NEW ZEALAND
AGRICULTURAL GREENHOUSE GAS
Research Centre

HIGHLIGHTS 2019

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.

A full list of acronyms used in NZAGRC publications can be found on the back page of this publication

The 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 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, capacity building and leads New Zealand science input into international activities and policy processes in the agricultural GHG area. 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.

About NZ$48.5 million was invested by the NZAGRC into research and development activities over the ten years to 2019. An extension of funding to 2020 has been agreed and discussions are underway for a further extension out to June 2025.

NEW ZEALAND AGRICULTURAL GREENHOUSE GAS RESEARCH CENTRE PGgRc WORKING TOGETHER

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

Ministry for Primary Industries Manatū Ahu Matua

New Zealand Government

OUR GOALS

ADVANCE KNOWLEDGE AND UNDERSTANDING

- 10 papers published plus 12 papers submitted
- 54 scientific conference papers
- Demonstration that differences in methane emissions between sheep selection lines continue to persist and diverge
- Successful demonstration that a novel compound reduced nitrous oxide emissions in a controlled laboratory study
- Balanced funding portfolio for research programmes across methane, nitrous oxide, soil carbon and integrated farm systems – proportion of science spending methane 29%, nitrous oxide 33%, soil carbon 26%, integrated farm systems 12%

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 transfers
- 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
- Contribution to substantial farmers' outreach programme being rolled out by MPI
- Organised successful New Zealand Agricultural Climate Change Conference with record attendance

CONTRIBUTE TO POLICY

- Centre's relationship with MPI and other Government departments continues to grow and strengthen
- Ongoing inputs into the GRA and other international initiatives
- Input of Director Harry Clark as part of the Interim Climate Change Committee
- National and international advisory roles including to the Parliamentary Commissioner for the Environment and Prime Minister's Chief Science Advisor's offices

DEVELOP SCIENCE CAPABILITY

- 6 PhD students graduated
- 3 undergraduate, 3 masters and 4 PhD students currently studying under NZAGRC funding
- 2 active NZAGRC-funded post-doctoral researchers under NZAGRC or GRA funding
- 5 active GRA-funded post-doctoral researchers

DEVELOP SCIENCE AND COMMERCIAL PARTNERSHIPS

- Leadership of science input into Global Research Alliance and coordination of Livestock Research Group with the Netherlands
- Developed several new flagship international research projects involving substantial leadership or input from New Zealand scientists on feed and nutrition, soil carbon and animal breeding
- Organised three major GRA engagement workshops in the Africa region in partnership with the World Bank, FAO and CGIAR's Climate Change, Agriculture and Food Security programme (CCAFS)
- Worked with CCAFS to develop and launch www.agMRV.org – a platform providing open access to information, tools and resources for improving the measurement, reporting and verification (MRV) of agricultural greenhouse gas emissions
- Supported Kenya, China and Indonesia to progress towards more advanced national greenhouse gas inventory systems for livestock emissions
- 4 exchanges funded by LEARN/GRASS Fellowships

OUR RESEARCH PROGRAMMES

MITIGATING METHANE EMISSIONS *(Joint programme with the PGgRc)*

- Reducing emissions through 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 C stabilisation capacity of New Zealand grassland soils

INTEGRATED FARM SYSTEMS

- Identifying profitable, practical and low-GHG emission 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

- Ensuring 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

The past year has seen a major milestone achieved by the Centre with our work being endorsed by an independent review panel, who strongly support the need for the research conducted by NZAGRC to continue and to expand significantly.

The major findings were that the Centre has built a high-quality international profile, fulfilling its brief. The review stated that the Centre is a scientific success and recommended that future thinking must ensure that science excellence and leadership is supported and maintained.

The panel recommended that the governance and advisory panels should be reconsidered to ensure that the NZAGRC has an effective, complete pipeline through to uptake and adoption for the national and global good, and commercialisation, with continued industry engagement and co-funding.

We await decisions on that future structure and the means through which resources will be channelled. In the meantime, some certainty has been achieved for the immediate future with the agreement for MPI to provide extended funding and additional funding also being provided by MBIE. The Centre's previous contract expired in June 2019 and an extension of this to 2020 has already been agreed and discussions are underway for a further extension out to June 2025.

This comes at a time when climate change policy is being recognised as a hugely important issue both internationally and domestically.

Domestically, the Interim Climate Change Committee (of which our Director, Dr Harry Clark, is a member) has reported its findings and recommendations. The Government is moving forward with the Zero Carbon Bill which will drive New Zealand's climate change policy towards low emissions and climate resilience.

Within this context, the research work conducted by the NZAGRC alongside the joint industry/Government-backed PGgRc, is important in identifying and developing areas of focus that will provide effective and practical results at farm level.

Overall, through its national and international roles and responsibilities, such as its active involvement in the Global Research Alliance, the Centre continued this year to build on its reputation as an important source of clear and unbiased advice on the science behind agricultural greenhouse gases and their mitigation options.

DIRECTOR'S REPORT

Dr Harry Clark
NZAGRC Director

This year was extremely significant for the Centre on two fronts.

I was a member of the Interim Climate Change Committee which was charged with advising the Government on the means by which agriculture might enter the Emissions Trading Scheme.

The release of the committee's report was heralded as breaking new ground. Climate Change Minister James Shaw welcomed the "historic consensus" across the rural sector for farm-level emissions pricing by 2025.

Inherent in that consensus is the knowledge that farmers will need the tools to estimate and mitigate their on-farm emissions. In the longer-term, technological breakthroughs will be needed to allow agricultural emissions to be reduced significantly.

For those reasons, the work we undertake at the Centre is assuming increasing importance. International collaborations and alliances will play an important role as we seek to find lasting global solutions.

The second milestone which occurred during the year was the findings of the review into the Centre's operation since our inception. The panel found the Centre is achieving its goal as an international leader in methane research and contributes significantly in nitrous oxide and soil carbon science globally.

The review praised the quality of research the NZAGRC undertakes in our main programmes (mitigating methane emissions, mitigating nitrous oxide emissions, increasing soil carbon content, integrated farm systems and Māori-focussed research). The Centre has developed a strong research base for future innovation and adoption and practical mitigation options.

The review also found that the Centre could develop wider partnerships as a more integrated research structure is created encompassing science, extension and commercialisation. Stakeholder input into the development of new programmes was recommended, as was a continuing leading role in the Global Research Alliance.

We have already embraced the recommendation to widen our engagement with science ideas and research proposals, supporting innovation and new thinking in greenhouse gas mitigation.

Interest in our work resulted in a highly-successful NZ Agricultural Climate Change Conference being held in Palmerston North in April, followed by a meeting of international scientists to plan future areas of research.

This will be an important contributor as we look forward to expanding our work on mitigation options and to delivering practical solutions for farmers.

METHANE RESEARCH PROGRAMME

PRINCIPAL INVESTIGATORS: DR PETER JANSSEN AND DR GRAEME ATTWOOD

The methane (CH_4) mitigation programme is planned and funded in partnership with the PGgRc and aligns with existing MPI programmes funded through its Sustainable Land Management and Climate Change (SLMACC) Research Programme and New Zealand funding in support of the Global Research Alliance. It aims to reduce methane emissions directly by targeting the methanogens through inhibitors and vaccines and indirectly through diets and changes in animal phenotype.

This year over 1000 methane emission measures were taken through Portable Accumulation Chambers (PAC) from grazing animals. These PAC measures support the provision of genomic breeding values on a national basis. The programme discussed the use of mobile measurement equipment and genotyping with breeders for on-farm selection of low methane animals. We predict that a 1% decrease in methane emissions per year is achievable. The sheep breeding programme is now also ready to make research breeding values for low methane emission available to selected ram breeders.

The breeding programme is unique in the world, and low and high methane-emission sheep, born in 2017, are predicted to differ on average by more than 11% since selection started in 2008. Animals are monitored for growth, reproduction and other performance parameters, and commercial breeding values favour the low line animals. Breeding for low methane also continues to yield interesting physiological changes such as smaller rumens, smaller, more frequent feeding patterns and an increase in lean muscle tissue with a greater content of branched chain fatty acids. There is also indication that low methane animals may need to eat more per kg of growth, but deposit more muscle and less fat.

Detailed analysis of differences in milk, blood plasma and rumen fluid composition between the high and low lines, has been another focus of work. Samples from 153 selection lines of ewes, 4 and 6 weeks post lambing are currently being analysed for detailed milk composition, rumen microbial profiling and fatty acid profiles, to determine whether they might provide proxies for methane emission.

On the vaccine side, three sheep vaccination trials did not reduce methane emissions, which reinforced the need for a better understanding of the factors that may limit the development of a rumen methane vaccine. In response, the methane vaccine programme used new assays for measuring 'effectiveness' of antibodies to answer critical questions about binding of antibodies to methanogens. The results suggest that effective targets for a vaccine will need to protrude out far enough from the cell wall to be accessible for interaction with antibodies. New vaccine antigens that have the potential to be more accessible to antibodies, have now been identified. These are being investigated in laboratory studies to refine them, prior to their application in animal trials.

Since 2017 the PGgRc has solely funded the methane inhibitor programme, advancing promising lead compounds that reduce methane by 20-30 % and that can be delivered to grazing livestock. The PGgRc is also advancing discussions with commercial companies about the potential delivery of the inhibitors to NZ and global farmers.

The results from the sheep breeding programme have also led to the establishment of an NZ Dairy Genetics collaborative working group to develop breeding options for low methane emitting cattle. Based on a review of genetic programmes internationally, it was decided to test the efficacy of using a C-Lock GreenFeed system to identify low emitting phenotypes. The trial is scheduled to start in early 2020.

PLANTS AND GHGS RESEARCH PROGRAMME REPORT

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

Following a review of the NZAGRC nitrous oxide, soil carbon and integrated farm systems programmes, the former nitrous oxide and soil carbon work streams were combined at the start of 2017/18. This ensures a strong overall conceptual framework, closer communication and full GHG analyses across the programme. The programme focuses 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 C stabilisation capacity of New Zealand grassland soils.**

The modelling work to identify and prioritise plant traits for low GHG emissions focussed on: (i) Plant compounds as nitrification inhibitors; (ii) the effect of plant nitrogen concentration on N secretion in dung and urine; (iii) growing deep-rooting plants to build soil C; (iv) frequency and method of pasture renewal; and (v) diuretic effect of plant compounds to affect urine N concentration and distribution of urine patches.

The modelling work estimated that annual nitrous oxide emissions from urine patches could be halved when nitrogen content in the diet reduced from 3.5 to 2.5% nitrogen in dry matter. In addition, the models estimated that increasing pasture renewal frequency increased soil carbon slightly, and that the diuretic effect of plants was most effective at very low stocking rates.

A plantain animal feeding trial was conducted in association with the Forages for Reduced Nitrate Leaching programme, to assess the impact of increasing proportions of plantain in the diet on methane yield and nitrogen excretion in urine and dung. No differences were found in total methane between the treatment groups, although there was a significant and linear reduction in urinary nitrogen *concentration* with increasing proportions of plantain.

Field trials conducted in Otago and Canterbury found that reduction in urinary nitrogen concentration due to increasing plantain content in the diet resulted in reduced associated nitrous oxide emissions. In Otago, there was a clear 'sward' effect with nitrous oxide emission linearly reducing with increasing plantain content. Conversely, in Canterbury, there was no significant effect, possibly because the free-draining soil led to rapid leaching of mineral-nitrogen out of the surface layer.

In respect of soil carbon, our findings provide independent evidence that the stabilisation of new carbon inputs rises with increasing saturation deficit and that soils with high mineral surface area are more effective at protecting carbon from loss.

Research demonstrating the importance of soil organic matter stratification and saturation deficit to soil organic carbon sequestration following pasture renewal will help provide national estimates of how much carbon could potentially be sequestered in New Zealand soils using new pasture renewal practices.

As indicated above, plantain is considered to decrease nitrous oxide emissions from pasture soils but integrating plantain into an existing ryegrass/clover sward could result in carbon losses and increased nitrous oxide emissions during establishment. A very short establishment phase (12 days) reduced carbon losses compared to several previous studies. The same trials also showed that losses of soil carbon could be reduced by modifying irrigation frequency.

Modelling of a land-use change from non-irrigated sheep grazing to irrigated dairy grazing resulted in a long-term increase in soil carbon stock and an increase in animal production.

Following the identification of the metabolites excreted in the urine of animals dosed with potential long-lasting nitrous oxide inhibitors, three nitrous oxide treatments were selected for a field experiment by Manaaki Whenua. These treatments have been sprayed onto the field site and nitrous oxide measurements are in progress.

INTEGRATED FARM SYSTEMS RESEARCH PROGRAMME

PRINCIPAL INVESTIGATORS: DR ROBYN DYNES AND DR KATHRYN HUTCHINSON

During 2018/19 the dairy programme has been a collaboration with DairyNZ and Reputation Matters (Liz Read) to develop a framework for a behaviour change programme. The sheep and beef programme has been co-developed with Beef + Lamb New Zealand (B+LNZ). These collaborations ensure alignment with relevant industry investment, initiatives and extension programmes.

A highlight of the year has been the way work in each of the work programmes has been closely followed by both Government and industry. Three briefings were given to MPI who actively wanted to see the work in progress because it was so relevant to their work. Liz Read also briefed a number of senior MPI and MfE leadership teams.

MPI staff were subsequently briefed to use the programme to inform their own planning and DairyNZ was able to use the work to demonstrate to the Minister of Primary Industries that the industry not only had its DACC activities underway but also this behaviour change programme under development, to inform future work and extension programmes.

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 GHG emissions for all eight Beef + Lamb New Zealand (B+LNZ) farm classes. The focus of the research this year has been on building a database of validated farm data, and the ongoing analysis is now based on confidential B+LNZ Economic Service data.

Data and analysis from this programme will be used for development of extension material/processes that enable sheep and beef farmers to understand which mitigation approaches are most effective across a range of farm classes.

Aspirational mitigation options (e.g. GHG at a collective level, carbon-neutral, integrated catchment management) are being investigated at the Highlands and Onetai Stations, and a farmer field day at Highlands considered GHG emissions and mitigation in the farm systems context . The next Onetai environment field day will be run in 2019/20.

Within the context of farmers making decisions with multiple economic, environmental and social drivers, a ‘behaviour change’ programme was developed in partnership with Liz Read (Reputation Matters) and experts from across AgResearch and DairyNZ. It builds on existing industry and Government initiatives, including Dairy Industry Action for Climate Change (DACC), DairyNZ’s Climate Change Ambassador programme. In early 2019 links with the NZAGRC-led SLMACC investment in GHG resources were established, to ensure complementary resource development.

Building on the Dairy Action for Climate Change (DACC) rural professionals (2017) and farmer (2018) workshops, the behaviour pilot presentations were made to target farmers (Māori) and to farmers/rural professionals (SIDE conference 2019). The behaviour change programme has already had significant uptake in Government and industry, with briefings to MPI staff from across multiple programmes and it being utilised in a scoping project (Project X) being undertaken by DairyNZ.

MĀORI-FOCUSSED RESEARCH PROGRAMME

PROGRAMME LEADERS: PHIL JOURNEAUX AND DR TANIRA KINGI

This programme aims to assist the Māori pastoral sector to improve its collective capacity to increase resource efficiency and farm productivity while lowering greenhouse gas (GHG) emissions.

During 2018/19 the project produced, in conjunction with industry partners, an information brochure for farmers and rural professionals: *Mitigation and cost of on-farm Greenhouse Gas Emissions*. In addition, the governance of both partner Māori Agri Business entities were interviewed as to their decision-making and likelihood of adopting GHG mitigation strategies. The project also worked closely with industry bodies to assist in information flow and understanding of project outcomes, and assisted in the development of a pilot one-day training session on climate change issues, for rural professionals.

Field days were organised on both Māori Agri Business entities that were attended by 50 and 40 participants, respectively. At the field days, general information was presented around GHG issues as well as the results of the modelling work done.

People were very interested in the mitigation strategies modelled, and the resultant impact on GHG emissions and farm profitability. There was also keen interest in helping identify trade-offs and synergies through the integration of issues such as farm profitability, GHG and nutrient discharge mitigation, and land use change.

There was also a lot of interest in using forestry as a carbon offset, but there were equally concerns at the potential impacts on rural communities from large-scale forestry development. In addition, the current toolbox to identify GHG mitigation options, was perceived to be too limited.

Overall, however, the field days were positive. Attendees want to learn, and appreciated the information provided.

RESEARCH TO SUPPORT POLICY

The comprehensive piece of work completed in the previous year by NZAGRC staff and key researchers, summarising what farmers can do now to reduce emissions, contributed to the report issued by the Government's Biological Emissions Reference Group in late 2018.

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 CH_4 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 an MPI/OVERSEER®/NZAGRC steering group. Work on implementing changes to the OVERSEER code commenced in early 2019.

The Director and Deputy Director of the Centre were closely involved with the Interim Climate Change Committee – the Director as part of the committee and the Deputy Director as a leading member of the secretariat. Their work contributed to the final report of the ICCC to Government in mid-2019. The report will assist the Government in deciding on future policy, including the possible inclusion of agriculture in the Emissions Trading Scheme, and the setting of targets for emissions reductions in order to adhere to the commitments New Zealand has made as part of the Paris Agreement.

During the year, the Centre worked closely with MPI and industry organisations to develop a series of practical resources to help strengthen the primary sector's understanding of climate change and agriculture's contribution. These resources were launched at the beginning of 2019/20, timed to coincide with the Government's release of the ICCC's report, and include:

- Three videos explaining climate change, why methane matters, and what mitigating action can be taken at the farm level
- A new website for farmers, growers and rural professionals to provide the above videos and other information about primary production and climate change
- A series of four science articles in Farmers Weekly by the NZAGRC Director related to the videos and website, published from 22 July 2019
- Development and piloting of a climate change basics seminar for rural professionals

This work was funded by SLMACC and NZAGRC's involvement will continue in the 2019/20 year.

PROGRESS TOWARDS SOLUTIONS – A SNAPSHOT

Identifying mitigation solutions is a key component of the NZAGRC's Vision and Mission. The complexity of the problem means that it is a long-term goal. Successfully reducing GHG 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 and NZAGRC/PGgRc co-funded research programmes contributes to a reduction of GHG emissions from New Zealand agriculture in practice. The table below highlights some key outputs from 2018/19 and their envisaged impacts.

NZAGRC / PGgRc CO-FUNDED	EXPECTED IMPACT
Over 1000 methane emission measures were taken through Portable Accumulation Chambers (PAC) from grazing animals. These PAC measures support the establishment of genomic breeding values on a national basis. Meetings with breeders discussed how they can use PAC to measure sheep on their own farms and in conjunction with genotyping selection for low methane	It may be possible to achieve a 1% lowering in methane emissions per animal generation based on single trait selection
Low and high methane-emitting sheep, born in 2017, have been monitored for growth, reproduction and performance and commercial breeding values	Breeding for low methane continues to yield interesting physiological changes such as smaller rumens, changes in feeding and consumption patterns and increases in lean muscle tissue with a higher content of branched chain fatty acids
Piloting of breeding within the sheep industry and the evaluation of proxies to support a national breeding scheme that can also inform similar future schemes for cattle and deer	Low-emission animals are currently being trialled by elite breeders. This is an important first step towards industry implementation

NZAGRC FUNDED	EXPECTED IMPACT
Animal feeding trials were conducted to assess the impact of increasing percentages of plantain in the diet on methane yield and nitrogen excretion in urine and dung	Increasing percentages of plantain lowered methane yield and nitrogen excretion per unit of dry matter intake (DMI). It is proposed to repeat these feeding trials using methane respiration chambers to confirm the effect of plantain on methane yield
Nitrous oxide field trials were conducted to assess the effect of urine composition and plantain content in the sward on nitrous oxide emissions from urine patches	Reduction of urinary nitrogen concentration due to increasing plantain content in the diet resulted in a reduction of nitrous oxide emissions, and further evidence on plantain's potential role in reducing nitrous oxide emissions needs to be gathered
Plant trait modelling work was completed and assessed the impact of key traits on nitrous oxide emissions	Model outputs suggest that modification of the nitrogen concentration in feed could be a promising mitigation option
Measurement and modelling the effects of pasture renewal on soil carbon stocks	A very short establishment phase (12 days) when including a new plant in the sward (plantain) resulted in very small carbon losses compared to several previous studies
Novel nitrous oxide inhibitor treatments are being tested in a field experiment by Manaaki Whenua and in laboratory trials at AgResearch	One inhibitor has shown potential in both laboratory and field trials. Further studies are needed to confirm this
Development of a 'behaviour change' programme to support farmers wanting to reduce GHG emissions and to provide new insights into the drivers of GHG on-farm	The programme has informed and shaped both industry and Government initiatives, and further analysis of the data collected will be used to develop extension material/processes that enable individual sheep and beef farmers to develop their lower emissions future
Continued to support the Māori pastoral sector to improve its collective capacity to increase efficiency and farm productivity while lowering GHG emissions	The work has increased the awareness of GHG mitigation potential through different management practices and their implications on farm profit

NZAGRC INTERNATIONAL DIMENSIONS

The New Zealand Government initiated the Global Research Alliance on Agricultural Greenhouse Gases (GRA) in 2009 to increase international cooperation and investment in agricultural research activities that mitigate the effect of greenhouse gas emissions. A decade later, 57 countries and 17 international and regional partners are working together in the pursuit of this goal. It remains key to New Zealand's work on climate change and agriculture, offering significant opportunities to build global research and commercial partnerships and strengthen domestic capability.

NZAGRC has played a critical science leadership role in the GRA since 2009, including continuing to co-chair the GRA's Livestock Research Group (LRG) and providing strategic advice and support to MPI (which administers the GRA Secretariat and the Government's dedicated GRA budget). NZAGRC works closely with key GRA partners such as the FAO, World Bank and CCAFS (the CGIAR's Research Programme 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 2018/19 as well as continuing to negotiate and manage GRA research contracts on behalf of MPI. NZAGRC's GRA work now involves the Centre Director, a newly appointed Deputy Director (from 1/9/2019) recruited from the CGIAR to replace Andy Reisinger who reduced his role significantly during 2018/19; Operations Manager (International); International Capability and Training Coordinator; a dedicated GRA Postdoctoral position and the NZAGRC Project Analyst, along with external contractors.

NZAGRC provided advice and support to MPI in its development of a bid for additional GRA funding from the Government's 2019 Budget. A further $8.5 million for the GRA was subsequently announced, for allocation by 30 June 2020 – the same end date as the existing budget. NZAGRC has since worked with MPI to identify opportunities to invest this funding top-up. Further work will be needed during 2019/20 to secure New Zealand funding for the GRA beyond June 2020.

NZAGRC represented the LRG at the 2018 GRA Council meeting in Germany and hosted a number of international delegations relating to the GRA.

NZAGRC also continued to facilitate New Zealand input to the IPCC, including via the Deputy Director's role in the IPCC Bureau. This input helped ensure more comprehensive coverage of mitigation options that respond to the challenges of enhancing food security, reducing emissions and increasing the climate-resilience of food systems. This was born out in the IPCC Special Report on Global Warming of 1.5 Degrees (published in October 2018), and is anticipated in the Special Report on Climate Change and Land due to be published in August 2019. In addition, the NZAGRC will have a lead role in the development of the 6th Assessment Report with the Centre's Director selected as a lead author in the working group on mitigation.

CAPABILITY BUILDING

Provision of capability building services to the GRA was another major area of effort for NZAGRC during 2018/19. Key achievements included:

- Securing a third phase of funding from the Climate and Clean Air Coalition (CCAC) for the joint GRA/FAO global project on 'Improving food security and livelihoods by reducing enteric fermentation'
- Launching the 'MRV Platform for Agriculture' together with CCAFS
- Organising regional engagement workshops to help raise the profile of the GRA across Africa
- Providing technical support and guidance to countries as they develop Tier 2 inventories for livestock

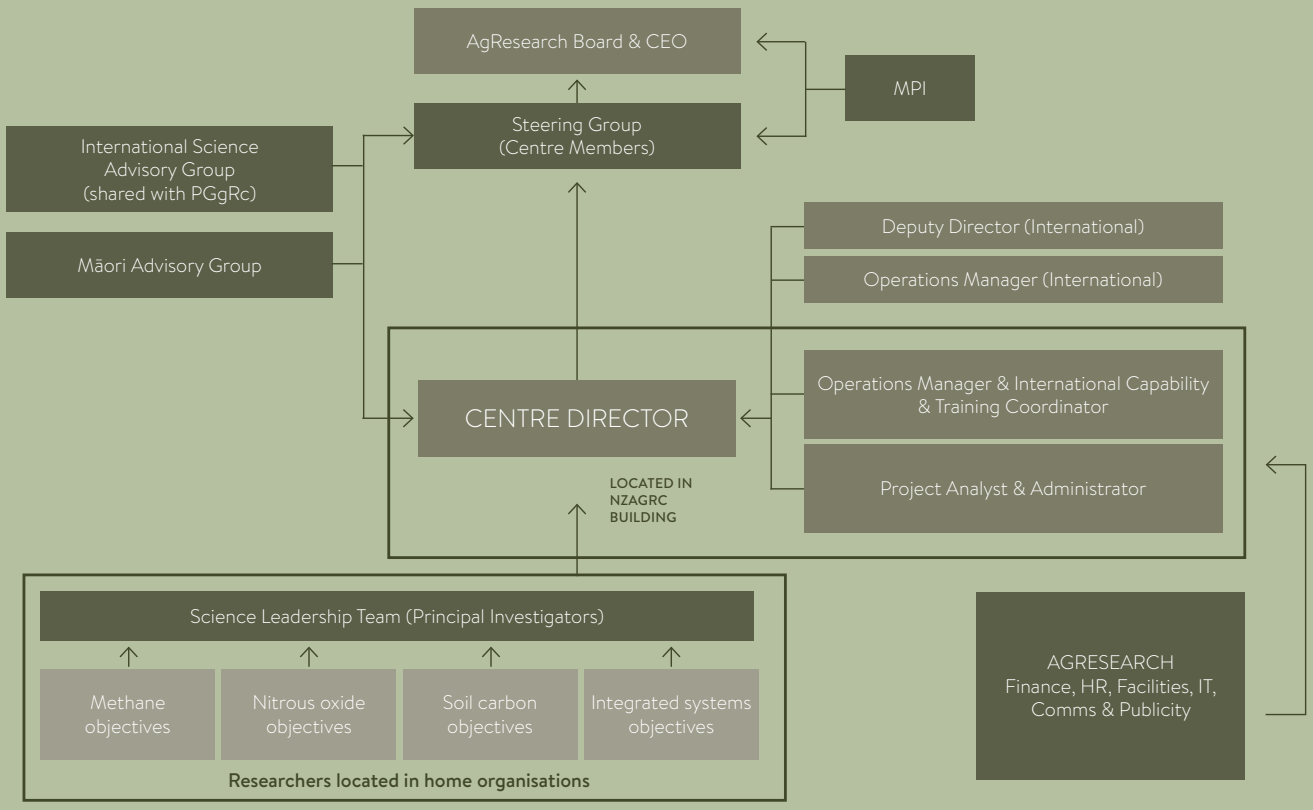
Further details can be found in the full NZAGRC Annual Report.

NZAGRC GOVERNANCE

As 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 SG.

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.



NZAGRC STAFF

NZAGRC STAFF

Dr Harry Clark
NZAGRC Director

Dr Heather Went (until May 2019)
NZAGRC Operations Manager

Jessica Somerton (from June 2019)
NZAGRC Operations Manager

Dr Andy Reisinger
Deputy Director (International)

Laura Kearney
Operations Manager (International)

Dr Sinead Leahy
International Capability and Training Coordinator

Kate Parlane (until March 2019)
Project Analyst

Jillian Sinclair (from January 2019)
Project Analyst

Trina Bishop
NZAGRC Administrator

STEERING GROUP REPRESENTATIVES

Trevor Suthridge

Dr David Burger

Dr Peter Millard (Chair)

Kevin Hurren

Prof Peter Kemp

Mike Harvey

Mark Aspin

Sarah Bromley

Dr Steve Wakelin

Neil Williams
MPI (Observer)

George Strachen
MPI (Observer)

Dr Gerald Rys
MPI (Observer)

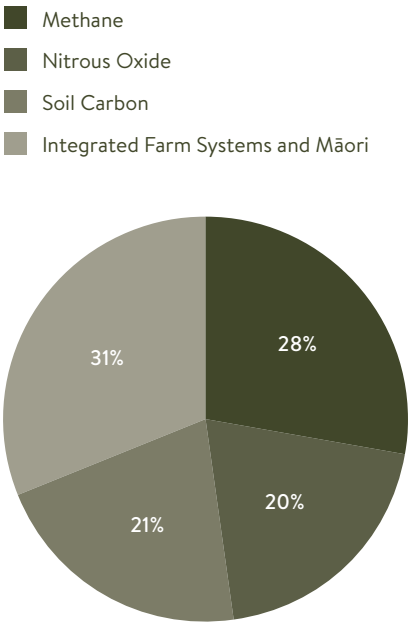
Vacant
MBIE (Observer)

FINANCES AND PERFORMANCE

Total funding for the Centre in 2018/19 was $5.8 million (including carry-over from 2017/18). This covers core research programmes, other research funding (including fellowships and short-term projects) and administration.

In addition to the investment 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 2018/19



CAPABILITY DEVELOPMENT *(ACTIVE IN 2018/19)*

PHDS 06

POST-DOCTORAL FELLOWS 02

MASTERS 03

UNDERGRADUATE INTERN 00

UNDERGRADUATE SUMMER STUDENTS
UNDERGRADUATE HONOURS STUDENTS 03

INTERACTIONS AND OUTPUTS 2018/19

75 MEETINGS AND PRESENTATIONS (NEW ZEALAND)

08 OTHER INTERACTIONS/ PUBLICATIONS

54 CONFERENCE PRESENTATIONS

19 GLOBAL RESEARCH ALLIANCE RELATED INTERACTIONS

10 MEDIA INTERACTIONS

28 MEETINGS AND PRESENTATIONS (INTERNATIONAL)
JOURNAL ARTICLES IN PRESS

10 JOURNAL ARTICLES PUBLISHED

07 INTERNATIONAL VISITORS AND GROUPS

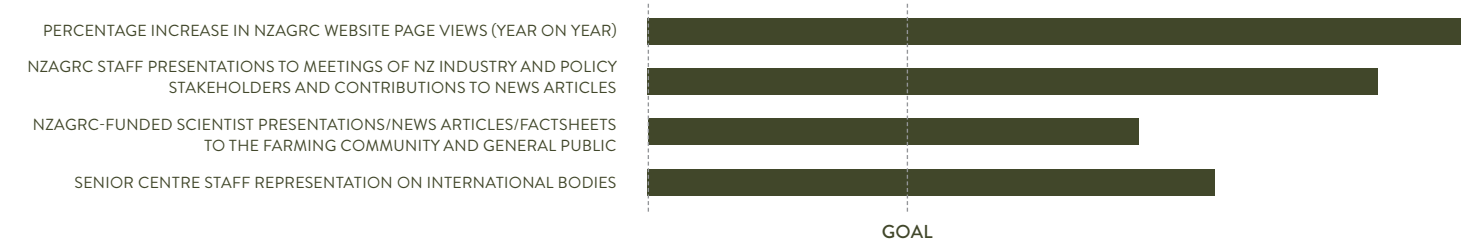
The NZAGRC has five Key Performance Indicators (KPIs) relating to its work for 2016-19. Below is the progress towards meeting these and our specific goals as at 30 June 2019.

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

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

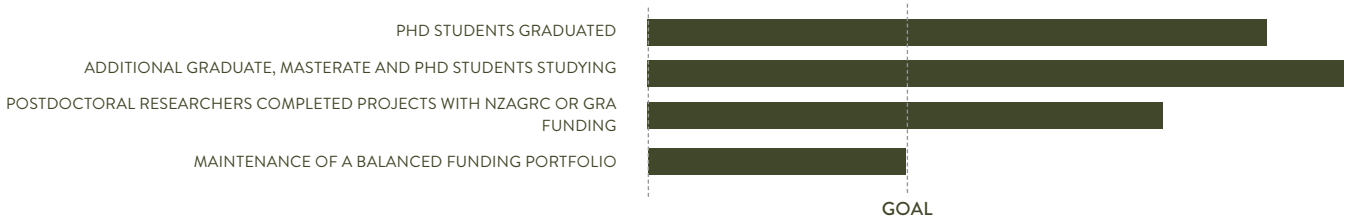


KPI 3: Contribute to policy

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

KPI 4: Develop science capability

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



KPI 5: Develop science and commercial partnerships

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

ACRONYMS USED IN NZAGRC DOCUMENTS

ACRONYM	DEFINITION
NZAGRC	New Zealand Agricultural Greenhouse Gas Research Centre
PGgRc	Pastoral Greenhouse Gas Research Consortium
GRA	Global Research Alliance on Agricultural Greenhouse Gases
GHG	Greenhouse gases
LEARN/GRASS	Fellowships – Livestock Emissions Abatement Research Network and Global Research Alliance Senior Scientist awards to build international capability in live stock emissions research
SOIL C	Soil carbon
MPI	Ministry of Primary Industries
SLMACC	The Sustainable Land Management and Climate Change Research Programme of MPI
DACC	Diary Action for Climate Change
FAO	The Food and Agriculture Organisation of the United Nations
CGIAR	A global partnership that unites organisations engaged in research for a food-secure future
CCAFS	The CGIAR's Research Programme on Climate Change, Agriculture and Food Security

LEADING PARTNERS IN SCIENCE

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