UK Agri-Science & Innovation

Supporting international actions to mitigate agricultural GHG emissions

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Welcome

to the fifth newsletter on United Kingdom (UK) activities which support the Global Research Alliance (GRA) on Agricultural Greenhouse Gases. UK technical and scientific participation in the GRA builds upon the UK Government investment in the UK Agricultural Greenhouse Gas (GHG) Research Platform and aims to promote and enhance UK research into agricultural GHG monitoring and mitigation.

The aim of the newsletter is to update UK and international readers on UK-led GRA actions, UK contributions at international meetings and capability building events, and participation in GRA networks and Agriculture, Food Security and Climate Change Joint Programming Initiative (FACCE-JPI) projects. The newsletter also features topical UK projects of international interest with this publication covering the UK research on 'Minimising Nitrous Oxide Intensities of Arable Crop Products (MIN-NO).'

Articles in this issue:

ABOUT THE GRA

The GRA brings countries together to find ways to grow more food without increasing GHG emissions. Established in 2009, the GRA aims to address the global challenge of mitigating GHG emissions and increasing soil carbon sequestration without impacting agricultural productivity, and therefore focusses on reducing GHG emissions intensity (emissions per unit of output). The GRA, which is founded on the voluntary, collaborative efforts of member countries, aims to enhance scientific capacity via active exchange of data and research, development and extension of technologies and practices, and identifying research gaps and potential opportunities for new cross-national research collaborations. Activities are progressed within three research groups (Livestock, Croplands and Paddy Rice) and two cross-cutting groups (Inventory & Monitoring and Soil Carbon & Nitrogen Cycling) which are currently being merged and enhanced to form a new 'Integrative Research Group'. There are currently 46 member countries including the UK. Visit the GRA website for further information.

UK ACTIVITIES SUPPORTING THE GRA

Earth Observation for GHG inventory reporting: recent webinars

Earth Observation (EO) has the potential to fulfil some of the activity data requirements of the integrated Agriculture, Forestry and Other Land Use (AFOLU) inventory. The outcomes of the UK-led project supporting the GRA which explored the potential for EO to provide agricultural activity data for inventory compilation were shared via a series of webinars on 29th February 2016. These webinars were facilitated by the Global Research Alliance Modelling Platform (GRAMP) and were repeated in a second session to accommodate different time zones and enable wide international participation.

In each session, the first webinar shared the outcomes of an international stocktake which surveyed GRA countries to characterise their inventory data requirements; existing utilisation of EO; and perceived strengths, weaknesses and potential for more widespread EO usage. This international survey was completed by ten countries with varying land areas, climate, and land use. It showed that EO data are already used to compile some aspects of GHG inventory data, with notable differences between inventory themes and countries, but that there is considerable scope for increased use of EO through wider knowledge sharing/transfer (e.g. method demonstration). The survey identified a number of requirements to promote wider adoption of EO and enable it to be used to its fullest potential, such as improving validation methodologies and procedures. Participating countries expressed willingness to collaborate on EO utilisation and capacity building via in-kind contributions or travel & subsistence for networking.

The international stocktake invited countries with previous experience of using EO for GHG reporting to take part in developing historic case studies to document their

experiences. Canada, Mexico and New Zealand provided three such case study examples. These case studies explored the underpinning reasons for using EO data; implementation processes and timescales; issues encountered and overcome; and plans for EO usage in the future. The second webinar in each session presented details of these case studies and concluded that, due to the range of classification approaches used, there is scope for more joint working across GRA countries to establish and parameterise best practice strategies for land use classification. It was recognised that EO image availability, temporal and spatial resolution, and associated costs are all rapidly changing as new sensors come on-line, and so sharing experiences with using newly-emerging EO data would accelerate EO technology utilisation, develop consistent best practice approaches, and reduce costs.

The third webinar in each session presented a novel case study which evaluated the use of the annually-updated land cover product derived from 500m MODIS satellite imagery for GHG accounting in the UK. The analysis showed that the coarse spatial resolution caused unavoidable mapping errors and subsequent bias in area estimates. Therefore further work should develop a cost-effective method incorporating EO that delivers accurate annual updates of land cover and land use at high spatial resolutions (i.e. 25m or less). This is entirely possible in light of recently-launched satellite constellations with spatial resolutions of 10-20m (e.g. Sentinel).

The webinar facility allowed participants to take part in discussion sessions after each presentation covering technical questions and comments, and exploring the potential to continue activities on the use of EO within the GRA. Further collaborative opportunities include pairing countries identified in the stocktake as having an activity data or EO needs with those countries that have relevant experience, as well as linking up the GRA with other fora and networks (e.g. COST and relevant international conferences).

Interested to find out more?

- ➔ Listen to the webinars here:
  - International Stocktake Handout
  - Historic International Case Studies Handout
  - Novel Case Study Handout
- ➔ View the handouts accompanying each webinar here
- ➔ Contact the project team (see handouts for contact details)

Global Research Alliance Modelling Platform (GRAMP) update

The GRAMP website, launched on 5th June 2015, now has 270 registered and active users. The map opposite shows the geographical distribution of active GRAMP users.

A workshop entitled "The Global Research Alliance Modelling Platform (GRAMP) – a virtual laboratory for biogeochemical ecosystem modelling" was organised at the British Ecological Society Annual Meeting, Edinburgh on 13th December 2015. This workshop brought together a number of leading European scientists and other experts to discuss issues related to GHG field data generation and data modelling to address the challenges of linking lab- and field-based research with ecosystem modelling frameworks. The main objectives were to discuss whether the participants see a role for the GRAMP in their research and networking activities, what the science community's expectations might be, and whether the GRAMP roadmap needs to adapt to meet those expectations. The context of the workshop was set by a number of questions covering scientific concerns.

Generated using https://www.google.co.uk/maps

GRAMP also facilitated the "Earth Observation for GHG Inventory reporting" webinars on 29th February 2016 (see previous article).

Third Annual Workshop of the Animal Health and GHG Emissions Intensity Network

Improved animal health results in productivity and efficiency gains and consequently lower GHG emissions per unit of output; therefore animal health interventions could play an important role in GHG abatement. There are also obvious co-benefits from improved animal health, such as improved farmer livelihoods, animal welfare and potentially human health. The international Animal Health and GHG Emissions Intensity Network brings together researchers in a variety of disciplines to explore links and synergies between livestock health and GHG emissions intensity, and possible GHG mitigation through disease control. The Network focuses on both infectious and non-infectious health challenges.

The third annual Network Workshop was recently held in the margins of the Society for Veterinary Epidemiology and Preventive Medicine conference (SVEPM) in Helsingor, Denmark. It was attended by 21 researchers from 9 countries. The Workshop was an opportunity to share new research and discuss research priorities and opportunities for collaboration. Presentations on current research linking animal disease with GHG emissions set the scene for discussion on research priorities and knowledge gaps. Priorities identified include estimating both aggregate and individual regional disease burden, gathering good quality surveillance data, and disseminating and correctly targeting information on the benefits of improving animal health.

The Network has links with a number of related initiatives and pursued these further in Denmark through presentations from NEAT, STAR-IDAZ, FACCE-JPI and MACSUR. A discussion on collaboration opportunities identified that future collaboration is dependent upon two linked factors: identifying tangible research needs through a gap analysis and securing adequate funding to carry out necessary research.

A collaborative approach would be beneficial to creating an inventory of models and data sources relevant to animal health and disease data. This would be valuable for testing existing and developing new models, as experimental data are often difficult to get hold of. The first step in achieving this is for all Network members to share details of research and published papers onto the Member's Share Area.

Funding options for collaborative projects were identified as; ERA-GAS, SusAn, Bill and Melinda Gates Foundation and COST. Members have taken on actions to apply to new funding streams. Read more on the workshop outcomes in the workshop report.

Following this workshop, the Network has now reached a milestone of over 100 participants. In total the Network has 111 members from 30 countries.

For further information please see the Network webpages.

Please contact animalhealthnetwork@adas.co.uk to be added to the Network's email circulation list, to gain access to the online Members Share Area, or if you have any questions.

UK PARTICIPATION IN INTERNATIONAL RESEARCH

Cattle health and GHG emissions in sub-Saharan Africa

Increasing the production of meat and milk within sub-Saharan Africa (SSA) should provide significant food security benefits. However the resulting increase in GHG emissions presents a challenge, particularly because of the relatively low production efficiencies in the region. One of the factors contributing to production inefficiency is the influence of endemic disease. In theory, disease control should improve the productivity and decrease the emissions intensity (EI) of livestock production. In order to test this, the effects of removing trypanosomiasis (one of the main cattle diseases in SSA) were explored in East and West Africa (MacLeod *et al.* 2015, 2016).

The emissions arising from cradle to farm-gate (i.e. the emissions occurring pre-farm and on-farm, but not post-farm) were quantified using an excel version of GLEAM[1]. The impacts of disease removal having been taken from previous studies, notably Shaw *et al*. (2006, 2014).

The results indicate that when trypanosomiasis is removed in East Africa, the relative increase in (meat and milk) protein output is greater than the increase in GHG emissions, leading to a reduction in the emissions intensity per unit of protein produced of between 2% and 8%, depending on the production system. The main drivers of the decrease in EI are the increases in milk yields and calving rates (see Figure 1).

In the West African systems, removal of trypanosomiasis led to decreases in EI in some systems and increases in others. Why might the EI increase when trypanosomiasis is removed? Although this may look surprising, when the disease is removed more males are kept and used for draft.

[1] FAO's Global Livestock Environmental Assessment Model

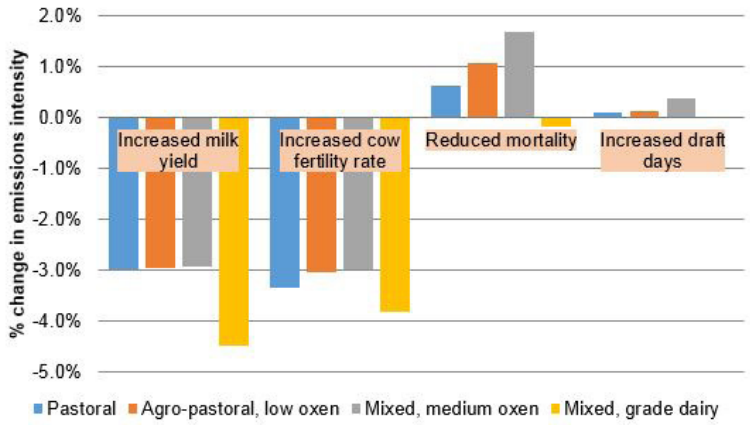

Figure 1. The % change in emissions intensity for separate effects of disease removal for four of the livestock systems in East Africa.

Thus the reductions in EI (arising from increased milk yield, increased cow fertility and decreased mortality) are largely offset by the increases in the use of draft animal power (DAP). While GLEAM allocates some of the emissions to DAP, the use of DAP can lead to an increase in EI in some systems. However, increasing the use of DAP could have a range of ancillary effects not currently captured by the model. For example, displacing human labour with DAP should lead to increased labour productivity and improvements in household income, which in turn should lead to self-reinforcing improvements in food security and economic development. Any change in EI therefore needs to be weighed against the other costs and benefits that arise from trypanosomiasis removal.

In conclusion, while the relationships between animal health, food security and GHG emissions are complex, modelling approaches, such as the one outlined in this article, can help us to understand these relationships and support decision-making.

This project is funded by the International Livestock Research Institute under CCAFS, the CGIAR Research Program "Climate Change, Agriculture and Food Security". The authors are grateful to the UN FAO for permission to use GLEAM in this study. The support of the Government of Italy through the FAO Project "Improving food security in sub-Saharan Africa by supporting the progressive reduction of tsetse-transmitted trypanosomosis in the framework of the NEPAD" (GTFS/RAF/474/ITA) is also acknowledged.

This project was carried out by a team which included Animal Health & GHG Emissions Intensity Network Champion, Dr Michael Macleod (SRUC), and Network Coordinator, Dr Timothy Robinson (ILRI).

Contacts: michael.macleod@sruc.ac.uk and t.robinson@cgiar.org

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MacLeod, M., Vera Eory, William Wint, Alexandra Shaw, Tim Robinson, Pierre Gerber, Giuliano Cecchi and Raffaele Mattioli (2015) Assessing the greenhouse gas mitigation effect of treating bovine trypanosomosis in Eastern Africa. Report to ILRI

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Nitrous oxide emissions from UK arable agriculture are less than previously thought

Results of a major UK research project on 'Minimising Nitrous Oxide Intensities of Arable Crop Products (MIN-NO)' show nitrous oxide (N_2O) emissions (due mainly to use of manufactured nitrogen (N) fertiliser) on UK arable land to be less than previously estimated. The MIN-NO research was conducted over 5 years by a consortium of 23 government, academic, farming and commercial partners with broad interests in future sustainability of the UK's food, feed and fuel supply chains. Multi-site industry data, field experiments and modelling were used to improve estimates of N_2O emissions and emission factors (EF) associated with major UK arable crops (winter wheat, winter oilseed rape, winter barley, spring barley, sugar beet, peas and beans) and representative arable products (chicken, frozen peas, bread, sugar, cooking oil, whisky, bioethanol and biodiesel).

Of 24 field experiments conducted in widely contrasting rainfall, soil and crop conditions, 21 showed measured direct N_2O emissions due to manufactured fertiliser N to be less than the 1% default EF assumed in the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines. A simple model based on fertiliser N rate, annual rainfall and soil clay content (the 'MIN-NO' model) summarised these emissions and predicted a 30-year average EF for arable land across the UK of only 0.46% of fertiliser N applied i.e. less than half the IPCC default.

A set of 'smart' EFs was devised for consideration by UK stakeholders, which were based on the 'MIN NO' model, other MIN-NO results and associated evidence. Calculations derived from these data estimated:

- The implementation of the smart EF for manufactured fertiliser N applied (0.46%) would decrease the current estimate of all N_2O-N emissions from UK agriculture by almost 10%
- The GHG intensity (carbon dioxide equivalent per tonne) of UK grown wheat (which recognises recent emission reductions from fertiliser manufacture) was approximately 30% less than the 'benchmark' GHG intensity using a current default Life Cycle Assessment.
- GHG intensities were also reduced for harvested rapeseed, were similar for sugar beet, and were increased for vining peas.

Most UK arable food products are therefore likely to have smaller GHG intensities than are being estimated at present and, in particular, biofuels made from N-fertilised crops should be considered more effective in reducing GHG emissions than is currently assumed.

Prospects for mitigation of N_2O emissions associated with UK arable cropping are, however, less than previously believed. Calculations showed that the effect of under-fertilising was small and, of the mitigation strategies considered, the maximum possible mitigation for grain or root crops would only be around 30%. Moreover, adoption of N_2O mitigation strategies will, without further regulatory developments, depend on their commercial viability. Consequently, farmers already using abated N fertilisers and following good practice can currently do little more than to continue to focus on fine-tuning their overall nutrient management for optimum efficiency.

The intensive MIN-NO dataset on N_2O emissions, together with data from additional government funded UK field experiments, have been used to improve the UK agricultural GHG inventory by the Agricultural Greenhouse Gas Inventory Research Platform project. Data from MIN-NO have also been used to revise the recently submitted, UK 'Regional emissions from biofuel cultivations' report. The full MIN-NO report is available from AHDB.

The MIN-NO project was sponsored by Defra and Scottish Government through the Sustainable Arable LINK Project LK09128, and we acknowledge extensive contributions of the MIN-NO consortium: ADAS, Agricultural Industries Confederation, AHDB Cereals & Oilseeds, Bayer CropScience, British Sugar, CF Fertilisers UK, the Co-operative Group, Country Land and Business Association, Frontier Agriculture, Hill Court Farm Research, NFU, North Energy Associates, PGRO, Renewable Energy Association, Rothamsted Research (North Wyke), Scotch Whisky Research Institute, SoilEssentials, SRUC, Vivergo fuels, Warburtons and Yara UK.

Contact: Roger.Sylvester-Bradley@adas.co.uk

Global Network for the development and maintenance of nutrition-related strategies for mitigation of CH_4 and N_2O emissions from ruminant livestock (Global Network)

Global Network is a 4 year collaborative project funded through FACCE-JPI involving 10 organisations in 8 countries. Activities of the Global Network are integrated with those of the Feed and Nutrition Network of the GRA Livestock Research Group in which the UK is one of 23 country partners*. Global Network focusses on using nutritional means to mitigate methane (CH_4) emissions and nitrogen losses from ruminants. It aims to stimulate cooperation and exchange of research groups at a global scale and assist stakeholders with state of the art research advice and assessment. Two key goals of Global Network are to create, update and expand databases on mitigation of enteric CH_4 and to develop Standard Operating Procedures and guidelines for conducting and assessing data from *in vitro* and *in vivo* studies designed to evaluate nutritional strategies for mitigation of enteric CH_4 emissions.

The team are currently carrying out meta-analyses of databases generated to evaluate key feed and animal characteristics that determine emissions. The analyses have looked at individual animal measurements of CH_4 and N excretion and at treatment means (both published means available in the literature and unpublished means shared by researchers). A review article on *in vitro* methods has been published in the journal Animal Feed Science and Technology and a review article on *in vivo* methods is currently in press for the same journal.

Last year's main project meeting was held at the University of Reading, UK, in the margins of the Joint Workshop of the GRA LRG Networks. This year the project meeting was held in the margins of GGAA2016 in Melbourne, Australia.

Contact: c.k.reynolds@reading.ac.uk

*List of participating countries and Chairing country: United States. Co-chairing country: the Netherlands. Facilitating countries (those that offered help to organise FNN activities): France, United Kingdom, Switzerland. Participating countries: Australia, Canada, Chile, China, Colombia, Denmark, Finland, Germany, Indonesia, Ireland, Italy, Japan, Malaysia, New Zealand, Norway, Spain, Sweden, Uruguay.

FURTHER INFORMATION

Please contact Defra for further information on UK participation in the GRA and other international initiatives (e.g. FACCE-JPI GHG Mitigation Call. Information on UK participation in the GRA is also available on the UK pages of the GRA website including previous UK Agri-Science & Innovation Newsletters.

Please contact GRA@Defra.gsi.gov.uk in order to receive regular updates on GRA activities, meeting reports, funding opportunities, publications and events.

New Publications from the research groups

Easy-to-read overviews of each research group are now available at the GRA website