FACCE-JPI – JPI Climate workshop on the use of emerging science to improve agricultural GHG inventories for the UNFCCC reporting

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Final Report

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This report was prepared by the Steering Committee organizing the workshop: ***Alexandre Fernandes*** (JPI Climate Secretariat, main author), ***Jean-François Soussana*** (FACCE-JPI Chair), ***Frank McGovern*** (JPI Climate Chair***), Frank Dentener*** (FACCE-JPI Scientific Advisory Board), ***Dorri te Boekhorst*** (FACCE-JPI Secretariat) and ***Heather McKhann*** (FACCE-JPI Secretariat) with valuable contributions from the speakers and participants of the Workshop.

Executive summary

The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement aims to limit global warming to well below 2°C compared to pre-industrial levels, and to pursue efforts to limit the increase to 1.5°C, while ensuring the climate resilience and sustainability of food production systems. This is an enormous challenge, and its success depends on the implementation of climate policies at the national level and the commitment of all countries and sectors, with an increasingly important role for agriculture and forestry (AFOLU).

Against this background, the pan-European Joint Programming Initiatives (JPIs) *"Agriculture, Food Security and Climate Change"* (FACCE-JPI) and *"Connecting Climate Knowledge for Europe"* (JPI Climate) have been collaborating in order to identify opportunities to produce the knowledge needed to improve national greenhouse gas (GHG) inventories from agriculture and associated land use to the UNFCCC and Paris Agreement reporting and accounting processes. National GHG inventories are central to climate policy and their ongoing development is a key science-policy interface. This is recognized in the Tier system used to categorise elements of the national inventories. Tier 1 is based on international/regional default data provided by the IPCC, whereas Tier 3 is based on the best available science. Tier 2 is an intermediate stage in which national data are used to determine GHG emissions and removals, through methodology that is internationally agreed upon by IPCC[1].

In the context of this collaboration, FACCE-JPI and JPI Climate organised a workshop on the use of emerging science to improve agricultural GHG inventories for the UNFCCC reporting, which took place in Brussels, on 19 and 20 October 2022. The workshop brought together around 50 participants – national inventory compilers, agricultural emissions experts, and policy makers – to discuss the state of the art, research needs, and the use of emerging science to improve agricultural GHG inventories. The aim was to start a discussion and to solidify a network around the improvement of GHG inventories in Europe, particularly having a vision for a Tier 3 system in Europe driven by combined data and modelling approaches.

The key messages from the workshop included:

- The impacts of farming practices targeting the environment and climate are not sufficiently detailed in GHG emission inventories, which may jeopardize using GHG inventories to measure the success of current and future climate and agricultural policies.
- High-resolution Earth Observation data have a significant potential to characterize important aspects of land-use and land-management at parcel level, but these data do not measure the resulting carbon fluxes and changes in carbon stocks, for which models are needed.
- There is a need to develop a concerted and systematic Europe-wide community approach towards integrated modelling of agricultural emissions/removals – from data collection to using these data in models and GHG emission sources and sinks.

[1] https://www.ipcc.ch/working-group/tfi/

- A key element for the successful implementation of a potential Tier 3 approach at a country level or Europe-wide is the development of interactive data collection tools that 1) are consistent with the GHG emissions in inventories in a harmonized way and 2) also provide feedback to the management practices implemented by the farmer.
- The limits and challenges for use of national GHG inventories in supporting policy developments, and interventions at higher spatial and temporal levels, warrant further exploration.

An ongoing engagement process involving researchers and compilers on this matter was proposed as a next step. This could take the form of a regular forum where the two communities can come together to exchange best practices and co-design research to improve agricultural GHG inventories for the UNFCCC reporting. The Governing Boards of JPI Climate and FACCE-JPI will be invited to take note of the outcomes and key messages from this workshop and to consider next steps in this collaboration.

Background and objectives

The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement aims to limit global warming to well below 2°C compared to pre-industrial levels, and to pursue efforts to limit the increase to 1.5°C[2]. This is an enormous challenge, and its success depends on the implementation of climate policies at the national level and the commitment of all countries and sectors, with an increasingly important role for agriculture and forestry.

In this context, the pan-European Joint Programming Initiatives (JPIs) *"Agriculture, Food Security and Climate Change"* (FACCE-JPI) and *"Connecting Climate Knowledge for Europe"* (JPI Climate) acknowledge the importance of land use and its management in climate actions and have been collaborating in order to identify opportunities to produce the knowledge needed to improve national greenhouse gas (GHG) inventories from agriculture to the UNFCCC reporting process.

In a first exploratory step, a joint online workshop entitled *"Land-based greenhouse gas (GHG) emissions/removals and analysis systems"*[3], was organised on 14 April 2021. The objectives of the workshop were to identify and consider research needed to bridge gaps between the top-down analysis of emissions and removals by managed terrestrial sinks (land) and the analysis provided in national GHG inventories. Further discussion between the two JPIs led to the proposal for this workshop, in order to identify areas of research priorities and investment, including around model comparison and collection and measuring of inventory related data.

Following on this recommendation, FACCE-JPI and JPI Climate organised a workshop on the use of emerging science to improve agricultural GHG inventories for the UNFCCC reporting, which took place in Brussels, on 19 and 20 October 2022. The workshop brought together around 50 participants – national inventory compilers, agricultural emissions experts, and policy makers – to discuss the state of the art, research needs, and the use of emerging science to improve agricultural GHG inventories. The workshop started a discussion on how to solidify a network around the improvement of GHG inventories in Europe, particularly having a data-driven/modelling vision for a Tier 3 system or similar in Europe.

The main outcomes from the discussions, key messages, and conclusions of this workshop are presented in the following sections.

[2] https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[3] https://jpi-climate.eu/document/report-of-the-joint-jpi-climate-facce-jpi-workshop-land-based-greenhouse-gas-ghg-emissions-removals-and-analysis-systems/

Presentations and discussions

Setting the Scene – challenges ahead

Part 1. Introduction

Frank McGovern (Environmental Protection Agency, Ireland [EPA] & JPI Climate Chair) welcomed the participants and provided a brief context to the workshop.

Reporting the GHG emissions from food and land is one of the most complex and challenging issues for climate change policies. This complexity is highlighted for example in the Special Report on Climate Change and Land[4], from the Intergovernmental Panel on Climate Change (IPCC).

FACCE-JPI and JPI Climate recognise the need to work collaboratively in this issue, so that climate policies can be informed by the best available science. One challenging task in this area is to reconcile differences between top-down analysis and bottom-up approaches, including national GHG inventories. These inventories are important for ambitious climate action, but often do not get the attention that other research topics and programmes in the field get.

In this context, the workshop provided a platform for dialogue among the various actors in this space, to share experiences in developing inventories and to articulate a vision for the future, paving the way for Europe to lead the way on this issue.

A. The European Green Deal and Soil Mission perspectives

Peter Wehrheim (European Commission [EC], Directorate-General for Research and Innovation - DG RTD) presented an overview of the use of emerging science to improve agricultural GHG inventories in the context of the European Union (EU)'s climate policy. Some of the relevant EU policies and programmes in this context include the European Green Deal, Horizon Europe, and it's Mission "A Soil Deal for Europe" (Mission Soil). Research and innovation are key to provide feedback and inform policy frameworks in this area.

B. Outlook on Fit for 55

Christian Holzleitner (EC, Directorate-General for Climate Action - DG CLIMA) presented an outlook on the "Fit for 55" package. Some of the elements covered in the presentation included:

- The impacts of public measures taken under the EU's common agricultural policy (CAP) on agricultural emissions
- Integrated incentive schemes for farmers
- The need for real-time monitoring of soils

[4] https://www.ipcc.ch/srccl/

- A legislative proposal for certification of carbon removals (a series of quality criteria should be included in this proposal and the research projects funded under Horizon Europe and the Mission Soil should inform the discussions of the Expert Group that will support the implementation of this certification scheme)
- A proposal by DG CLIMA and DG Environment (in 2023) on forest monitoring, to identify the key indicators for forest health
- The usefulness of a single reporting system to the EU and to the UNFCCC

The discussion with the workshop participants focused on the following aspects:

- There are options for development of the reporting systems to provide more local and focused analysis, in addition to the current annual reporting system.
- The Mission Soil will provide the opportunity to scale up investments in soil and Tier 3 monitoring and link with the European Soil Observatory
- Different EU tools and instruments should be better mobilized, to promote synergies and avoid duplication of resources
- Consider how to integrate other agricultural GHG (nitrous oxide – N_2O, methane – CH_4) in the accounting when developing carbon farming schemes. There may be a need for a dedicated climate policy for these gases. A discussion on this should take place over the next two years
- What is the mandate of the Expert Group that will support the implementation of the certification scheme for carbon removals? This group should help developing the specific methodologies for this scheme. The framework should be set up by the EC and then developed considering the recommendations from the expert group
- How can emissions and removals be compared (e.g., emissions from livestock with afforestation measures)? How can carbon removals that may seem too academic for farmers be certified?
- Some of the issues discussed here will be explored in the upcoming (spring 2024) Climate Neutrality Forum, organised by JPI Climate.

Key message A. and B.: EU policy aims for rapid transition to Tier 3 AFOLU reporting/accounting. However, there are practical difficulties for this, and alternative approaches may be needed.

C. Agriculture NGHGI estimates with the IPCC Inventory Software

Sandro Federici (IPCC Task Force on National Greenhouse Gas Inventories – TFI) presented the new IPCC Inventory Software for National GHG Inventories (NGHGI).

The discussion with the workshop participants covered the following elements:

- Using the IPCC software is time consuming and that may pose a barrier for its use by the European inventory compilers

- The IPCC Inventory Software is being developed to allow exporting the entire NGHGI in a format readable by the UNFCCC reporting tool for the Paris Agreement
- Where European countries see the need to refine the current methodological guidance provided by IPCC to fully capture the impact on sinks/sources of activities/actions implemented in the land sector, this goal can be achieved through a request to IPCC to refine its methodological guidance as actually framed in the IPCC procedures.

Key Message C.: The IPCC Inventory Software implements all methodological tiers and approaches provided by the IPCC 2006 Guidelines for National Greenhouse Gas Inventories at a subnational level, so allowing to track and store GHG emissions/removals from specific activities within a single database. The use of the IPCC Inventory Software is supported by the IPCC and the UNFCCC.

D. GHG inventories covering agriculture

Peter Iversen (European Environment Agency - EEA) provided an overview of GHG inventories covering agriculture. Some examples where the science seems mature, but it has not been taken up by the GHG inventories, were presented. Different types of barriers (including systemic barriers) may be preventing the uptake of the science in the inventories. A mapping of these barriers by the national agencies responsible for the inventories may be a useful exercise to address these barriers.

The presentation has also shown that there is an increase in agricultural production in Europe, but a reduction on emissions from agriculture. Strong European policies (e.g., the European nitrates directive) that are already in place may help explaining these observations.

Key message D.: Barriers to the use of latest science in European inventories need to be assessed and, were possible, addressed.

E. Agriculture and LULUCF – from practices to improving inventories

Frank Dentener (EC, Joint Research Centre [JRC]) presented the work of the JRC on improving inventories for agriculture and land use, land-use change and forestry (LULUCF), and examples of the JRC meta-review of the impact 26 farming practices on GHG emissions and other environmental impacts. In GHG inventories, enteric fermentation and manure management have the highest use of tier 3 methods, however it is difficult to quality control reported emissions (“black boxes”). Elements of the discussion included how to account for the increased frequency of climate extremes and variability in carbon accounting. While the models can consider these, it is difficult to distinguish between the role of climate and the role of policies in carbon accounting. Quality control aspects were also discussed. These include, for example: the need to ensure that there are robust scientific methods driving the carbon accounting process; systems that ensure the quality of earth observation data and the respective models, which are key for land use characterization. The open nature of the data and

the different approaches by European countries (e.g., some European Member States are making the data publicly available, whereas others keep the data private) were also debated.

Key Message E.: The role of the JRC is evolving and is now focused on developing and promoting new data-model based methods for estimating spatially explicit GHG emissions and sinks from land, and supporting Member States in implementing these methods.

Part 2. GHG

F. Enteric methane

Andre Bannink (Wageningen Research, part of WUR) focused on the contribution of enteric methane (CH_4) in agricultural emissions. Discussions included the uncertainty of methane numbers in the inventories, the possibility to use a Tier 3 approach for methane at the farm level, the emissions from manure, and challenges associated with collecting data at the farm scale (farm accounting/farm specificity) and use of data at the national scale (national inventories). Reductions in enteric methane emissions through the use of feed additives is not included yet in accounting and inventory, and it is anticipated that research will be conducted to be able to update the Tier 3 approach in The Netherlands for this. Generalizing a Tier 3 approach for Europe will be hard to achieve, also depending on type of production system. The best approach is to include the most important variables that cause variating in enteric methane (in an averaged, general way) in a consolidated estimate in the inventories. In case there are major challenges associated with data collection, having a detailed, tailored approach for individual farms may not make sense and should be simplified. A standardized approach at the national level may be useful for the national inventory.

Key message F.: Tier 3 approaches to estimate enteric methane and manure management emissions are being developed with potential for uptake into farm accounting as well as national inventory.

G. Nitrous oxide (N_2O)

Andreas Pacholski (Thünen Institute) and Ole-Kenneth Nielsen (Aarhus University) highlighted some of the challenges associated with reporting of nitrous oxide (N_2O) emissions in national inventories. Some of these challenges include the distinction between emission factors for natural and fertilized soils, the emissions from manure, differences in emission factors with organic versus inorganic fertilizers, and the challenges associated with peer-reviewed articles in informing national inventories (the long publication time is considered a bottleneck).

Key message G.: Progress on reporting N_2O emissions, is still needed. Some of the bottlenecks identified include the delays between research results and their use for national inventories.

H. Soil carbon

Jean-François Soussana (National Research Institute for Agriculture, Food and Environment - INRAE) and Daniel Zimmer (Climate-KIC) provided an overview of the challenge to estimate agricultural soil carbon sources and sinks. Discussions included the lack of infrastructure in European countries to generate soil carbon stock data, the soil layers used for carbon inventories and monitoring (topsoil versus subsoil, the need for a coordinated approach to establish the baseline data for the soil carbon inventories, the potential of Tier 3 approaches combining soil data, climate data, agricultural practices data, remote sensing and calibrated models.

Key message H.: Changes in agricultural soil organic carbon stocks can be monitored from field to country scale by modelling coupled with remote sensing and farm data, provided that soil information systems are strongly improved in the EU.

Plenary discussion:

The participants discussed the current gaps in this field, concrete implementation actions to address them in the next 2-3 years, and the barriers to implement these actions.

Some highlights from the discussions included:

- The need to remove barriers in terms of data sharing between the farm level and the national inventory level to facilitate reporting and providing benefits for farmers taking actions.
- The role of inventories as an enabler, rather than a barrier, for reporting needs to be explored
- The potential of carbon farming schemes in providing detailed data to inform models, which can be very useful for inventories
- Processes at the country level (e.g., reviews and how these are addressed in developing inventories) to support the improvement of national inventories should be supported through research
- Efforts by global actors (e.g., Global Research Alliance on Agricultural Greenhouse Gases – GRA) to ensure the intercomparability of different datasets across continents
- The need for common protocols and databases to build a common European Database Emission Factors. This work is currently being carried on project-based funding, but there is a need for longer-term funding streams to develop this work
- The usefulness of a regular forum to bring researchers and inventory compilers together to promote dialogue and co-design solutions to improve agricultural GHG inventories for the UNFCCC reporting
- The role of FACCE-JPI and JPI Climate in facilitating this dialogue and the co-design of solutions
- There is merit in exploring how well the current inventory system is aligned with informing progress towards the Paris Agreement goals and requirements. The current system is highly influenced by the Kyoto Protocol requirements, which are referenced to historic baseline data for emissions and removals (e.g., 1990). The Paris Agreement looks forward to a future balance of GHG emissions and removals, which is consistent with a global temperature goal.

Improvements, solutions, contributions

Part 3. Improving GHG inventories using novel sources of information

I. Farm accountancy data

Marcin Zarzycki (EC, Directorate-General for Agriculture and Rural Development - DG AGRI) presented two relevant initiatives from DG AGRI: the current Farm Accountancy Data Network (FADN)[5] and its progress towards the Farm Sustainability Data Network (FSDN)[6].

A FSDN workshop will take place in November 2022 with representatives from Member States (MS) and experts to kick-off the process of identifying variables/indicators to track the progress of this network.

The participants in this workshop discussed to what extent the FSDN will make use of national datasets that are already established, the need to have a multi-perspective assessment of the Common Agricultural Policy (CAP) before identifying suitable variables/indicators, and the potential contributions from the science and inventories communities to inform this process.

J. Remote sensing

Eric Ceschia (INRAE) presented the role of remote sensing and modelling in assessing the carbon budget components. A 3 TIERs approach developed for the H2020 NIVA project was presented allowing to produce 10 m resolution annual maps of net CO2 flux estimates (TIER1) to C budget estimates (TIER2 and 3) for cropland. TIER 1 is an empirical approach based on the relationship between net CO2 fluxes and the duration of active vegetation coverage derived from remote sensing which can be applied to most crops in Europe. TIER 2 combines the TIER 1 outputs with farmers data to estimate annual C budget. TIER3 is based on the AgriCarbon-EO pre-operational processing chain allowing to estimate the C budget components (biomass, yield, CO2 fluxes, soil C stock changes) as well as their uncertainties for the main crops and some cover crops. One of the main limits for implementing TIER 2 & 3 methods is the limited access to farmer's management data at plot level.

The participants discussed the activity data needed to develop a Tier 3 approach in Europe, the synergies between this approach and the work of national inventory compilers, and the time resolution for the different parameters presented.

K. Accurate representation of precision agriculture data in GHG inventories

Sander Janssen (WUR) discussed the accurate representation of precision agriculture data in GHG inventories. Key messages included: precision agriculture/farm-derived data have potential for

[5] https://agriculture.ec.europa.eu/data-and-analysis/farm-structures-and-economics/fadn_en

[6] https://agriculture.ec.europa.eu/system/files/2021-12/summary-second-fsdn-workshop_en_0.pdf

monitoring of GHGs, but simpler methods are needed in the short-term; the active engagement of the farmers and benefits for the farmers in these processes are key to their success.

Key message I., J., K.: Combining data is key to achieving high quality national GHG inventories. There are new methods to do this, and their development should be encouraged to reach, by reducing administrative and operational barriers

Part 4. A data/modelling driven TIER 3 vision for Europe

Frank McGovern and Jean-François Soussana led a plenary discussion on *"What the Tier 3 vision is for Europe"*. Participants were invited to provide their inputs considering the following guiding questions:

I – What is possible already?

- To what extent do we already capture available promising interventions in the agricultural sector in the national inventories?
- Do we have criteria for fit-for-purpose representation of GHG emission accounting in policy intervention and its linkage to GHG inventories?

II – What is still needed?

- How can inventories inform/support policy actions?
- How can we combine the various data inputs and the modelling?
- How to translate scientific results into inventory schemes?
- How to go from local, farm-based data to national reporting?
- What are challenges for inventories to evaluate effectiveness of implement Carbon Farming Certificates?
- What is a roadmap to improving Tier 3 (modelling) approaches?
- How can this be framed by the Paris Agreement requirements?

The outcomes of this plenary discussion are captured in the following sections of this report: *"Points on a Europe-wide Tier 3 approach"* and *"Conclusions and next steps"*.

Points on a Europe-wide Tier 3 approach

The following key messages are derived from the discussions during the two days of the workshop, and particularly from the plenary discussion on *"What the Tier 3 vision is for Europe":*

- Currently, the impacts of farming practices targeting the environment and climate are not sufficiently reflected in GHG emission inventories. This may jeopardize using GHG inventories to measure the success of current and future policies that target decreasing emissions of agriculture and land-use.

- High-resolution Earth Observation data have a significant potential to characterize important aspects of land-use and land-management at parcel level, but these data do not measure the resulting carbon fluxes and changes in carbon stocks, for which models are needed. Concerted efforts are needed to advance the scientific methods that can include complex interactions of farming practices with the GHG emissions of CO_2, CH_4 and N_2O, and the data needed to drive these models. Characterization of most farming practices requires collection and access to additional statistical farm level data, and these data are still not sufficiently collected or made available. Assessment of fit-for-purpose and quality of data is needed.

- There is a need to develop a concerted and systematic Europe-wide community approach towards integrated modelling of agricultural emissions - from using data to models and GHG emission sources and sinks. Such approach may include sharing of best practices for Tier 3 modelling methods, but also systematic evaluation of the fit-for-purpose of emerging model systems that integrate data and models and quantify their resulting uncertainties in GHG emission estimates.

- A key element for the successful implementation of a potential Europe-wide Tier 3 approach is the development of interactive data collection tools that 1) are consistent with the GHG emissions outcomes in a harmonized way and 2) also provide feedback to the management practices implemented by the farmer.

Conclusions and next steps

The two-day workshop was considered an important and useful meeting that has opened the opportunity to explore issues that are central to climate policy and action.

The workshop allowed for valuable exchanges among national inventory compilers, agricultural emissions experts and policy makers, and provided actionable recommendations on the following issues:

- To what extent do we already capture available promising interventions in the agricultural sector in the national inventories?
- How to go from local, farm-based data to national reporting?
- What are the challenges for inventories to evaluate the effectiveness of implementing Carbon Farming Certificates?

In terms of next steps, a concerted action involving researchers and compilers on this matter was proposed. This could take the form of a regular forum where the two communities can come together to exchange best practices and co-design research to improve agricultural GHG inventories for the UNFCCC reporting.

The Governing Boards of JPI Climate and FACCE-JPI will be invited to take note of the outcomes and key messages from this workshop and to consider next steps in this collaboration.