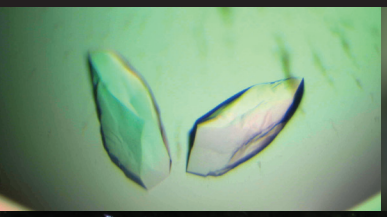
NEW ZEALAND
AGRICULTURAL GREENHOUSE GAS
Research Centre

Highlights 2010





Chairman's Report

"The Centre must develop into a highly effective partnership and become a leading example of how scientists, teams, research organisations and key stakeholders can successfully work together to deliver and implement practical solutions for New Zealand - and for other countries."

Peter Benfell

New Zealand is in the unique position for a developed country of having an economy dependent on the primary sector, with 44% of export earnings derived from agriculture - however currently about half of our nation's greenhouse gas (GHG) emissions come from livestock agriculture. It is therefore imperative that we develop and implement solutions to abate livestock emissions.

The New Zealand Agricultural Greenhouse Research Centre (NZAGRC) has been established to complement and build on the existing research efforts of the Centre's research members: AgResearch, DairyNZ, Landcare Research, Lincoln University, Massey University, NIWA, Plant & Food Research and Scion. In addition, the NZAGRC is adding to the already significant investment of the Pastoral Greenhouse Gas Research Consortium, particularly in methane work.

It is vital that this nationally coordinated research effort across methane and nitrous oxide mitigation and soil carbon leads to solutions that are strongly adopted by the agricultural sector – and that enable New Zealand to meet its international obligations – and to assist other countries in doing this.

It is important to acknowledge the New Zealand Government for its decision to establish the NZAGRC and its investment over 10 years of $48.5 million. Excellent collaboration ensured that the Centre was established in a matter of months and quickly began operating. This required huge and valuable efforts across all of the nine member organisations and in several government agencies, with Harry Clark's leadership being instrumental. I sincerely thank you all for this.

I look forward to 2010/11 being a very productive and successful year!

Peter Benfell
Chair of NZAGRC Steering Group

Director's Report

Although we only officially opened at the start of March 2010, it has been a busy few months here in Palmerston North at the newly refurbished NZAGRC office.

The NZAGRC long term research programme has been signed off by government with significant input from a range of talented, senior scientific experts. The research programme includes approaches to reduce methane and nitrous oxide emissions, increase soil carbon accumulation and to develop the tools needed to design novel, practical and credible farm systems that maintain/enhance profitability while reducing GHG emissions. Eight Principle Investigators (PI's) have been appointed from across the member organisations. The PI's are responsible for managing the science teams, the delivery of research and outputs and building capability within and across the four research areas. An annual review of the research will ensure it remains relevant.

In addition to its science goals, the NZAGRC has broader responsibilities which have been shaped during this year. These include encouraging awareness of GHG issues and mitigation options among stakeholders, providing information to policy makers and developing science and commercial partnerships. The governance structure of the NZAGRC, which involves the Steering Group and two key advisory groups, will be pivotal in ensuring that the Centre meets its responsibilities by keeping one eye on the bigger picture and the other firmly on the operational details.

During the year the NZAGRC and its member organisations have also hosted a range of visiting scientists and policy makers from around the world, including Ireland, Thailand, China and Brazil. Centre researchers and I have presented to groups of industry stakeholders, future PhD students, school children and the general public about the science that is underway and the role of the NZAGRC.

Additionally, I have been coordinating the New Zealand science input into the Global Research Alliance and am looking forward to coordinating the Alliance Livestock Research Group alongside the Netherlands.

I look forward to an eventful and productive 2010/11.

Dr Harry Clark
Centre Director

"I thank all the scientists and support staff who have facilitated the successful establishment of NZAGRC."

Dr Harry Clark

The New Zealand Agricultural Greenhouse Gas Research Centre

The NZAGRC was opened by the Prime Minister, The Right Hon. John Key on 3rd March 2010. The NZAGRC is a collaboration between eight leading New Zealand research providers and the Pastoral Greenhouse Gas Research Consortium (PGgRc). The Government has pledged NZ$48.5m to NZAGRC to invest into research and development activities over the next ten years.

The Vision

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

By 2015, the NZAGRC plans to be (i) a source of practical, cost effective technologies and/or practices that reduce emissions/increase sinks and clearly demonstrate that farm businesses can be both lower emitting and profitable; (ii) a focal point for New Zealand activities in agricultural GHG mitigation/soil carbon sink solutions; (iii) New Zealand's leading source of technical advice and support on agricultural GHG emissions and soil carbon sinks.

Additionally, the NZAGRC will lead New Zealand's science input into the Global Research Alliance.

The Mission

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

Research and development will focus on reducing emissions of methane (CH_4) and nitrous oxide (N_2O) and increasing carbon sinks/reducing carbon losses in agricultural soils so as to improve the efficiency and productivity of agricultural systems.

The NZAGRC's activities will primarily focus on the pastoral sector which accounts for more than 95% of New Zealand's agricultural emissions. However, the NZAGRC recognises that opportunities exist to mitigate emissions in the non-pastoral agricultural sectors and will engage with these sectors to develop and promote these opportunities.

The NZAGRC will strive to transfer knowledge that is innovative, practical, credible and able to stand up to international peer review. Its activities will be transparent and effectively communicated to its stakeholders.

Hon. David Carter, The Right Hon. John Key

Dr Heather Went, Dr Harry Clark, Kate Parlane

NZAGRC Staff

Director

Dr Harry Clark worked for MAFF (UK) after obtaining his agriculture PhD. He moved to New Zealand to work for AgResearch to study the impacts of climate change on pastoral agriculture. He was the PI of PGgRc until 2010 and from 2007 he was the Section Manager of Climate, Land and Environment; a grouping of 70 science staff.

Operations Manager

Dr Heather Went joined the NZAGRC in March 2010 from her role as a Business Development Manager for AgResearch. She has a chemistry degree and PhD in biophysical chemistry from the UK and worked in London for a management consulting firm specialising in the pharmaceutical industry prior to moving to New Zealand at the end of 2005.

Administrator

Kate Parlane moved to the Manawatu and joined the NZAGRC at the end of March 2010. Her previous role was based in the Office of the Chief Executive at Wellington City Council.

Please refer to back cover for photo credits.

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Leading Partners in Science

There are nine members in the NZAGRC, who between them represent research and development, education and industry. Each member brings unique strengths to the NZAGRC collaboration (as outlined below), which will significantly contribute to the ongoing success of the research programmes:

AgResearch — Farming, Food and Health. First™ — Te Ahuwhenua, Te Kai me te Whai Ora. Tuatahi

Host of the NZAGRC. Scientists will take a lead role in methane and nitrous oxide emission mitigation and will contribute to research on increasing soil carbon sinks.

DairyNZ

Scientists will take a lead role in integrating research outcomes for the dairy industry, applying those outcomes in dairy farming systems and in stimulating uptake of new knowledge within the dairy industry.

Landcare Research Manaaki Whenua

Scientists will coordinate research in emission measurement and soil carbon and contribute to the nitrous oxide programme.

Lincoln University — Te Whare Wānaka o Aoraki — Christchurch • New Zealand — New Zealand's specialist land-based university

Scientists will lead research in nitrous oxide emission mitigation and facilitate a programme to develop new capability and capacity in GHG mitigation research.

Massey University

Scientists will lead research into biochar and innovative management practices that reduce GHG emissions and facilitate a programme to develop capability and capacity in GHG mitigation research.

NIWA — Taihoro Nukurangi

Scientists will take a lead role in assessing the effectiveness of mitigation outcomes on climate change impacts in New Zealand.

PGgRc — Pastoral Greenhouse Gas Research Consortium

Will be a key conduit for industry guidance to ensure the applicability of NZAGRC's research to the agriculture sector, and will be an important pathway for commercialisation and practice change.

Plant & Food Research — Rangahau Ahumara Kai

Scientists will lead research on soil carbon mitigation, stocks and rates of change and nitrous oxide mitigation.

SCION — Next generation biomaterials

Scientists will contribute to research on soil carbon.

The Steering Group

Responsible for overseeing the performance of the NZAGRC against its strategic plan, the Steering Group comprises a nominated representative from each member organisation.

Peter Benfell
Science and Technology General Manager, Agriculture and Environment, AgResearch

Peter is Chair of the NZAGRC Steering Group. His science management responsibilities at AgResearch include the Environment, Management and Farm Systems Teams. Peter is also a Director of the PGgRc and the Manawatu BioCommerce Centre.

Dr David Johns
Investment Policy Manager, DairyNZ

David was Group Manager, Investment Strategies for FRST prior to joining DairyNZ.

Dr Richard Gordon
General Manager, Environment and Society, Landcare Research

Richard's role spans greenhouse gas, sustainable land resources, and integrated social, economic and environmental science.

Dr Peter John
Director of Research and Commercialisation, Lincoln University

Peter is Deputy Chair of the NZAGRC Steering Group. Previously he was CEO of Lincoln Ventures Ltd and recently he has specialised in technology transfer and intellectual property management.

Professor Mike Hedley
Professor Soil and Earth Sciences, Massey University

Mike has extensive research experience in biogeochemical cycles in grazed pasture systems including detailed work on the impact of farming systems on the soil carbon, nitrogen potassium and phosphate cycles. Mike is also Director of the Fertiliser and Lime Research Centre in the Institute of Natural Resources.

Dr Murray Poulter
Chief Scientist, Atmosphere, Natural Hazards & Energy, NIWA

Murray has worked on applying radar methods to determine the role of ocean waves on coastal and air-sea interaction processes. He is a representative on the Board of the PGgRc, Natural Hazards Platform, Joint Antarctic Research Institute, Aotearoa Wave and Tidal Energy Association, and Technical Working Group on High Performance Computing.

Mark Aspin
Consortium Manager, PGgRc

Mark is Manager of the PGgRc and responsible for the consortium's operations since 2004. Based in Wellington at Beef + Lamb New Zealand, Mark has a background in managing science investment for the Sheep and Beef sector where he has had responsibility across all aspects of on-farm research since 1992.

Warrick Nelson
Portfolio Manager - Sustainable Production, Plant and Food Research

Warrick has more than 20 years' experience in sales and general management roles in seed and environmental testing organisations, and more recently business management in a Crown Research Institute.

Dr Trevor Stuthridge
Group Manager Sustainable Design, Scion

Trevor is a member of Scion's Executive Management Team as Group Manager for Sustainable Design. He was previously Unit Leader - Eco-Smart Technologies at Scand. Trevor is an active researcher and serves as the Scion representative on the Board of Directors for Beacon Pathways Ltd.

Infrastructure

The NZAGRC has made significant investment this year in support of our vision to be an internationally recognised centre for research and development into agricultural GHG mitigation solutions.

The capital investment was spent on items that our partners would have been unable to support alone, plus smaller items critical to the success of the NZAGRC's research programmes. The table below lists all the investments the NZAGRC has made across our member organisations.

Investment in infrastructure in two particular areas by the NZAGRC has enabled our scientists to take the leading edge in their areas of research. Details of investment in the National Nitrous Oxide Measurement Centre at Lincoln University and the Soil Respiration System at Landcare Research are outlined:

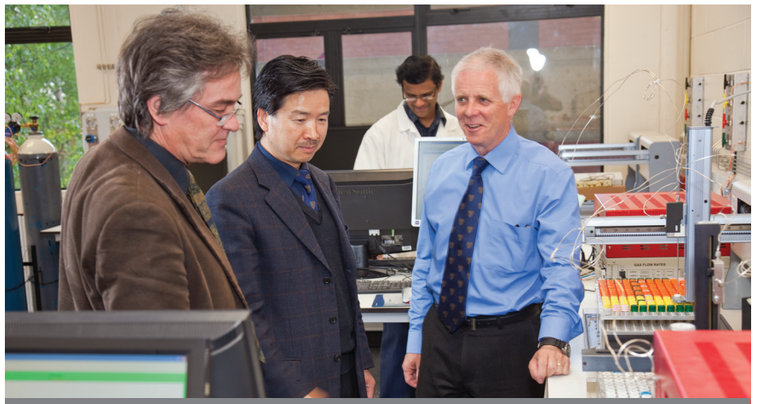
Organisation	Infrastructure Funded	Investment $
AgResearch	National CH_4 Measurement Centre, Grasslands campus Palmerston North	800,000
AgResearch	CH_4 Calorimeters and Servomix analyser	325,000
Lincoln University	National N_2O Measurement Centre	525,000
Landcare Research	Gas Chromatograph for N_2O analysis	120,000
Plant & Food Research	Automated field N_2O measurement system (Co-funding of $175,000 from Plant & Food)	180,000
AgResearch	Quantitative PCR systems for soil microbiology (Co-funding of $60,000 from AgResearch)	79,000
Landcare Research	Soil respiration system	82,600
University of Waikato	Eddy Co-Variance	67,000
NIWA	Algal harvesting and waste CH_4 measurement	50,000

National Nitrous Oxide Measurement Centre

New Zealand scientists have been leading research to measure and reduce nitrous oxide (N_2O) emissions from agricultural soils for many years but lacked sufficient measurement capacity. With funding from the NZAGRC, the National N_2O Measurement Centre at Lincoln University has been upgraded to enable the analysis of a large number of gas samples generated from that research. More than 1,000 N_2O samples a day will be able to be processed in the laboratory, making it one of the most modern facilities of its kind in the world.

The Measurement Centre will have a total of seven gas chromatographs, each equipped with an auto-sampler and new computer enabling the rapid processing of large numbers of gas samples. There will also be a video link to the NZAGRC in Palmerston North to assist regular communication.

The original gas chromatograph laboratory at Lincoln University has been completely re-designed and rebuilt to specifically cater for the new Measurement Centre. This involved removing walls to enlarge the size of the lab, fitting new benches, installing uninterrupted power supply units and a new gas reticulation system, purchasing and commissioning three new gas chromatographs, purchasing and installing four new auto-samplers, linking up new computers to each gas chromatograph and installing video equipment.



National N_2O Measurement Centre. L-R Prof. Rob Sherlock, Prof. Hong Di and Prof. Keith Cameron

Managing the Measurement Centre's upgrade at Lincoln University, Professor of Soil and Environmental Science, Hong Di says "the intention was that the Centre would house the greatest N_2O gas chromatograph analytical capability in New Zealand."

"It will certainly be among the best specialist facilities in the world."

Professor Hong Di

Soil respiration system

New equipment to measure carbon dioxide (CO_2) being released into the atmosphere from soil will be installed on a new experimental site on a Canterbury dairy farm by autumn next year.

One of the NZAGRC's main goals is to increase carbon storage in the soil. Essential to that work is measuring how much carbon is released back into the atmosphere. With funding secured from the NZAGRC, Dr David Whitehead from Landcare Research (based at Lincoln), is preparing to install an automatic soil respiration system imported from the United States to measure CO_2 released from the soil surface when organic matter breaks down.

Use of the current single chamber system has been time consuming. The new automated system places four chambers on the soil to continuously measure at hourly intervals throughout the day. "And we can keep it running over several months," Dr Whitehead says.

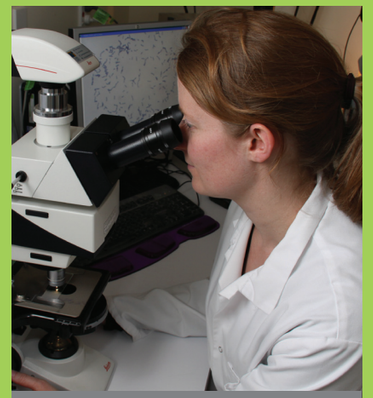
The soil respiration system

Pastoral soils are a major focus for retaining and increasing carbon storage. The soil carbon storage rate depends on carbon exchange with the atmosphere, a balance of input by photosynthesis and loss by respiration.

Carbon loss by respiration is related to conditions such as temperature and soil additives such as fertiliser, soil type, irrigation measures and plant matter. The soil respiration system will be able to measure the effects of those variables, to work out what are the important drivers of carbon turnover.

Science Programme
Methane

Lead scientists Peter Janssen and Graeme Attwood are overseeing multiple cutting-edge research programmes at the NZAGRC that will mitigate emissions of enteric methane. Up to 97% of all agricultural methane emissions in New Zealand arise from the digestion of feed by ruminant animals (cattle, sheep, deer).



Dr Gemma Henderson observing rumen microbes

The work builds on existing well-targeted research funded by PGgRc, Sustainable Land Management and Climate Change (SLMACC) and others to advance the discovery of cost effective solutions that will have a big impact on ruminant CH_4, and therefore GHG emissions. The long-term goal is to develop simple and profitable solutions that are easy to use and effective within a total farm system.

The research is focused on how we may alter the function of the rumen (the fermentation pouch). The work varies between understanding how changes in nutrition affects methane production in the rumen, to discovering genetic markers that can be used to rapidly and cheaply breed low emitting animals. Vaccines are also a critical research area and the work will further our knowledge of how to stimulate anti-methanogen antibody production.

The NZAGRC also funds the development of tools that will enable farmers to make better informed decisions on how to capture and utilise methane from dairy effluent ponds. Reducing methane emissions from animal waste provides an immediate opportunity to make a difference to the level of emissions.

"The programme is world-leading. No-one else has such a comprehensive, integrated programme."

Dr Peter Janssen

Dr Peter Janssen is a principal scientist at AgResearch. His early research was on the microbiology of anaerobic systems and he is a recognised expert in culturing microorganisms. Peter is a Humboldt Fellow and was previously a research team leader at a Max Planck Institute and an Associate Professor at the University of Melbourne.

Dr Graeme Attwood is a principal scientist at AgResearch. He has developed and led rumen microbial genome sequencing programmes. More recently he has initiated a research programme investigating the fibre-degrading activities of the uncultured, plant-associated rumen microbiome using a combined metagenomics and directed cultivation approach.

Science Programme
Nitrous Oxide

Nitrous Oxide being collected

Nitrous oxide (N_2O) is a potent GHG with a long-term global warming potential 310 times that of CO_2. In New Zealand, approximately 20% of total GHG's are N_2O.

Professor Hong Di and Dr Cecile de Klein are leading programmes of research funded by the NZAGRC which seek to reduce N_2O emissions from agriculture and explore possible management options for these emissions.

A major area of research is seeking to optimise the effectiveness and longevity of nitrification inhibitors which reduce N_2O emissions. Nitrification inhibitors are substances that, once applied to the soil, can slow down nitrification (the conversion of ammonium from animal urine to nitrate), thus reducing N_2O emissions and nitrate leaching from animal urine patch areas in grazed pastures. By reducing nitrogen losses, nitrification inhibitors can also increase nitrogen-use efficiency by the pasture.

Research is also focused on the feasibility of growing a high-yielding pasture species with a lower nitrogen content. Pasture species need higher nitrogen content for optimum growth compared to the amount that animals need for optimum milk/meat production. Animals excrete 75-90% of the nitrogen they ingest in concentrated urine patches which are hot-spots for N_2O loss. This is an exciting opportunity to assess the feasibility of reducing nitrogen concentration in the urine through developing low nitrogen pasture species, and to investigate how this impacts on N_2O emissions.

Professor Hong Di is Professor of Soil and Environmental Science in the Agriculture and Life Sciences Faculty, Lincoln University. He is a Fellow of the New Zealand Society of Soil Science, a Fellow of the New Zealand Institute of Agricultural and Horticultural Sciences and in 2008 he was made an Officer of the New Zealand Order of Merit (ONZM) for Services to Agricultural Research.

Dr Cecile de Klein, a principal scientist with AgResearch, has been working on nitrous oxide research for more than 20 years. She is an internationally recognised expert and the Chair of the national nitrous oxide research network, NzOnet. She currently leads various nitrous oxide inventory and mitigation research projects.

Science Programme
Soil Carbon

Soils sequester and store atmospheric carbon via the removal of carbon dioxide (CO_2) from the atmosphere during photosynthesis.

Biochar being tested by Massey University

The soil carbon storage rate is highly variable and to date much of New Zealand research has concentrated on accurately quantifying the amount of carbon stored in soils. Research has shown that New Zealand soils are already rich in organic matter and their ability to store more carbon is limited. Focus now needs to shift, and the NZAGRC has funded scientists to lead research that will discover ways to maintain and increase carbon storage rates in agricultural soils.

Professor Frank Kelliher and Dr David Whitehead lead a team of plant, animal, soil and biochar scientists across New Zealand. The research will begin by defining the upper limit of carbon storage in New Zealand agricultural soils and qualifying how close New Zealand soils are to this limit. A mix of modelling and field trials will be used in this approach.

Innovative field experiments are monitoring the effects of plant species (pastures of ryegrass versus alternative deep-rooting species) and grazing intensity on carbon exchange with the atmosphere. The addition of earthworms and different biochars will be monitored and tested to quantify the rates of input, incorporation and retention of soil carbon under different soil types.

Dr David Whitehead is based at Landcare Research, Lincoln, where he leads a research programme with a focus on measuring, process-based modelling, spatial scaling and mitigation of GHG emissions from terrestrial systems. David received acknowledgment for his contribution to the Nobel Peace Prize for 2007 awarded to the IPCC.

Professor Frank Kelliher is a principal scientist at AgResearch and Professor of Soil Science, Lincoln University. He has contributed significantly to the development of New Zealand's agricultural GHG emissions inventories and uncertainty assessment. Frank is Chair of the soil carbon network, CarbonNet.

Science Programme
Integrated Systems

The NZAGRC's integrated farm systems research programme is focused on developing the tools to design novel, practical, credible and cost-effective low GHG-emitting farm systems for New Zealand farms.

Farmers manage complex systems and constantly make decisions involving trade-offs between competing goals. To help dairy, sheep, beef, and deer farms with GHG emissions, it is essential to understand how interventions at any single point in the whole farm system impacts upon the multiple goals farmers have to manage.

DairyNZ team (L-R) Dr Pablo Gregorini, Dr Piere Beukes, Dr Alvaro Romera and Mr Dave Clark

Developing integrated solutions will require a suite of linked models that can simulate farms and key elements of the farm system, so if someone has a bright idea anywhere in the world, researchers can see if it will have any effect on GHG emissions across the whole farm system.

Current models are either too simple to provide new insights, or complex, requiring input data that are unavailable and are not validated for New Zealand. So research leaders, Mr Dave Clark and Dr Robyn Dynes, initially need to assess, model and test the existing models that predict N_2O and CH_4 emissions from ruminants, under New Zealand conditions. Once this is achieved successfully and there are models capable of demonstrating reduced emissions of both N_2O and CH_4 then farm systems trials will demonstrate the physical and financial viability of new low emitting systems. These new systems will consider methane and nitrous oxide emissions and the management of above and below-ground soil carbon pools.

Mr Dave Clark is a principal scientist at DairyNZ. His current research interests include improving the profitability of once-daily milking, the economic and environmental sustainability of intensive dairying and pasture assessment using satellite technology.

Dr Robyn Dynes is a senior scientist for AgResearch. Her research interests include the impact of farm management decisions on GHG emissions and determining how science and specialist knowledge on GHG fits into the whole farm system.

Financial Summary

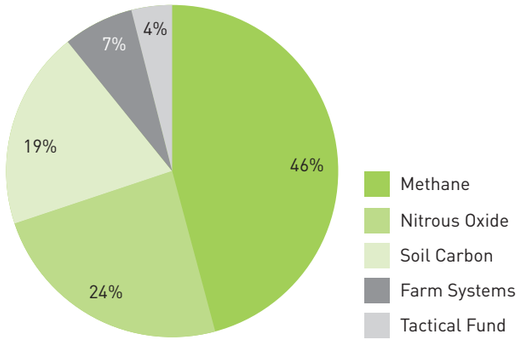
The NZAGRC opened in March 2010 with an operating budget of $4.85m for the financial year which ended in June 2010. Spending has been across three key areas: Science ($1.46m), Infrastructure ($2.73m) and Administration ($0.65m).

The science has been funded across four research areas, in accordance with the NZAGRC's approved science plan: Methane, Nitrous Oxide, Soil Carbon and Integrated Farm Systems. A tactical research fund has also been established to build capability and capacity across the research platform.

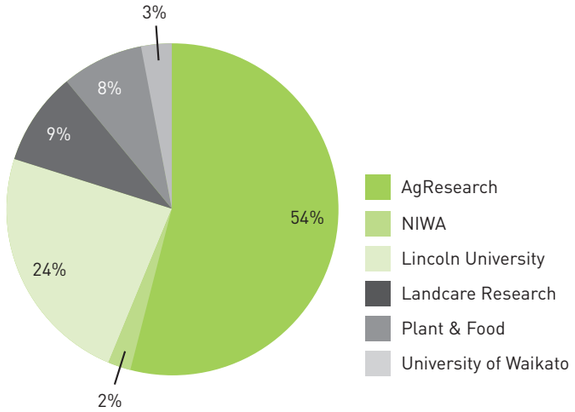
In addition to the investment made in the science programme, the Government supported the decision for the NZAGRC to make one-off investments in much needed capital equipment across the member organisations in order to facilitate the successful delivery of the science plan.

Money has also been set aside to support the delivery of a Maori Strategy and Maori Capability development.

NZAGRC Science Spending 2009/2010



NZAGRC Investment in Capital Equipment Across Member Organisations



Governance Structure

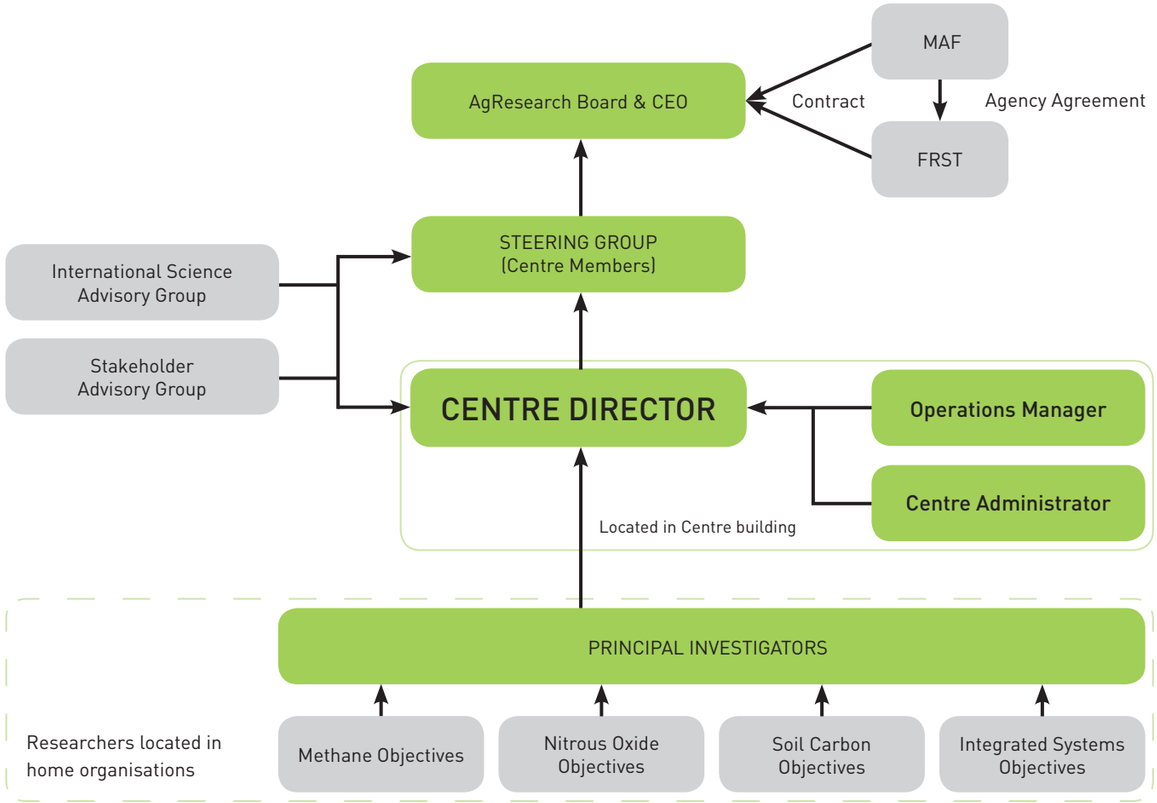


Photo credits from page 5

1. Dr Sandra Kittlemann (AgResearch (working on PGgRc funded research))
2. Mr Roger Cresswell (Lincoln University)
3. Mr Chris Dunlop and Dr Mike Beare (Plant and Food Research)
4. Biogas ponds (Landcare Research)
5. Dr Frank Li, Dr Iris Vogeler (AgResearch) and Dr Donna Giltrap (Landcare Research)
6. Dr Roberto Pereira (Massey University)
7. Associate Professor Louis Schipper (University of Waikato)
8. Professor Keith Cameron and Professor Hong Di (Lincoln University)
9. Dr Linley Schofield and Miss Amy Knights (AgResearch (working on PGgRc funded research))

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