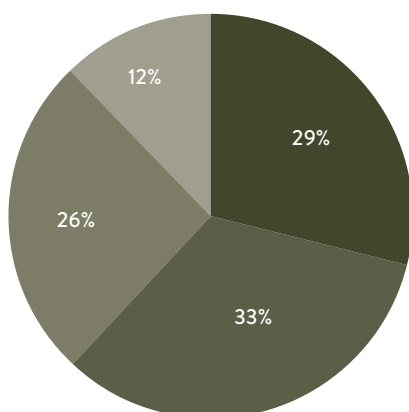**Prof Tim Payn / Dr Steve Wakelin**

Principal Scientist, Sustainable Forest
Management / Research Leader,
Forest Systems Ecology

FINANCES AND PERFORMANCE

Total funding for the Centre in 2017/18 was $5.25m (including carry over from 2016/17). This covers core research programmes, other research (including fellowships and short-term projects) and administration.

In addition to the investment made in science, funding has also been used to contribute to governmental policy projects and the implementation of a communications outreach plan.

NZAGRC CORE RESEARCH FUNDING SPLIT 2017/18

- ■ Methane
- ■ Nitrous Oxide
- ■ Soil Carbon
- ■ Integrated Farm Systems and Māori

12%
29%
26%
33%
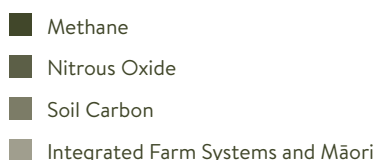
CAPABILITY DEVELOPMENT
(ACTIVE IN 2017/18)

INTERACTIONS AND OUTPUTS 2017/18

104 — MEETINGS AND PRESENTATIONS (NEW ZEALAND)

42 — OTHER INTERACTIONS/ PUBLICATIONS

30 — CONFERENCE PRESENTATIONS

26 — GLOBAL RESEARCH ALLIANCE RELATED INTERACTIONS

21 — MEDIA INTERACTIONS

15 — MEETINGS AND PRESENTATIONS (INTERNATIONAL)
JOURNAL ARTICLES IN PRESS

12 — JOURNAL ARTICLES PUBLISHED

11 — INTERNATIONAL VISITORS AND GROUPS

PHDS — **10**

POST-DOCTORAL FELLOWS — **04**

MASTERS — **03**

UNDERGRADUATE INTERN — **02**

UNDERGRADUATE SUMMER STUDENTS
UNDERGRADUATE HONOURS STUDENTS — **01**

**The NZAGRC has five Key Performance Indicators (KPIs) relating to its work for 2016-2019.
Below is the progress toward meeting these and our specific goals as at 30 June 2018.**

KPI 1: Advance knowledge and understanding

To be the most important and trusted NZ source of scientific knowledge in the field of agricultural GHG emissions mitigation

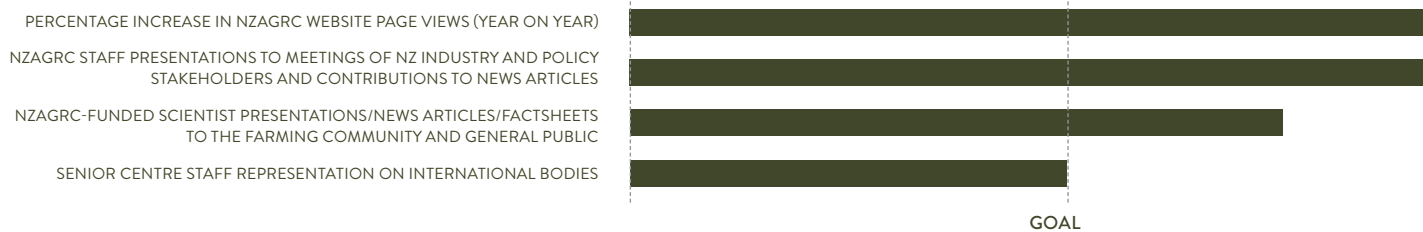|	
PEER-REVIEWED SCIENTIFIC JOURNAL PAPERS PUBLISHED	
SCIENTIFIC CONFERENCE PAPERS PUBLISHED AND PRESENTED	
VALUABLE PIECES OF IP PRODUCED OR CONTRIBUTED TO	
ON-FARM MITIGATION PRACTICES AND TECHNOLOGIES IDENTIFIED	

GOAL

KPI 2: Enhance awareness among stakeholders

To be the most important and trusted source of information for New Zealand agricultural stakeholders on agricultural GHG emission mitigation

PERCENTAGE INCREASE IN NZAGRC WEBSITE PAGE VIEWS (YEAR ON YEAR)	
NZAGRC STAFF PRESENTATIONS TO MEETINGS OF NZ INDUSTRY AND POLICY STAKEHOLDERS AND CONTRIBUTIONS TO NEWS ARTICLES	
NZAGRC-FUNDED SCIENTIST PRESENTATIONS/NEWS ARTICLES/FACTSHEETS TO THE FARMING COMMUNITY AND GENERAL PUBLIC	
SENIOR CENTRE STAFF REPRESENTATION ON INTERNATIONAL BODIES	

GOAL
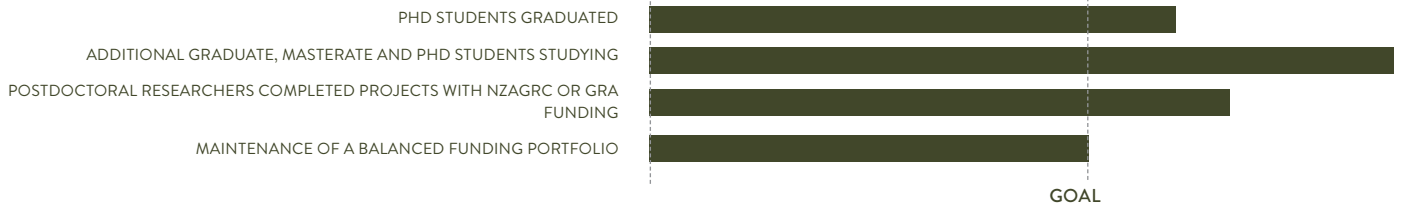
KPI 3: Contribute to policy

To be the authoritative source of information for the New Zealand government on agricultural GHG emission mitigation

NZAGRC STAFF PRESENTATIONS TO MEETINGS OF NZ GOVT POLICY STAFF AND MINISTERS	
ADHERENCE TO MPI REQUESTS FOR NZAGRC WRITTEN REPORTS PREPARED FOR GOVT POLICY STAFF	

GOAL

KPI 4: Develop science capability

To be a major source of new capability in the field of agricultural GHG emission mitigation

PHD STUDENTS GRADUATED	
ADDITIONAL GRADUATE, MASTERATE AND PHD STUDENTS STUDYING	
POSTDOCTORAL RESEARCHERS COMPLETED PROJECTS WITH NZAGRC OR GRA FUNDING	
MAINTENANCE OF A BALANCED FUNDING PORTFOLIO	

GOAL

KPI 5: Develop science and commercial partnerships

To be a key player in many research and commercial partnerships relating to agricultural GHG emission mitigation

GRA-RELATED ACTIVITIES INCL. ATTENDANCE AT INTERNATIONAL MEETINGS AND CONFERENCES, TRAINING AND DEVELOPMENT AND COLLABORATION WITH OTHER RESEARCH FUNDS	
VISITING SCIENTISTS FROM OVERSEAS RESEARCH ORGANISATIONS HOSTED	
NEW RESEARCH COLLABORATIONS AGREED WITH RESEARCH ORGANISATIONS, PROGRAMMES AND CENTRES, BOTH NATIONALLY AND INTERNATIONALLY	

GOAL

NEW ZEALAND
AGRICULTURAL GREENHOUSE GAS
Research Centre

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