LIVESTOCK RESEARCH GROUP
newsletter
GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

June 2018

Update from the Co-Chairs

Welcome to the June 2018 edition of the Livestock Research Group's newsletter.

This newsletter comes fresh to you from the annual gathering of the Livestock Research Group (LRG), this year in Ho Chi Minh City, Vietnam.

We are very grateful to the Government of Vietnam and the Institute of Agricultural Sciences of South Vietnam for hosting us. As well as providing the conditions for a highly productive LRG meeting – which you can read more about on pages 2-4 – they organised a very interesting field trip, visiting pig, cattle and buffalo research farms, and we also enjoyed a traditional Vietnamese meal at the tranquil Binh Quoi Village. Our thanks to those of you who were able to join us in Ho Chi Minh City – we hope you got as much from the meeting as we did.

The meeting in Vietnam was a chance to welcome new faces and old to the LRG. It was an opportunity to celebrate our near-decade of working together to address livestock greenhouse gas (GHG) emissions and to reflect on our achievements over that time. We have come a long way since that first meeting in Wellington, New Zealand in 2010. We have set up five major global networks, as well as several regional networks, and have seen LRG scientists contribute significantly to advancing global progress in reducing livestock GHGs. We have built enduring partnerships with others working in this area, including the FAO, CCAFS, the World Bank, the Climate and Clean Air Coalition, and the Sustainable Agriculture Initiative, as well as a number of regional organisations. We have worked with countries across Latin America and Asia to build capability, particularly around strengthening GHG inventories and enhancing research programmes, and critical work is now underway in Africa.

From our humble beginnings in 2010, the LRG now comprises some 50 countries and at least 10 partner organisations all working together in the pursuit of solutions for better understanding and reducing livestock GHG emissions. With increasing global attention on livestock's impact on the climate, we must make sure – more than ever before – that our science connects with and supports those developing the policies for low emissions livestock.

As a part of the LRG community, you really can make a difference in all of this, whether it be by:

- stepping forward as an IPCC author or expert reviewer;
- reaching out to government colleagues to find out more about their work in the UN climate change negotiations or their work to set domestic ambitions for your country (and, in turn, raising their awareness of the LRG);
- publishing regional or targeted literature reviews for the IPCC or translating non-English language publications to make them more accessible; or
- simply raising awareness of the GRA's work within your own organisations and networks

We encourage you to get involved. The future is bright (and we hope you enjoy this edition)!

Martin and Harry

This month's newsletter brings you:

Save the date

Greenhouse Gas & Animal Agriculture conference and LRG meeting – August 2019

From 4-10 August 2019, Brazil will host the major international scientific gathering on climate change and livestock – the Greenhouse Gas and Animal Agriculture (GGAA) conference. The GGAA will take place in Foz do Iguaçu, Paraná, Brazil near the spectacular Iguaçu Falls – one of the world's largest waterfall systems. The LRG will meet in the margins of the GGAA conference from 9-10 August, making the most of this international gathering of livestock GHG scientists.

Eight years of international collaboration on livestock emissions

The 10th LRG meeting concluded in Vietnam last month with participants celebrating nearly a decade of joint work to better understand and reduce greenhouse gas (GHG) emissions from livestock production.

More than 40 participants from 26 countries and LRG partner organisations gathered in Ho Chi Minh City, Vietnam from 14-17 May 2018 for the annual LRG meeting. This year's meeting took the theme of 'working together', recognising the LRG's collaborative approach to researching livestock GHGs. The following is a summary of the meeting's main outcomes. For meeting presentations, please see here. For updates from the LRG's networks, please see page 5.

Country priorities

With a number of new people (and countries) attending, the meeting began with participants sharing the key challenges and opportunities in livestock GHG research in their home countries, and where support was needed to build capabilities. Common themes included:

- Strengthening GHG inventories for livestock emissions, including improved data and emission factors, and facilitating greater experience-sharing between countries
- More clearly framing the debate on productivity, food security and mitigation so that it is relevant for key stakeholders such as government and industry
- Estimation and measurement of emissions – do we have the tools to measure and demonstrate mitigation at a range of scales and across different farm systems
- Challenges with coordinating institutions within countries
- Sharing experiences with adoption and implementation of low emissions practices
- Identifying funding for further activities

Subsequent discussions on the LRG's work plan then reflected on these themes.

GRA flagships

The LRG meeting saw the first projects under the GRA's Enteric Fermentation Flagship launched, along with the first project under the Nitrous Oxide Flagship[2]:

1. **Rumen Microbiome Project:** New Zealand and Australian scientists have developed a method for rapid and low-cost profiling of sheep rumen microbiomes to identify low methane emitting animals. As a flagship project, this method will be extended to identify a low methane trait in dairy cattle that can be characterised for breeding purposes. Rumen fluid from a wide range of cattle around the world, but particularly from tropical systems, will be sequenced to understand the heritability of microbial communities and structures. Countries are invited to contribute to the project by submitting rumen samples and accompanying methane emissions data, which will be sequenced and analysed by a LEARN Postdoctoral Fellow based at AgResearch, New Zealand. For more information, please contact Suzanne Rowe (suzanne.rowe@agresearch.co.nz).

2. **CEDERS Plus:** CEDERS (Capturing the Effects of Diet on Emissions from Ruminant Systems) is an existing project funded by FACCE-JPI and participating countries to understand on-farm dietary effects on GHGs and the associated trade-offs in participating countries (Europe, USA, New Zealand) – see pages 5 and 9 for more details. CEDERS Plus takes this initial work and turns it into a flagship project by expanding it to bring in data from South East Asia and Latin America. Two LEARN Postdoctoral Fellows will deliver this work to the project leaders in the US (Alex Hristov, Penn State University) and the Netherlands (Andre Bannink, Wageningen). The outcome of this expanded project will be the identification and recommendation of applicable methane mitigation options for the given production systems. These will take into account methane yield and nutritional measures and how the mitigation practices can be implemented and reflected in national GHG inventories. Data from forage and grazing animals will also be collected as part of the flagship project, which are not well reflected in the original work. For more information, please contact Alex Hristov (anh13@psu.edu)

3. **Dataman:** This project will establish a manure management database to help refine national GHG inventories and improve understanding of the influence of key variables affecting nitrous oxide, ammonia and methane emissions from manure including housing, storage, land application and direct deposition by livestock. The project is about better quantification and bringing together existing data to help develop emission factors for manure from housed or pasture systems, rather than comparing the processes involved in each system. For more information, please contact Tony van der Weerden (tony.vanderweerden@agresearch.co.nz).

LRG meetings

2010 Canada, Banff
2011 France, Clermont-Ferrand
2011 Netherlands, Amsterdam
2012 Uruguay, Punte del Este
2013 Ireland, Dublin
2014 Indonesia, Yogyakarta
2015 Italy, Lodi
2016 Australia, Melbourne
2017 USA, Washington DC
2018 Vietnam, Ho Chi Minh City

1. *For an overview on the Enteric Fermentation Flagship, please see the October 2017 LRG Newsletter*
2. *The Nitrous Oxide Flagship is yet to be formally confirmed by the GRA Council. Until this takes place, the project will be carried forward as an initiative of the LRG and its Manure Management Network.*

The LRG's Rumen Microbial Genomics Network is also working on a possible project for the Enteric Fermentation Flagship. Please see the network update on page 5.

GRA Flagships are priority thematic areas, advanced through specific actions and can include research, capacity building, guidance and transfer. Projects within the flagships will become focal activities for the GRA, involving as many members and partners as possible. They will contribute to:

- Reducing greenhouse gas emissions while supporting food security
- Advancing global knowledge through collaboration
- Supporting countries in their developing and implementing solutions
- Promoting synergies between mitigation and adaptation

Flagship projects must identify their own funding source/s – in the case of the three launched in Vietnam, the New Zealand Government is the major investor.

In addition to the Enteric Fermentation and Nitrous Oxide Flagships, the GRA is working on four other flagships:

- **Inventory Flagship:** the taskforce for this flagship has identified an initial list of potential projects although has struggled to find project leaders or resourcing to take things further. Development of a project proposal on 'shared farm systems/production typologies' is currently underway with leadership from CCAFS and the GRA's GHG Inventory Network.
- **Soil Carbon Sequestration Flagship:** this flagship aims to understand the soil carbon sequestration potential at an 'almost global' scale for arable and grassland systems, with countries providing the underpinning data. A number of partners and initiatives will come under the umbrella of this flagship, including the Global Soil Partnership to develop methodologies and guidelines, and the CIRCASA[3] project. Countries within the flagship taskforce are also working on a number of additional project proposals, including reviewing soil carbon management practices; rapid assessment of indirect methodologies for soil carbon stock change; and the economics of soil carbon sequestration.
- **Proposed Circular Food Systems Flagship:** the concept of 'circular food systems' is to avoid waste in food production chains – turning our linear modes of production to circular. Livestock production is key to the development of circular food systems as crop/food by-products can be used as animal feed and animal manure is a valuable fertiliser. Wageningen University in the Netherlands has established a taskforce to develop this flagship concept further, including potentially holding a workshop in the margins of the GRA Council meeting in Germany in September 2018.

LRG members are invited to continue submitting ideas for new flagship projects, especially ahead of the flagship report-back to the Council meeting in September 2018.

Engaging internationally

The LRG (and the wider GRA) is uniquely placed to share its wealth of work on the challenges and opportunities to reduce livestock GHGs with various processes underway internationally.

The LRG meeting heard how the **Intergovernmental Panel on Climate Change** (IPCC) has a number of high profile reports that could benefit from strengthened knowledge on agricultural mitigation options. See page 12 for more detail on this, including the timeframe for involvement.

The **Climate and Clean Air Coalition** (CCAC), which helps develop control measures for short-lived climate pollutants including methane, has recently revised its Agriculture Initiative strategy. This aims to see countries raise ambitions for reducing agricultural short-lived pollutants, with funding available to support relevant GRA workshops and other activities. Requests need to come from CCAC member countries. Regional assessments for short lived climate pollutants and key sources are also being undertaken. Assessments have been undertaken for countries in South America, Africa and Asia.

There is also an opportunity for the GRA to help inform the UN Framework Convention on Climate Change (UNFCCC) **'Koronivia joint work programme on agriculture'**. This was adopted in late 2017 and requests that "issues relating to agriculture" be jointly addressed including through workshops and expert meetings. The UNFCCC's most recent negotiating session (May 2018) agreed that submissions should be called on three key topics, with workshops to follow:

1. Methods and approaches for assessing adaptation, adaptation co-benefits and resilience and improved soil carbon, soil health and fertility under grassland and cropland as well as integrated systems, including water management – submissions by 6 May 2019
2. Improved nutrient use and manure management towards sustainable and resilient agricultural systems – submissions by 30 September 2019
3. Improved livestock management systems, including agro-pastoral production systems, and socio-economic and food security dimensions of climate change in the agricultural sector – submissions by 20 April 2020

LRG members are encouraged to make contact with their climate change representatives (usually in foreign, agriculture or environment ministries) to discuss these topics and find out how our research can help make a difference in underpinning these important negotiations.

Livestock Research Group meeting, Ho Chi Minh City, Viet Nam, 14-17 May 2018

3. Coordination of International Research Cooperation on soil CArbon Sequestration in Agriculture

Building capability

The LRG has a number of major initiatives underway to help build countries' capabilities to understand, measure, report and reduce livestock GHGs:

- Work with CCAFS and UNIQUE to develop much-needed resources to strengthen national GHG inventories for livestock emissions, including:
    - Documenting countries' experiences in improving methods for measuring, reporting and verifying (MRV) livestock GHGs
    - Guidelines to address gaps and uncertainties in the activity data needed for livestock inventories
    - An online platform of existing tools and resources for livestock MRV
- Work with FAO and CCAC to deliver a multi-country and multi-phased project on **reducing enteric methane for food security and livelihoods**
- Work with CCAFS to jointly host the **Cliff-GRADS Scholarship** programme aimed at placing agricultural GHG PhD students from developing countries in short-term scientific training and research stays – see page 13 for details.

Delegates got together in working groups to identify priorities for regional capability building, as outlined in the following table.

AFRICA	LATIN AMERICA	ASIA
Priorities are: • Understanding the links between mitigation and productivity • Improving capability and training for GHG inventories (moving from Tier 1 to Tier 2) • Better data for animal numbers and emission factors • A methodology for collecting measurements specific to Africa to inform development of emission factors • Regional training and exchange programmes	**Priorities are:** • Decoupling deforestation and livestock production • Regional emission factors • Achieving carbon neutrality through sequestration **Capability building needs include:** • Life Cycle Analysis training to understand effective on-farm mitigation strategies • Development of better databases • Better data / measurement for dry matter intake in grazing systems	**Priority:** • Moving from Tier 1 to Tier 2 inventories for livestock GHGs **Capability building needs include:** • Assistance for pilot research studies • Technical training to improve measurement methodologies • Standardisation of basic activity data for improved accuracy • Shared experiences of GHG measurements from the global community • Simplification / translation of IPCC inventory guidelines, including to local languages

Potential funding sources were discussed, acknowledging the largely solo role the New Zealand Government has played in supporting LRG capability building activities to date. Future support may be able to come from Japan and Germany, and other funding sources such as the FAO, Green Climate Fund and Global Environment Facility were identified as potentially available for inventory development. The regional needs identified would also be presented to the GRA Council at its meeting in September.

Participants in the Africa working group also agreed the need to establish a regional network within the LRG, similar to those that already operate in Asia and Latin America. This would aim to:

- Raise awareness of GRA research that shows the importance of both mitigation-for-adaptation and adaptation-for-mitigation purposes
- Discuss the prospects for a regional paper providing an African perspective on linking the Sustainable Development Goals with agricultural climate action (as a contribution to IPCC processes - see page 12)
- Provide data from African scientists and research institutions to the CCAC African Regional Assessment of Short Lived Climate Pollutants that will commence later in 2018

The group intends to hold a workshop in 2018, potentially in Zimbabwe.

Co-chairs conclusions

In summarising the discussions over the two-day meeting, the LRG Co-chairs identified the four main priorities for the LRG as being:

- GHG inventories
- Improved methodologies for measurement, capability building and standardisation
- Identifying regionally appropriate mitigation actions
- Extension of shared experiences and practices for different production systems

The LRG will next meet in the margins of the international Greenhouse Gas and Animal Agriculture (GGAA) conference, 4-10 August 2019 in Brazil.

Co-chair Dr Martin Scholten and other LRG meeting delegates at the Binh Thang Pig Research and Development Centre as part of the field trip

Updates from the LRG's networks

Animal Health & GHG Intensity Network (AHN)

The AHN investigates the connection between animal diseases and GHGs, aiming to demonstrate how disease control helps reduce livestock GHGs. Four papers have been published recently:

- Challenges and priorities for modelling livestock health and pathogens in the context of climate change
- Study to model the impacts of controlling endemic cattle diseases and conditions on national cattle productivity, agricultural performance and greenhouse gas emissions
- Greenhouse gas abatement potential of productivity improving measures applied to cattle systems in developing region
- Animal Health and greenhouse gas emissions intensity: the paradox of periparturient parasitism

The AHN is currently looking for funding support for network coordination and welcomes suggestions for projects that could act as a central focus for network activities.

Coordinator: Dirk van Schoosten, Germany (Dirk.von_Soosten@fli.de)

Animal Selection, Genetics & Genomics Network (ASGGN)

Breeding as a long-term strategy to reduce livestock GHGs is the focus of the ASGGN, along with identifying how other genetic traits can affect mitigation.

The network has a major GRA flagship project underway, led by New Zealand (see page 2), and countries are encouraged to contribute by sharing data and samples for sequencing. ASGGN members have also published a white paper, 'Consensus methods for breeding low methane-emitting animals', and have contributed to an International Committee for Animal Recording (ICAR) working group, recording trait definitions and metadata. The ASGGN met most recently in February 2018 but may hold a further workshop in August 2018.

Coordinator: Suzanne Rowe, New Zealand (suzanne.rowe@agresearch.co.nz)

Feed & Nutrition Network (FNN)

The FNN is a collaborative forum for scientists working on ways to reduce GHG emissions via nutritional means. One of the network's key achievements has been the Global Network project that aims to address issues with the available global data on the impact of feed and nutrition on livestock GHGs. A major part of this has been the development of more accurate estimates of methane emissions from dairy cattle – see page 8. The project has also delivered three review papers:

- Design, implementation and interpretation of in vitro batch culture experiments to assess enteric methane mitigation in ruminants—a review
- Review of current in vivo measurement techniques for quantifying enteric methane emission from ruminants
- Symposium review: Uncertainties in enteric methane inventories, measurement techniques, and prediction models

Members of the FNN are also leading the 'CEDERS' project, funded by FACCE-JPI, which will be expanded to become a GRA flagship – see pages 2 and 9.

Coordinator: Alex Hristov, USA (anh13@psu.edu)

Manure Management Network (MMN)

The LRG's MMN is focused on reducing livestock GHGs through manure management. Under new coordination, led by Dr Hongmin Dong, Chinese Academy of Agricultural Scientists, the network has a renewed focus on:

- Understanding the different practices and regulations that countries have in place for manure management
- Monitoring GHG emissions from manure (storage and application), and measuring methane emissions
- Manure treatment to reduce emissions
- Reuse of manure as organic fertiliser – embodying circular agriculture and supporting soil carbon sequestration

Network members are working with CCAFS to develop a proposal to improve emission factors for national inventories, building on the priorities listed above. The network is currently seeking funding for this activity and associated coordination.

The network will also support the delivery of Dataman, a project under the GRA's Nitrous Oxide Flagship – see page 2.

Coordinator: Hongmin Dong, China (donghongmin@caas.cn)

Rumen Microbial Genomics Network (RMG)

Understanding the microbes that affect methane emissions from ruminant livestock is at the heart of the RMG's efforts. The network has had two major projects in recent years:

- **Global Rumen Census:** concluded in 2015 with the critical finding that the same major groups of methanogens dominate in nearly all rumens across a wide variety of species and animal diets. More here.
- **Hungate 1000:** developing a reference set of rumen microbial genome sequences, results recently published in *Nature*. For a full account of that paper, see page 6.

RMG scientists have been involved in two other projects, both funded through FACCE-JPI. RumenStability looked at long-term effects of short-duration dietary treatments on methane production and rumen function, and concluded in 2017. RumenPredict is a new project looking at the interactions between the animal genome and the rumen microbiome. It will review feed-based mitigation strategies, compare microbial genes, develop an analytical platform, and identify biomarkers to predict nitrogen and methane losses. The network is currently looking at ways to expand RumenPredict as a project under the Enteric Fermentation Flagship, enabling countries to participate from outside of the original FACCE-JPI membership.

The RMG has also contributed to a special topic in the Frontiers in Microbiology journal – 27 papers published so far, with at least 10 more to come. A new special research topic has recently opened on gut microbiome modulation in ruminants, with a deadline for abstracts of 18 September 2018.

Coordinator: Sharon Huws, UK (S.Huws@qub.ac.uk)

Hungate1000 leaders, New Zealand scientists Dr Bill Kelly and Dr Sinead Leahy

Recent research achievements: Major LRG work on rumen microbial genomes published in Nature

Scientists in the LRG's Rumen Microbial Genomics Network have had their work to develop a global reference set of genome sequences of rumen microbes published in the respected international scientific journal *Nature Biotechnology*.

The project, called the Hungate1000[1], was led by New Zealand scientists Dr Bill Kelly and Dr Sinead Leahy and brought together nearly 60 scientists from 14 research organisations across nine countries[2]. This global collaboration has generated a reference catalogue of 501 rumen microbial genomes. Before Hungate1000, just 15 rumen microbial genomes were available to the scientific community.

Dr Kelly says the project gives a new understanding of what exactly is taking place inside a rumen.

"Hungate1000 means we can now start to reveal the intricacies of how the rumen microbial community functions, and provide a roadmap for where to take the science next," he says. "These data can be translated into interventions that are globally useful, such as identifying targets for vaccines and inhibitors to reduce methane emissions and improve productivity, among other things."

Dr Leahy says the project represents a major scientific advancement in the field of rumen microbiology, an area of science that up until recently had largely been unexplored.

"These microbes in the stomachs of ruminants are crucially important—they convert grass and other dietary components into smaller compounds that the sheep or cow uses to make meat and milk," she says. "The data we've made available with Hungate1000 will underpin the development of technologies to target these microbes and aid productivity or reduce greenhouse gas emissions—you need to know what you're targeting to make a specific impact on the rumen microbiome environment."

Dr Andy Reisinger, Deputy Director of the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) and New Zealand representative in the LRG, says Hungate1000 is central to the work that the LRG and New Zealand are leading.

"Hungate1000 shows what a powerhouse the rumen is in converting digestible plant material to energy, and gives us a much better understanding of how we might be able to use science to influence that process," he says. "This will help us find ways not only to enhance productivity but also to achieve emissions reductions and deliver solutions to farmers—such as inhibitors and vaccines—that don't affect their economic baselines."

In line with the GRA's philosophy that research should be conducted in a manner that ensures the widest possible benefit, the Hungate1000 data is publicly available as a community resource on the United States Department of Energy **Joint Genome Institute website**.

The Hungate1000 was funded by the New Zealand Government in support of the Global Research Alliance on Agricultural Greenhouse Gases. The genome sequencing and analysis component of the project was supported by the United States Department of Energy's Joint Genome Institute (JGI), via its Community Science Program.

Dr Harry Clark, NZAGRC Director and Co-chair of the LRG, says Hungate1000 would not have happened without the GRA.

"This project shows the power of international collaboration we've been able to bring scientists together from around the world to create this resource that can benefit all countries," he says. "We're already looking at ways that the Hungate1000 data can be exploited in future LRG collaborations."

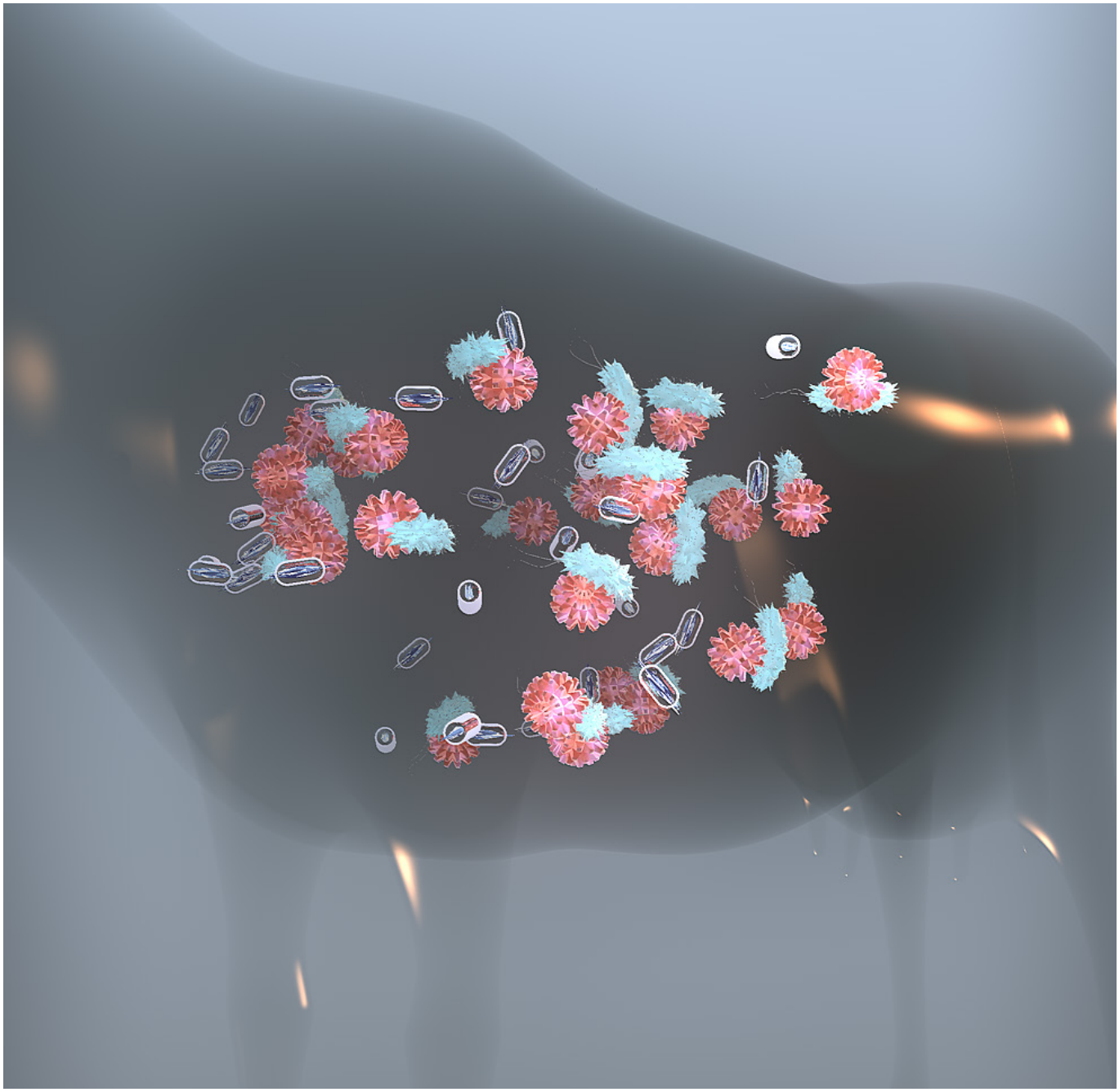
One such example is **RumenPredict**, a European-funded project that will bring together Hungate1000 and the **Global Rumen Census** (an earlier New Zealand-funded LRG collaboration) to link rumen microbiome information to host genetics and phenotype and develop feed-based mitigation strategies. For more on these projects and the work of the Rumen Microbial Genomics Network, please see page 9.

Dr Kelly says he and the rest of the Hungate1000 team are delighted to see their work published in *Nature Biotechnology*.

"It's the culmination of a long journey and a lot of work, and we have achieved something that I think is really worthwhile," he says. "The kudos of getting something published in a high-impact journal like Nature Biotechnology is enormous, and highlights the value of this work to a global audience."

For more information, contact:

Dr Sinead Leahy
Email: sinead.leahy@nzagrc.org.nz



1. *So-named after Bob Hungate, an American scientist who developed the pioneering technique of growing anaerobic bacteria that has been the cornerstone of the project.*
2. *Argentina, Australia, Canada, France, Japan, New Zealand, Scotland, USA, Wales*

Recent research achievements: More accurate estimates of methane emissions from dairy cattle developed

Having more accurate models for predicting enteric methane emissions from livestock is important because these emissions represent a significant portion of global greenhouse gases. And if current and future mitigation efforts are to be measured and analysed for their effectiveness, governments need accurate data for existing enteric methane levels and resulting decreases.

Leading the worldwide effort to get a better handle on methane emissions from animals, an international consortium of researchers from the LRG's Feed and Nutrition Network (FNN) has devised more accurate models to estimate the amount of enteric methane produced by dairy cattle.

In a large study that involved individual data from more than 5,200 lactating dairy cows, assembled through a collaboration of animal scientists from 15 countries, researchers discovered that methane emissions from dairy cattle can be predicted using simplified models. Because feed dry-matter intake is the key factor for methane production prediction, the new models require readily available feed-related variables.

These more accurate models can be used to develop region-specific enteric —intestinal — methane inventories, explained lead researcher and coordinator of the FNN, Alex Hristov, Professor of Dairy Nutrition at Penn State College of Agricultural Sciences in the US. He pointed out that the large scope of the project resulted in previously unreachable conclusions.

"Developing such a large database of individual animal data has never been done before," he said. "When we put this project together four years ago, we contacted researchers around the world with a consortium agreement so we could collect confidential data from their studies, and they provided individual animal data for methane emissions and all related measurements. That gave us the opportunity to develop more robust, more accurate prediction models for enteric methane emissions."

Although complex models that use both feed intake and detailed chemical composition had the best performance in predicting methane production, models requiring only feed dry-matter intake and dietary fibre content had the second-best predictive ability. Those offer an alternative to complex models currently being used by regulatory agencies such as the U.S. Environmental Protection Agency.

"The EPA inventory is based on a complicated set of equations with high uncertainty," Hristov said.

A major finding of the research, which was published this month in ***Global Change Biology***, is that revised methane emission conversion factors for specific regions are expected to improve emission estimates in national inventories. The concept of applying a methane emission conversion factor was introduced by the Intergovernmental Panel on Climate Change to indicate the proportion of an animal's energy intake that is converted to energy in methane.

This factor is widely used for national greenhouse gas emission inventories and global research on mitigation strategies. The research by the consortium, Hristov noted, offers opportunities to include region-specific methane conversion factors in national inventories. This is essential to improve the accuracy of carbon footprint assessments of dairy cattle production systems in regions around the world and to help devise mitigation strategies.

"Dairy cows in different regions of the world, depending on their diets, their genetics and their management systems, belch different amounts and intensities of methane," Hristov said.

The team that conducted the study is currently developing similar databases for predicting enteric methane emissions from beef cattle, sheep and goats. "We started with dairy cattle because more research data is available for dairy animals," Hristov said.

Having more robust and accurate models for predicting enteric methane emissions from livestock is important, Hristov pointed out, because these emissions represent a significant portion of global greenhouse gases blamed for causing climate change. And if current and future mitigation efforts are to be measured and analysed for their effectiveness, regulatory agencies must have accurate data for existing enteric methane levels and resulting decreases.

Thirty-six researchers from the U.S., Europe, Australia and New Zealand were involved in the study.

The core project, GLOBAL NETWORK, led by Penn State, was developed by a consortium of eight countries — U.S., U.K., Netherlands, France, Spain, Ireland, Switzerland and Finland — and was funded by national governments mostly via the European Joint Programming Initiative on Agriculture, Food Security and Climate Change. The U.S. Department of Agriculture funded the U.S. researchers.

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To read the full paper in Global Change Biology, see here: DOI: 10.1111/gcb.14094

Related activities

LRG project underway on 'Capturing Effects of Diet on Emissions from Ruminant Systems' (CEDERS)

FNN scientists are also working together in a related project that builds on GLOBAL NETWORK by capturing dietary effects on greenhouse gas emissions. This includes developing databases and prediction models to evaluate the impact of dietary strategies on the mitigation of greenhouse gases, undertaking experiments to fill high-priority knowledge gaps on dietary effects on ruminant manure emissions, and helping improve farm accounting and national inventory methodologies so that they better capture dietary effects on mitigation. CEDERS currently involves European and New Zealand scientists but is being expanded through the GRA's Enteric Fermentation Flagship to include data from tropical systems and systems relying on by-products for feed (see page X for details). This will enable the development of methane yield values that are more specific for local feeds and production circumstances in the target regions (initially South East Asia and Latin America) and the identification of methane mitigation technologies that are practical and feasible in those systems.

For more on this important work for the FNN, please see:

https://globalresearchalliance.org/research/livestock/networks/feed-nutrition-network/

FNN paper confirms the ability to predict enteric methane emissions based on dry matter intake along with simple feed- or animal-related inputs

Scientists in the FNN have also recently published a paper in the Journal of Dairy Science reviewing the uncertainties and discrepancies in enteric methane inventories as related to livestock emissions, methane measurement methods, and Dry Matter Intake (DMI) and methane prediction models. The paper draws helpful conclusions about the use of enteric methane prediction models for national greenhouse gas inventory purposes. It finds that in situations where sufficient details or accuracy on dietary inputs is lacking, inventory compilers could still draw on simplified enteric methane prediction models based on DMI alone or DMI and limited feed- and animal-related inputs. To achieve high prediction accuracy, broadly applicable and robust prediction models must be developed from large data sets generated through international collaboration. These data sets should encompass a wide range of diets and production systems within regions and globally. Development of regionally specific Ym values and DMI prediction equations would also assist. The LRG has several research projects underway to help deliver on these recommendations.

The full article can be found here:

https://doi.org/10.3168/jds.2017-13536

For more on these projects and the work of the FNN, please see page 5

How much is enough?

Country mitigation targets for agriculture sector needed to meet 2°C goal calculated for first time

Voluntary mitigation targets set by countries as part of the Paris Agreement are insufficient to limit climate change to a 2°C increase.

Scientists have calculated, for the first time, **the extent to which countries must reduce agricultural emissions** to meet the climate agreement to limit warming to 2°C in 2100.

The agriculture and land use sector comprised almost a fifth of anthropogenic emissions in 2010 and may comprise three-quarters of emissions by 2100, but its critical role in climate change is often overlooked in favour of the energy and transportation sectors.

Scientists have determined that the **agriculture sector must realise a global mitigation target** of 1 gigaton of carbon dioxide equivalents per year ($GtCO_2e$ yr^{-1}) by 2030 to contribute to the 2 °C target. To meet this target, countries will need to decrease business-as-usual agricultural emissions in 2030 by an average of 10%.

An article published by CCAFS scientists in the journal *Climate Policy* presents different approaches for calculating country-level mitigation targets that would together meet the global 1 gigaton target for the agriculture sector.

National targets for climate change mitigation vary according to principles, approaches

Since the inception of the UN Framework Convention on Climate Change (UNFCCC) in 1992, several approaches to allocate emissions allowances or reduction targets among countries have been proposed. Approaches based on principles of equity take into consideration:

- Historical responsibility for climate change
- Capability to mitigate
- Equality of emissions
- Development needs

Other approaches allocate mitigation targets based on the cost-effectiveness of mitigation, rather than principles of equity. And some approaches combine multiple principles or stagger countries' participation across stages.

"There are different ways of assessing contributions to the 2°C goal. This analysis can help countries guide their ambition," Meryl Richards, lead author and scientist at the University of Vermont's Rubenstein School for Environment and Natural Resources and the CGIAR Research Program on Climate Change, Agriculture and Food Security, said.

Allocations to specific countries vary widely by approach[1]. Mitigation effort by the United States, for example, ranges from 40 megatons of carbon dioxide equivalent in an approach focusing on capability to 483 megatons in an approach assigning equal per capita emissions. India, on the other hand, would not need to mitigate agricultural emissions, in an equal per capita emissions approach.

Some countries have ambitious targets

In Nationally Determined Contributions to the UNFCCC, only some countries included specific targets for the agriculture and land use sector.

Among countries that developed agricultural mitigation targets, some countries (mostly in Africa) chose to make ambitious commitments that are in line with the 2°C – or even the 1.5°C – target. However, these commitments are voluntary.

If countries consistently choose the most ambitious targets from the approaches described in the paper, then global agricultural emissions would be reduced by 4.6 GtCO2e in 2030, vastly exceeding the 1 GtCO2e yr-1 target. On the other hand, if countries consistently choose minimum mitigation targets, then global agricultural emissions would actually increase 1.9 GtCO2e yr-1 above the 2030 baseline, the authors wrote.

"It is extremely unlikely that we will be able to limit warming to 1.5 or 2 °C if countries do not consistently choose ambitious mitigation targets in agriculture," co-author Lini Wollenberg said. Wollenberg, a professor at the University of Vermont Gund Institute for Environment, leads low emissions development research for the CGIAR Research Program on Climate Change, Agriculture and Food Security.

Research shows different ways countries can take responsibility for meeting the mitigation target in agriculture and argues that systemically ambitious approaches will be necessary.

Early, ambitious, collective action needed

Given the grand challenge of meeting a 1.5 or 2°C warming limit, the authors suggest that countries with minimal mitigation targets increase their ambition.

The Technology Mechanism under the UNFCCC – which will also serve the Paris Agreement – can support the transfer of more advanced technologies to developing countries, including technologies that may provide adaptation benefits as well.

Developed countries can invest in new technologies, for example breeding ruminants for lower emissions, and they can provide the finance needed for developing countries to transition to low emissions agriculture.

"National governments will need to work with their farmers and food companies, and each other, to pursue greenhouse gas emission reductions. Early, ambitious, and collective effort and development of new agricultural production technologies are urgently needed in the agriculture sector," Richards said.

Download the publication:

Richards M, Wollenberg E, van Vuuren D. 2018. National contributions to climate change mitigation from agriculture: allocating a global target. Climate Policy.

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Julianna White, CCAFS Low Emissions Development, University of Vermont (julianna.m.white@uvm.edu)

1. *The analysis was limited to methane and nitrous oxide, which make up the majority of emissions from agriculture. Sequestration of carbon in trees and soils could be other mitigation options, but high variability, lack of data, and the reversibility of carbon storage make the exact potential of such options uncertain.*

Supporting the work of the Intergovernmental Panel on Climate Change

By Dr Andy Reisinger, Vice-Chair of IPCC Working Group III and New Zealand representative in the LRG.

The IPCC is widely regarded as the foremost authority on climate change. Its reports serve as the most influential scientific input to global climate change agreements and actions by countries. Governments and policy-makers rely on the information provided in these reports, including understanding the options for mitigation in agriculture. The reports reflect published research and rely on reviews and suggestions from the research community. There is an opportunity to ensure that these reports reflect the work of the GRA – but this is only possible if individuals involved in the GRA are more active.

The GRA's focus on reducing the emissions intensity of food production can serve as a key entry point to more comprehensive mitigation actions by countries, designed to address multiple challenges of enhancing food security, reducing emissions and increasing the climate-resilience of food systems. However, if researchers engaged in the GRA do not participate in IPCC peer review processes, then our work risks going unnoticed by IPCC authors. The consequence of this is that governments will not readily see the value that GRA-related research can provide to achieve both food security and climate change mitigation. As an example, there was limited engagement from the GRA community in the peer review of the IPCC's Special Report on global warming of 1.5 degrees and related emission pathways. As a result, the report's coverage of options to reduce agricultural GHGs without jeopardising food security may be less comprehensive than perhaps it might have been – a missed opportunity.

The IPCC has another report highly relevant to the work of the LRG underway and for which there is still an important chance to contribute. A draft of the IPCC Special Report on **climate change and land** is available for expert review, from 11 June until 5 August 2018. LRG members are encouraged to **register as a reviewer** (deadline of **29 July 2018, 23:59 (CEST)**) and provide constructive comments to help ensure that the GRA's perspective on the twin challenges of mitigation and food security are given adequate consideration. References to peer reviewed publications are essential for effective comments.

Increasing the availability and relevance of published literature that IPCC authors can draw on is another important way that the LRG community can make a demonstrable difference. Although the Special Report on global warming of 1.5 degrees has now been finalised, papers for the Special Report on Climate Change and Land and the Sixth Assessment Report are still very much needed and relevant (see table below). LRG members should consider publishing research that captures not just specific results but also GRA-type

Dr Andy Reisinger presents the work of the IPCC to the recent LRG meeting

thinking, including regional reviews and synthesis papers about mitigation. For example:

- How, where, how much could we reduce emissions intensity (beyond business as usual) in different systems and regions – regional assessments of mitigation potentials and strategies that integrate mitigation, livelihoods and food security
- How reducing emissions intensity links with the UN Paris Agreement on climate change and sustainable development goals - what policy packages would achieve multiple objectives
- Assessments of emerging mitigation options and novel technologies - demonstrating the value of agricultural GHG mitigation research for delivering on the goals of the Paris Agreement
- How important effective mitigation strategies for agriculture are in achieving the Paris Agreement goals for mitigation and food security.

IPCC REPORT	CUT-OFF DATE FOR PUBLICATIONS
Climate Change and Land	• Submitted to scientific journal or available as draft technical report – **by 28 October 2018** • Accepted by scientific journal or published as technical report – **by 7 April 2019**
Sixth Assessment Report – chapter on mitigation of climate change (Working Group III, published in July 2021)	• Submitted to scientific journal or available as draft technical report – **by April 2020** • Accepted by scientific journal or published as technical report – **by October 2020**

CLIFF-GRADS Awardees announced

The first recipients of a joint GRA and CCAFS international doctorate scholarship programme for agriculture scientists have been announced – from Argentina, Colombia, Ethiopia, Nigeria and Tunisia.

The CLIFF-GRADS scheme aims to help up-and-coming early career scientists in developing countries working on agricultural greenhouse gas mitigation research. It invites applications from PhD students seeking to undertake short-term scientific training and research stays on topics related to the measurement and management of greenhouse gas emissions and carbon storage in agricultural systems.

Some 65 applicants from 23 countries applied for the scholarship following its launch at the United Nations climate conference in November 2017. Nine recipients have been successful:

Abubakar Halilu
Ahmadu Bello University
Nigeria

Sebastián Vangeli
National Institute of Agricultural Technology
Argentina

Ridha Ibidhi
Mediterranean Institute for Agricultural Economics of Zaragoza
Tunisia

Yohannes Gelan Regassa
Bahir Dar University
Ethiopia

Isabel Cristina Molina Botero
Universidad Autonoma de Yucatan
Colombia

Banira Lombardi
National University of the Centre of the Province of Buenos Aires
Argentina

María De Bernardi
National University of the Centre of the Province of Buenos Aires
Argentina

Florencia Garcia
National University of Córdoba
Argentina

Ofonime Eyo
Pan African University institute of Life and Earth Sciences (University of Ibadan)
Nigeria

These scientists will work in a range of research fields including nutrient management, pasture management, soil and rumen microbiology, tropical agriculture and greenhouse gas measurement. They will be hosted by the International Centre for Tropical Agriculture in Colombia, Rothamsted Research and Bangor University in the UK, Wageningen University and Research in the Netherlands, the International Centre for Maize and Wheat Improvement, and the National Institute of Agricultural Research in Chile.

To read more about their scholarships, see here.

A second application round may be opened later in 2018. Please check here for more information.

Dr Sandeep Kumar, LEARN Co-funded PhD Scholarship recipient from India

LEARN PhD student gets to the bottom of a beneficial bacterium

Growing up in a remote village in India gave Dr Sandeep Kumar a first-hand understanding of the significant impact that farming can have on a society. Even the small-scale farms of his tiny hometown, where families might each have one or two cows in their backyard, made a big impression on the young Sandeep and fostered a desire to learn more about the very building blocks of agriculture.

That fascination led Sandeep all the way to New Zealand, and with the help of the New Zealand Agricultural Greenhouse Gas Research Centre, he graduated last month from Massey University with a PhD on the physiology of rumen bacteria associated with low-methane emitting sheep.

After graduating with a Master's degree in microbiology in India, Sandeep worked for the Indian Veterinary Research Institute as a rumen microbiologist. It was there he first made contact with a fellow rumen microbiologist on the other side of the world: AgResearch's Dr Peter Janssen, who is the Principal Investigator of the jointly-funded PGgRc-NZAGRC methane mitigation programme.

"Like India, New Zealand also places a lot of value on agriculture, and I was quite fascinated by the dairy farming systems in New Zealand too, which are highly organised and very productive," he says. "I had some conversations with Peter Janssen and we figured out that I could come to New Zealand on a LEARN Co-funded PhD scholarship, which I was lucky enough to do in 2011."

Sandeep worked as a technician with Dr Janssen and Dr Gemma Henderson at AgResearch for six months, then returned to India for a year. However, he felt he had unfinished business in New Zealand, and came back to AgResearch to study what's known in rumen microbiology circles as an historically iconic rumen bacteria, *Quinella ovalis*.

Along with *Sharpea* and *Kandleria*, *Quinella ovalis* has been found to be abundant in low-methane emitting sheep, and Sandeep wanted to understand why.

"This bacterium was first identified in 1913, more than a century ago, but it had never been cultured in the lab or studied in depth. In fact, the only two papers that had previously been written about how *Quinella* works appeared to contradict each other," he says.

Sandeep received a Walsh fellowship from **Teagasc** (Ireland), along with research funding from the NZAGRC, which allowed him to enrol at Massey University to do his PhD. He was based mainly at AgResearch's Grasslands campus in Palmerston North, and his research was supervised by Dr Janssen, Dr Mark Patchett (Massey) and Dr Sinead Waters (Teagasc). He also received valuable mentorship from a number of other current and former AgResearch scientists.

Because *Quinella* could not be cultured, Sandeep worked on developing different ways to analyse its metabolism to gain a better understanding of why it is more abundant in sheep that produce less methane and how it might be cultured. He worked out how to concentrate cells of *Quinella* from rumen contents and extracted their DNA. He discovered there were multiple *Quinella* species—he sequenced the genomes of four different species. He then analysed the proteins encoded by those genomes, and the key enzymes involved in the metabolic processes of this bacterium.

"This was the first time anyone had studied the physiology of *Quinella*," says Sandeep. "Reconstructing its metabolic pathways showed that it creates a range of different products during the fermentation process: propionate, acetate and lactate. These products appeared in both of the previous studies, which shows they weren't contradictory after all but actually demonstrated the different pathways that *Quinella* has."

Sandeep's research also showed *Quinella* either produces no hydrogen or much less hydrogen (which is the main precursor of methane in the rumen) than other bacteria.

"I think my work will be helpful for any future research in low-methane emitting animals, especially for things like breeding programmes, as well as a number of other research areas that the NZAGRC is supporting."

Sandeep's PhD thesis is currently under embargo while papers detailing some of his findings are being finalised and will be published in scientific journals.

He would one day like to take his knowledge back to India, but for now has accepted a position with AgResearch's forage science group. "This will allow me to research the plant part of the digestive process, which is eaten by the animal and which ultimately contributes towards methane emissions," Sandeep says.

"AgResearch are really among the world leaders in the field of rumen microbiology—the work they're doing and the international recognition they're receiving is amazing, so it's been a real privilege to work with Peter Janssen and the other scientists there."

LEARN Awards

LEARN
Building Capability in Livestock Emissions Research

LEARN is an awards scheme sponsored by the New Zealand Government to build international capability in livestock emissions research. It is part of New Zealand's support for the GRA.

LEARN is focused on:

- Supporting technical staff and scientists from developing countries and GRA member countries to work alongside New Zealand colleagues
- Sharing knowledge on livestock greenhouse gas emissions measurement, modeling and mitigation practices to increase the level of scientific skills and technological capabilities internationally.
- Supporting strategic research and capability building activities that align with the priorities of the GRA as well as relevant New Zealand science priorities.
- Advancing common research interests between countries and building enduring relationships.

There are currently two LEARN awards on offer:

- LEARN Technical Training Award
- Global Research Alliance Senior Scientist (GRASS) Award

These awards are assessed on a quarterly basis, following a two stage application process. The next two closing dates for full applications are 31 July 2018 and 30 October 2018. All applications must be developed in close collaboration with a New Zealand research institution.

For more information, please see:

www.livestockemissions.net

Please note that applications for LEARN Co-funded PhD Scholarships and LEARN Postdoctoral Fellowships are not being taken at this time.

Upcoming events

Review of draft IPCC Special Report on Climate Change and Land

Members of the LRG community are asked to assist the IPCC with an expert review of the first order draft of its special report on climate change and land. The review period extends from 11 June until 5 August 2018.

Date: 29 July 2018 – to register as an expert reviewer
Website: https://www.ipcc.ch/apps/comments/srccl/fod/register.php
Additional information: http://www.ipcc.ch/report/sr2/pdf/SRCCL_FOD_ExpertReviewer.pdf

18th Asian Australasian Animal Production Congress

The AAAP Congress is a platform for animal science and industry to come together to discuss current advances in research and technology.

Date: 1-5 August 2018
Location: Kuching, Malaysia
Website: http://conferences.academicjournals.org/cat/agricultural-sciences/18th-asian-australasian-animal-production-congress-aaap-2018

Call for papers: 8th International Symposium on Non-CO2 GHGs

The 8th International Symposium on Non-CO2 Greenhouse Gases (NCGG8) will take place 12-14 June 2019 in Amsterdam, the Netherlands. The scope of the NCGG8 is 'global challenges and local solutions' with themes covering the sources, sinks and atmospheric processes of non-CO2 gases; mitigation options; policies and measures; and the science-policy-industry interface. Short abstracts addressing these topics are invited.

Deadline for submission of abstracts: 1 September 2018

Website: https://www.ncgg.info/call-for-papers

African Green Revolution Forum

The African Green Revolution Forum is a platform for global and African leaders to develop actionable plans that will move African agriculture forwards.

Date: 3-7 September 2018
Location: Kigali, Rwanda
Website: https://www.agrf.org/index.html

Circular Food Systems Flagship meeting

GRA members interested in helping establish the Circular Food Systems Flagship are invited to attend an inception meeting.

Date: 9 September 2018
Location: Berlin, Germany
Contact: secretariat@globalresearchalliance.org

GRA Council meeting

The GRA Council will hold its 8th annual meeting, this time in parallel with the AgriGHG 2018 Conference (see below).

Date: 10-11 September 2018
Location: Berlin, Germany
Contact: secretariat@globalresearchalliance.org

AgriGHG 2018 Conference

The German Federal Ministry of Food and Agriculture is hosting a high-level 'International Conference on Agricultural GHG Emissions and Food Security – Connecting Research to Policy and Practice'. This is jointly organised under the aegis of the GRA and FACCE-JPI, in collaboration with CCAFS.

Date: 10-13 September 2018
Location: Berlin, Germany
Website: https://www.faccejpi.com/Calendar/International-Conference-on-Agricultural-GHG-Emissions-and-Food-Security

Frontiers in Microbiology Research Topic

The journal Frontiers in Microbiology has opened a new Research Topic on 'Gut Microbiome Modulation in Ruminants: Enhancing Advantages and Minimizing Drawbacks'. Frontiers Research Topics unify influential researchers, the latest key findings and historical advances in a hot research area.

Date: 30 September 2018 for abstracts (with manuscripts by 30 September 2019)
Website: https://www.frontiersin.org/research-topics/7850/gut-microbiome-modulation-in-ruminants-enhancing-advantages-and-minimizing-drawbacks

Publications to be considered for IPCC Special Report on Climate Change and Land

LRG members are encouraged to publish relevant scientific articles and technical reports to inform development of the IPCC Special Report on Climate Change and Land.

Date: 28 October 2018 submitted to scientific journal or available as draft technical report (with acceptance by journal or publication as report by 7 April 2019)
Website: http://www.ipcc.ch/report/sr2/

7th Greenhouse Gas and Animal Agriculture (GGAA) conference

Save the date – more information to follow.

Date: 4-10 August 2019
Location: Foz do Iguaçu, Paraná, Brazil

2019 GRA Livestock Research Group meeting

The LRG will hold its 2019 meeting in Brazil in the margins of the GGAA. More information will be provided in due course.

Date: 9-10 August 2019
Location: Foz do Iguaçu, Paraná, Brazil
Contact: secretariat@globalresearchalliance.org

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