Integrative Research Group Meeting

4 February 2019 – Centro Internacional Agricultura Tropica (CIAT), Cali, Colombia

4-5 February 2019

Meeting Report

OVERVIEW

The third meeting of the Integrative Research Group (IRG) of the Global Research Alliance on Agricultural Greenhouse Gases ("the Alliance") was held in Cali, Colombia at El Centro Internacional Agricultura Tropica (CIAT) on the 4th and 5th February 2019. The Alliance meeting was Co-Chaired by France (Dr. Jean- François Soussana, INRA) and Canada (Pamela Joosse, AACD), noting that apologies were received from Richard Eckard, the IRG Co-Chair from Australia.

This report is a summary of the key discussions and outcomes of the meeting. PDF's of the presentations can be downloaded from the resource library on the Alliance website.

PARTICIPANTS

The meeting was attended by 36 participants, representing 13 Alliance member countries, and invited experts. A full list of those in attendance is provided in Appendix 1.

Alliance Members attending: Australia, Brazil, Canada, Denmark, France, New Zealand, Norway, Spain, The Netherlands, United Kingdom, United States of America and Uruguay.

Invited Experts: ISRIC, CIAT, CIRCASA, CCAFS, 4per1000, CIRAD, and EU.

MEETING OUTCOMES

The meeting achieved the following outcomes:

- Network organization and restructuring with three active networks;
    1. Inventories and Nationally Determined Contribution (NDC) Support Network.
    2. Farm to Regional Modelling Network.
    3. Soil Carbon Sequestration Network.
- IRG organisational change: a new Co-Chair sought to replace Richard Eckard from Australia.
- A set of CLIFF-GRADS projects developed by Uruguay.

- Communications: suggested a series of webinars to raise awareness and understanding of IRG activities beyond the research audience, to include policy makers, as a means of demonstrating impact of the IRG networks and wider Alliance activities.
- A short term outcome for the Soil Carbon Sequestration (SCS) Network is a collaboration between Pete Smith and the interested network scientists on an invited review Global Change Biology, with the target submission date of July 2019. The author list for the review is evolving but will likely include 10 – 20 authors. The review currently has the working title of:
    - *"How do we measure, report and verify soil carbon change to realize the potential of soil carbon sequestration for atmospheric greenhouse gas removal?"*
- A call for Members to submit updates to country profiles on the Alliance website.
- The Agri-Benchmark network was discussed at the meeting as a useful collaboration for IRG's scientists and other industry partners through approaching emission reductions by decreasing product level emission intensity.

SUMMARY OF DISCUSSIONS

GROUP OVERVIEW

1. The meeting was opened by the IRG Co-Chair, Dr Jean-Francois Soussana of France. The IRG has held two prior annual meetings with the last meeting held in Paris from the 17th to 18th January 2018. The group has since undergone organizational changes in Canada's representation with Dr Pamela Joosse replacing Dr Brian McConkey, and in Australia's representation with Robyn Johnstone being replaced by Dr Richard Eckard. Richard indicated that Australia will now be seeking a Co-Chair to replace him.

2. In Paris, the five initial IRG Networks were streamlined into the following four networks; Soil Carbon Sequestration, Field Scale Modelling, Farm to Regional Scale and Greenhouse Gas Inventories.

3. The purpose of the IRG is to foster collaboration in the science community across Alliance research groups and between Alliance member countries, international partnerships, research organisations and research institutions to ultimately develop international knowledge and capabilities for estimation, monitoring, and projecting greenhouse gas emissions and mitigation, as well as soil carbon sequestration, within and across agricultural systems.

SECRETARIAT UPDATE

4. The Alliance Special Representative, Hayden Montgomery provided an update on the progress of the Alliance since the 2018 council meeting, including new members and partners, new collaborations and an overview of its international participation.

5. The Alliance now has 56 members, five of them new since the last IRG annual meeting Malawi, Mongolia, Ethiopia, eSwatini and Uganda. The number of Alliance partnerships grew from 14 to 17 in 2018. The Alliance will continue to work on growing its membership and partnership to foster international research collaboration in greenhouse gas quantification and mitigation.

6. Outcomes from the 2018 council meeting that are of interest to the IRG are;

- Germany and Indonesia took on the roles of Council Chair and Vice-Chair.
- Senegal confirmed as the third Co-Chair for the Paddy Rice Research Group (PRRG).

- The Council discussed the need for a wider Alliance communications plan targeted at improving science communication.
- The term for the Special Representative position will be renewed, following the successful two year trial period for this position. The Terms of Reference for the Special Representative will also be reviewed.
- Two new Flagships were proposed by the Council; 1) Nitrogen – to better quantify nitrous oxide emissions and implement mitigation solutions and, 2) Circular Food Systems – to assess the feasibility and potential of decreasing greenhouse gas emissions from circular agro-food systems. Co-Chairs emphasized the need for Members to support Flagships with people and resources if they are to succeed as intended.
- The Koronivia Joint Work on Agriculture (KJWA) will be hosting a series of workshops at the regular sessions of the Subsidiary Bodies of the United Nations Framework Convention on Climate Change (UNFCCC) focused on soil carbon, nutrient management, livestock, amongst other topics, and the Alliance hopes to be invited to attend as an expert presenter at these workshops.

7. Over the past year, the Alliance has awarded multiple scholarships through a joint scholarship programme known as CLIFF-GRADS[1]. The CLIFF-GRADS programme provides short-term scientific training and research stays and is open to students from developing countries currently enrolled in PhD programmes. Topics of research are related to the measurement and management of greenhouse gas emissions and carbon storage in agricultural systems as well as greenhouse gas emissions from food loss and waste.

8. All Alliance Members and Partners are encouraged to put forth relevant projects where PhD students could be hosted to be considered for the next CLIFF-GRADS call. Developing country Members are encouraged to communicate CLIFF-GRADS calls to students with the relevant expertise. There have been two CLIFF-GRADS calls to date with a total of 42 scholarships having been awarded to students from 18 different countries. There are plans for a third call later in 2019 and Alliance Members are encouraged to identify research opportunities to advertise in this call.

9. The 9th annual Alliance Council meeting will be held alongside the Global Science Conference on Climate Smart Agriculture in Bali, Indonesia from the 6th to the 7th October 2019.

NETWORK UPDATES & BREAKOUT SESSION OUTCOMES

10. On the first day, the current IRG Network leads gave an update on their Flagships, progress to date and future opportunities.

11. It was discussed following the updates that there should be a change to the organizational structure of the Networks, with the Grasslands Network having naturally merged into the Soil Carbon Sequestration Network, and the Field Integration Network likewise being incorporated into the Farm to Regional Scale Network due to the similitude and crossover of ongoing research. The proposed new name for the Greenhouse Gas Inventories Network is the Inventories and NDC's Support Network to encapsulate the significance of highlighting the role of greenhouse gas emission and mitigation research in achieving NDC's across all Alliance members.

[1] CLIFF-GRADS is a combination of the Climate Food and Farming (CLIFF) network of Climate Change, Agriculture and Food Security (CCAFS) programme of the Consultative Group on International Agriculture Research (CGIAR) and the GRA Development Scholarships (GRADS)

12. Three breakout sessions for targeting future IRG Network action were conducted based on this new Network structure arising from the third IRG meeting;

1. Farm to Regional Scale,
2. Inventories and NDC Support, and
3. Soil Carbon Sequestration.

13. The following summarizes the Networks, their achievements to date and the outcomes from the 2019 IRG annual meeting breakout sessions.

Field Integration Network *(merged with the Farm to Regional Scale Network)*

14. The Field Integration Network was chaired by Jean-François Soussana of INRA France and Co-Chaired by Pete Smith of Aberdeen University in the UK. The objective of the Network was to advance integrative knowledge on agricultural greenhouse gas (GHG) emissions at field scale. The main activity undertaken was to compare, improve and benchmark 24 biogeochemical plant-soil-atmosphere models for their ability to simulate greenhouse gas emissions and soil carbon stock changes, as well as their mitigation options both for arable crop rotations and for grasslands.

15. The Network comprised over 50 scientists providing site based data and from both the fields of modelling and statistics. Several papers were published which directly contribute to the Alliance's core work and are a good example of international collaboration facilitated through the IRG;

1. *The use of biogeochemical models to evaluate mitigation of greenhouse gas emissions from managed grasslands. R Sándor, F Ehrhardt, L Brilli, M Carozzi, S Recous, P Smith, V Snow, ... Science of The Total Environment 642, 292-306*
2. *Assessing uncertainties in crop and pasture ensemble model simulations of productivity and N_2O emissions. F Ehrhardt, JF Soussana, G Bellocchi, P Grace, R McAuliffe, S Recous, ... Global change biology 24 (2), e603-e616*
3. *Review and analysis of strengths and weaknesses of agro-ecosystem models for simulating C and N fluxes*
   L Brilli, L Bechini, M Bindi, M Carozzi, D Cavalli, R Conant, CD Dorich, ...Science of the Total Environment 598, 445-470

16. It was concluded through this work that ensembles of models simulating nitrous oxide emissions perform well with minimal data, and that across the final model ensembles there is a significant correlation in emission intensity between model simulations and observations across all sites, crops and stages of growth.

17. No more coordinated activities are planned in 2019 by this Network, but individual projects continue and forthcoming papers are planned especially on mitigation options and in comparisons of bare fallow models. Work identified for this Network has largely been completed or incorporated into the Soil Carbon Sequestration or Farm to Regional Scale Networks. The next steps will be to upscale from field to farm and region. Therefore, follow-up activities will be organized within the Farm to Regional Scale Network.

Farm to Regional Scale Network

18. The Farm to Regional Scale Network update was presented by Pamela Joosse on behalf of the co-lead, Richard Eckard of Australia, and is co-led by Petr Havlik of IIASA[2]. The objective of the Network is to foster and encourage collaboration between experienced and emerging scientists with

[2] International Institute for Applied Systems Analysis.

experience in farm systems modelling of greenhouse gas emissions for mitigation options. The work of the Network remains highly relevant in the global context due to the need to accurately represent regional variations within farm systems and their wider region (e.g. Mediterranean).

19. The Network has been successful with an expanding global network of scientists who are committed to collaborating with the next generation of farm systems modellers, which was a core Network aim established in Paris at the second annual meeting.

20. Training and capability building was one of the four projects identified at the 2018 IRG meeting. An IRG workshop coincident with the 7th annual Greenhouse Gas and Animal Agriculture Conference (GGAA)[3] in Brazil in early August has been proposed to facilitate this Network goal. No progress was identified for the three other Network projects from the 2018 meeting:

1) to consider the economics of soil carbon sequestration, typology of activities and barriers,
2) global modelling of land degradation, climate change, land use change and NDCs, (this will be completed under the CIRCASA project),
3) to identify farms internationally with sufficient data to validate models; shared farm/production system typologies.

21. During the breakout session, the Network objectives were re-examined and it was felt that this Network should focus on research related to the adoption of mitigating practices by farmers, both from the perspective of how more adoption would benefit NDC's and also what the productivity, efficiency and profitability benefits are to farmers. This research involves more socio-economic questions and so this expertise from the Alliance needs to be sought. Project research theme ideas discussed included:

i. integrating farm level models with inventories/NDC's – scaling up/bottom up inventory examples and determining impact of carbon price on abatement,
ii. how to establish a representative number of farms that could represent a region both biophysically and for management decisions, and
iii. an understanding of probability of risk (pests, disease, crop failure) and risk aversion at the farm level with and without soil carbon sequestration management practices.

22. Moving forward, it was suggested that economic work being done for the Coordination of International Research Cooperation on Soil Carbon Sequestration in Agriculture (CIRCASA) project and Agri Benchmark project on costing agricultural practices (presentation by Julian Chara, CIPAV Colombia) should be consulted and cooperation promoted. Also a stocktake of Alliance Members undertaking farm to regions modelling including productivity and mitigation benefits. The Network leadership and membership needs to be reaffirmed and built to include the range of expertise desired and capability to have project ideas further developed. Pamela Joosse is willing to help continue and build this Network but will be seeking/re-affirming co-leads.

23. In line with improving science communication, a series of webinars was proposed for the Network.

Greenhouse Gas Inventories Network

24. The Greenhouse Gas Inventories Network has been Co-Chaired by Andrea Pickering of New Zealand, Jan Verhagen of The Netherlands and Pamela Joosse of Canada. The objective of the

[3] http://www.ggaa2019.org/

Network was to assess inventory approaches for their applicability, improve existing methodologies and facilitate international collaboration for method-sharing and capability building.

25. In the context or agricultural greenhouse gas emissions, inventories remain the main tool connecting policy with mitigation however many countries face major challenges with either a lack of relevant data or non-existent data and only 5 out of 141 countries conduct a tier 2 inventory for their agriculture sector. Further, increases in productivity and efficiency are not captured in developing nations and national inventories do not yet have direct mitigation technologies included.

26. Work directly related to inventories continues through the wider Alliance's other research groups. The Livestock Research Group is supporting tier 2 livestock inventory improvements in developing countries, and contributes to the growing body of science for emissions from enteric fermentation. The Croplands Research Group and Paddy Rice Research Group are focusing on activities related to increasing understanding in soil carbon sequestration and emission factors, as well as emissions from different rice management practices respectively. Other objectives for the Network include contributing to the Alliance's online MRV Platform[4] synthesizing inventory methodologies and approaches.

27. It was emphasized that the role of international partners is crucial for inventory capability building in developing nations. In many cases, research departments in many countries are not responsible for national inventory development and maintenance, nor for training. This highlights the value of the Alliance's Network in assisting with connecting relevant partners, organisations, research institutes and member countries for these activities, within and outside perhaps the most cross-cutting of all IRG Networks."

28. The Network has had four specific projects in the work plan, however have struggled to find project leaders and resourcing to advance these significantly since the last IRG annual meeting. This may be due to a lack of forward perspective, which a focus on developing a well-founded and achievable agricultural NDC will provide. This was discussed in the breakout session and outcomes are summarised below.

29. It was decided to change the scope and create an Inventories and NDC Support Network. This Network should be policy relevant, and avoid being policy prescriptive. The Network was redefined with a central aim of improving the evidence base and to better connect governments and relevant expertise to subsequently improve the quality of agricultural NDC's and the way their achievements are reflected by national GHG inventories. Incorporating a focus on agricultural NDC's arises from the approaching requirement for countries to revise their NDC in 2020. With the right coordination, the Network can collaborate and disseminate knowledge and tools, such as a platform for countries to work together to share emission factors to improve their inventories, enabling them to develop more aggressive agricultural NDC's and greater emission reductions.

30. The objective of this redefined Network is to facilitate links across organisations, research institutes and government so that the expertise is accessible. The Network will focus on:

i. generating methods and improving data, and collecting activity data where it has not previously been available;
ii. providing technical support and skills, for capacity building and knowledge transfer;
iii. build upon existing shared databases and develop new platforms where there is a need; and

[4] https://www.agmrv.org/

iv. creating in-country capability and avoiding international consultancy so as to build country capabilities.

31. A working group has been formed to publish an article and/or tool to show what can be measured with current inventory methods and how improving the inventories could contribute to developing clearer, more aggressive agricultural NDCs. Future opportunities for collaboration for the Network include a meeting in Bonn in June alongside the meeting of the UNFCCC's Subsidiary Bodies[5], and potentially a side event at COP25 in Chile. Finally, the Network leadership was also restructured, with Andrea Pickering remaining a co-lead and two new co-leads currently being sought.

Soil Carbon Sequestration Network

32. The Soil Carbon Sequestration Network is led by Denis Angers of Agriculture and Agri-Food Canada and Claire Chenu from INRA France. The Network was established at the first IRG annual meeting to pool greenhouse gas emission efforts in soil science from across the wider Alliance's research groups. The Network now has four priority areas:

1. Estimating the potential of soil carbon sequestration across spatial and temporal scales.
2. Understanding trade-offs and synergies with non-carbon dioxide greenhouse gas emissions, as well as costs and barriers to their adoption.
3. Understanding the co-benefits of soil carbon sequestration for soil health and agricultural production.
4. Producing a set of best practice guidance on monitoring soil organic carbon stocks over space and time.

33. Potential future opportunities for Network collaboration include:

i. a stocktake of current initiatives in member countries;
ii. a stocktake of approaches in estimating SCS potential; and
iii. thematic sessions at international conferences such as Eurosoil, European Geosciences Union (EGU), and the American Geophysical Union (AGU) etc.

34. During the breakout session, two new activities that may contribute to the SCS Flagships were discussed in depth:

i. a Monitoring, Reporting and Verification (MRV) project to determine the potential of SCS through MRV; and
ii. an irrigation project to assess how soil carbon is changed with the introduction of irrigation management practices.

35. The MRV project would be time bound and applicable globally. In the short term, Prof. Pete Smith of the University of Aberdeen proposed collaboration from the Network's scientists and researchers for an invited review publication he is working on. The research objective of this publication is to assess how MRV of soil carbon stock changes can realise the full potential for SCS. Network scientists have the opportunity to collectively contribute to this publication, ensuring a multidisciplinary and robust publication is the end result.

[5] https://unfccc.int/process/bodies/subsidiary-bodies/sbsta; https://unfccc.int/process/bodies/subsidiary-bodies/sbi; https://unfccc.int/topics/land-use/workstreams/agriculture https://unfccc.int/process/bodies/subsidiary-bodies/sbi;

36. The irrigation project's objective would be to develop a common methodology in the face of an increasing demand for irrigation across agriculture sectors internationally. However, this potential project needs to be refined by the Network before it is clearly time bound and globally relevant.

37. Further, during the breakout there were a number of meeting opportunities for coordination of Network events, including; the European Geosciences Union (EGU) in April 2020, Eurosoil in Geneva sometime in August 2020, the Soil Organic Matter Dialogue in Adelaide October 2019, the American Geophysical Union (AGU) in San Francisco in December 2019, and it was discussed to hold a meeting somewhere in Latin America or Asia which may encourage a diversified audience.

38. During the plenary, it was also agreed that the Soil Carbon Sequestration Network would support the development of a Latin American Network on soil organic carbon MRV in grasslands (Lead: F. Lattanzi, Uruguay).

FLAGSHIP ACTIVITIES

39. The existing Greenhouse Gas Inventories and Soil Carbon Sequestration (SCS) Flagships were discussed in a dedicated session at the end of the first day. It was noted that there appears to have been some deviation from the initial development of the Alliance Flagships at the first annual IRG meeting in Rome in 2017, where it was specified that a Flagship activity should have both *practical application* and *broad relevance*, or preferably they should be globally relevant. It was also discussed that there is a close relationship between successful flagships and their level of human resources, funding and momentum. However, funding is highly dependent on a clear project outline including its application, relevance and timeframe for completion. This discussion was kept in mind throughout the meeting and during discussions of potential future flagships in the network parallel breakout sessions.

Greenhouse Gas Inventory Flagship

40. At the 2018 IRG meeting, the Greenhouse Gas Inventories Network discussed the nine projects proposed for the Flagship, and intentions were to choose one or two of these to progress as a Flagship. The projects have not been progressed due to lack of project leadership and the necessary resources to support their activities. The work of the Flagship is undoubtedly still crucial as we shift internationally to better accounting practices, however projects within this Flagship may be better housed within the GHG Inventory Network until they have sufficient momentum and resources.

41. At this meeting it was determined that there was no immediate need to maintain a Greenhouse Gas Inventory Flagship at this time due to lack of clear definition on the Flagship's *practical application* and *broad relevance*. None of the current flagship activities are both time bound and globally relevant and so it was agreed this Flagship could be retired, with work to instead continue in the Inventories and NDC Support Network.

Soil Carbon Sequestration Flagship

42. The Soil Carbon Sequestration (SCS) Flagship's focus areas are in developing, monitoring and adopting solutions to improve SCS in agricultural and other soils. The SCS Flagship has joined with a European Commission funded project for CIRCASA.

43. The 2018 meeting outcome for this Flagship was that it would operate at two different scales, the global scale through the 4p1000 soils initiative, and at the regional scale through various regional projects.

44. Proposed regional activities within this Flagship and their next steps are below:

i. Developing solutions: regional maps of crop and pasture practices and their implications – requires further interactions with countries and agencies.
ii. Monitoring solutions: handbooks and guidelines for project scale Monitoring, Reporting and Verification (MRV) that are adaptable to regional circumstances and agricultural systems – requires further interactions with countries and agencies.
iii. Adopting solutions: requires regional SCS stakeholder workshops and a set of criteria for sustainable sequestration projects that support livelihoods.

45. The SCS Network has had some clear products from their work in this field, in particular the development of the MRV paper described previously. Like the Greenhouse Gas Inventories Flagship, the SCS Flagship's work may need to have more specific outcomes, obtain more diverse input, momentum and resources to more clearly align the Flagship activities in terms of their global relevance and time boundaries as a defined Flagship.

GROUP STRUCTURE AND COMMUNICATIONS

Organizational Change

46. The main organisational changes include changes in Network leaders as well as to project and Flagship leads which were discussed in their relevant sections, and re-evaluating the four IRG Networks resulting in three redefined Networks from five.

Communications

47. Webinars were discussed throughout the meeting as a useful means to communicate science beyond the research community. However webinar success will depend whether the science is communicated in a manner well adapted to the target audience. It was noted that webinars should target mitigation strategy applicability, and build a business case so as to promote emission reduction technology adoption at both the farm level and at the regional or national level.

48. It was also highlighted that the existing Alliance website has many resources available including publications for MRV, inventory tier improvements and national case studies.

49. There was a call for member countries to update their country profiles so that all Alliance members and any other interested party may see what work is being done in which country. Currently, only 15 of 56 member countries have completed country profiles.

COUNTRY UPDATES

50. Country representatives provided the group with an overview of the NDC's of their country to assess any opportunities for collaboration across the Alliance. Representatives also provided and overview of projects, initiatives and activities that each country contributes to the group and any future opportunities.

Australia

60. Australia is a Co-Chair of the IRG but announced they are looking for a replacement for the outgoing Co-Chair, Richard Eckard.

61. Australia has committed to reduce emissions by 26 to 28% below 2005 levels by 2030 and there are two main mechanisms in place by which this will be achieved; the Emissions Reduction Fund (ERF) and the National Energy Guarantee. The ERF covers all agricultural and industrial sectors, participation is voluntary and the government is the sole purchaser of credits. The first auction spent $660 million, with the majority going to farmers committed to avoiding clearing native vegetation.

62. Since then, up to 115 million tonnes has been contracted from landholders for fencing off native vegetation or creating new plantings.

63. Credits for collecting methane off effluent dams and generating biogas around $10.4 million, to abate 200,000 tonnes of CO2e.

64. Savanna burning - Raging savanna fires contribute 4 per cent of Australia's greenhouse gases. Contracts have been award to northern Australian Indigenous landowners and graziers, where mosaic burns are conducted in cooler months to reduce the incidence of hot tropical fires.

65. Agriculture directly includes practices for establishing higher quality pasture, using ruminant feed supplements, improving weaning percentage by culling unproductive cows and soil carbon.

66. In August 2018 the government announced and expanded coverage of soil carbon activities in the ERF and revocation of the 2014 soil carbon method - Sequestering Carbon in Soils in Grazing Systems. The new method is called - The Measurement of Soil Carbon Sequestration in Agricultural Systems and is designed to increase the number of eligible activities over the 2014 method as well as reduce costs of undertaking soil carbon measurements.

67. Public perception in Australia around climate change is shifting with the frequency and severity of recent bushfires, the breaking of drought and heat records, and the fisheries industry experiencing significant losses.

68. The Australian Centre for International Agriculture Research (ACIAR) is looking at further developing in investments in climate change research for both mitigation and adaptation.

69. For example, we are looking at a new project ‘Emission-reduction options for NDCs in the Asia-Pacific region’ to investigate the agricultural emission-reduction options - initially within pilot countries Fiji and Vietnam - and what incentives and policy levers are required for farmers to engage.

70. The project will also look at the measures that are required to account, verify and report these emissions reductions towards the countries NDCs. This project will complement the Inventories and NDC’s Support Network and is potentially of interest to the Alliance as Australia looks for additional member countries to contribute to this work.

Brazil

71. Brazil contributes to all three of the IRG networks and to the Grasslands network in the wider Alliance’s Cropland Research Group and is co-chair of the Cropland Research Group. This is predominantly through projects of Embrapa’s Climate Change Portfolio which encapsulates social, environmental, economic and political research related to climate change. More specifically the Embrapa portfolio related to the Alliance’s core work, is their mitigation work in improving research related to greenhouse gas emission. More recently, Brazil is participating in the CIRCASA network through Embrapa, which supports the 4p1000 Initiative as a consortium member and in its scientific and technical committee.

72. Activities of note for the IRG in Brazil are:

1. Plataforma ABC; a multi-institutional platform for monitoring, reporting and verification of greenhouse gas emission reductions, led by the Ministry of Agriculture of Brazil
2. RedeClima (sub-network on Agriculture); a Brazilian network of research institutions and universities on climate change with studies in greenhouse gas emissions, soil carbon sequestration, and adaptation to climate change, created as a scientific and technical support for advising National Climate Change Policy
3. PronaSolos; a national soils programme with the goal of systemizing and identifying gaps in existing national soil data and executing a national soil survey to enhance soil data resolution in Brazil
4. SEEG; a system for estimating greenhouse gas emissions on an annual basis where the national inventory report is currently reported on a 5 yearly basis
5. MapBiomas; a Brazilian Annual Land Use and Land Cover Mapping Project, an initiative led by the Climate Observatory under SEEG, to generates Brazil's annual land use and land cover time series
6. Integrated Crop-Livestock-Forestry Network Association; a partnership between the public and private sectors, led by Embrapa, with activities in technology transfer, training of technical assistance staff, communication, and research
7. Brazilian No-Till Farmers' Federation; a metwork to represent farmers and farmers' associations that stimulated and promoted adoption of no-till farming

73. In addition to their research programmes, Brazil has conducted a number of technical trainings for professionals in practical mitigation strategies, reducing soil nitrous oxide emissions and enhancing carbon sequestration.

Canada

74. Canada Co-Chairs the IRG and co-leads the Soil Carbon Sequestration Network, as well as contributing to the Farm to Regional Scale Network.

75. Canada's NDC is to reduce emissions by 30% from 2005 levels by 2030, with the Pan-Canadian Framework Plan predominantly targeting emissions from the energy, industry and transportation sectors. Agriculture is not currently an important part of the plan, and biofuel from agriculturally derived feedstock remains the largest effective agricultural contribution.

76. Canada is using an advanced Tier 2 approach for its dairy sector accounting which places them as a useful contributor to the Alliance's activities targeted at improving inventories internationally.

77. Incremental funding of $190,000 has been provided to existing AAFC research projects to support collaboration with the Alliance through the International Funding Initiative from 2017 through 2020.

78. Canada has allocated a five year, $27 million fund for non-governmental research under the Agricultural Greenhouse Gases Program (AGGP2) targeted at research that will enhancing the understanding and accessibility of technologies and management practices that will mitigate agricultural greenhouse gases. Of the 20 research projects, 14 are related to the work of the IRG and its Networks or Flagships.

79. Canadian researchers are using an integrated modelling approach to model emissions from manured soils which may prove to be a useful contribution to the Inventories and NDC's Support

Network and potentially even the Nitrogen Flagship and is therefore an activity of interest to the Alliance.

Denmark

80. Denmark, like the Alliance's other European members, aims to reduce its non-ETS emissions by 39% by 2030 based on 1990 levels under the EU joint NDC. Agriculture in Denmark contributes 21% of total national emissions. There has been a shift within agricultural industries and organisations who are now looking seriously to reduce emissions and seeking guidance as a result of the increased political and public focus on agriculture to contribute to total emission reductions.

81. Denmark's specific contributions relevant to the IRG include the CTOOL for modelling comparisons of soil carbon in bare soils, and contributions to the MAGGNet database, its participation in the EJP-SOIL proposal and a recent survey of 2000 soil carbon stakeholders contributed to the CIRCASA network. It is expected that both CTOOL and MAGGNet will contribute largely to the Alliance activities into the future.

82. A recent report published has led to a government funded research programme of $12 million euros over the next three years with applications for funding closing later this year.

83. Denmark has identified some key focus areas for agricultural emission mitigation including methods related to cattle feed, manure management, fertilizer types and nitrogen inhibitors, biorefining and biogas, conservation agriculture, farm scale and chain cycle perspective. Farming in Denmark is predominantly cereals and there is a need for more grasses which could be used for livestock protein feed.

France

84. France Co-Chairs the IRG and is a co-lead for the SCS Network. It is also involved in leading CRG and LRG activities in the wider Alliance.

85. Research trends show an exponential increase in soil science, which is reflected in initiatives of interest to the Alliance that France coordinates including CIRCASA and EJP-SOIL as well as the 4p1000 research programme. Of specific interest to the alliance is the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) where greenhouse gas mitigation is a core research themes, as well as the above-mentioned CIRCASA projects. France holds several ERA-Net projects on greenhouse gas mitigation and soil carbon alongside some of the other Alliance countries including the USA, New Zealand and Uruguay. Soil research mobilizes approximately € 30 million annually at INRA. Research includes operational monitoring of soil quality with arable, grassland and forest uses, as well as funding for long-term field sites, modelling, greenhouse gas flux measurements and experiments related to mitigation options.

86. Like other European Alliance members, France falls under the EU joint NDC. Agriculture and the land sector are expected to contribute to France's total emission reduction under the EU climate agreement by 2050.

87. In French Guiana, through the French Agricultural Research and Cooperation Organization (CIRAD), France is conducting research in greenhouse gas monitoring for livestock grazing systems using eddy covariance towers. Other research of interest to the Alliance includes SORE-PRO at the volcanic Reunion Island in the Indian Ocean, which is assessing the impact of residual organic matter on sugar cane. Further, there is a project in Senegal with the primary objective of achieving a greenhouse gas balance in agro-forestry landscape.

New Zealand

88. New Zealand co-leads the Inventories and NDC's Support Network, Co-Chairs the Livestock Research Group and hosts the Alliance Secretariat.

89. New Zealand's NDC is to reduce emissions by 30% by 2030 based on 2005 levels and agriculture will need to contribute significantly to total reductions. Due to the high proportion of agricultural emissions in the total emission profile there is a significant amount of research into reducing emissions from enteric fermentation and other livestock related emissions which in turn will lead to improvements to the agricultural inventory.

90. Traditionally soil carbon research has not been a large focus for New Zealand, however this is shifting with an emphasis being placed on maintaining existing soil carbon and preventing losses. New Zealand is leading research in cumulative soil carbon emissions with methane and nitrous oxide measured and summed over the course of a year. A recent soil carbon collaboration of interest to the Alliance is joint work between the Uruguayan National Institute for Agriculture Research (INIA) and Landcare Research, which is outlined in more detail in the Uruguay country report below.

91. New Zealand has funded research to produce a publication on a collection of tier 2 inventory approaches within the livestock sector, and alongside the Climate Change, Agriculture and Food Security (CCAFS) research programme, has developed an online platform to provide resources and guidance specific to monitoring, reporting and verification (MRV) of agricultural emissions (www.agmrv.org).

Norway

92. Norway contributes to the Soil Carbon Sequestration Network in the IRG. Under the wider Alliance, Norway co-leads the Peatlands Management and GHG Emissions Network in the Croplands Research Group.

93. At both the 2018 and 2019 European Geoscience Union general assembly, Norway organized dedicated sessions on greenhouse gas mitigation strategies and peatland management.

94. Norway's involvement in specific projects of interest to the Alliance include their contribution to the FAO's Livestock Environmental Assessment and Performance (LEAP) report with the European Union Thematic Annual Programme (TAP) SOIL modelling soil carbon stocks and their changes, as well as participating in 6 work plans of the EJP-SOIL network. A recent initiative, Klimasmart Landbruk, is a tool for farm and product level greenhouse gas accounting based on the whole farm model HolosNor.

95. Norwegian national and institutional (NIBIO and NMBU) research assesses possibilities for agricultural emission mitigation measures, challenges for increasing soil carbon sequestration in agricultural soils and targets improvements to nitrous oxide reporting for Norway's national inventory. Norway is currently developing a tier 3 method for reporting carbon stocks in agricultural soils.

96. Norway is looking to develop an inventory of all soil carbon networks that are available to improve the accessibility and determine the gaps in soil carbon sequestration research.

Russia

98. At a federal level, the Russian government is running what translates to the *Clean Country program*, to reduce absolute greenhouse gas emissions by ~840 thousand tonnes of carbon dioxide

equivalent per year from 2017 through to 2025 but predominantly relates to non-agricultural emission reductions from land reclamation.

99. Activities under the federal programme *Melioration* are more specifically related to agricultural emission reductions.

100. Currently, the Ministry of Agriculture of Russia is working to expand the scope of new forms of nitrogen fertilizer application by 2020. These include slow-acting fertilizers, nitrogen fertilizers with nitrification inhibitors, as well as other agrotechnologies to coordinate farming, an minimize inefficient use of mineral nitrogen in crop production.

101. A methodology and a monitoring system for agricultural emissions and removals is being developed and has the following activities planned:

i. organization of systematic monitoring for greenhouse gases on agricultural lands using a Geographical Network of experiments with fertilizers, which will identify changes in soil carbon accumulation, as well as nitrogen related and methane emissions,
ii. clarify the values of direct nitrogen emission coefficients for nitrogen fertilizer application to the main soil types, which will allow more accurate estimates of direct methane emissions in agricultural production;
iii. forecast of the evolution of nitrogen and methane emissions in the field of flora and fauna under various scenarios.
iv. prepare a final report for the President on the advisability of ratifying the Paris Agreement which will be the basis for the draft of Russia's "Long-term development strategy with low greenhouse gas emissions until 2050 ".

102. The Eurasian Centre for Food Security of Moscow State University (MSU) runs educational and informational activities related to agricultural emission mitigation through global partnerships with BRICS, Russia G20, G8, APEC, ASEAN and the Global Soil Partnership. A CIRCASA-MSU partnership is utilizing the RothC model to simulate soil carbon stocks in seven long term experiments, which was identified by a Russian study to be an area with insufficient data.

103. A lack of understanding in the economic feasibility of sustainable land management practices remains the main barrier to their implementation in Russia.

104. Specialists from joint Russian-Vietnamese Tropical Research and Technology Center are conducting long-term research on greenhouse gas fluxes in tropical ecosystems, including the daily and seasonal dynamics of carbon dioxide fluxes from soils.

Spain

105. A national initiative with the potential for collaboration for the Alliance is the Network for Updating Emissions Values in Spanish Agriculture (NUEVA) which is tasked with reviewing existing emission factors and methodologies, identifying gaps in knowledge and promoting internationalization with policymakers and stakeholders.

106. Spain hosted a national coordination meeting in February 2018 in Madrid, which the Alliance attended, and in February 2019 for the second year is offering an advanced course for professionals offered by The Mediterranean Agronomic Institute of Zaragoza (IAMZ-CIHEAM). The course covers livestock emissions assessment, mitigation practices and climate change adaptation. The Alliance was able to contribute to this capability building training through sponsoring ten international professionals and prior LEARN[1] alumni from developing countries to attend the course. A previous

course on GHG mitigation in arable systems was organized by IAMS-CIHEAM together with REMEDIA (The Spanish network on GHG mitigation in the agricultural sector), still very active since its creation in 2010.

107. Directly relevant to the Inventories and NDC's Support Network, Spain has a national initiative to shift to a tier 2 inventory in Spanish cropping systems, and have conducted research to improve the nitrous oxide emission factors. Assessment of current literature identified gaps in the research body on nitrous oxide emissions in Mediterranean soils. **T**his **is** part of a Special Issue published in 2017 **in Agriculture, Ecosystems and Environment**: **"**Quantification and mitigation of greenhouse gas emissions in Mediterranean cropping systems". Spain therefore proposed a working group within the IRG to improve nitrous oxide emission factors internationally and encouraged the use of Spain as a case study.

108. Spain is involved in all the groups of the wider Alliance, contributing particularly to the IRG, Livestock Research Group and Co-Chairing the Croplands Research Group. Following discussions in this meeting, Spain is considering co-leading the new NDCs-Inventories Network.

109. Like other European Alliance members, Spain falls under the EU joint NDC. Agriculture and the land sector are expected to contribute to Spain's total emission reduction under the EU climate agreement by 2050. There is also a proposal for a National Law on Climate Change, currently under consideration. Apart from national research projects funded from the Spanish National Research Plan, Spain is involved in international initiatives of interest to the Alliance such as TAP-SOIL, EJP-SOIL and FACCE-JPI. Spain gives support to the Initiative 4p1000 providing a person as scientific officer in the Scientific and Technical Committee of the Initiative.

The Netherlands

110. The Netherlands have an aggressive emission reduction target of a 49% reduction on 2005 levels by 2030. The agriculture sector is expected to contribute 3.5 megatonnes of carbon dioxide equivalent reduction in 2030.

111. The Netherlands currently host two PhD students from the GRA and CCAFS joint CLIFF-GRADS[6] programme, and co-lead the Circular Food Systems Flagship. This cross cuts the work of the IRG as to have a truly circular food system, its greenhouse gas emissions must be accounted for.

112. Relevant to the IRG, The Netherlands is conducting an analysis, the System of Environmental Economic Accounting (SEEA), targeted at decoupling greenhouse gas emissions from agricultural production and physical material flows. Other networks that The Netherlands are involved with are CIRCASA, EJP-SOIL, and FACCE-JPI.

United Kingdom

113. The United Kingdom (UK) have a number of projects ranging in scale and approach of interest for the IRG and its work, in particular the Farm to Regional Scale Network. These include research under the Locked Up scheme at a soil aggregate scale, a project quantifying the potential of soil organic carbon mitigation in the UK at the field scale, a smart agriculture farm observation project at the farm scale, iCASP[7]at the watershed scale and Soils-R-GRREAT [8]at a national to global scale.

[6] www.ccafs.cgiar.org/CLIFF-GRADS
[7] Yorkshire Integrated Catchment Solutions Programme, Public Goods Review on Soil and Health.
[8] Soils Research to deliver Greenhouse Gas Removals and Abatement Technologies.

114. All projects are related to the Inventories and NDC's Support Network through increasing capability in soil carbon and greenhouse gas quantification, however the Soils-R-GRREAT initiative is targeted specifically at delivering technologies and approaches for greenhouse gas removals including an element of economic analysis.

115. The UK have identified that future EU funding is under threat due to current BREXIT negotiations. The Global Challenges Research Fund (GCRF) is a UK government funded initiative relevant for research related the Alliance's core work, predominantly targeting projects in developing nations and is expected to see funding increases in the future.

United States of America

116. The United States of America (USA) have a number of activities specifically related to IRG work, in particular the Soil Carbon Sequestration and Inventories and NDC's Support Networks. Namely, the US Department of Agriculture Agricultural Research Service (USDA-ARS) the Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network (GRACEnet) for collaboration on improving existing emission factors for grazed and cropped soils as well as developing improved management practices to enhance carbon sequestration.

117. Recent research is looking at validating and refining the DayCENT model using international field trial results for fertilizers. The 'four R's' of fertiliser application are right source, rate, time and place and field trials will improve fertiliser data monitoring, reporting and verification (MRV).

118. The US has developed COMET-Farm, an open online tool for North American farmers. COMET-Farm is a good example of a farm scale online tool and while specifically developed for North American climate and farming practices, and could be used anywhere in the world as a rough estimate for farmers interested in farm scale greenhouse gas emissions.

Uruguay

119. There are a number of international collaborations that Uruguay participates in including INIA, ANDE and MGAP which are already running projects in AgroGEO, soil organic carbon in irrigated crops, and soil use plans respectively. These are relevant for the IRG's Soil Carbon Sequestration Network.

120. Further, Uruguay is collaborating with Landcare Research, New Zealand on a joint FACCE-ERANET proposal for soil organic carbon monitoring at both the regional and national scale. The Alliance and FONTAGRO[9] are preparing a proposal for a project in soil organic carbon sequestration in Latin American and Caribbean (LATAC) countries.

121. Uruguay expressed interest in postgraduate students willing to work on the projects which have recently been approved including ones assessing soil organic carbon in natural grasslands and in crop or pasture integrated systems and an independent group on biogeochemistry of carbon and nitrogen in soil, the latter being a cooperation with the Max Planck institute.

122. This is an opportunity for the Alliance to assist in seeking post graduate students interested in these specific topics through the CLIFF-GRADS programme. Students would need to be seeking further study and also have a background in the following;

1. Soil Organic Carbon (SOC) in Natural Grasslands:
    a. impact of intensification

[9] www.fontagro.org

    b. impact of the inclusion of legumes
    c. impact of degradation
2. SOC in crop/pasture integrated systems (long-term experiments)
    a. Irrigated rice
3. Project developing an independent group on biogeochemistry of C and N

123. Uruguay also acknowledged useful Alliance contributions to their agricultural greenhouse gas research in the form of networks and knowledge dissemination.

OTHER INITIATIVES FROM JOINT CIRCASA-IRG SESSION

124. Following the IRG third annual meeting, CIRCASA hosted their first annual meeting with the first session dedicated to future links between CIRCASA-IRG projects. The examples that were discussed include FONTAGRO PROCISUR, the agri-Benchmark network, a Brazilian Embrapa greenhouse gas related public policies presentation and an IIASA project modelling climate mitigation strategies.

Agri-Benchmark

125. Agri-benchmark is an international network started in 2002 that is highly relevant for Alliance work in integrating farm-level economics and sustainability analysis to build the case for farmer adoption of emission mitigation strategies. The network will prove a useful collaboration for IRG's scientists and other industry partners as it approaches emission reductions through decreasing product level emission intensity. Less greenhouse gas per unit of product will result in more productive systems globally, producing more food at a lower emission cost. Connecting IRG network projects with Agri-benchmark will build a stronger business case for adopting emission mitigation strategies.

Embrapa Public Policies

https://globalresearchalliance.org/wp-content/uploads/2019/02/Cali-Columbia-IRG-Meeting-Presentation-05-day-3-Public-Policies-in-Brazil-February-2019.pdf.

IIASA Modelling Climate Mitigation Strategies

https://globalresearchalliance.org/wp-content/uploads/2019/02/Cali-Columbia-IRG-Meeting-Presentation-06-day-3-model-based-scenarios-climate-mitigation-February-2019.pdf

FONTAGRO PROCISUR

https://globalresearchalliance.org/wp-content/uploads/2019/02/Cali-Columbia-IRG-Meeting-Presentation-09-day-3-Sustainable-intensification-livestock-systems-february-2019.pdf

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APPENDIX 2: Publications List from Network Activities

1. *The use of biogeochemical models to evaluate mitigation of greenhouse gas emissions from managed grasslands. R Sándor, F Ehrhardt, L Brilli, M Carozzi, S Recous, P Smith, V Snow, ... Science of The Total Environment 642, 292-306*
2. *Assessing uncertainties in crop and pasture ensemble model simulations of productivity and N_2O emissions. F Ehrhardt, JF Soussana, G Bellocchi, P Grace, R McAuliffe, S Recous, ... Global change biology 24 (2), e603-e616*
3. *Unpublished; invited review for Global Change Biology, target submission date of July 2019. Author list is evolving. Working title: "How do we measure, report and verify soil carbon change to realise the potential of soil carbon sequestration for atmospheric greenhouse gas removal?"*