GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

2011 – 2023

CELEBRATING 12 YEARS

of the Global Research Alliance on Agricultural Greenhouse Gases

PRODUCED BY **THE GRA**

CONTENTS

1.0 About Us

We bring countries together to find ways to grow more food without growing greenhouse gas emissions.

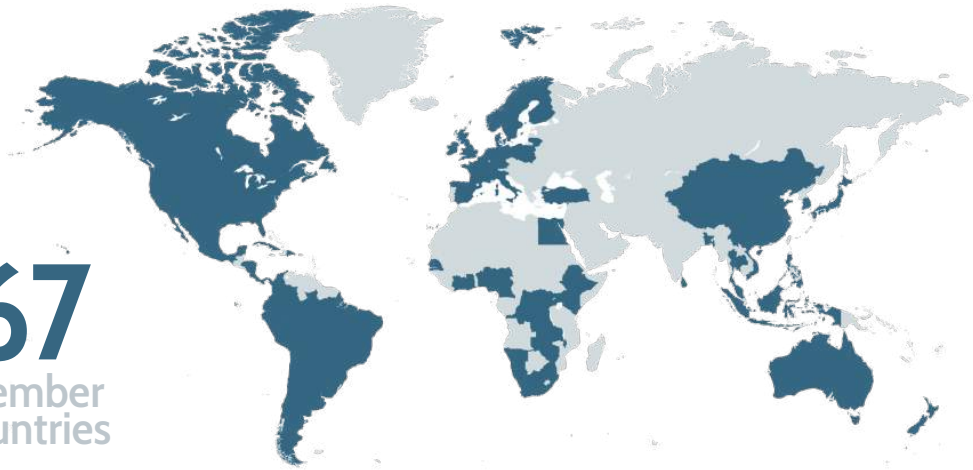
Agriculture has a vital role to play in the coming decades with the world's population estimated to reach 9.6 billion by 2050. With more mouths to feed but limited natural resources to draw on, the sector must find ways to produce additional food and fibre sustainably, while also contributing to broader development goals.

The Global Research Alliance on Agricultural Greenhouse Gases (GRA) is increasing cooperation and investment in research activities to help reduce the emissions intensity of agricultural production systems and increase their potential for soil carbon sequestration. The goals are to improve their efficiency, productivity, resilience, and adaptive capacity. This contributes in a sustainable way to overall mitigation efforts but also helps meet food security objectives.

Improving the quantification of agricultural greenhouse gas emissions under different management scenarios is also key to understanding best practice. Many countries already have research underway to better understand, measure, and manage agricultural greenhouse gases emissions. By linking up these efforts through the GRA, we can achieve faster progress towards the solutions needed for improving agricultural productivity and reducing its greenhouse gas emissions.

Climate change cannot be tackled by any country or research institution working alone.

The GRA is a tremendous opportunity to be part of an initiative that is bringing together the world's best in agricultural greenhouse gas emissions research and mitigation practices and technologies.



67 member countries

4 research groups

Paddy rice | Croplands | Livestock | Integrative

More than **3,000** scientists involved in activities of the GRA

80 technical guidelines, resource materials and databases produced

53 technical training workshops held

18 science networks

30 partner organisations

152 collaborative projects supporting the GRA including six current Flagship Projects

278 fellowships awarded to recipients from 49 countries

The GRA is working together to provide knowledge and build capability for a better future.

The GRA has gone from strength to strength since it's launch at COP15 in Copenhagen in 2009. The initial alliance of 28 countries has become truly global, with countries from all regions of the world now coming together to address the question of how best to ensure future food security, whilst minimising agriculture's environmental footprint.

The Research Groups and Networks are led by representatives from a wide range of countries. Plus, the GRA Secretariat, supported by New Zealand, has grown to include staff based in Europe, Africa and Latin America.

As the GRA has grown, it has become increasingly recognised for its knowledge and expertise. Knowledge partnerships have been built with groups such as Pathways to Dairy Net Zero and the Agricultural Innovation Mission for Climate.

The GRA has also been involved in supporting low- and middle-income countries (LMIC) to participate in international and regional research calls such as European Research Area Networks (ERA-NET), the European Joint Programme Cofund on Agricultural Soil Management (EJP SOIL) and the Regional Fund for Agriculture Technology in Latin America (FONTAGRO).

Growing more food without growing emissions has never been a more important goal. The GRA is working at all levels to build capacity and capability to drive towards this target.

2.0 Message from the GRA Special Representative

Dr Harry Clark

Dear Colleagues and Partners,

I am delighted to present the 12-year stocktake report of the Global Research Alliance on Agricultural Greenhouse Gases (GRA). This report is a testament to the collaborative efforts of our member countries and partner organisations, addressing the crucial intersection of agriculture, climate change, and food security.

Since the launch of the GRA, the conversation about the role agriculture can play in reducing emissions has become more intense and identifying and implementing innovative solutions is and will continue to be a global priority. The GRA's membership has grown to 67 countries and 30 partner organisations from all regions of the world focussed on developing cooperative actions to reduce emissions, enhance soil carbon sequestration, and improve the efficiency, productivity, and resilience of agricultural systems.

Within these pages, you will find highlights of research projects undertaken by scientists from GRA member countries and partner organisations. These projects span crucial areas such as paddy rice, cropping, and livestock, reflecting our collective commitment to developing breakthrough solutions for addressing agricultural greenhouse gas emissions across the agricultural sector.

The report also showcases notable achievements in publications, underlining the GRA's dedication to high quality research accessible to both science and policy communities. Our community of scientists continues to contribute significantly to the global body of knowledge, sharing best practices and fostering international collaboration.

In addition to research and publications, the report features highlights from GRA events held over the past 12 years. These events serve as platforms for knowledge sharing, collaboration, and the exchange of ideas. They underscore the GRA's commitment to facilitating dialogue among scientists, policymakers, and stakeholders to address the challenges faced by the agriculture sector in the face of climate change.

As the Special Representative of the GRA, my role goes beyond ambassadorship. I am dedicated to assisting our members in maximising the benefits of their GRA participation, elevating the GRA's profile at international meetings, broadening links with diverse organisations, securing funding for essential projects, and expanding membership to include active participation from currently under-represented regions.

I extend my gratitude to the dedicated individuals who contribute to the success of the GRA. This report reflects our shared commitment to creating a more sustainable and resilient future for global agriculture.

Sincerely,

Dr. Harry Clark

Special Representative
Global Research Alliance on Agricultural Greenhouse Gases

3.0 Research project highlights

Over the last 12 years, the GRA community has worked together to address shared research challenges. The following section highlights four research projects (one for each GRA research group) that demonstrate global collaboration and have generated results of relevance for policymakers and/or international research organisations. These projects are only a selection of many further project highlights which you can find here: https://globalresearchalliance.org/

since 2012

MIRSA: Greenhouse gas mitigation in irrigated rice paddies in Southeast Asia

2014 - 2017

Benchmark and ensemble crop and grassland model estimates

since 2016

CNMM-DNDC as a hydro-biogeochemical model

2018 - 2021

DATAMAN

3.1 MIRSA: Greenhouse gas mitigation in irrigated rice paddies in Southeast Asia (since 2012)

Impact

The guidelines developed by the project provide a benchmark standard for international researchers measuring greenhouse gas emissions from paddy rice fields.

The guidelines have been cited in the following IPCC guidelines: Box 5.2A, page 5.57, Chapter 5, Volume 4, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

The MIRSA project focuses on greenhouse gas mitigation in irrigated rice paddies in South-East Asia. Simultaneous experimental field trials were initiated in September 2013 in Jakenan (Indonesia), Nueva Ecija (Philippines), Prachin Buri (Thailand), and Hue (Vietnam), and continued for 6 seasons (3 years) to assess the site-specific feasibility of alternate wetting and drying as a mitigation option for methane and nitrous oxide emissions from irrigated rice fields.

The study aimed to develop standardised protocols for the effective implementation of alternate wetting and drying at multiple locations in South-East Asia to achieve the emission reduction target of 30% relative to conventional water management and to acquire a generalised scientific knowledge about the influence of alternate wetting and drying on greenhouse gas emissions reduction.

Key messages:

- The results have shown the effectiveness of alternate wetting and drying to reduce methane and nitrous oxide emissions.
- The project developed guidelines on the effective implementation of alternate wetting and drying at multiple locations in Southeast Asia to achieve the emission reduction target of 30% relative to conventional water management.

Involved members / partners:

Indonesia, Japan, Philippines, Thailand, Vietnam and CGIAR (IRRI)

Find out more:

https://globalresearchalliance.org/library/mitigation-in-irrigated-rice-systems-project/

3.2 Benchmark and ensemble crop and grassland model estimates (2014 - 2017)

Impact

Coordination by Integrative Research Group of the GRA enabled joint activities between five research projects.

40 researchers from 12 countries (Australia, Canada, China, France, Germany, Hungary, India, Italy, New Zealand, Spain, United Kingdom and USA) have been involved.

More than 8 scientific articles have been published.

Uncertainties in the response of crop and grassland models to management and environmental drivers can be attributed to differences in the structure of different models. This has created an urgent need for international benchmarking of models, where uncertainties are estimated by running several models that simulate the same physical and management conditions (ensemble modelling) to generate expanded envelopes of uncertainty. Simulations of the agricultural carbon and nitrogen fluxes, in particular, are inherently uncertain because they are driven by complex interactions and characterized by considerable spatial and temporal variability in the measurements.

In this context, the Integrative Research Group of the Global Research Alliance on Agricultural Greenhouse Gases promoted a coordinated activity across multiple international projects (e.g. CN-MIP, Models4Pastures, MACSUR, COMET Global and MAGGNET) to benchmark and compare simulation models that estimate carbon-nitrogen related outputs (including greenhouse gas emissions) from arable crop and grassland systems.

Key messages:

- Inclusion of additional data, such as phenological observations, could help refine model estimates and form a baseline for screening agricultural practices and mitigation options at croplands and grasslands
- Further analyses and better understanding of multi-model ensembles are required to achieve key progress in crop and grassland modelling by assessing more in-depth model responses and uncertainties against climate and management drivers.

Involved members / partners:

Australia, Canada, China, France, Germany, Hungary, India, Italy, New Zealand, Spain, United Kingdom and USA

Find out more:

https://globalresearchalliance.org/research/integrative/collaborative-activities/models4pastures/

3.3 CNMM-DNDC as a hydro-biogeochemical model

Development and application in addressing issues of multiple UN Sustainable Development Goals and agricultural greenhouse gases (since 2016)

Impact

The model provides accurate predictions of net greenhouse gas balance and component fluxes, thus, helping reduce agricultural greenhouse gas emissions.

The model serves as a shared resource for developing decision-support systems that can be utilised by policymakers worldwide.

The model enables decision-makers to identify and implement practices that enhance productivity while minimising negative environmental impact.

The development of the CNMM-DNDC model is a sophisticated tool designed to simulate high-resolution 3D hydro-biogeochemical processes.

It couples life elements (such as Carbon, Nitrogen and Phosphorus) with water cycles to predict ecosystem productivity, greenhouse gas balance, the fluxes of its components, agricultural product footprints, and more.

Developed by a dedicated Chinese research team, the model has undergone multiple updates (V1.0 to V5.0) with support from prestigious institutions.

Among the key features of this model are its versatile application, multi-scale optimisation, and global validation. In essence, CNMM-DNDC is a powerful and adaptable model contributing to global sustainability efforts.

Key messages:

- CNMM-DNDC is a core working model of the Agricultural System Landscape Management Research Network of the GRA.
- It is designed as a robust process-oriented tool for multi-goals (in terms of SDGs) optimisation of terrestrial ecosystem management practices at plot, catchment, regional, national, continental or global scales.
- The model software is provided as a tool for international research organisations that develop decision supporting systems that can be used by policymakers.

Involved members / partners:

Australia, China, Germany, Kenya, USA, UNEP and CGIAR

Find out more:

https://youtu.be/-w6pMlxdMtk?si=rqQa2nJLfZAZ7pD7

3.4 DATAMAN (2018 - 2021)

Impact

The DATAMAN project has generated three key outcomes, in addition to a collection of scientific publications. The three key outcomes are:

DATAMAN online database: This database is freely available to researchers, inventory compilers and policy staff aiming to calculate emission factor values for their specific situation and/or evaluate mitigation strategies.

Guidelines for improving inventories: The guidelines aid countries with improving their national inventories in relation to greenhouse gas emissions from manure management.

Revised ammonia and nitrous oxide emission factors, including mitigations: The revised emission factors and mitigations have been accepted into the IPCC emission factors database (EFDB), ensuring countries will be able to adopt these latest emission factors values for their national inventory compilation.

DATAMAN seeks to collate, consolidate and unify methane and nitrous oxide emissions datasets associated with manure from international project participants along with ancillary data to create a central database. Analysis of the resulting data will allow the project team to generate empirical relationships between ancillary manure composition, climate and abiotic data and Emissions Factors and provide a global resource for upgrading national inventories.

Disaggregated emissions data and specific emission factors for methane, nitrous oxide and ammonia emissions from manure including housing, storage and field application/ deposition will be collated, along with ancillary activity data. The project will be of core interest to the GRA's Manure Management Network, as well as being put forward as a key activity under the GRA's proposed flagship research programme on nitrous oxide.

Key messages:

- There have been few studies focusing on the drivers of manure-related emissions using a global dataset.
- One of the features of this new research is the opportunity for researchers and inventory compilers to model the nitrous oxide excreta emission factor value based on the dietary nitrogen content for cattle and sheep grazing. This directly addresses the concerns raised in a recent paper where the authors felt the refined IPCC values for excreta in dry climates were too high due to the relatively high dietary nitrogen content used for calculating the excreta emission factor value.

Involved members/partners:

Chile, Denmark, France, Germany, Ireland, New Zealand and United Kingdom

Find out more:

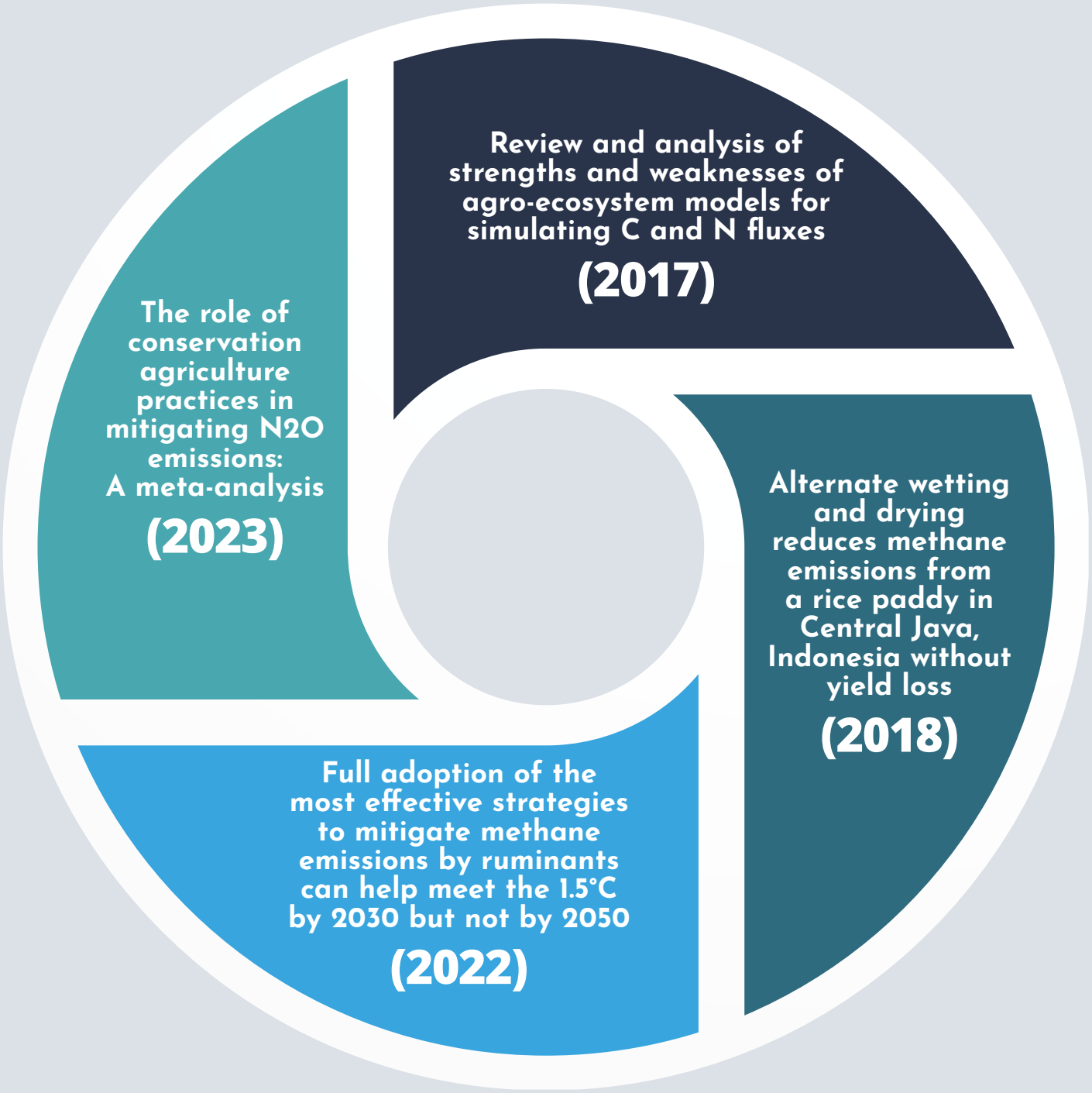
https://www.dataman.co.nz/

https://doi.org/10.1002/jeq2.20186

https://globalresearchalliance.org/research/livestock/collaborative-activities/dataman/

4.0 Publication highlights

Over the last 12 years, the GRA community has been a strong voice in publishing research on agricultural greenhouse gases. The following section highlights four publications (one for each GRA research group) that demonstrate global collaboration, have a significant outreach and have generated results of relevance for policymakers and/or international research organisations. These publications are only a selection of many further publication highlights which you can find here: https://globalresearchalliance.org/publication-library/



4.1 Review and analysis of strengths and weaknesses of agro-ecosystem models for simulating C and N fluxes (2017)

Impact

26 researchers from 7 countries (Australia, Canada, France, Italy, New Zealand, United Kingdom and USA) have been involved in developing the publication.

The publication has been cited over 130 times.

Contributed to model intercomparison initiatives. These initiatives, supported by multiple projects, have played a crucial role in identifying limitations in various models, prompting modelling teams to address these concerns.

Biogeochemical simulation models are important tools for describing and quantifying the contribution of agricultural systems to carbon sequestration and greenhouse gas source/sink status. The abundance of simulation tools developed over recent decades, however, creates a difficulty because predictions from different models show large variability. Discrepancies between the conclusions of different modelling studies are often ascribed to differences in the physical and biogeochemical processes incorporated in equations of carbon and nitrogen cycles and their interactions.

This literature review determined the state-of-the-art in modelling agricultural (crop and grassland) systems. The models were assessed for the quality and comprehensiveness of underlying processes related to pedo-climatic conditions and management practices, but also concerning time and space of application, and for their accuracy in multiple contexts.

Overall, it emerged that there is a possible impact of ill-defined pedo-climatic conditions in the unsatisfactory performance of the models (46.2%), followed by limitations in the algorithms simulating the effects of management practices (33.1%). The multiplicity of scales in both time and space is a fundamental feature, which explains the remaining weaknesses (i.e. 20.7%).

Innovative aspects have been identified for future development of carbon and nitrogen models. They include the explicit representation of soil microbial biomass to drive soil organic matter turnover, the effect of nitrogen shortage on soil organic matter decomposition, the improvements related to the production and consumption of gases and adequate simulations of gas transport in soil.

On these bases, the assessment of trends and gaps in the modelling approaches currently employed to represent biogeochemical cycles in crop and grassland systems appears an essential step for future research.

Key messages:

- Biogeochemical models have limits in simulating pedo-climatic conditions and management effects.
- Biogeochemical models should include the explicit representation of soil microbial biomass to drive soil organic matter turnover.
- Improved approaches to simulate gas transport in soil are required for future modelling work.

Authors:

Brilli L, Bechini L, Bindi M, Carozzi M, Cavalli D, Conant R, Dorich CD, Doro L, Ehrhardt F, Farina R, Ferrise R, Fitton N, Francaviglia R, Grace P, Iocola I, Klumpp K, Léonard J, Martin R, Massad RS, Recous S, Seddaiu G, Sharp J, Smith P, Smith WN, Soussana JF, Bellocchi G

Find out more:

https://doi.org/10.1016/j.scitotenv.2017.03.208

4.2 Alternate wetting and drying reduces methane emissions from a rice paddy in Central Java, Indonesia without yield loss (2018)

Impact

Researchers from Japan and the Philippines have been involved in developing the publication.

The article has been cited over 60 times.

This study outlined the potential of alternate wetting and drying in reducing greenhouse gas emissions from paddy rice in Indonesia, while maintaining yield.

Water regimes play a central role in regulating methane and nitrous oxide emissions from irrigated rice fields. Alternate wetting and drying is a possible option, but there is limited information on its feasibility under local environmental conditions, especially for tropical regions. Therefore a 3-year experiment in a paddy field in Central Java, Indonesia was carried out to investigate the feasibility of alternate wetting and drying in terms of rice productivity, greenhouse gas emission, and water usage both in wet and dry seasons.

The treatments of water management were (1) continuous flooding, (2) flooding when surface water level naturally declines to 15 cm below the soil surface, and (3) site-specific alternate wetting and drying with different criteria of soil drying established to find out the optimum for greenhouse gas emission reduction.

Gas flux measurement was conducted by a static closed chamber method. Rice growth was generally normal and the grain yield did not significantly differ among the three treatments both in wet and dry seasons. Both alternate wetting and drying treatments significantly reduced the total water use (irrigation + rainfall) as compared to continuous flooding. As expected, the seasonal total methane emission was significantly reduced by alternate wetting and drying.

On average, the methane emissions under alternate wetting and drying were 35% to 38% lower than those under continuous flooding. It should be noted that alternate wetting and drying was effective even in the wet season partly due to the field location on an inland, upland area that facilitates the drainage. The seasonal total nitrous oxide emission did not significantly differ among the treatments.

Key messages:

- The results indicate that alternate wetting and drying is a promising option to reduce greenhouse gas emissions, as well as water use without sacrificing rice productivity in this field.
- Yield was not significantly impacted by alternate wetting and drying both in dry and wet seasons.

Authors:

Prihasto Setyanto, Ali Pramono, Terry Ayu Adriany, Helena Lina Susilawati, Takeshi Tokida, Agnes T. Padre & Kazunori Minamikawa

Find out more:

https://doi.org/10.1080/00380768.2017.1409600

4.3 Full adoption of the most effective strategies to mitigate methane emissions by ruminants can help meet the 1.5°C by 2030 but not by 2050 (2022)

Impact

24 researchers from 10 countries (Finland, France, Ireland, Kenya, The Netherlands, Norway, Spain, Switzerland, United Kingdom, USA) have contributed to the development of the publication.

The article has been cited over 60 times.

This article used a database including findings from 430 peer-reviewed studies; reporting 98 mitigations strategies.

To meet the 1.5 °C target, methane emissions from agriculture must be reduced by 11 to 30% by 2030 and 24 to 47% by 2050 compared to 2010 levels. A meta-analysis identified strategies to decrease product-based (methane per unit meat or milk) and absolute enteric methane emissions while maintaining or increasing animal productivity. Next, the potential of different adoption rates of one product-based or one absolute strategy to contribute to the 1.5 °C target was estimated.

The database included findings from 430 peer-reviewed studies, which reported 98 mitigation strategies that can be classified into three categories: animal and feed management, diet formulation, and rumen manipulation. Three product-based strategies—namely, increasing feeding level, decreasing grass maturity, and decreasing dietary forage-to-concentrate ratio—decreased methane per unit meat or milk by on average 12% and increased animal productivity by a median of 17%.

Five strategies—namely methane inhibitors, tanniferous forages, electron sinks, oils and fats, and oilseeds—decreased daily methane by on average 21%. Globally, only 100% simultaneous adoption of the two most effective product-based and absolute strategies can meet the 1.5°C target by 2030 but not 2050, because mitigation effects are expected to be offset by projected increases in methane emissions due to increasing milk and meat demand.

Notably, by 2030 and 2050, low- and middle-income countries may not meet their contribution to the 1.5°C target for this same reason, whereas high-income countries could meet their contributions due to only a minor projected increase in enteric methane emissions.

Key messages:

- Europe has the technical potential to meet its contribution to the 1.5°C target, but not Africa.
- The 1.5°C target by 2030 can be technically met but is unlikely to be met due to adoption barriers; the 2050 target cannot be met using the two most effective strategies.
- More effective strategies are needed for different production contexts to increase the adoption of practices. Besides research on mitigation strategies, research is needed on adoption and adoption barriers in different systems.
- Many strategies (64% of all strategies) were identified not to be effective in decreasing methane emissions, highlighting the need to carefully scrutinize proposed methane mitigation strategies.

Authors:

Claudia Arndt, Alexander N. Hristov, William J. Price, Shelby C. McClelland, Amalia M. Pelaez, Sergio F. Cueva, Joonpyo Oh, Jan Dijkstra, André Bannink, Ali R. Bayat, Les A. Crompton, Maguy A. Eugène, Dolapo Enahoro, Ermias Kebreab, Michael Kreuzer, Mark McGee, Cécile Martin, Charles J. Newbold, Christopher K. Reynolds, Angela Schwarm, Kevin J. Shingfield, Jolien B. Veneman, David R. Yáñez-Ruiz, and Zhongtang Yu

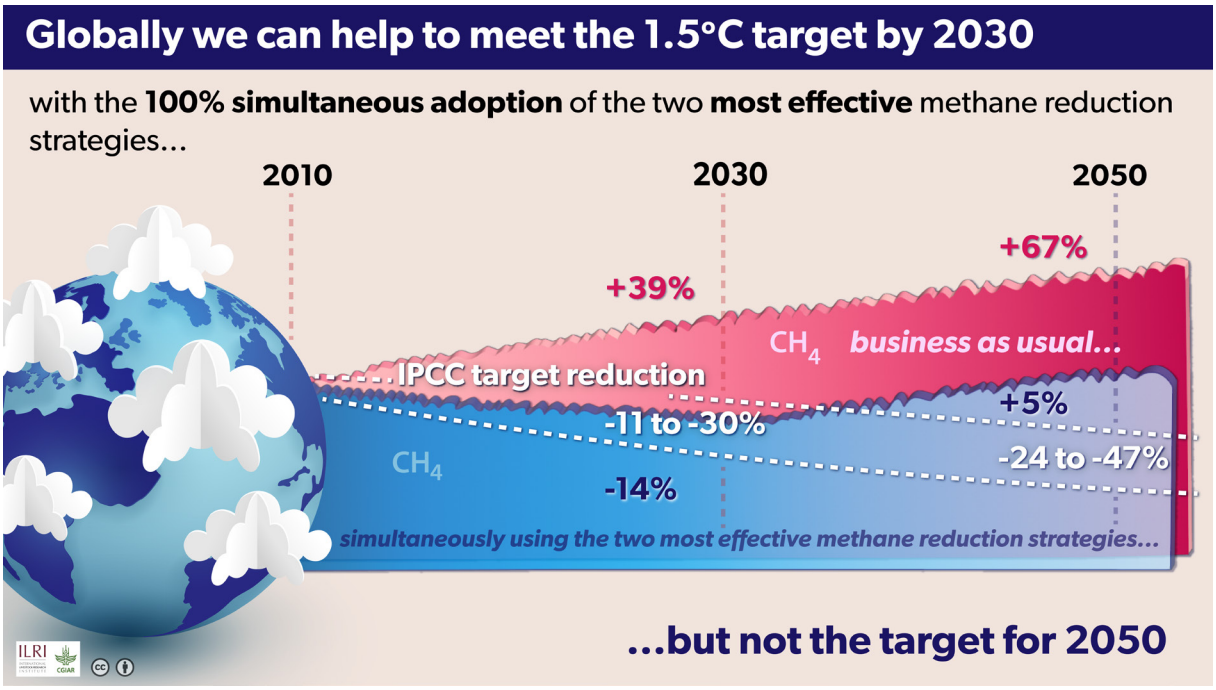
Find out more:

https://doi.org/10.1073/pnas.2111294119

https://www.ilri.org/news/full-adoption-existing-mitigation-strategies-can-help-meet-livestock-methane-reduction-0

https://theconversation.com/less-burping-more-meat-and-milk-how-livestock-farmers-can-help-tackle-the-climate-crisis-194822

https://www.wur.nl/en/show/adoption-of-existing-mitigation-strategies-can-help-meet-livestock-methane-reduction-targets-by-2030.htm



4.4 The role of conservation agriculture practices in mitigating N2O emissions: A meta-analysis (2023)

Impact

Researchers from four countries (Canada, China, Denmark, USA) have been involved in developing the publication.

The publication offers insights into the impact of conservation agriculture practices on nitrous oxide emissions and crop yields, aligning with GRA's mission to reduce greenhouse gas emissions while sustaining food production.

The project facilitated international collaboration and knowledge-sharing among researchers, contributing to a global effort to address climate change through sustainable agricultural practices.

This project investigated the impact of three main conservation agriculture practices—no-till/reduced tillage, cover crops, and diversified crop rotations—on soil nitrous oxide emissions. Utilising a sophisticated random meta-forest approach, the study discerned key factors influencing the effectiveness of these practices on nitrous oxide emissions.

The primary objectives encompassed a concurrent assessment of the practices, the integration of diverse predictors including soil characteristics, and the development of a predictive framework. Through a thorough review and meta-analysis, findings revealed that, on average, no-till/reduced tillage reduced soil nitrous oxide emissions by 11% compared to conventional tillage. However, the impact of cover crops and diversified crop rotations was contingent upon factors such as soil pH, carbon content, and nitrogen levels.

The study underscored the pivotal role of climate and soil conditions in shaping the efficacy of these conservation practices for nitrous oxide emissions mitigation. In conclusion, this project furnishes valuable insights into the role of conservation agriculture in mitigating nitrous oxide emissions, setting the stage for a predictive framework to inform the strategic adoption of these practices for climate change mitigation.

Key messages:

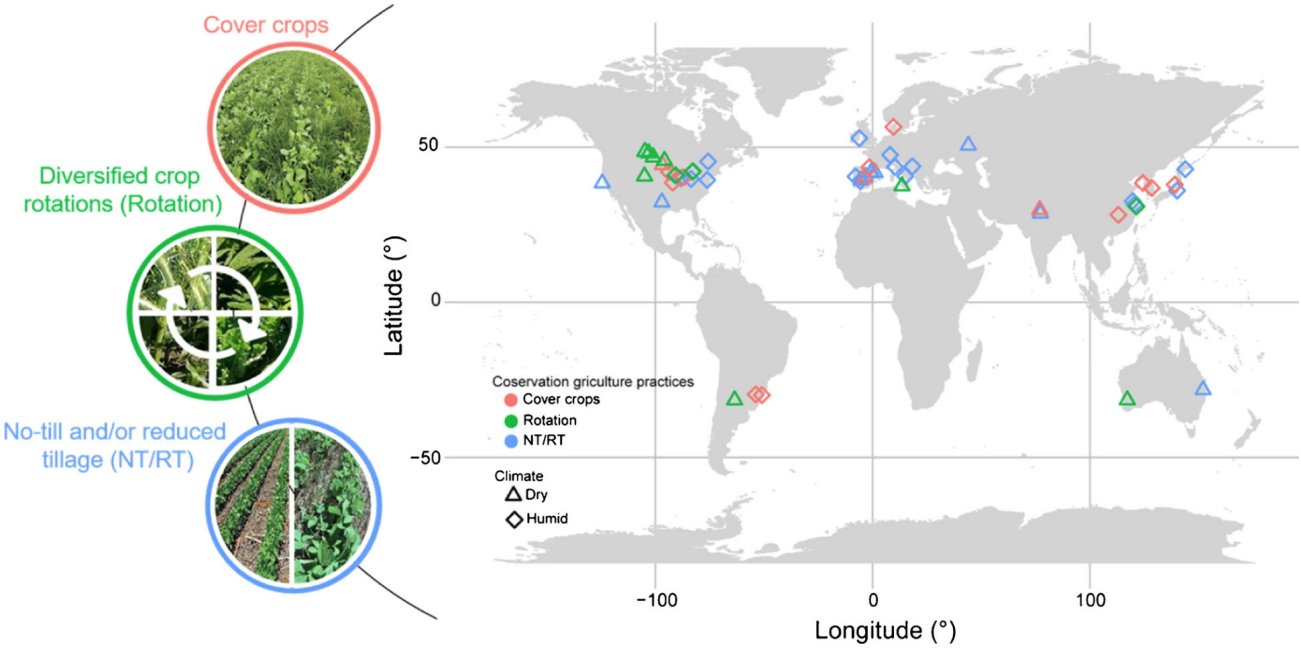
- Conservation agriculture practices, including no-till/reduced tillage, cover crops, and diversified crop rotations, have varying effects on soil nitrous oxide emissions. Policymakers and researchers must consider these dual impacts to reconcile the goals of increasing food production while reducing agricultural greenhouse gas emissions.
- Climate and soil parameters play a significant role in determining the effectiveness of conservation agriculture practices in mitigating nitrous oxide emissions. Different practices may be more suitable for specific environmental conditions.
- Developing a comprehensive predictive framework is essential to understand the conditions under which various conservation agriculture practices can effectively contribute to climate change mitigation. This framework should consider the interaction of soil properties, climatic factors, and management practices.

Authors:

Yue Li, Ji Chen, Diego Abalos, Craig F. Drury, Zhaozhi Wang, Mark Liebig, Jane M. F. Johnson, Hao Feng

Find out more:

https://link.springer.com/article/10.1007/s13593-023-00911-x



Source of image: https://link.springer.com/article/10.1007/s13593-023-00911-x/figures/1

5.0 Event highlights

Over the last 12 years, the GRA community, including research groups, networks and teams involved in research projects, have demonstrated a focus on knowledge sharing and capability building through the organisation of workshops, meetings and other events. The following overview of selected events demonstrates the wide reach of GRA activities and/or their significance to the research community. These events are only a selection of many further event highlights which you can find here: https://globalresearchalliance.org/events/

27 – 31 July 2015

African Inventory and Monitoring workshop

African regional participants were invited to attend an inventories workshop in New Zealand. Participants were inventory compilers and/or agriculture, forestry and other land use (AFOLU)/agriculture sector experts from Ghana, Botswana and South Africa. The workshop was held over a week with three days in Wellington and two days in Palmerston North visiting research centres and field sites.

5th March 2018

Workshop "Sustainable management of northern peatlands"

Key outcomes of the event:

- Identified where lands should be cultivated and the best management options to reduce emissions;
- Identified what peatlands should/could be restored based on the policies and requirements for each country;
- Completed a stocktake and inventory –of fertilisation and drainage policies globally;
- Created a database of sustainable fertiliser practices.

9 – 12 April 2018

Regional technical training workshop "Construction and use of respiration chambers for small ruminant studies"

NZAGRC together with the University of Putra Malaysia and AgResearch Limited organised this 4-day hands-on regional workshop in Malaysia covering the design, construction, and operation of low-cost respiration chambers for small ruminants. Participants from Vietnam, Sri Lanka, Thailand, Indonesia, Philippines, China, Malaysia, and New Zealand learned how to construct, calibrate and run such a respiration chamber in their own countries. The workshop also covered animal handling, QA/QC procedures, data calculation and interpretation, and the costs, benefits, limitations, and options for further improvements to the chamber methodology.

October and November 2018

Workshop and Capacity Building Training as part of the project "Capacity Building on Management Technologies for Climate Smart Rice Cultivation in the South-East Asian and Latin American Rice Sector "

These events took place as part of the project 'Capacity Building on Management Technologies for Climate Smart Rice Cultivation in the South-East Asian and Latin American Rice Sector' initiated by the Ministry of Agriculture, Forestry, and Fisheries (MAFF), Japan. The events, held in Thailand and Chile, brought together researchers, experts, and rice producers, including GRA scientists. These collaborative sessions included comprehensive training on rice management technologies, field exercises, and strategies for climate change mitigation. The events aimed to empower participants with the knowledge and skills necessary for sustainable and resilient rice cultivation in the targeted regions.

11 – 15 February 2019

Workshop "Livestock and climate change: Assessment of emissions, mitigation options and adaptation strategies"

The GRA together with the International Center for Advanced Mediterranean Agronomic Studies (CIHEAM), the Food and Agriculture Organization of the United Nations (FAO), the International Center for Agricultural Research in Dry Areas (ICARDA), the Red Remedia, and the 4 per 1000 Initiative organised an advanced course for professionals on livestock and climate change.

It provided participants with over 20 hours of in-class training and 14 hours of practical work and debate supplemented by real-life case studies in the context of Mediterranean agriculture and climate change conditions. Participants were given the opportunity to engage in practical exercises on greenhouse gas national inventories calculations while learning more about adaptation and mitigation strategies, measuring methodologies and modelling tools in livestock systems. They also networked with experts and professionals from other countries interested in livestock farming and the mitigation of the effects on the climate and the environment."

16th October 2020

Modelling Mitigation and Adaptation Co-Benefits (MAC-B)

Key outcomes of the event:

- Initiated AgMIP/GRA modelling framework for mitigation and adaptation co-benefits;
- Planned for a peer-reviewed journal article, to be included in a planned Special Collection to be hosted in the AGU journal "Earth's Future", on rationale and protocols for the mitigation and adaptation framework;
- Initiated a Special Issue on MAC-B for CABI journal.
- Developed a set of pilot projects to test the MAC-B framework and protocols, comprised of selected regions with contrasting agroecosystems and challenges.

April 2021

Webinar "New tools for monitoring, reporting, and verification of GHG mitigation in rice"

This online webinar, promoted the application of new MRV tools in rice production for planning and implementing cost-effective mitigation programs, contributing to achieving countries' NDC targets.

The webinar recording is available at:
https://youtu.be/kOnX4w1ldRE?feature=shared

21st May 2021

Webinar "Full inversion tillage in mixed crop/pasture systems to sequester soil C & reduce N2O risk emissions"

The webinar recording is available at: https://www.youtube.com/live/lAehkwoP2Fs?feature=shared

24th May 2022

INDC webinar series 2022 - Session 1: The policy relevance of national GHG inventories in guiding mitigation for agriculture

This webinar brought together leading experts and industry stakeholders to discuss the relevance of national agriculture inventories in guiding policy decisions and questions including:

- Why are agriculture GHG inventories so crucial for policy decisions?
- How can industry organisations and the inventory work together?
- What is the relationship between climate finance, research, and national agriculture inventories?

The webinar recording is available at: https://youtu.be/xZzM_SUqZaY

14th June 2022

INDC webinar series 2022 - Session 2: National agriculture inventory data collection and management

The aim of this webinar was to increase awareness on overcoming a lack of good quality data, and on setting up data management frameworks to support increasing emissions reporting from Tier 1 to Tier 2 levels. The session brought together expert speakers whose work focuses on improving agriculture inventory activity data related issues.

The webinar recording is available at: https://youtu.be/jaP2xYdKD34

5th July 2022

INDC webinar series 2022 - Session 3: Commissioning and managing agriculture inventory research projects

The webinar recording is available at: https://youtu.be/V15n1fp2dGc

11th April 2022

Session at Circular@WUR Conference: The Circular Food Systems network: exploring opportunities for food security by circularity in different regions in the world

This session has been organised by the Circular Food Systems network of the GRA. It aims to take the global lead in bringing together, developing, and disseminating knowledge about circular food systems. The network invited researchers and policy-makers to discuss their experiences with circular food systems across the world. Together with the session participants they further built the concept and explored opportunities of circularity for different regions worldwide.

https://library.wur.nl/ojs/index.php/CircularWUR2022/article/view/18306/17724

May 2023

INDC webinar series 2022 - 1st annual meeting of the GRA Indigenous Research Network

The Indigenous Research Network had its first annual meeting in May 2023 hosted by a Māori (indigenous New Zealand) tribe, Ngati Tuwharetoa. New Zealand hosted an International Delegation from Thailand, and the Pacific for this meeting as well as a study tour to facilitate indigenous-to-indigenous connections on-ground, creating the opportunity for an international indigenous project plan. From this visit, the network has created its first collaboration supporting a community action research project with the Te Aitanga a Mate land collective in Ngati Porou (a Maori tribe) in New Zealand and Thailand's Agri-Nature Foundation to build a long-term sustainable land management plan.

https://globalresearchalliance.org/library/indigenous-research-network-intro-video/

1st September 2023

Organised Session at EAAE Congress: Economics Of Climate Change Mitigation Strategies At Farm-Level

This session has been organised by the Farm To Regional Scale Integration network of the GRA. In this session results from projects that are analyzing the costs of climate mitigation measures at farm-level have been presented to identify the most cost-effective climate mitigation measures by production system, farm type and region. The session helped to connect the network with the community of European Agricultural Economists.

https://globalresearchalliance.org/research/integrative/networks/farm-to-regional-integration-network/view/18306/17724

6.0 Selected publications

1. Söderström, B., Hedlund, K., Jackson, L.E. et al. What are the effects of agricultural management on soil organic carbon (SOC) stocks?. Environ Evid 3, 2 (2014). https://doi.org/10.1186/2047-2382-3-2

2. Berndt, A., T. M. Boland, M. H. Deighton, J. I. Gere, C. Grainger, R. S. Hegarty, A. D. Iwaasa, J. P. Koolaard, K. R. Lassey, D. Luo, R. J. Martin, C. Martin, P. J. Moate, G. Molano, C. Pinares-Patiño, B. E. Ribaux, N. M. Swainson, G. C. Waghorn, and S. R. O. Williams (2014): Guidelines for use of sulphur hexafluoride (SF6) tracer technique to measure enteric methane emissions from ruminants. Pages 166. M. G. Lambert, ed. New Zealand Agricultural Greenhouse Gas Research Centre, New Zealand.

3. Pickering, N. K.; Oddy, V. H.; Basarab, J.; Cammack, K.; Hayes, B.; Hegarty, R. S. et al. (2015): Animal board invited review: genetic possibilities to reduce enteric methane emissions from ruminants. In: Animal : an international journal of animal bioscience 9 (9), pp. 1431–1440. DOI: 10.1017/S1751731115000968.

4. Hammond, K. J.; Crompton, L. A.; Bannink, A.; Dijkstra, J.; Yáñez-Ruiz, D. R.; O'Kiely, P. et al. (2016): Review of current in vivo measurement techniques for quantifying enteric methane emission from ruminants. In: Animal Feed Science and Technology 219, pp. 13–30. DOI: 10.1016/j.anifeedsci.2016.05.018.

5. Yáñez-Ruiz, D. R.; Bannink, A.; Dijkstra, J.; Kebreab, E.; Morgavi, D. P.; O'Kiely, P. et al. (2016): Design, implementation and interpretation of in vitro batch culture experiments to assess enteric methane mitigation in ruminants—a review. In: Animal Feed Science and Technology 216, pp. 1–18. DOI: 10.1016/j.anifeedsci.2016.03.016.

6. Haas, Y. de; Pszczola, M.; Soyeurt, H.; Wall, E.; Lassen, J. (2017): Invited review: Phenotypes to genetically reduce greenhouse gas emissions in dairying. In: Journal of dairy science 100 (2), pp. 855–870. DOI: 10.3168/jds.2016-11246.

7. Ehrhardt, Fiona; Soussana, Jean-François; Bellocchi, Gianni; Grace, Peter; McAuliffe, Russel; Recous, Sylvie et al. (2018): Assessing uncertainties in crop and pasture ensemble model simulations of productivity and N2 O emissions. In: Global change biology 24 (2), e603-e616. DOI: 10.1111/gcb.13965.

8. Seshadri, R., Leahy, S., Attwood, G. et al. Cultivation and sequencing of rumen microbiome members from the Hungate1000 Collection. Nat Biotechnol 36, 359–367 (2018). https://doi.org/10.1038/nbt.4110

9. Hristov, A. N.; Kebreab, E.; Niu, M.; Oh, J.; Bannink, A.; Bayat, A. R. et al. (2018): Symposium review: Uncertainties in enteric methane inventories, measurement techniques, and prediction models. In: Journal of dairy science 101 (7), pp. 6655–6674. DOI: 10.3168/jds.2017-13536.

10. Waghorn, G.; Jonker, A.; McAuliffe, R. (2018): GreenFeed standard operating procedure. https://globalresearchalliance.org/wp-content/uploads/2018/08/GreenFeeds-SOP-_final.pdf

11. Huws, Sharon A.; Creevey, Christopher J.; Oyama, Linda B.; Mizrahi, Itzhak; Denman, Stuart E.; Popova, Milka et al. (2018): Addressing Global Ruminant Agricultural Challenges Through Understanding the Rumen Microbiome: Past, Present, and Future. In: Frontiers in microbiology 9, p. 2161. DOI: 10.3389/fmicb.2018.02161.

12. Pinares, Cesar; Waghorn, Garry (Hg.) (2018): Technical manual on respiration chamber designs. Wellington: Ministry of Agriculture and Forestry. https://globalresearchalliance.org/wp-content/uploads/2018/02/LRG-Manual-Facility-BestPract-Sept-2018.pdf

13. Damianidis, Christos; Santiago-Freijanes, Jose Javier; Herder, Michael den; Burgess, Paul; Mosquera-Losada, Maria Rosa; Graves, Anil et al. (2021): Agroforestry as a sustainable land use option to reduce wildfires risk in European Mediterranean areas. In: Agroforest Syst 95 (5), pp. 919–929. DOI: 10.1007/s10457-020-00482-w.

14. de Klein et al. (2020): Special Section: GRA N2O Chamber Methodology Guidelines. In: Journal of environmental quality 49 (5), pp. 1073-1202. https://acsess.onlinelibrary.wiley.com/toc/15372537/2020/49/5

15. Hegarty RS, Cortez Passetti RA, Dittmer KM, Wang Y, Shelton S, Emmet-Booth J, Wollenberg E, McAllister T, Leahy S, Beauchemin K, Gurwick N. 2021. An evaluation of emerging feed additives to reduce methane emissions from livestock. Edition 1. A report coordinated by Climate Change, Agriculture and Food Security (CCAFS) and the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) initiative of the Global Research Alliance (GRA)

16. Parodi, Alejandro; Villamonte-Cuneo, Gianfranco; Loboguerrero, Ana Maria; Martínez-Barón, Deissy; Vázquez-Rowe, Ian (2022): Embedding circularity into the transition towards sustainable agroforestry systems in Peru. In: The Science of the total environment 838 (Pt 3), S. 156376. DOI: 10.1016/j.scitotenv.2022.156376.

17. Sándor, Renáta; Ehrhardt, Fiona; Grace, Peter; Recous, Sylvie; Smith, Pete; Snow, Val et al. (2023): Residual correlation and ensemble modelling to improve crop and grassland models. In: Environmental Modelling & Software 161, S. 105625. DOI: 10.1016/j.envsoft.2023.105625.

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