

Global Research Alliance Livestock Research Group Networks Workshop

University of Reading, United Kingdom

26th June 2015

This workshop was undertaken by participants of the Livestock Research Group Networks to support the objectives of the Global Research Alliance on Agricultural Greenhouse Gases. The information contained within should not be taken to represent the views of the Alliance as a whole or its Partners.

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EXECUTIVE SUMMARY

Research networks of the GRA Livestock Research Group (LRG) held a joint workshop at the University of Reading, United Kingdom, on 26th June 2015. The objectives were to improve communication and collaboration amongst the Networks and explore interdisciplinary approaches for tackling greenhouse gas emissions from animal agriculture. The workshop was attended by 52 participants representing 18 countries, from Africa, the Americas, Asia and Europe. Presentations on each of the Networks and scientific presentations made for a very informative morning session and the afternoon breakout discussions addressed the benefits and roadblocks to enhanced collaboration within and between Networks and ideas for ways to increase joint activities. The workshop was live-streamed on YouTube and live-tweeted by @AHGHGN (<https://twitter.com/AHGHGN>), @RMG_network and @METHAGENE.

Through better collaboration, the Networks will increase awareness of, and access to, databases and protocols, will be better placed to explore the whole farm system, and will avoid duplication of effort. Funding was raised as a barrier to progressing the Networks but a number of potential funding routes were identified. Other issues discussed on the day included the need to build stronger links with industry, to create multi-disciplinary research proposals, encourage smaller active groups within the Networks and engage early-career scientists.

Participants agreed that this was a productive workshop and they would be keen to attend another which had greater involvement from PhD students and post-docs. In the meantime better communication between Networks needs to be supported (e.g. webinars, sharing newsletters).

This report is a summary of key discussions, action points and outcomes from the workshop and is aimed at all Network members and researchers/research funders interested in the GRA Livestock Research Group Networks and the links between them.

LIST OF ABBREVIATIONS

AHN	Animal Health & GHG Emissions Intensity Network
AOB	Any Other Business
ASGGN	Animal Selection, Genetics & Genomics Network
COST	European Cooperation in Science and Technology
CropM	Crop Modelling
Defra	UK Government Department for Environment, Food and Rural Affairs
ERA-NET	European Research Area Net.
EU	European Union
FACCE-JPI	Agriculture, Food Security and Climate Change Joint Programming Initiative
FAO	Food and Agriculture Organisation of the United Nations
FNN	Feed and Nutrition Network
GASL	Global Agenda for Sustainable Livestock
GGAA	Greenhouse Gas and Animal Agriculture Conference
GHG	Greenhouse Gas
GHGe	Greenhouse Gas Emissions Intensity
GRA	Global Research Alliance on Agricultural Greenhouse gases
KTN	Knowledge Transfer Network
LCA	Life Cycle Analysis
LiveM	Modelling of livestock, permanent grassland and farms
LRG	Livestock Research Group
MACSUR	Modelling European Agriculture with Climate Change for Food Security
SRUC	Scotland's Rural College
STAR-IDAZ	Global Strategic Alliances for the Coordination of Research on the Major Infectious Diseases of Animals and Zoonoses
SOP	Standard Operating Procedure
TradeM	Trade Modelling
UK	United Kingdom

1 SUMMARY AND OUTCOMES OF THE GLOBAL RESEARCH ALLIANCE LIVESTOCK RESEARCH NETWORKS WORKSHOP

1.1 Overview of the workshop

Research networks of the Livestock Research Group (LRG) of the Global Research Alliance (GRA) on Agricultural Greenhouse Gases held the first joint workshop on the 26th June 2015 at the University of Reading, England. This international workshop brought together researchers from all of the dedicated LRG research Networks and was attended by 52 participants representing 18 countries: Argentina, Belgium, Chile, Colombia, Denmark, Finland, France, Germany, India, Kenya, the Netherlands, Poland, Spain, Sri Lanka, Switzerland, the UK, Uruguay and the USA (see Appendix 1 for participants list and Appendix 2 for the group photo).

The objectives for the meeting were to:

- Develop/improve communication and collaboration among GRA LRG Networks; and,
- Explore interdisciplinary approaches for tackling the issue of greenhouse gas (GHG) emissions from animal agriculture: identifying the challenges, looking for synergies, creating collaborative opportunities and defining remaining interdisciplinary questions.

The workshop was chaired by Professor Chris Reynolds who opened the day by thanking the UK Government Department for Environment, Food and Rural Affairs (Defra) for providing funding before handing over to Professor Ian Givens (Director of the University of Reading's Food Production and Quality Research Division) for an introduction. The workshop provided an excellent opportunity for delegates to get to know one another and to discuss network aims and commonalities.

The morning session was dedicated to presentations introducing the networks and scientific presentations from each of the networks. The focus of the afternoon session was group discussions based on pre-set questions to identify challenges within livestock GHG mitigation research and areas for collaboration, and propose ideas for sustaining the future of the Networks. The workshop agenda is provided in Appendix 3.

This report will be circulated to all workshop participants and Network members. It will be uploaded onto the GRA website (<http://www.globalresearchalliance.org/updates/>) and summarised in the UK Agri-Science & Innovation newsletter. Readers are invited to circulate the report to interested researchers and research funders.

2 INTRODUCTIONS FROM EACH NETWORK

All six LRG networks were represented at the workshop and each presented an overview of membership, objectives and current status. Presentations from associated projects and networks, RuminOmics and Pangenome, were also given.

2.1 Feed and Nutrition Network (FNN) – Dr Alex Hristov

The network has representation within 30 countries, but wishes to involve more researchers and scientists within countries not currently represented in FNN (e.g. China).

The scope of the network is to build on and utilise a body of work on the mitigation of enteric methane emissions from ruminants through feed and nutrition along with developing recommendations for stakeholders and identifying areas for future research.

There are a number of current projects in progress:

- Two research papers are being prepared for publication in peer reviewed journals;
- The concept of producing guidance for researchers conducting *in vivo* and *in vitro* methane measurements is being explored;
- A four year project (funded by the Agriculture, Food Security and Climate Change Joint Programming Initiative (FACCE-JPI)) is in progress which is aimed at reducing GHG from livestock (more details see: <http://news.psu.edu/story/306497/2014/03/04/research/penn-state-led-project-aimed-reducing-greenhouse-gases-livestock>); and,
- Two databases are being created:
 - Treatment means database (goal – to provide effective, science-based enteric methane mitigation options). Concentrating on nutritional treatments working to mitigate emissions.
 - Individual animals database (goal – to develop robust enteric methane prediction models). *[If anyone has relevant data or wants to get involved, contact Alex Hristov]*

More information on FNN can be found on their website (hosted by Penn-State University) at <http://animalscience.psu.edu/fnn>.

The next meeting of the FNN will be held alongside the 6th Greenhouse Gas and Animal Agriculture Conference (GGAA) in Melbourne 2016 (<http://www.ggaa2016.org/>).

2.2 Grassland Research Network (GRN) – José Ignacio Velazco

Net GHG emissions from grasslands under grazing could be reduced through better management strategies that improve production efficiency. This could lead to an important impact on global net GHG emissions since current figures estimate that 26% of the world land area and 70% of the world agricultural area are covered by grasslands, largely used for livestock grazing.

The original scope of the network was focused on grassland systems dedicated to livestock production and its link to GHG emissions and removals at farm level for cultivated pastures and rangelands. Carbon sequestration, followed by adaptation and mitigation were the main foci. However this will eventually expand to include other GHGs.

The network objectives are to:

- Elaborate a stock-take of main published or on-going research on the relation between grasslands and GHG emissions and removals;
- Publish reviews focused on grasslands management strategies to reduce GHG emissions intensity, and CO₂ removal from soils. Improve understanding of the implications of Soil Carbon (SOC) losses and degradation and the multiple benefits that could be obtained from applying good management strategies to restore SOC and/or avoid emissions from soil;
- Encourage research activities for the improvement of management strategies for grasslands production systems to reduce GHG emission intensity;
- Encourage the production of whole-system models for assessing the net GHG footprint of grassland based herbivore production systems;

- Disseminate best practices to improve management and efficiency of grasslands' production systems that reduce net emissions intensity;
- Identify grasslands species with GHG mitigation effects;
- Identify knowledge gaps and opportunities for research collaboration and dissemination.

2.3 Manure Management Network (MNN) – *Dr Jonathan Levin*

The network exists to promote manure as a source of nutrients, energy and soil organic matter as well as addressing the challenges of integrating measurements and models across the global scientific community.

The network objectives are to:

- Exchange research findings, experience and data in the field of manure management;
- Identify research gaps;
- Provide an evidence base for policy makers;
- Propose appropriate experimental protocols for emission factor derivation and assessing mitigation protocols; and,
- Standardise meta-data and reporting.

In order to achieve the objectives, the next steps for the network are to:

- Compile mitigation methods;
- Harmonise protocols;
- Define requirements for metadata;
- Produce a glossary of terms; and,
- Increase membership across all countries.

It was identified that there are synergies between MMN and other LRG networks FNN and GRN, although the network members are open to collaboration in any relevant field.

The next meeting of the MNN will be held alongside GGAA in Melbourne 2016.

2.4 Animal Health and Greenhouse Gas Emissions Intensity Network (AHN) – *Professor Ilias Kyriazakis*

AHN is the newest network within the LRG and comprises 79 members across 25 countries covering each continent. Defra support the network by providing funding for the secretariat and workshops and travel for UK researchers, however this ends in June 2016.

The aim of the network is to bring together researchers (in veterinary science, epidemiology, animal science, modelling, economics etc.) to explore links and synergies between animal disease control and GHG emissions intensity reductions in order to achieve the following objectives:

- To share information on current and planned funding activities in the field of animal health and GHG emissions intensity (GHGe), so as to avoid duplication of effort, identify gaps and help focus research efforts;
- Maintain and enhance capacity in this field of research, including the ability of practitioners from the GHGe and animal health fields to interact, and engaging with social scientists;
- Encourage and facilitate a joined-up approach from fundamental science to strategic and applied research and research-into-use while avoiding overlaps and identifying gaps and opportunities for collaboration;

- Establish common agreement on priority issues and explore funding opportunities to address them, including links with more traditional animal health and agricultural and rural development programmes; and,
- Pursue synergies with stakeholders and other relevant initiatives in order to further strengthen global cooperation and networks., including the Global Strategic Alliances for the Coordination of Research on the Major Infectious Diseases of Animals and Zoonoses (STAR-IDAZ), Modelling European Agriculture with Climate Change for Food Security (MACSUR), Global Agenda for Sustainable Livestock (GASL), FACCE-JPI and the Network to enhance the use of economics in animal health education, research and policy making in Europe and beyond (NEAT). As well as the World Organisation for Animal Health (OIE), Food and Agriculture Organisation of the United Nations (FAO), World Bank and other rural development organisations etc.

AHN has developed links with a number of the initiatives listed above. Two annual Network workshops have taken place in the margins of relevant conferences and one regional workshop focussed on Africa. The network is currently seeking funding opportunities for a global scoping study, targeting animal health interventions to reduce GHG emissions intensities. Updates are communicated in the UK Agri-Science and Innovation newsletter (<http://globalresearchalliance.org/country/united-kingdom/>).

2.5 Animal Selection Genetics and Genomics Network (ASGGN) & METHAGENE – *Dr Yvette de Haas*

The Animal Selection Genetics and Genomics Network (ASGGN) was formed to offer a forum and environment in which scientists from all over the world can share information and data relating to breeding for the mitigation of methane emissions from grazing livestock. Establishing the heritability of methane emissions and its genetic associations with other performance traits is key to predicting the expected response to selection. Understanding how these parameters change with environment (i.e. genotype by environment interactions) is also important for incorporation into breeding objectives.

The aims of ASSGN are to:

- Produce a common protocol for the measurement of methane emissions;
- Identify co-measurement of appropriate correlated and productive traits;
- Formalise protocols for the collection and storage of rumen samples from all animals measured; and,
- Define the criteria for data sharing and analysis (including meta-analysis) among all contributing parties.

See <http://www.asggn.org/> for further information.

The livestock sector, particularly ruminants, is estimated to contribute up to 18% of total global anthropogenic GHG emissions. Preliminary data suggests that genetic selection to reduce methane emissions is possible. The METHAGENE Network was formed to co-ordinate and strengthen EU scientific and technical research through improved cooperation and interactions, which is essential for breeding ruminants with lower environmental footprints resulting in less contribution to global warming. METHAGENE is supported through COST action FA1302.

METHAGENE aims to:

- Establish a network of EU researchers to enable large-scale methane measurement on individual ruminants for genetic evaluation (4 working group + communication group)
- Define the best trait for methane emissions;
- Harmonise protocols for large-scale methane measurements using different techniques;
- Identify proxies for methane emissions to be used for genetic evaluations; and,
- Quantify benefits for producers when incorporating genetics into GHG reductions.

See <http://www.methagene.eu/> for further information.

2.6 Rumen Microbial Genomics Network (RMG) – *Dr Sharon Huws*

The Rumen Microbial Genomics Network (RMG) is a global collaborative network of researchers with a common set of principles and guidelines in rumen microbial genomics to underpin the development of methane mitigation and rumen adaptation technologies. The Network's efforts are focused on generating a shared comprehensive data resource that will enable investigators to characterise the relationship between the composition of the rumen microbiome (or of parts of the rumen microbiome) and the efficient bioconversion of fibrous feedstuffs, leading to a more environmentally acceptable production of nutritious foods in all parts of the world.

The aim of the network is to use genomic technologies to better understand rumen microbes. This was initially expected to be achieved through the exchange of staff/students (but this required funding mechanisms).

Within the Network are two projects:

- Global Rumen Census
 - To survey the diversity of microbes present in rumen samples obtained from a range of locations and farming situations covering a wide range of ruminant species, breeds, feeds and locations.
- Hungate1000
 - To produce a reference set of rumen microbial genome sequences from cultivated rumen bacteria and methanogenic archaea, together with representative cultures of rumen anaerobic fungi and ciliate protozoa.

The network has a database of 200 email addresses, covering all continents, however they are not all actively participating.

Further information is available at <http://www.rmgnetwork.org.nz/>.

2.7 RuminOmics – *Dr Kevin Shingfield*

The FP7 RuminOmics project, aims to address the question of whether the animal itself determines its own microbiome and whether this is a heritable trait. The project aspirations are to:

- Answer the animal-microbe conundrum;
- Leave a bioinformatics and environmental legacy; and,
- Produce a trained and more efficient industry.

The project has compiled data from experiments that have been finished in order to prepare papers for publication before the project ends in 2016.

RuminOmics comprises of 11 partner organisations, which cover a number of different skills to enable the development of tools for the research community, train young scientists and disseminate information.

For further information see <http://www.ruminomics.eu/>.

2.8 Pangenome – Professor Phil Vercoe (presented by Dr Yvette de Haas)

This international collaboration brings together scientific expertise to coordinate livestock systems research focused on reduction and/or abatement of GHG emissions. The programme is funded by the Federal Department of Agriculture (Australia) and Meat and Livestock Australia to focus on the challenge of extending the pangenome concept to link the host genome to its rumen microbiome in order to maximise the impact on reducing methane emissions and optimising productivity.

3 SCIENTIFIC PRESENTATIONS

Network members were invited to give presentations on relevant work, in order to highlight the breadth of expertise within and across Networks. The session was very well received by delegates and it was requested that it should be repeated at any future Joint LRG Networks workshops, with a special emphasis of inviting post-doctoral and PhD students in order to drive engagement.

The presentation titles are given below:

- Association between metabolic status and methane production in dairy cows – *Dr Björn Kuhla, Leibniz Institute for Farm Animal Biology*
- Mitigating enteric methane emissions: impact of nutritional quality of grass herbage and grass silage – *Dr Jan Dijkstra, Wageningen University and Research Centre*
- Early-life nutritional interventions to reduce methane emissions – *Dr David. R. Yanez-Ruiz, Spanish Council for Scientific Research*
- Variation in methane emissions in large populations of dairy cows – *Prof. Phil Garnsworthy, University of Nottingham*
- Comparison of methods to determine methane emissions from dairy cows – *Prof. Pekka Huhtanen, Swedish University of Agricultural Sciences*
- Proxies in the context of COST action ‘Methagene’ and Overview of FACCE-JPI ‘RumenStability’ project – *Prof. Richard Dewhurst, Scotland’s Rural College*
- Lipogenic and glucogenic compounds: their interaction with rumen metabolism, animal health, product quality and potential as biomarker – *Prof. Veerle Fievez, Ghent University*
- Use of the milk MIR spectra with a lactation stage specific model to predict methane emitted by dairy cows – *Frédéric Dehareng, Walloon Agriculture Research Centre*
- Investigations into novel pathogens associated with bovine reproductive failure – *Dr Nick Wheelhouse, Moredun Research Institute*
- Greenhouse gas emissions and Trypanosomiasis control in East Africa – *Tim Robinson, International Livestock Research Initiative*
- Climate change, methane emission and livestock production: Indian perspective – *Dr Raghavendra Bhatta, National Institute of Animal Nutrition and Physiology*
- Creation of database for meta-analysis – *Prof. Ermais Kebreab, University of California, Davis*

4 DISCUSSION SESSION

The session focused on small group discussions (groups given in Table 1) around the below pre-set questions:

1. Identify a major challenge(s) in the area of livestock GHG mitigation research.
2. What can be gained from collaboration between LRG Networks?
3. What are the roadblocks to enhancing collaboration among members within a network?
4. What are the roadblocks to enhancing collaboration among LRG networks?
5. Propose one specific step/action that is likely to increase collaboration among networks.
6. How can the Networks be sustained in the future and are we on a route to survival or a route to extinction?

Table 1 Groups for afternoon discussion session

Group	1	2	3	4	5
Chair	Ilias Kyriazakis	Alex Hristov	Tim Robinson	Chris Reynolds	Yvette de Haas
Minutes	Adele Hulin	Juliana Lopes	Alice Willett	Kirsty Hammond	Les Crompton
Participants	Daniel Rearte Veerle Fievez Hernando Florez-Diaz Eugene Maguy Jamie Newbold Eileen Wall Sharon Huws	José Ignacio Arroquy Peter Lund Björn Kuhla Kevin Shingfield Richard Dewhurst Claudia Arndt	Frédéric Dehareng Marie-Laure Vanrobays Alireza Bayat Raghavendra Bhatta Nick Wheelhouse Phil Garnsworthy Scott Zimmerman Thakshala Seresinhe	Nico Peiren Jose Luis Rodriguez Ilma Tapio Angela Schwarm Stephen Olinga Juan Tricarico Soren Peterson Abdul Chaudhry	Camila Muñoz Per Theilgaard Cécile Martin Jan Dijkstra David R. Yanez-Ruiz Michael MacLeod Ermias Kebreab Jonathan Levin José Ignacio Velazco

The summary drawn from the conclusions of each group is listed under the relevant question headings.

4.1 Identify a major challenge(s) in the area of livestock GHG mitigation research.

Table 2 Challenges identified in the area of livestock GHG mitigation research

Challenge	Comments
Funding	E.g. working with the available data requires funding.
Engaging (feed) industry in GHG mitigation research through proposing win-win solutions.	The feed industry is more likely to support grain-based systems, whereas GHG mitigation research and consumers might support grass-based systems.
Limitations to the metrics currently used to estimate the environmental impacts of livestock production.	Metrics related to ecology and biodiversity should be included
Increasing production efficiency in livestock production systems in Latin America.	
Convincing the industry and consumer about the necessity to change the way beef/milk is produced in the tropics.	

Challenge	Comments
Poor availability of quality data.	Would it be too much for the animal science community to come together and say that you can't publish unless you make the data available?
The available data are not often in a compatible format.	Data, methods and statistics need to be shared.
Integration and interaction of different approaches to mitigation research are required.	
Focus more on bi-products.	
Consider ruminant production in diverse systems.	
There is a need for standard benchmarks and common objectives across a range of disciplines or groups.	'Roadblocks' are caused by enforcing the standardisation of data recording.
We are unable to measure everything.	
No clear, quantified economic benefits for GHG mitigation from a whole systems perspective (calculating/modelling vs. measured).	Economic impact needs to be accounted for
There are a lot of confounding effects/conflicting outcomes.	For example decreasing methane whilst increasing nitrogen
The effects that are measured can often be small.	The measurements need to be proven and are often variable and difficult to pinpoint.
How can the benefits be proven?	
The area of work is becoming largely technology driven.	This causes issues with a lack of biology and experimental design. Development of Standard Operating Procedures (SOP) required and a translation into practical aspects.
Understanding the limitations of studies and realising that they are not applicable across the board.	
Sensitivity analysis (Life Cycle Assessment)	
Multi-disciplinary approach is required.	Inputs from other disciplines are needed, in order to develop new research, as communities often talk to the same people regularly. Where outside of the networks or research areas do we need to look?
Increase public perception, including farmers (particularly in developing countries)	Increase understanding and awareness of the need to reduce GHGs.

4.2 What can be gained from collaboration between LRG Networks?

The discussions clearly identified that there are benefits to be gained through collaboration between LRG networks. Key areas highlighted were preventing the duplication of effort, sharing knowledge and data and providing an awareness of the work that others are carrying out. This may help to reduce individual and institution workloads as well as providing different perspectives, approaches or techniques for tackling problems. Collaboration across the Networks had the benefit of encouraging challenge by colleagues which would result in improved methodology or added depth to current research along with giving members the time to explore interactions between different types of GHG interventions.

Funding was an issue that was highlighted as a major challenge to the area of livestock GHG mitigation research. Collaboration across the Networks was thought to be beneficial in facilitating the sharing of information about funding opportunities and enabling collaboration in putting together proposals and project consortiums.

The structure of this Joint Networks Workshop, provided a more systems-based type of collaboration than would typically be achieved from scientific conferences. As well as providing an opportunity for active learning and broadening individuals areas of expertise and contacts.

Developing trust was another example of what can be gained through collaborations between networks. A well-established network, and the results of networking opportunities, leads to trust between researchers, which is essential if the networks want to encourage the sharing of data and collaboration. Finally, it was identified that the networks could come together to share administrative burdens.

4.3 What are the roadblocks to enhancing collaboration among members within a network?

Funding and time were discussed as roadblocks to greater levels of collaboration between members with a network. This encompasses the ability to propose and seek funding for joint projects, fund network administration as well as getting sponsorship for holding meetings and covering researcher's travel costs.

Mechanisms are needed to make it easier for less developed countries to collaborate with developed countries. In the case of Latin America, country or institute may be willing to put money into a project but need involvement from more developed research institutes.

The confidentiality of projects as well as the competitive nature of achieving funding can prevent the sharing of information. This is further confounded by the influence of the personal relationship of an individual has with the networks and between members. The level of engagement people have with an action influences the input and as such the "what's in it for me?" element will influence how proactive individuals are at getting involved. Therefore tangible benefits are required to encourage member participation (benefits such as data sharing, techniques, training opportunities) The networks comprise of a large number of members, and so there was thought to be a benefit to enabling smaller working groups when tackling specific issues or proposals.

A further roadblock to collaboration among members within a network, was cited as resulting from poor communication.

Input from early career scientists was seen as very important as they are the future of the networks and research communities. There is currently little input from early career/younger generation scientists in the networks and it was suggested that key scientists need to bring post-docs and PhD students to network workshops; the benefits for junior staff would be high as they don't generally have many contacts. Start-up PhD students could be involved in more multi-disciplinary project proposals.

4.4 What are the roadblocks to enhancing collaboration among LRG networks?

A number of the roadblocks that were highlighted as preventing collaboration within networks, such as time (to input into networks and keep up with the activity of other networks), funding and confidentiality, were also quoted as roadblocks to collaboration between networks.

Communication between networks was identified as a roadblock. Although the LRG newsletter releases articles on all networks, not everyone reads them. A possible solution is for individuals who are involved in more than one network to be a portal for communication. Further to this, finding imaginative ways to conduct LRG network meetings to encourage wider participation is important. However, it was noted, that in the early stages of a network, it is important for members to be able to meet face to face in order to develop relationships and gain trust.

The question was raised as to whether all relevant people were included within the networks and if there is a motivation for individuals to learn or work 'outside the box'. The active participation of industry was thought to be an important solution, as it provides a trigger for change.

4.5 Specific steps/actions that are likely to increase collaboration among networks

Action	Desired outcome
Better communications between networks	<ul style="list-style-type: none"> • Could be achieved with the use of webinars, such as those used by the GRA Modelling Platform (GRAMP) • Dedicated website for each network (ideally located within the GRA website), that gives detail about what is happening and who to contact. • Build in more interaction/communication into our activities and allocate time (i.e. during workshops). • Include interaction/communication into project protocols (work packages) as a measurable impact.
Create a better level of understanding about the work of individuals and networks.	<ul style="list-style-type: none"> • Host visitors to your office or lab. • Enable staff and PhD exchanges between network members. • Host regional conferences/meetings (maximum of a few hours) that are easier to attend and encourage greater participation. • Produce a twice yearly newsletter from each network, to be distributed around all LRG networks.
Provide administrative support across networks	<ul style="list-style-type: none"> • Enable better communication and ease of arranging meetings or collaborative working. • Identify what functions are available to provide funding to facilitate people working within the networks and coordinate with each other. • Organise and promote cross-cutting meetings.
Develop focus topics or specific issues that attract required disciplines.	<ul style="list-style-type: none"> • PhD studentships and papers. • Review membership to enhance the engagement of end-users. • Identify common objectives and cross cutting studies that would be relevant to all networks (i.e. yield gap analysis). • Promote joint publications to encourage people to collaborate and share data/information/time (a metric within UK universities is the number of papers in collaboration outside the UK).

Action	Desired outcome
Incentivise early career scientists through e.g. a Master Class competition with a prestigious award	<ul style="list-style-type: none"> Identify top PhD and post-doc students to bring small groups together from each network, enabling them to form links throughout their career. Local governments could be approached to provide funds.
Improve access to and quality of data.	Encourage journals and funders to require primary data to be published.

4.6 How can the Networks be sustained in the future and are we on a route to survival or extinction?

The overall conclusion from each group was that the networks were on a route to survival, however one group encouraged members to think about the completion of the networks as a positive; as we are aiming towards solving the problem of GHGs from agriculture.

In order to sustain the networks, the most common suggestion was to showcase the benefits of the networks and highlight tangible outputs. This will have multiple outcomes, in that it will encourage more network members to become active participants and will help to attract funding opportunities. Further ways of attracting funding included inviting policy makers and industry to join networks and attend workshops and to produce media releases directed at the general public, scientific community and industry. There was a diversity of views regarding the appropriateness of supporting the Networks through Industry funding. This was considered more appropriate for some Networks rather than others. Bringing in early career scientists was seen as important for the long term sustainability of the networks.

The possibility of supporting the Networks through international, global initiatives was also discussed. Horizon 2020 may offer some opportunities for Network funding and support. The Marie Curie Rise scheme was highlighted as a funding stream that could help the Networks and it was thought that a consortium approach would achieve greatest success (Dr Sharon Huws offered to forward details).

The overarching theme across the discussion questions and a key to the survival of the Networks is through building and maintaining good relationships with people in and across Networks.

5 CLOSING REMARKS AND FURTHER ACTIONS

The workshop was closed with a discussion open to all participants. Feedback on the Joint Networks workshop was that it had been a success and had provided an opportunity to find out about activities of the other Networks, however there is a need to invite PhD students and Post-Docs to ensure the future of the research and to bring enthusiasm and drive to the Networks. Future joint workshops would not need to go into as much detail on the network presentations which would give more time for scientific presentations and networking activities. It was agreed that there should be another joint workshop, the possibility of holding it in the margins of Greenhouse Gas and Animal Agriculture Conference in Melbourne, Australia (14-18 February 2016) was raised.

The requirement for financial assistance for the Networks was a recurring theme throughout the workshop. It was agreed that there was no appetite to charge membership fees, particularly as there are no tangible outputs, and as this would be likely to exclude participants from developing countries. Some EU funding streams to support the Networks were identified. The Networks need to be flexible and could, for example, get involved with other initiatives or alliances that require expertise (e.g.

nutritional recommendations). The networks provide a useful resource as they hold a lot of expertise. It would be worth spending time considering different structures for collaboration.

Engagement with industry was discussed. There are links with industry that can be drawn upon e.g. the Animal Health Network has links with GASL, an industry wide body, and STAR-IDAZ which has industry involvement. The Networks need to be careful not to expand their remit into roles / initiatives that are already there. The Networks are academic groupings which need to engage with industry and policy makers to define whether outputs are realistic. Networks need to invite industry to share their vision and information on their objectives. A multi-disciplinary approach, provided by collaboration between the networks, could be beneficial to industry. It was suggested that industry may have a place within smaller working groups of scientists from relevant networks.

The focus solely on GHG emissions is limiting and the networks need to expand their focus by including wider diffuse pollution issues. It is important for the networks to identify and effectively communicate win-wins. Addressing more than one issue would boost industry interest as stakeholder / customer requests can be varied.

It was identified that each Network needs an output and that they should define one or two outputs that will be delivered (e.g. review paper, recommendation of a practice). The Networks can't achieve everything so need to focus on producing some specific tangible outputs. Some countries would find it easier to be involved in a network if they have a clear project or output to contribute towards.

All Networks need to be proactive in promoting their outputs to other networks, industry and policy makers, as well as feeding them back to the GRA. The Networks need to provide ideas to the LRG Co-chairs on how the GRA can support them (e.g. finding funding opportunities for research and/or administrative support).

The LRG are producing case studies of research and activities delivered under the GRA and the Networks should utilise this opportunity to demonstrate the usefulness of the networks and what they are achieving.

The chair of the concluding session, Dr Alex Hristov, encouraged all members of the Networks to read communications (emails, newsletters, etc.) and provide ideas. This is needed from all members and not just core participants. Bi-annual brainstorming sessions would provide an opportunity to share ideas.

APPENDIX 1: PARTICIPANTS LIST

Forename	Surname	Research institute	Country
Claudia	Arndt	Environmental Defence Fund	Germany
José Ignacio	Arroquy	National Agricultural Technology Institute (INTA)	Argentina
André	Bannink	Wageningen UR	Netherlands
Dave	Bartley	Moredun Research Institute	UK
Alireza	Bayat	Natural Resources Institute Finland (Luke)	Finland
Raghavendra	Bhatta	National Institute of Animal Nutrition and Physiology (ICAR)	India
Abdul	Chaudhry	Newcastle University	UK
Adam	Cieslak	Poznań University of Life Sciences	Poland
Les	Crompton	Reading University	UK
Yvette	de Haas	Wageningen UR	Netherlands
Frédéric	Dehareng	CRA-W, Valorisation of Agricultural Products Department	Belgium
Richard	Dewhurst	Scotland's Rural College (SRUC)	UK
Jan	Dijkstra	Wageningen UR	Netherlands
Veerle	Fievez	Ghent University - Lanupro	Belgium
Hernando	Florez-Diaz	Colombian Corporation of Agricultural and Livestock Research (CORPOICA)	Colombia
Phil	Garnsworthy	University of Nottingham	UK
Hedi	Hammani	University of Liège- Gembloux Agro-Bio Tech	Belgium
Kirsty	Hammond	Uni of Reading UK/AgResearch NZ	UK & New Zealand
Alex	Hristov	Penn State University	USA
Pekka	Huhtanen	Swedish University of Agricultural Sciences	Sweden
Adele	Hulin	ADAS	UK
Sharon	Huws	Aberystwyth University	UK
Ermias	Kebreab	UC Davis	USA
Björn	Kuhla	Leibniz Institute for Farm Animal Biology (FBN)	Germany
Ilias	Kyriazakis	Newcastle University	UK
Jonathan	Levin	INRA	France
Juliana	Lopes	Penn State University	USA
Peter	Lund	Aarhus University, AU Foulum	Denmark
Michael	MacLeod	Scotland's Rural College (SRUC)	UK
Maguy	Eugene	INRA	France
Cécile	Martin	INRA	France

Forename	Surname	Research institute	Country
Michaël	Mathot	Walloon Agricultural Research Centre CRA-W, Gembloux	Belgium
Camila	Muñoz	Instituto de Investigaciones Agropecuarias (INIA Remehue)	Chile
Jamie	Newbold	Aberystwyth University	UK
Nico	Peiren	Institute for Agricultural and Fisheries Research (ILVO)	Belgium
Soren	Peterson	Aarhus University	Denmark
Daniel	Rearte	National Agricultural Technology Institute (INTA)	Argentina
Chris	Reynolds	Reading University	UK
Tim	Robinson	ILRI	Kenya
Jose Luis	Rodriguez	Colombian Corporation of Research in Livestock and Agriculture	Colombia
Angela	Schwarm	ETH Zurich	Switzerland
Thakshala	Seresinhe	University of Ruhuna, Mapalana, Kamburupitiya	Sri Lanka
Kevin	Shingfield	Aberystwyth University	UK
Ilma	Tapio	Natural Resources Institute Finland (Luke)	Finland
Per	Theilgaard	Vitfoss	Denmark
Juan	Tricarico	Innovation Center for U.S. Dairy	USA
Marie-Laure	Vanrobays	University of Liège- Gembloux Agro-Bio Tech	Belgium
José Ignacio	Velazco	INIA - Treinta y Tres	Uruguay
Eileen	Wall	Scotland's Rural College (SRUC)	UK
Nick	Wheelhouse	Moredun Research Institute	UK
Alice	Willett	ADAS	UK
David R.	Yanez-Ruiz	Spanish Council for Scientific Research (CSIC)	Spain
Scott	Zimmerman	C-Lock Inc	USA

APPENDIX 2: GROUP PHOTO



Global Research Alliance Livestock Research Group Networks Workshop



**26th June
2015
08.30 – 17.15**



University of Reading, UK

Address: School of Agriculture, Policy and Development, University of Reading, Earley Gate, Reading Berkshire. Sat Nav post code RG6 7BE

Parking: Car Park 23 in front of the School of Agriculture or Car Park 22 next to the surrounding buildings. Parking permits are available via sending your vehicle registration to h.f.owens@reading.ac.uk

Overview

This workshop brings together the dedicated research networks of the Livestock Research Group of the Global Research Alliance (GRA) on Agricultural Greenhouse Gases (www.globalresearchalliance.org)

Workshop objectives

- 1) Develop/improve communication and collaboration among GRA Livestock Research Group Networks;
 - 2) Explore interdisciplinary approaches for tackling the issue of greenhouse gas emissions from animal agriculture: identifying the challenges, looking for synergies, creating collaborative opportunities, and defining remaining interdisciplinary questions.
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Workshop Agenda

Friday 26th June 2015, Joint Networks Meeting

Posters available for viewing throughout the day.

Time	Agenda Item	Delegate
8.30 – 8.45	Registration	
8.45 – 9.00	Welcome	Chris Reynolds
9.00 – 10.20	Network Presentations, 10 min each (8 min for presentation, 2 min for questions)	<i>Chaired by Chris Reynolds</i>
9.00 – 9.10	Feed and Nutrition Network (FNN)	Alex Hristov
9.10 – 9.20	Grassland Research Network (GRN)	José Ignacio Velazco
9.20 – 9.30	Manure Management Network (MNN)	Jonathan Levin
9.30 – 9.40	Animal Health Network (AHN)	Ilias Kyriazakis
9.40 – 9.50	Animal Genetics Networks (ASGGN + METHAGENE)	Yvette de Haas
9.50 – 10.00	Rumen Microbial Genomics Network (RMG)	Sharon Huws
10.00 – 10.10	Ruminomics	Kevin Shingfield
10.10 – 10.20	Pangenome	Phil Vercoe presented by Yvette de Haas
10.20 – 10.30	Opportunity for discussion	<i>Chaired by Chris Reynolds</i>
10.30 – 11.00	<i>Tea/coffee break</i>	
11.00 – 13.00	Scientific presentations, 10 min each (8 min presentation and 2 min for questions)	<i>Chaired by Chris Reynolds</i>
11.00 – 11.10	Association between metabolic status and CH ₄ production in dairy cows	Björn Kuhla
11.10 – 11.20	Mitigating enteric methane emissions: impact of nutritional quality of grass herbage and grass silage	Jan Dijkstra
11.20 – 11.30	Early-life nutritional interventions to reduce CH ₄ emissions	David R. Yanez-Ruiz
11.30 – 11.40	Variation in methane emissions in large populations of dairy cows	Phil Garnsworthy
11.40 – 11.50	Comparison of methods to determine methane emissions from dairy cows	Pekka Huhtanen
11.50 – 12.00	Proxies in the context of COST action 'Methagene' and Overview of FACCE/JPI 'RumenStability' project	Richard Dewhurst
12.00 – 12.10	Lipogenic and glucogenic compounds: their interaction with rumen metabolism, animal health, product quality and potential as biomarker	Veerle Fievez

12.10 – 12.20	Use of the milk MIR spectra with a lactation stage specific model to predict CH ₄ emitted by dairy cows	Frédéric Dehareng
12.20 – 12.30	Investigations into novel pathogens associated with bovine reproductive failure	Nick Wheelhouse
12.30 – 12.40	Greenhouse Gas emissions and Trypanosomiasis control in East Africa	Tim Robinson
12.40 – 12.50	Climate change, methane emission and livestock production- Indian perspective	Raghavendra Bhatta
12.50 – 13.00	Creation of database for meta-analysis	Ermias Kebreab
13.00 – 14.00	<i>Lunch</i>	
14.00 – 14.45	Break-out discussion sessions	<i>Chaired by Alex Hristov</i>
14.45 – 15.15	<i>Tea/Coffee Break</i>	
15.15 – 16.45	Report by each discussion group (about 5 min), followed by general discussion and overall conclusions	<i>Chaired by Alex Hristov</i>
16.45 – 17.15	Closing remarks and further steps	Chris Reynolds / Alex Hristov
17.15	Meeting Adjourned	