



Joint Meeting Croplands Research Group and Integrative Research Group Seville, Spain

17-18 January 2023

Meeting Report

OVERVIEW

The joint meeting of the Integrative Research Group (IRG) and the Croplands Research Group (CRG) of the Global Research Alliance on Agricultural Greenhouse Gases (GRA) was held in Seville, Spain, at the Andalusia Agency for Agriculture and Fisheries Development (AGAPA) on 17-18 January 2023.

The GRA meeting was chaired by Rosa Mosquera (University of Santiago de Compostela, Spain), Jean-François Soussana (INRAE, France), Pamela Joosse (Agriculture and Agri-Food Canada) and Hero Gollany (USDA-ARS, USA) as Co-Chairs of both Groups.

The two-day meeting included a mix of joint plenary sessions and separate sessions for each Research Group. Participants attended the meeting in-person and online.

This report is a summary of the key discussions and outcomes of the meeting. PDF's and pre-recorded videos of the presentations can be downloaded from GRA website (see [here](#)).

PARTICIPANTS

The meeting was attended by 52 participants, including online, representing 23 GRA Alliance Member countries, and invited partners.

- **GRA Members attending:** Argentina, Australia, Belgium, Brazil, Canada, China, Denmark, France, Germany, Ghana, Ireland, Japan, Republic of Korea, Malaysia, Netherlands, New Zealand, Nigeria, Norway, Spain, Switzerland, United Kingdom, United States, Zimbabwe.
- **Invited Partners:** CIAT, Environmental Defense Fund, European Commission and FONTAGRO.
- **Observer country:** Portugal

MEETING OUTCOMES

The meeting achieved the following outcomes:

- Priority activities:
 - Joint review paper "Towards carbon neutral carbon farming systems?"
 - Paper "Soil organic carbon estimations"
 - Agroforestry flagship project

- Decisions to:
 - merge the activities of the Nutrient Management Network into the Conservation Agriculture Network and close the Nutrient Management Network in the Cropland Research Group.
 - include the newly proposed Indigenous Research Network under the Integrative Research Group
 - have Simon Weldon as new Co-Lead for the Peatland Management Network
- Opportunities:
 - The CRG is planning to write a paper on soil organic carbon estimations, see draft outline [here](#). Interested GRA members that would like to contribute should contact Maria Rosa Mosquera-Losada (mrosa.mosquera.losada@usc.es).
 - The IRG and CRG are still looking for further contributors for the joint review paper “Towards carbon neutral carbon farming systems?” See draft outline [here](#). Interested GRA members should contact Jean-François Soussana (jean-francois.soussana@inrae.fr).
 - The agroforestry flagship project is still looking for partners. Interested GRA members should contact Maria Rosa Mosquera-Losada (mrosa.mosquera.losada@usc.es).
 - The Peatland Management Network is looking for new members. Interested GRA members should contact the Network Co-Leads (fahmuddin_agus@yahoo.com; Simon.Weldon@nibio.no).
 - The Landscape Management of Agricultural Systems (LMAS) Network is looking for GRA members to join their activities on validation and application of the CNMM-DNDC model to develop carbon neutrality strategies of crop production and landscape management. Interested GRA members should contact Prof. Dr. Xunhua Zheng (xunhua.zheng@post.iap.ac.cn).
 - The Conservation Agriculture Network is looking for new Network members and another Network Co-Lead. Interested GRA members should contact Craig Drury (craig.drury@agr.gc.ca).
 - The CRG Co-Chairs are editors of a research topic “[Soil Carbon Sequestration in Tropical and Subtropical Regions: A Paradigm Change](#)” in the journal Frontiers in Soil Science. Manuscript submission deadline is 3 March 2023.
 - The São Paulo Research Foundation, FAPESP, has a research call with opportunities for international cooperation: “[Land-use changes and agriculture: strategies for reducing GHG emissions and adaptation](#)” (deadline for submissions: 1 March 2023)
 - FONTAGRO has a call for research funding: “Science, technology and innovation to make agriculture and food security more sustainable and resilient to climate change in Latin America and the Caribbean”. The closing date is 3 April 2023. See Terms of Reference [here](#).

SUMMARY OF DISCUSSIONS

MEETING OVERVIEW

The meeting was opened by Dr. Rosa Mosquera Losada, Co-Chair of the Croplands Research Group (CRG) and Pamela Joose, Co-Chair of the Integrative Research Group (IRG) who welcomed all participants to Spain and the joint meeting of the Croplands and Integrative Research Groups. See presentation [here](#).

WELCOME - Andalusia Agency for Agriculture and Fisheries Development (AGAPA)

Inmaculada Parrado (AGAPA) welcomed the IRG and CRG members to the Hacienda de Quinto and provided an overview of AGAPA activities with relevance for the GRA. A transcript of the presentation can be found [here](#) (note this has been translated from Spanish).

SECRETARIAT UPDATE (see presentation [here](#))

Nina Grassnick (GRA Secretariat team member) provided an update on the activities of the GRA.

The GRA now has 66 Member Countries, with Kenya joining in the past year. The GRA now works with 27 Partner organisations, with the Environmental Defense Fund (EDF) joining in the last year.

The Secretariat team has been growing over the past year and has regional support in West/Central Africa (Sega Ndao) and Latin America (Nicolas Costa).

Hayden Montgomery has left the role of GRA Special Representative and is working full time with the Global Methane Hub. Harry Clark has been assisting as the acting Special Representative until the position is filled.

The next Council meeting will be organized by the incoming Spanish GRA Council Chair and will be held in Madrid from 24-26 April 2023. Topics that will be discussed at that meeting are, amongst others, outcomes of the GRA member survey and flagship projects. Six flagship projects were accepted by the GRA Council at their meeting in 2022, new flagship projects will be proposed in Madrid (e.g., agroforestry).

The CLIFF-GRADS Round 5 has been completed and the awardees were announced at COP27. 48 students received awards.

A second round of RUFORUM awards will be announced in 2023.

RESEARCH GROUP DISCUSSIONS

The Research Groups held a separate session each day to discuss their respective Group work plans, country and Network activities, before returning to the joint plenary session to discuss the meeting topic 'towards carbon neutral cropping systems'. A summary of the discussions across the two days, and the presentations submitted prior to the meeting, is provided below for each of the Research Groups.

Croplands Research Group

The Networks and countries provided an update of their activities to the Group.

Agroforestry Network - Maria Rosa Mosquera Losada (see presentation [here](#))

Greece and the US are hosting a webinar.

Agroforestry flagship, with FAO and ICRAF linked to European union projects [AF4EU](#) and [Undertrees](#). The following contributors have been identified for the flagship project: Maria Rosa Mosquera Losada (Spain), Ladislau Nieto (Brasil), Marcelo Javier Beltrán (Argentina), Yeluripati Jagadeesh (UK), Anastasia Pantera (Greece), Hero Gollany (USA) and Marta Alfaro (Chile). Further contributors are welcome to join the flagship project, please contact Maria Rosa Mosquera-Losada (mrosa.mosquera.losada@usc.es).

Peatland Management Network - Fahmuddin Agus (see pre-recorded presentation [here](#))

The Peatland Management Network requests GRA members to confirm their membership in the Network. Others interested in becoming a member, please contact Simon Weldon (NIBIO, Norway), the new Co-Lead for the Network.

The Peatland Management Network has identified the following research (funding) opportunities:

- “Improving nutrient (especially K, Ca, Mg, B) management by using stonemeal: Economic feasibility and GHG intensity reduction” with potential funding by BDPKS (agency for managing palm oil export levy)
- Enhancing carbon stock using biochar
- Water table management for reconciling oil yield and GHG emissions

Landscape Management of Agricultural Systems Network - Xunhua Zheng (see pre-recorded presentation [here](#))

CNMM-DNDC model (Catchment Nutrients Management Model - DeNitrification-DeComposition) has been updated, e.g. a new module to calculate off-farm GHG emissions and improved NH₃ volatilization mechanisms (see published paper [here](#)).

The model is used in different projects, e.g. in an international cooperation project to identify the best management strategies to mitigate non-CO₂ emissions from croplands toward carbon neutrality.

The Network asks GRA members to join the validation and application of the CNMM-DNDC model to develop carbon neutrality strategies of crop production and landscape management.

The Network plans to further improve the following model functions: (1) enable process-oriented simulations for complex cropping systems or agroforests with intercropping features, (2) add a groundwater module and (3) couple CNMM-DNDC with an atmospheric model.

The network is interested in identifying opportunities of cooperation with the Integrative and Paddy Rice Research Groups to use the CNMM-DNDC as a research tool.

Conservation Agriculture Network - Craig Drury (see presentation [here](#))

The Conservation Agriculture Network (CAN) has published a special section in the Soil Science Society of America Journal on finding practices to mitigate nitrous oxide emission and enhance carbon sequestration (see [here](#)).

The Network completed its meta-analysis project looking at the role of conservation agriculture in mitigating nitrous oxide emissions. The meta-analysis was submitted for publication in November 2022. The practices analysed in this paper go from conservation tillage, cover crops and diversified crop rotation. The authors identified under what climatic and soil conditions these practices are most effective.

The CAN and Nutrient Management Network are looking at merging, to investigate the impact of stacking practices, e.g. conservation and nutrient management, to reduce GHG emissions from soil while enhancing SOC sequestration.

The Network will meet again at the end of March to identify conservation and nutrient management practices that are most effective and applicable at global scale.

The Network is looking for new members and another Network Co-Lead.

Argentina - Marcelo Javier Beltran (see pre-recorded presentation [here](#))

Marcelo Javier Beltran (INTA) noted that Argentina has been involved in numerous national and international meetings, webinars and farm days focused on sustainable practices that improve carbon balance of the soils. Argentina is engaged in several international projects about mitigation and adaptation to climate change through collaboration with FONTAGRO, Circularity, SRUC and FAO.

Argentina identified research and capability opportunities related to cropping systems carbon neutrality, and the identification of workshops and training for students. Argentina would like to focus on the intensification of the agricultural systems and the interaction with production systems, and on determining how we can add value to sustainable productions through the carbon market.

Brazil - Ladislau Martin-Neto (see presentation slides [here](#))

Commitments of Brazil at COP27:

- Reduction of deforestation to zero until 2030
- Carbon Neutrality until 2050
- Low Carbon Agriculture Plan (LCAP): eligible LCAP practices with relevance for cropping systems are e.g. reforestation and no-tillage

Ladislau Martin-Neto is editor of Research Topic "[Soil Carbon Sequestration in Tropical and Subtropical Regions: A Paradigm Change](#)" in journal *Frontiers in Soil Science*. Manuscript submission deadline is 3 March 2023.

EMBRAPA has [30 on-going projects](#) addressing subjects on mitigation, adaptation and forecasting impacts in agriculture.

[FAPESP Research Program on Global Climate Change 2020-2030 \(PFPMCG\)](#) was launched in 2021 with opportunities for international cooperation: Recent Call "[Land-use Changes and Agriculture: Strategies for reducing GHG emissions and adaptation to climate change](#)" (deadline submissions: 1 March 2023).

Ongoing project supported by GRA: [Synergies in integrated systems: Improving carbon balance, resource use efficiency while mitigating greenhouse gas emissions through well-informed decisions about circularity \(SENSE\)](#). Relevant project with private sector involvement: Carbon Balance and Footprint in the production of soybean, maize and sugarcane: metrics, tools and protocols to tropical and subtropical areas from Brazil.

Canada - Craig Drury

Craig Drury (Agriculture and Agri-Food Canada) presented on the investments made by Canada on carbon sequestration and GHG mitigation projects; soil health; sustainable management and reversing soil degradation.

Canada is aiming to reduce its GHG emissions in the agricultural sector by 3-5 MT of CO₂ per year. To do so, the government is setting up new initiatives to reduce nitrous oxide emission from fertilizers by 30% and achieving net zero emission from agriculture by 2050. This will require a major transformation of the agricultural systems.

On-farm climate action fund promotes four practices: reduction of fertilizer, rotational grazing, cover crops, and reduced tillage.

New Agriculture and Agri-Food Canada (AAFC) Strategic Plan for Science includes four science mission areas: (1) Mitigation and adapting to climate change, (2) Increasing resiliency of agro-ecosystems, (3) Advancing the circular economy and (4) Accelerating digital transformation.

Research opportunities: “Living Labs” platform for engagement by producers and researchers in on-farm trials is entering a second phase - Agriculture Climate Solutions; 13 projects.

Norway - Simon Weldon

Simon Weldon is the new contact for Norway. His research background is in peatland research and application of biochar for mitigating GHG emissions and enhancing C storage.

Norway is involved in different [EJP soil](#) projects (e.g. CarboSeq, SOMMIT, INSURE and TRUESOIL).

Norway identified the following research opportunities: (1) Increasing carbon storage in agricultural soils and reducing loss, (2) climate adaptation and (3) improving peatland inventories and monitoring status.

South Korea - Sun Il Lee (see presentation slides [here](#))

New Carbon Neutrality Law in S. Korea entered into force in 2022 with the aim to achieve carbon neutrality by 2050.

South Korea has identified the following research opportunities: Agricultural climate change response project is implemented from 2020 to 2027 (\$ 170 million). Possible collaboration topics are biochar, GHG modelling, water management (paddy rice), etc.

Possibility to collaborate with [AFACI](#), [KAFACI](#), [KoLFACI](#) and [KOPIA](#) on activities related to climate change mitigation in agriculture.

USA - Hero Gollany (see presentation slides [here](#))

Hero Gollany is editor of the research topic “[Soil Carbon Sequestration in Tropical and Subtropical Regions: A Paradigm Change](#)” in journal *Frontiers in Soil Science*.

NIFA has set up a new grant program “[Regional Innovation and Demonstration of Climate-smart Agriculture for Future Farms \(CAFF\)](#)”.

The USDA -NRCS [Climate Hubs](#) provide financial assistance to 155,000 producers, managers and forest landowners. The Climate Hubs and their partners support USDA’s Climate Adaptation and Resilience Plan connecting science and practice through place-based resources.

[USDA Agriculture Innovation Mission for Climate \(AIM for Climate\) Summit](#) takes place 8-10 May 2023 in Washington DC.

Paper on soil organic carbon estimation

The CRG agreed on writing a paper on soil organic carbon estimations with the following draft outline and contributors:

1. Relevance of soil organic carbon: CRG Co-Chairs
2. Soil sampling - timing, spatial
3. Current soil organic matter methodology estimation - from chemical to satellite images: INRAE
4. Acidic soils results: USC
5. Peatland results: Heinz Flessa, Simon Weldon
6. Saline and sodic soils: Marcelo Javier Beltrán
7. Temperate Drylands results: Hero Gollany
8. Temperate Humid lands results: USC
9. Tropical results: Brazil
10. Practices to improve soil organic carbon:
 - a. conservation tillage, crop rotation, organic amendments, crop diversification, inverted tillage: Craig Drury
 - b. Agroforestry: USC
11. Conclusions

May be interesting to collaborate with FONTAGRO. Further interested contributors are invited to send an email to Maria Rosa Mosquera-Losada (mrosa.mosquera.losada@usc.es).

Integrative Research Group

Soil Carbon Sequestration Network - Jean-François Soussana

Summary/slides to be provided.

Inventories and NDC Network - Andrea Pickering (see pre-recorded presentation [here](#))

The INDC Network has three new Co-Leads: Dr. Mai Van Trinh, Dr. Natalie Doran-Browne and Dr. Andrea Pickering.

The Network has three main activities planned for 2023: (1) a trip to New Zealand for 7 Fijian and 7 Samoan representatives at the end of February 2023 for inventory capability building, (2) organizing an Agricultural Sector Compilers Workshop and (3) writing a 2019 IPCC Refinement Summary of key amendments to 2006 IPCC guidelines.

The Network has identified the following research opportunities: (1) Measurement capability (equipment, expertise and analysis facilities) of African, Asia and Pacific countries (2) Measurement and validation of agriculture emissions.

Circular Food Systems Network - Flavia Casu (see pre-recorded presentation [here](#))

The Network has written a white paper based on the short communications by the selected case studies of circular food systems which is highlighting knowledge gaps and research questions in this area. The white paper will be published soon.

Following a call for proposals of research projects to develop indicators for circular food systems, the network has approved 3 research projects which started in January 2023.

The Network plans to identify topics/activities to collaborate with other GRA research Networks.

The Network has identified the following research opportunities: (1) Indicators for circularity: implementation, (2) Circular food systems and beyond: ecosystem services, regenerative agriculture & climate mitigation and adaptation, (3) Designing region-specific circular food systems and (4) Link with policy & climate action agenda.

The Network has identified the following capability opportunities: (1) [Circular Agronomics Conference](#) (15 February 2023; Brussels), (2) International conference '[Closed cycles and the Circular Society 2023](#)' (1-5 October 2023; Greece) and (3) [International Bioeconomy conference](#) (14-15 June 2023; Germany)

Farm To Regional Scale Integration Network - Nina Grassnick (see presentation [here](#))

In collaboration with Daniel Bretscher (Agroscope), the Network has conducted an online survey on farm-level GHG accounting tools. Based on the results of the survey, the Network aims to develop a work program and will discuss this in a workshop in 2023. It is also planned to publish a journal article.

The Network is coordinating the flagship project "Economics of GHG mitigation at farm level in global cattle production systems (EMiFa)" and will collect data for six more countries. Furthermore, it is planned to kick-off the work packages "mitigation strategies", "trade-offs and co-benefits" and "adoption barriers".

The Network has identified the following research opportunities: (1) How to address GHG leakage in agricultural science and in agriculture policy design? (2) Is it feasible to aim for net zero/carbon neutral agricultural production?

The Network has identified the following capability opportunities: (1) *agri benchmark* beef and sheep conference (15-21 June 2023, Paraguay) and (2) *agri benchmark* cash crops conference (18-24 June 2023, Kenya)

Discussion on Network activities

Jean-François Soussana mentioned ongoing efforts by FACCE-JPI and JPI-Climate at European level to include Tier 3 methodology in inventories (e.g., feed additives, soil organic carbon) by connecting compilers with scientists. This may be a good opportunity to collaborate with the INDC network.

Flavia Casu discussed the definition of circular food systems. The CFS Network is working with three types: (1) systems that minimize nutrient losses which is often achieved by mixed livestock and cropping systems, (2) linking different types of cropping systems to increase circularity and (3) agricultural systems that minimize waste and reuse waste streams.

Australia - Rowena Nankivell (see presentation slides [here](#))

Australia recently joined the Global Methane Pledge, the Glasgow Breakthrough Agenda on Agriculture and the Forest and Climate Leaders Partnership.

Australia's national soil action plan aims on improving soil conditions and aligns with the Future Drought fund.

Australia has presented the following activities and opportunities: (1) [CSIRO Australian Grains GHG Baseline and Mitigation Assessment](#), (2) [National Soil Carbon Innovation Challenge](#): 8 successful projects have received grants and (3) Activities by Grains Research and Development Corporation (GRDC) on GHG emissions and accounting, Precision farming techniques to reduce inputs, Fertiliser use and soil carbon.

Canada - Pamela Josse (see presentation [here](#))

See summary of presentation provided by Craig Drury during the CRG meeting [here](#).

European Union – Jean-François Soussana

Carbon Farming is currently high on the agenda of the EU commission. The EU commission has recently released a [note](#) on how to develop an EU certification for carbon removals. The note describes issues that should be addressed by the certification scheme such as transparency and additionality. The scheme should cover agriculture and forestry. The note refers to the broader context of “carbon dioxide removals” which includes land use change, agriculture but also industry related solutions. Currently a group of experts is developing methodologies that have to be approved by the EU commission.

Germany - Claudia Heidecke (see presentation slides [here](#))

Germany has identified the following research opportunities: (1) HumusKlimaNetz: 150 pilot farms for carbon sequestration measures in Germany for the next 10 years, (2) Second National Inventory of Agricultural Soils: Improving reporting of soil organic carbon changes, (3) Carbon sequestration by improving root growth and establishment of new hedges (projects WurCel and CatchHedge) and (4) Climate Mitigation in Agriculture - funding by the Federal Ministry of Agriculture to approach the more stringent climate targets for agriculture (call will be launched soon; international partner involvement possible with own funding).

USA - James P. Dobrowolski (see presentation slides [here](#))

The USA has identified the following research opportunities: New Crosscutting Programs from USDA-NIFA for 2022: Extension, Education & USDA Climate Hubs Partnership; Rapid Response to Extreme Weather Events Across Food and Agricultural Systems (CAP Grants); and Regional Innovation and Demonstration of Climate-smart Agriculture for Future Farms (CAFF) (see [here](#)).

The USA has identified the following capability opportunities: Farmers.gov Resources for Climate-Smart Agriculture and Forestry: USDA offers voluntary programs and services to help agricultural producers and land managers build soil health, sequester carbon, reduce greenhouse gas emissions, enhance productivity and commodity marketability, and mitigate the impacts of climate change while building resilience to strengthen their operation (see [here](#))

Discussion on country updates

Australia suffers from severe weather events: are mitigation and adaptation efforts compatible or conflicting? The Australian government takes this into consideration in current policy plans and tries to integrate mitigation and adaptation measures as much as possible.

The Canadian living labs are different from demonstration farms because they connect scientists closer with the farmers. There is a co-development process with the farmers for the research questions and trials as well as a frequent feedback loop during the project phase.

Jean-François Soussana proposed that the IRG Networks could work more on renewable energy related topics, e.g. biofuels, biogas, photovoltaic systems.

Discussion on Indigenous Research Network

New Zealand and Samoa are establishing an [Indigenous Research Network](#) (IRN) to strengthen the participation of indigenous scientists and issues in research related to reducing agricultural greenhouse gases. New Zealand proposed that the Indigenous Research Network be included as a Network of the Integrative Research Group, as the topic cuts across the research of all the GRA Groups including the existing IRG Networks.

The IRG members in general agreed to the idea to include the IRN in the IRG but are suggesting changing the name of the Network to allow wider participation by countries which do not necessarily have indigenous communities.

Webinars

The IRG Networks have frequently organized webinars in the past and will continue to do so in 2023. There are benefits to webinar recordings because of different time zones and the ability to share later. There is opportunity to publicize the Network webinars more broadly to IRG and GRA members rather than creating a separate IRG webinar series.

Strategic Planning

It was suggested that the IRG would benefit from a strategic discussion about priorities and needs to focus the work of the IRG as the Network topics are diverse and priorities are not clear. Therefore, the IRG plans to engage the IRG members to identify topics/research questions that are of interest to policy members in the member countries to help focus the research priorities for the IRG Networks.

TOWARDS CARBON NEUTRAL CROPPING SYSTEMS

The aim of the joint session was to discuss how to reach carbon neutral cropping systems. The session was kicked-off by two keynote presentations, followed by a proposal from the IRG Co-Chairs regarding how to jointly work with the IRG and CRG on this topic in the future.

Keynote Presentation: Carbon sequestration in croplands in tropical and subtropical regions - Dr Beata Madari (Embrapa, Brazil) (see presentation [here](#))

The Brazilian policy for adaptation to climate change and for Low C Emission Agriculture (ABC+, 2020-2030) focusses on adaptation and mitigation as a co-benefit. The three main technologies that are promoted by ABC+ are (1) Restoration/Recovery of pastures, (2) Zero Tillage System and (3) Integrated Crop-Livestock-Forestry and Agroforestry. EMBRAPA carried out different studies to analyse the carbon sequestration potential of no-tillage and integrated Crop-Livestock systems. The results show that integrated crop-livestock systems in tropical and subtropical areas could enhance soil carbon sequestration, especially through brachiária grass. Further practices that increase soil organic carbon are the elimination of fallow, permanent living soil cover and enhancing C inputs. Soil carbon sequestration does not necessarily lead to carbon neutral systems and it should be combined with circularity measures to further reduce GHG emissions.

Keynote Presentation: Climate Neutral Farms - Dr Jacques-Erics Bergez (INRAE, France) (see presentation [here](#))

Climate Neutral Farms (ClieNFarms) is a four-year project that is funded by the European Union and has the aim to co-develop and upscale systemic locally relevant solutions to reach climate neutral and climate resilient sustainable farms across Europe. The following production systems are included: dairy, monogastrics, arable crops, specialised culture, beef and sheep. ClieNFarms scope is based on a demonstration approach through the creation of innovative, systemic solution spaces (I3S). The goal of I3S is to develop business models together with food processors that ensure the financial sustainability of the solutions (e.g. through carbon credits), with an upscaling methodology. To design a MRV scheme, ClieNFarms will consider data availability and feasibility, the number of models (tools) to accurately measure and report, field sampling and/or modelling, data quality and

accuracy, verification procedures, stakeholder engagement, legal and regulatory requirements and using a decision tree. The MRV scheme will be designed in collaboration with OrcaSa and Marvic Horizon projects.

Discussion

Carbon farming should take into account the whole value chain; problem: stakeholder engagement.

ClieNFarms project is already collaborating with GRA through different researchers who are also involved in GRA projects. Would be a good idea to have a meeting in 2-3 years to share results from ClieNFarms project with results from GRA projects.

Proposal on joint work of IRG and CRG – Jean-François Sousanna

Discussion on carbon-neutral cropping systems. May be impossible to have carbon neutral cropping systems. Slightly extended definition: cropping system within the landscape (trees, grasslands) and within the value chain (using renewable energy).

- How do you design C neutral cropping systems?
- Which MRV System?
- How do you design payments for farmers and the value chain (utilize the value chain)?

How do you get there? What are the roadblocks? What are the opportunities? What are the threats?

Possible contributions by Networks	
CRG	IRG
Conservation agriculture: reduced tillage, crop rotations	Soil carbon sequestration
Nutrient management: biological N fixation, reduced N losses, nitrification inhibitors	Farm (to regional) scale: integration with economics, farming system change
Peatland management: rewetting organic soils	Circular food systems: recycling wastes
Agroforestry systems: storing carbon in soils and biomass	Inventories and NDCs: policy interface
Integrated crop-livestock: recycling nutrients, improving SOC	<i>MAC-B flagship</i> : incentive to mitigate by integrating with adaptation

Cropland Research Group Co-chairs presented their thoughts on carbon neutral cropping systems and how to get there:

- Need for off-farm carbon accounting through LCA; value chains and society
- Need to recognize soil carbon sequestration
- Need to recognize carbon sequestration techniques (e.g. biochar)
- Need for payments to avoid carbon release associated with different soil types
- Need for understanding of C balance where practices are implemented (e.g. forest in peatlands)
- Need for proper modelling (appropriate research models, but also easy-to-use tools for farmers and policy makers)
- Important to not only focus on increasing soil carbon sequestration, but also to avoid the release of already stored soil organic carbon through soil protection
- Need for long-term experiments and permanence to avoid loss of previous stored carbon in the soils
- Minimize trade-offs, e.g. water or air pollution
- Different management practices should be considered when proposing best practices
- Need for living labs and lighthouses
- Consider adaptation co-benefits

Pamela Josse presented on “The Canadian Agroecosystem Living Labs Network as a Regional Participatory Research Process” (see presentation [here](#))

- Starting in 2018, AAFC launched a [nationwide network of living labs](#) to help accelerate the development and adoption of sustainable practices and technologies by Canadian farmers.
- Living labs bring together farmers, scientists and other partners to co-develop solutions. These solutions are tested in real-life context and evaluated by all stakeholders.
- Focus is on (1) adjustment to climate change, (2) reduce water contamination, (3) improve soil and water conservation and (4) maximize habitat capacity and biodiversity.
- In 2021, a new initiative “[agricultural climate solutions](#)” started and this runs until 2031. It includes 13 living labs currently and focuses on best management practices that store carbon and reduce greenhouse gases. These 13 living labs are joined together in a Canadian Agroecosystem Living Lab Network.
- International Forum on Agroecosystem Living Labs will be co-hosted by AAFC and INRAE at Adaptation Futures Conference on 4-6 October 2023 in Montreal (Canada)

NETWORK PRESENTATIONS AND DISCUSSION

Network Leads presented their thoughts on carbon neutral cropping systems and how to get there. The following information has been uploaded to the meeting website prior to the meeting (see [here](#)). Further ideas have been also discussed during the Research Group discussions (see [here](#)):

Agroforestry Network

Barriers to achieving C neutrality in cropping systems: (1) Soil monitoring and standardization, and (2) Biodiversity inclusion in policies.

Opportunities to achieve C neutrality in cropping systems: (1) Soil carbon credit recognition, and (2) Biomass production enhancement through biodiversity promotion.

Peatland Management Network

Barriers to achieving C neutrality in cropping systems: (1) Current high economic-value, and high market demand crops are cultivated under drained peat conditions, rather than under undrained condition (paludiculture), and (2) In some countries agricultural areas under drained peatland are relatively large.

Opportunities to achieve C neutrality in cropping systems: (1) There are regulations in many countries on peatland protection and (2) Emission reduction from peatland is an important part of NDC among parties to the UNFCCC.

Circular Food Systems Network

Barriers to achieving C neutrality in cropping systems: (1) Legislation (testing of opportunities and new technologies) and (2) Measuring C neutrality: indicators and metrics.

Opportunities to achieve C neutrality in cropping systems: C neutrality on what level? Systems' perspective in C neutrality. (1) integration with the whole food system (agri-food chain, crop-livestock integration) and (2) Synergies & trade-offs with other sustainability goals.

Inventories and NDC Network

Barriers to achieving C neutrality in cropping systems: (1) No approved methodology to incorporate mitigation technologies into GHG inventories or to demonstrate C neutrality of systems and (2) inadequate analytical infrastructure for measurement and quantification of emissions in developing countries.

Opportunities to achieving C neutrality in cropping systems: (1) Collaboration of GRA network of scientists and compilers to develop approved methodologies for incorporating mitigation technologies into GHG inventories and (2) Duplicate livestock inventory work currently underway in Africa, Asia, LAC and the Pacific for cropping.

Farm To Regional Scale Integration Network

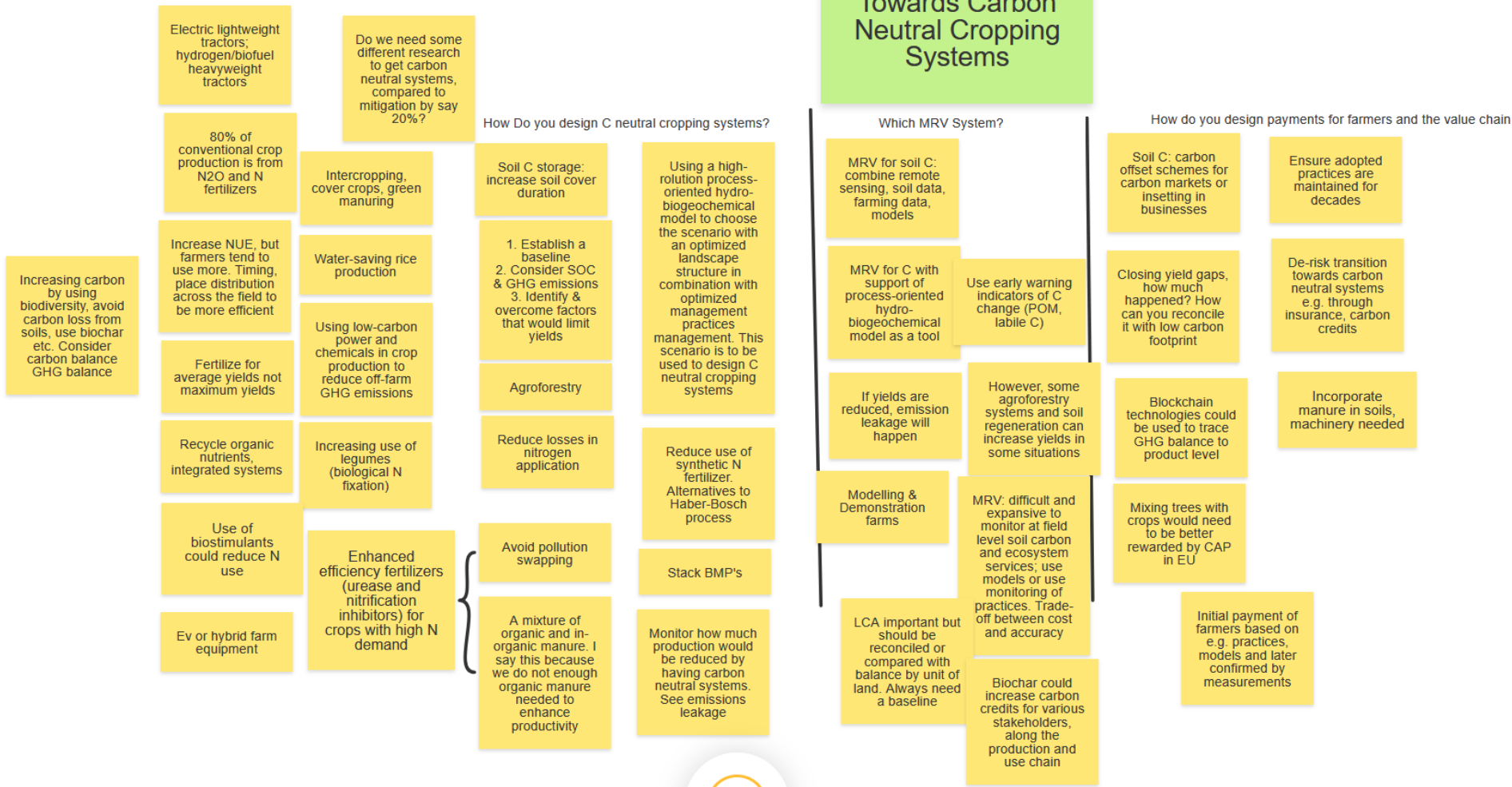
Barriers to achieving C neutrality in cropping systems: (1) Lack of political agreements and scientific rules to avoid carbon leakage and overcome/avoid narrow national perspectives.

Opportunities to achieving C neutrality in cropping systems: (1) Synergies from political measures to reduce nutrient losses (mainly nitrogen) in order to protect water systems for GHG mitigation, (2) some national policies (e.g. at EU level: farm to fork, ban of crop protection products) prompt growers to revisit their cropping systems anyhow and (3) Food industry and banking sector are increasingly asking growers to monitor and improve their GHG balances.

Discussion

During the meeting these ideas and further ideas from the meeting participants were discussed and the outcomes were presented on a whiteboard:

Towards Carbon Neutral Cropping Systems



COUNTRY DISCUSSION

IRG and CRG country representatives provided their thoughts on carbon neutral cropping systems and how to get there prior to the meeting. See the presentations [here](#). Some of the information has also been provided in the country updates during the Research Group discussions, see [here](#).

Argentina - Marcelo Javier Beltran (see pre-recorded presentation [here](#))

Argentina has developed guidelines and protocols that can be used to measure the C footprint of crops (wheat, rice and corn). INTA is working on the monitoring of different sustainable practices that could increase carbon sequestration, e.g. cover crops, pasture improvements, intensification and integrated systems. Argentina is interested in understanding how the carbon market could promote the adoption of sustainable practices by farmers.

Brazil - Ladislau Martin-Neto (see presentation slides [here](#))

Research opportunities: (1) New tools to facilitate and to cost reduction of soil C stocks determination in large-scale of agricultural production systems, (2) To establish a digital and integrated platform for large-scale monitoring of C and N stocks and GHG emissions to relevant croplands and integrated production agricultural systems.

Increase cooperation with private companies and farmers to consolidate a soil carbon credits market.

Germany - Heinz Flessa and Claudia Heidecke (see presentation slides [here](#))

Main challenges and fields of action towards carbon neutrality in cropping systems in Germany:

- Reduction of direct and indirect N₂O emission
- Using fertilizers with a low carbon footprint
- Reducing emissions from field management
- No drainage of organic soils for crop production; rewetting of drained organic soils
- Maintaining and increasing sequestration of SOC (e.g. improving reporting SOC changes and improving root growth and establishment of new hedges)

South Korea - Sun Il Lee (see presentation slides [here](#))

South Korea focuses on reducing the use of nitrogen fertilizers (green manure crop, slow-release fertilizer and use of by-product fertilizers) and mitigating emissions from croplands (conservation tillage, water management, conversion of field use and biochar). The key initiatives that are included in the South Korea NDC related to rice and crop cultivation are reduced use of mineral and nitrogen fertilizers, environmental-friendly cultivation, use of biochar to absorb carbon in the soil, more efficient irrigation in rice paddies, development of new crop varieties.

USA - Hero Gollany (see presentation slides [here](#))

USDA-ARS GRACEnet ([Greenhouse gas Reduction through Agricultural Carbon Enhancement network](#)) and LTAR ([Long-Term Agroecosystem Research](#)) sites conduct research to reduce C footprint. A barrier to C neutrality under the dryland production system is water availability. USDA-NRCS obligated \$501M on all climate mitigation practices, including cover crops to increase SOC. There is a growing interest of the private sector regarding neutral carbon agricultural production systems and MRV.

USA identified the following research opportunities related to cropping system carbon neutrality:

- Landscape management of nutrients to reach cropping system C neutrality under dryland cropping system.
- Intercropping or cover cropping legumes to reduce N fertilizer and herbicide use.

Joint review paper by CRG and IRG: “Towards carbon neutral carbon farming systems?”

Following the discussion on carbon neutral cropping systems, the IRG and CRG members agreed on writing a joint review paper titled “Towards carbon neutral carbon farming systems?” with the draft paper outline, planning and preliminary contributors list described in Appendix 2.

Further interested GRA members are welcome to join the paper and should contact Jean-François Soussana (jean-francois.soussana@inrae.fr).

FUNDING OPPORTUNITIES: FONTAGRO - Eugenia Saini

FONTAGRO is a unique cooperation mechanism for co-financing science, technology, and innovation for the agrifood sector in Latin America and the Caribbean. FONTAGRO has been working with the GRA since 2010. See project overview [here](#).

Currently, a call for proposals is open for “Science, technology and innovation to make agriculture and food security more sustainable and resilient to climate change in Latin America and the Caribbean”. The closing date is 3 April 2023. See Terms of Reference [here](#). This funding may be used as part of another initiative. If GRA members would like to apply for funding they can contact Eugenia Saini. Non-members can join FONTAGRO initiatives through “seed funds”.

Currently, FONTAGRO is co-funding two GRA projects related to soil carbon sequestration (see [here](#) and [here](#)) and is collaborating with the [Carbon Farming Alliance for Research and Management \(C-Farm\)](#). If GRA members are interested in working with C-Farm, they can contact Eugenia Saini.

PLANNED ACTIVITIES BY SPANISH GRA COUNCIL CHAIR - Guy Vancanneyt (see presentation [here](#))

The Spanish GRA Council Chair will be connected to the Spanish National Institute for Agricultural and Food Research and Technology which belongs to the Spanish National Research Council (INIA-CSIC). INIA-CSIS is well connected with Latin America through FONTAGRO, is participating in the European Framework Programme (e.g. [EJP Soil](#), Soil Mission, [Partnership on Agroecology](#)), part of the Standing Committee on Agricultural Research (SCAR), involved in 4 per 1000 initiative and GRA.

The main objectives during the Spanish GRA Council Presidency will be to strengthen Spanish participation in GRA research activities, capacity building, dissemination and organizing the GRA Council 2023. Spain will strengthen on-going flagship projects, i.e. Feed additives to reduce methane, Rumen Data Mining for Methane Reduction and N₂O Emission Reduction and Improved Accounting, and promote a new flagship project on Agroforestry. Spain is proposing a new Mediterranean Network on Greenhouse Gases in Agriculture, as a collaboration between REMEDIA and CIHEAM.

Spain has planned three capacity building activities: (1) Advanced course at IAMZ-CIHEAM (Autumn 2023) “Greenhouse gas assessment and mitigation in agriculture: concepts, methods and simulation

tools”, (2) Hosting of 3 CLIFF-GRADS students, (3) AECID course: La importancia de los datos en agricultura de precisión: del campo al mapa y viceversa (October 2023, Guatemala).

The following opportunities will be used to disseminate GRA research results: (1) REMEDIA Workshop, Bilbao, 2023, (2) RUENA National meeting, Murcia, 2023, (3) FONTAGRO Technical Workshop, Madrid, July 2023.

CONCLUSION

The IRG and CRG have developed different initiatives to collaborate in the future on the topics “How to reach carbon neutral carbon farming systems?” and “Quantification of soil carbon sequestration”. A focus of this work will be on transparent and credible monitoring systems of GHG emissions in soil, life cycle analysis, ecosystem services and biodiversity.

The following aspects have been highlighted to achieve climate neutral cropping systems: the temporal and spatial use of biodiversity, bioeconomy and circular systems, certification of carbon sequestration techniques such as biochar, living labs to foster the transformation/redesign of cropping systems. A holistic, synergistic and systemic approach is essential for the achievement of climate neutrality through the combination of different practices and the control of inputs and outputs derived from the system.

Funding opportunities via Horizon Europe and FONTAGRO have been identified for this work.

Three main research activities are planned for 2023:

- Joint review paper “Toward carbon neutral carbon farming systems?”
- Paper “Soil organic carbon estimations”
- Agroforestry flagship project

The results of the joint meeting of the Croplands and Integrative Research Groups were presented by Maria Rosa Mosquera-Losada at the International Congress for Agroecology (19-21 January 2023, Seville, Spain).

APPENDIX 1: Participants List

Members	
Argentina	Marcelo Javier Beltran, INTA
Australia	Rowena Nankivell, DAFF
Belgium	Marie Collard, CRA-W / Walloon agricultural research center
Brazil	Beata Madari, EMBRAPA Pedro Machado, EMBRAPA
Canada	Craig Drury, Agriculture and Agri-Food Canada Pamela Joosse, Agriculture and Agri-Food Canada
China	Xunhua Zheng, CAS
Denmark	Soren O. Peterson, Aarhus University Lars Munkholm, Aarhus University Diego Abalos, Aarhus University
France	Guillaume Humbert Jacques-Eric Bergez, INRAE Jean-François Soussana, INRAE Sylvain Pellerin, INRAE
Germany	Claudia Heidecke, Thuenen Institute Heinz Flessa, Thuenen Institute
Ghana	Samuel Anuga, EUI
Ireland	John Harrison
Japan	Ayaka Kishimoto-Mo, NARO
Republic of Korea	Sun Il Lee, National Institute of Agricultural Sciences
Malaysia	Mohd Fairuz, MARDI Bin Rashid Mohd Aziz, MARDI Fauzi Jumat, MARDI Nur Hidayah Abdullah, MARDI Nurul Atilia Shafienaz Hanifah, MARDI
Netherlands	Flavia Casu, Wageningen Livestock Research
New Zealand	Cecile de Klein, AgResearch Andrea Pickering, NZAGRC Lee Nelson, NZAGRC
Nigeria	Taiwo Ayinde, Ahmadu Bello University
Norway	Simon Weldon, NIBIO
Portugal	Maria de Belém Ferreira da Silva da Costa Freitas, University of Algarve
Spain	Guy Vancanneyt, INIA-CSIC Marisa Tello, INIA-CSIC Francisco Javier Rodriguez-Riguerio, University of Santiago de Compostela Jose Javier Santiago-Freijanes, University of Santiago de Compostela Maria Rosa Mosquera Losada, University of Santiago de Compostela Nuria Ferreiro-Domínguez, University of Santiago de Compostela Tamara Isabel Franco-Grandas, University of Santiago de Compostela
Switzerland	Daniel Bretscher, Agroscope
United Kingdom	Jagadeesh Yeluripati, The James Hutton Institute
United States	Hero Gollany, USDA-ARS Jim Dobrowolski, USDA-NIFA
Zimbabwe	Never Mujere, University of Zimbabwe

Partners	
CGIAR - CIAT	Louis Verchot
Environmental Defense Fund	Alison Eagle John Tauzel
European Commission	Leo Maier
FONTAGRO	Eugenia Saini
GRA Secretariat	
	Nina Grassnick Deborah Knox

APPENDIX 2: Towards carbon neutral carbon farming systems? – Proposed paper outline, planning and preliminary contributors list

Draft paper outline

- Context: Why is this question timely?
- Framing the question
 - Definitions and framing issues
 - GHG balance in CO₂ equivalents, carbon storage => reversibility; long-term commitment
 - Systems studied and limitations
 - Cropping systems, avoiding mixed systems with livestock (for sake of simplicity)
 - Need to take two complementary perspectives: farm scale and farm+pre-chain emissions. Is GHG balance close to zero at farm scale only? Or should it be also accounting with pre-chain emissions?
 - What about side-effects for socio-economics, for ecosystems services, climate change adaptation etc.
 - Baseline issues
 - Systems that have already been improved: can we include in the analysis, farms that have already reduced their emissions?
 - Can we find in the literature examples of close to zero emissions arable farms with cropping systems? Also in our projects
- Changes in practices and technologies at farm scale
 - Inputs from all networks: nutrients, soil carbon, agroforestry, system changes etc...
 - Quantify the impacts of each option, need a combination of several options to get to C neutrality
- Changes in pre-chain
 - Fertilizers (reducing, substituting synthetic N), organic N, biogas and digestates, biochar etc.
 - Genetics and breeding
 - Open question on photovoltaic systems. Agrivoltaics combination of PV + crops (or grasslands), impacts on yields, resilience to heat, drought... → Accounting question: is a farm producing renewable electricity contributing to mitigation elsewhere, is it a good option for carbon neutrality? However, this is not the same sector. PV is very costly?
- MRV
 - What would be specific for methods covering changes in farms to get towards carbon neutrality?
 - Beyond changes in practices, so understanding how the baseline is changing may not be easy?
 - You may have transient increases in emissions?
 - What about link with national inventories? – many changes in practices would not be reflected
- Socio-economics and incentives
 - Should you have only increases or same productivity? And how do you estimate this? How do you estimate carbon leakage?
- Region specific issues

- e.g. water constraints
- Call for regional studies on this
 - Design studies?
 - Focus groups and living labs?

Planning

- Revised outline – IRG and CRG Co-Chairs – 1st version: February 1st
- Open to comments in order to complete it by February 20.
- Literature survey: Jean-François Soussana + others by end March
- Open the Klaxoon to provide inputs as ideas, please contribute. Stop the Klaxoon by mid-February
- Sections – Open for contributions between February 20 and April 1.
- First draft of the paper for revision due by April 15
- Second draft by May

Contributors - first list - to be expanded

- Conservation Agriculture & Nutrient Management Network: practices, technologies
- Circular Food Systems Network: changes in systems and broader
- Farm to Regional Scale Integration Network: socio-economic of GHG mitigation at international scale, complement practices with costs
- Agroforestry Network: AF4EU
- Soil Carbon Sequestration Network: farm practices
- Framing issue: Jacques-Eric Bergez, Simon Weldon, IRG and CRG Co-Chairs, Pedro Machado (introducing carbon negative vs. carbon-neutral)
- Inputs and pre-chain: Simon Weldon (compost, biochar etc., waste management), Nuria Ferreiro-Domínguez
- Landscape Management Network: process oriented modelling for GHG (MRV)
- Section on design studies and desk studies (modelling): Jean-François Soussana + others
- Section on focus group and living labs: Yelto Zimmer, Pamela Joosse, Maria Rosa Mosquera-Losada, Jacques-Eric Bergez, Claudia Heidecke + others
- Company desert control: using a specific product, recovering soils not yet fitted for agriculture (outside of scope presumably)

Further interested GRA members are welcome to join the paper and could contact Jean-François Soussana (jean-francois.soussana@inrae.fr).