

GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

Country report : Spain

Alberto Sanz-Cobeña, Jorge Alvaro-Fuentes, Pilar Merino, Fernando Estellés, Agustín del Prado, David Yañez, Luis Lassaletta, Eduardo Aguilera, Antonio Vallejo, Salvador Calvet



MINISTERIO
DE CIENCIA
E INNOVACIÓN



Presentation to IRG Annual Meeting
Cali, 5 February 2019

No specific contributions to IRG but national and international projects contributing to IRG's topics

- **International initiatives:** (e.g.) **FAO-IAEA** research group on **N₂O mitigation and C sequestration** in cropping systems; **ILTER** (**I**nternational **L**ong **T**erm **E**cological **R**esearch **N**etwork)
- **National research projects** on N and C management towards sustainable cropping systems (e.g. Agrisost, others).
- National research initiative to improve N₂O EF in cropping systems (from Tier 1 to Tier 2).
- Zootecnic documents for Spanish Ministry of Agriculture, Fisheries and Food
- **National research networks:** REMEDIA (GHG mitigation in agroforestry), **RED NUEVA** (to develop/improve) national GHG EF in croplands and livestock systems.
- **GRA meeting in Madrid** (February, 2018): proposal for **GRA sub-group in Mediterranean areas**

National and international projects contributing to IRG's topics

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- Gestión de deyecciones en sistemas productivos de vacuno de leche de la cornisa cantábrica. De la explotación al territorio: Eficiencia del uso de **nutrientes, mitigación de gases de efecto invernadero y reducción de la huella de C.** RTA 2015-00058-C06-04 2017 – 2020. Partners: Serida, Ingacal, BC3, Intia
- Propagating **innovations for more resilient dairy farming** in the Atlantic area 2018 -2021 Partners: INGACAL, SRUC, IDELE, Teagasc, CAFRE, INRA, AHDB, UTAD, Chambre d'agriculture Bretagne
- **Tecnología Destinada A La Sostenibilidad De Los Sistemas Agrícolas.** 2019 -2022 Partners: UPM, INIA, CIEMAT, UAM. Programa de Investigación financiado por la Comunidad de Madrid y los Fondos Estructurales Europeos (AGRISOST-CM, S2018/BAA4330)
- Others...

National networks contributing to IRG's topics

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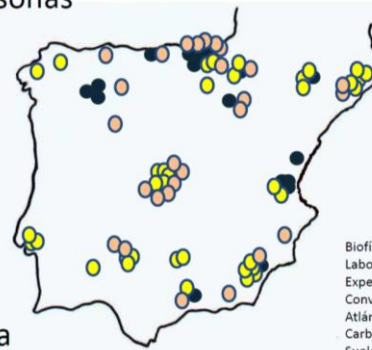
Workshops



Since 2012

Aprox.
400 -500 personas

Red de
investigación



transfereencia



Biofísica, social, económica, políticas
Laboratorio, parcela, granja, paisaje, regional
Experimentos, modelización, ACV, inventarios
Convencional, ecológico, conservación,
Atlántico, mediterráneo, montaña,
Carbono, nitrógeno, emisiones indirectas
Suelo, planta, aire, agua, forestal, animal,
subproductos, compost, residuos,
Mecanicistas, empíricos, estadísticos, holísticos,
Deterministas

remedia

RED CIENTIFICA DE MITIGACIÓN DE EMISIONES
DE GASES DE EFECTO INVERNADERO EN EL
SECTOR AGROFORESTAL.

Res.
papers

Blogs & Social Networks

Courses



10 OCTUBRE, 2017 DE MLCAYUELA

Web específica para contenidos de la Global Research Alliance (GRA) dentro del portal de Investigación Agroalimentaria y Forestal AGRIPA

El INIA ha desarrollado una página web dentro del portal de Investigación Agroalimentaria y Forestal AGRIPA (www.agripa.org) específica para los contenidos relativos a la GRA. (<http://gra.agripa.org/>), y en particular para información de presentaciones e informes de reuniones con el fin de que puedan estar disponibles como información compartida.

La página ha sido diseñada con una estructura básica que puede ser ampliada con las sugerencias que consideréis. La intención del INIA es mantener esta página directamente

Curso Avanzado
EVALUACIÓN Y MITIGACIÓN DE LAS EMISIONES DE GASES DE EFECTO INVERNADERO EN AGRICULTURA: CONCEPTOS, MÉTODOS Y HERRAMIENTAS DE SIMULACIÓN
Zaragoza (España), 12-16 marzo 2018

Objetivo del curso
En el marco del Acuerdo de París sobre el Cambio Climático, todos los sectores económicos deben reducir sus emisiones de gases de efecto invernadero (GEI). La agricultura es el sector responsable aproximadamente del 10-12% de las emisiones antropogénicas de GEI en el mundo. Numerosos estudios indican que existe potencial para reducir las emisiones de GEI y favorecer el secuestro de carbono en los suelos agrícolas. No obstante, las emi-

Día de inicio (ICARDA), y la Red REMEDIA (Red científica de mitigación de emisiones de gases de efecto invernadero en el sector agroforestal). El curso se celebrará en el Instituto Agronómico Mediterráneo de Zaragoza, con profesorado de reconocida experiencia, procedente de organizaciones internacionales, y de universidades y centros de investigación de diversos países. El curso tendrá una duración de una semana y se desarrollará, en horario de mañana y tarde, del 12 al 16 de marzo de 2018.

Strategies for greenhouse gas agriculture: A review
A. Sanz Cobena¹, L. Lasaterra², E. A. A. Iglesias³, B. Sánchez⁴, C. Caunedo⁵, J. Piquero-Rodríguez⁶, E. Moral⁷, E. A. Mejías⁸, C. Parra⁹, J. Alvaro-Palero¹⁰, S. González-Olivares¹¹, M. J. Casado¹², M. Quesada¹³, E. Lario¹⁴, S. Calvet¹⁵, B. C. Conen¹⁶, A. Valiela¹⁷, F. Sarda¹⁸

Direct nitrous oxide emissions in Mediterranean climate cropping systems: Emission factors based on a meta-analysis of available measurement data
María L. Casado¹, Eduardo Aguilera², Alberto Sanz-Cobena³, Deán C. Adams⁴, Diego Abalos⁵, Louise Barton⁶, Rebecca Ryden⁷, Whitmore L. Silver⁸, María A. Alfaro⁹, Yovanis A. Pappa¹⁰, Peter Smith¹¹, Joost Gassner¹², Gilles Billen¹³, Lars Rosenmund¹⁴, Alberto Bondara¹⁵, Luis Lasaterra¹⁶

& more...

National networks contributing to IRG's topics

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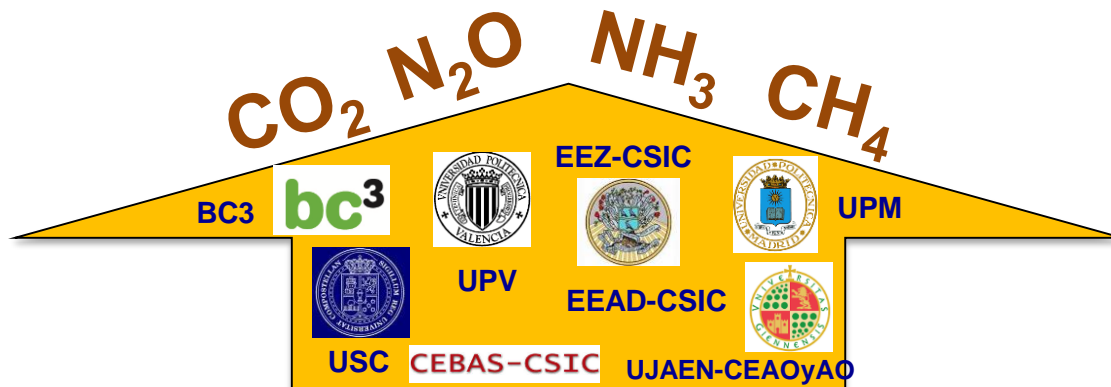
ON AGRICULTURAL GREENHOUSE GASES

Network for **U**pdating **E**mission **V**alues in spanish **A**griculture

'Assessment of GHG EFs in the Spanish agricultural sector'



- To define EFs evaluation criteria/review existing methodologies
- To explore GHG measurement approaches
- To identify 'gaps of knowledge'
- To promote internationalization and communication with policymakers and stakeholders

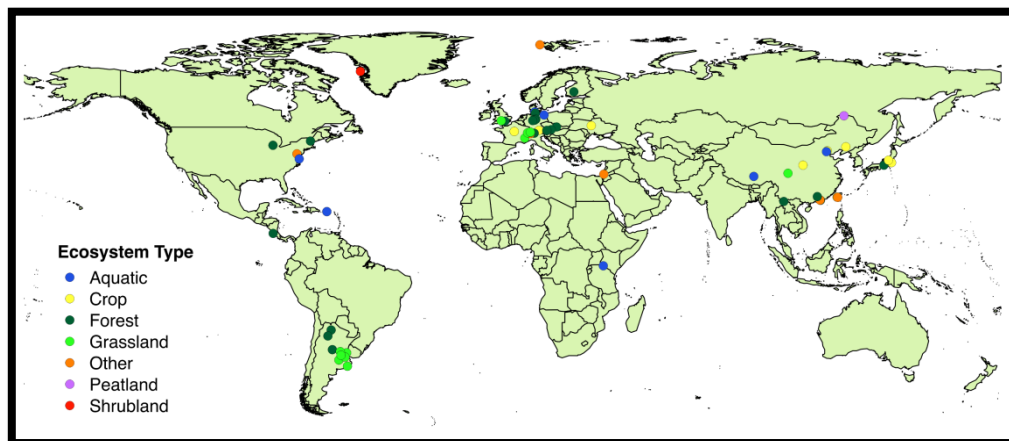


Global assessment of N₂O emission from aquatic and terrestrial ecosystems: the ILTER-N initiative

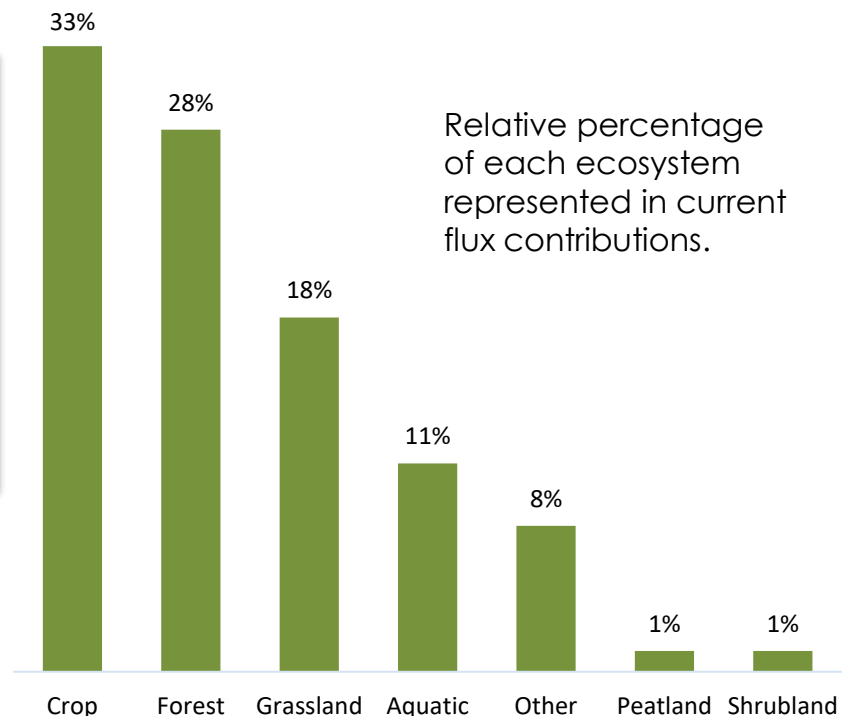
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The ILTER-N initiative aims to foster global collaborative and comparative research on the fluxes of N₂O from aquatic and terrestrial ecosystems, with an emphasis on long-term measurements.



N₂O fluxes from various climates and ecosystems within the ILTER and related site networks. In our initial responses, 90 sites reporting N₂O measurements with varying sampling intensity and methodology.



Workshop planned in Madrid (fall 2019)

William H. McDowell, Allison Herreid, Luis Lassaletta, Hideaki Shibata, Alberto Sanz-Cobeña, Jody Potter

National research initiative to improve N₂O EF in Spanish cropping systems (inventories network)

Lower N₂O emission factors than temperate systems

IPCC Tier I default value

Rainfed (62)

Rainfed <450 mm (38)

Rainfed >450 mm (24)

Irrigated (138)

Flood (14)

Furrow (27)

Drip (52)

Sprinkler (45)

Mean EF for Mediterranean crops (223)

0.3 ± 0.2

0.2 ± 0.3

0.3 ± 0.3

0.6 ± 0.1

0.2 ± 0.5

0.5 ± 0.4

0.5 ± 0.3

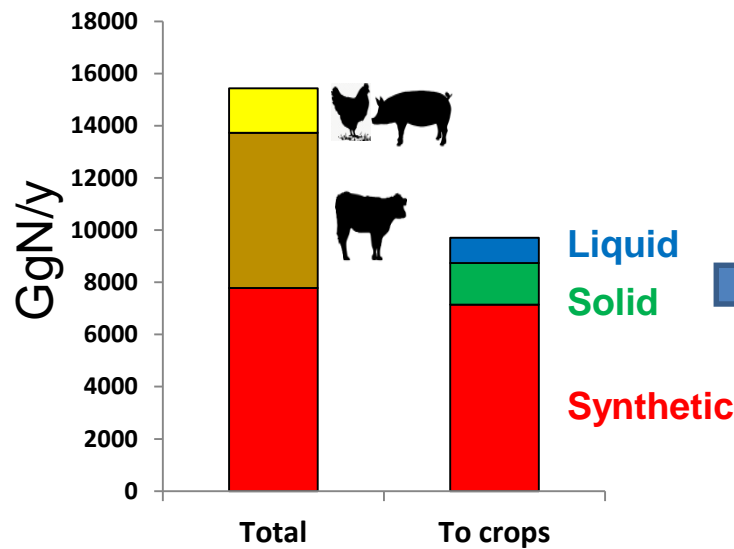
0.9 ± 0.2

0.5 ± 0.1

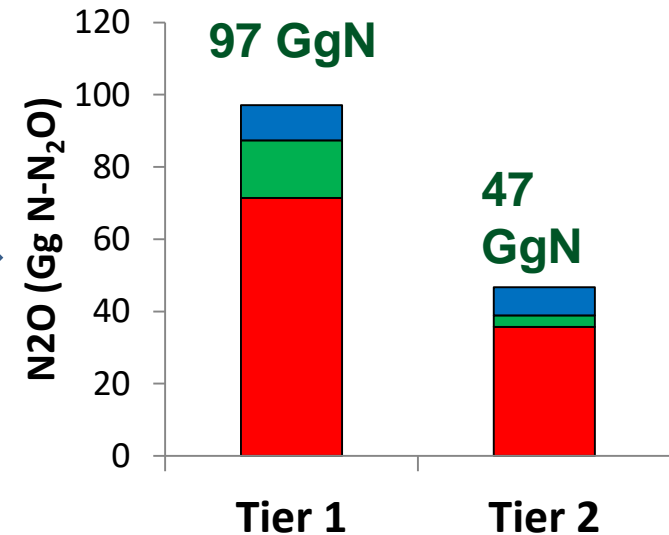
0.0 0.4 0.8 1.2

The importance of a Tier-2 transition in the national inventories

Input to Mediterranean crops



N₂O Tier 1 vs Tier 2



Zootecnic documents for Spanish Ministry of Agriculture, Fisheries and Food

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Revised methodology for Spanish National Inventory of Livestock emissions (TIER II) based on IPCC guidelines(2006) and EMEP/EEA (2013) to calculate National NH₃, NO, NO₂, N₂O, CH₄, COVM, PM2,5, PM10 and TSP emissions.

GOBIERNO DE ESPAÑA MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACIÓN

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Temas

- Producción y mercados ganaderos
- Trazabilidad animal
- Sanidad animal e higiene ganadera
- Comercio exterior ganadero
- Etiquetado de la producción primaria
- Ganadería y medio ambiente**
 - Balance de nitrógeno e inventario de emisiones de gases
- ECOGAN. Cálculo de emisiones y consumos
- Jornadas técnicas y publicaciones
- Alimentación animal - SILUM
- Zootecnia
- Laboratorios de Sanidad y Genética animal
- Reuniones sectoriales
- Días mundiales y fechas destacadas
- Servicios
- Ayudas y subvenciones
- Estadísticas
- Formación, congresos y jornadas
- Legislación
- Participación pública
- Planes y estrategias
- Proyectos de cooperación

Balance de nitrógeno e inventario de emisiones de gases



Las actividades ganaderas contribuyen a la emisión de gases de efecto invernadero y de otros contaminantes a la atmósfera. La fermentación entérica de los herbívoros libera directamente metano (CH₄), mientras que su excreta emite, además de metano, amoníaco (NH₃), óxidos de nitrógeno (NO, NO₂, N₂O) y otros compuestos orgánicos volátiles no metánicos (COVM). Por otra parte, las tareas necesarias para la cría y manejo del ganado y de su excreta generan material particulado que permanece en suspensión aérea y que puede afectar a la salud humana y al balance radiativo del sistema Tierra-atmósfera.

El Sistema Español de Inventario (SEI) tiene la responsabilidad de calcular el total de emisiones de cada uno de los contaminantes citados, para cada una de las categorías y actividades ganaderas consideradas por la normativa internacional y de la UE. Estas emisiones deben ser estimadas de acuerdo con directrices establecidas por el Panel Intergubernamental sobre Cambio Climático (IPCC) y el Programa Europeo de Evaluación y Control Ambiental (EMEP/EEA). Adicionalmente, el Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente debe elaborar anualmente un "Balance de Nitrógeno y Fósforo en la Agricultura Española" (BNAE) para dar respuesta a los requerimientos de Eurostat.

La Subdirección General de Medios de Producción Ganaderos, Punto Focal informativo de determinados aspectos de las actividades ganaderas dentro del SEI, es responsable de la elaboración de las guías metodológicas para la determinación del balance de nitrógeno y fósforo de las especies animales que conforman la ganadería española, que proporcionan una información completa y detallada para satisfacer las necesidades del SEI y del BNAE.

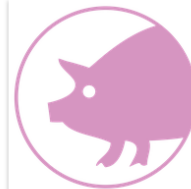
La metodología desarrollada satisface los requisitos establecidos en las últimas ediciones de las guías IPCC (2006) y EMEP/EEA (2013), permitiendo la estimación de las emisiones de NH₃, NO, NO₂, N₂O, CH₄, COVM, así como la materia particulada (PM_{2.5}, PM₁₀ y TSP) con un nivel de complejidad avanzado (TIER II).

A fin de garantizar la transparencia en la determinación de estas emisiones, se procede a la publicación de la metodología, parámetros y los datos utilizados, que serán de obligada revisión en la medida que avancen los conocimientos científicos y técnicos y, al menos, con una periodicidad quinquenal.

Guías para el cálculo del balance alimentario de nitrógeno y fósforo

- [Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en équidos.](#)
- [Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en porcino blanco.](#)
- [Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en aves de carne.](#)
- [Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y fósforo en aves de puesta.](#)

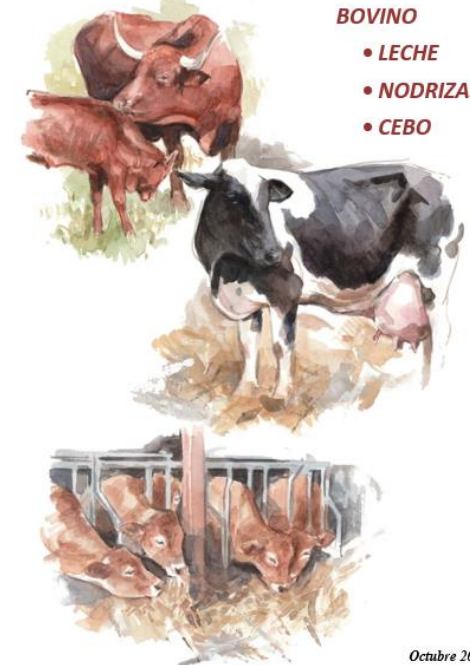
BASES ZOOTÉCNICAS PARA EL CÁLCULO DEL BALANCE ALIMENTARIO DE NITRÓGENO Y FÓSFORO



BASES ZOOTÉCNICAS PARA EL CÁLCULO DEL BALANCE ALIMENTARIO DE NITRÓGENO Y DE FÓSFORO

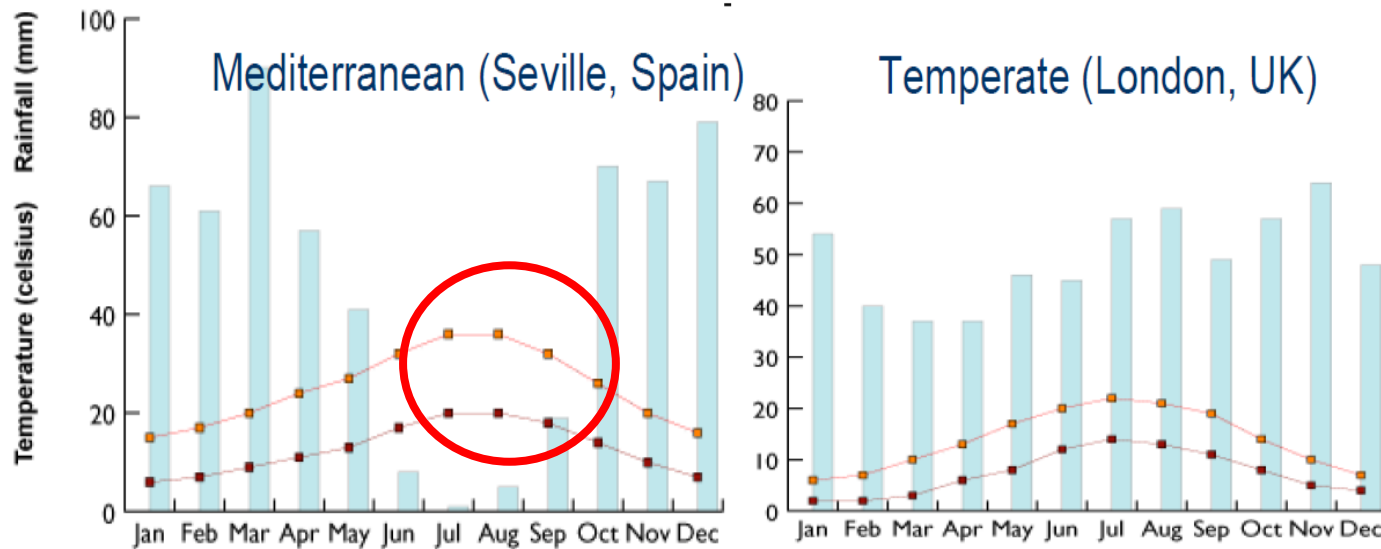
BOVINO

- LECHE
- NODRIZAS
- CEBO



Octubre 2018

Future actions: proposal of GRA/IRG case study in Mediterranean countries for (e.g.) inventories development/improvement

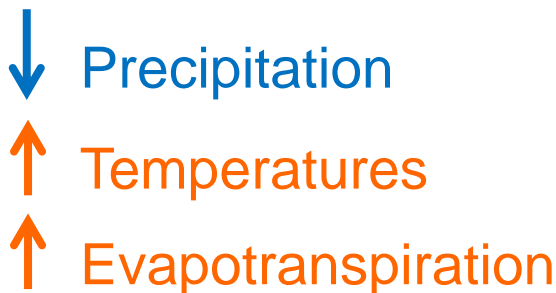


Water availability Max. Irradiation Water availability

- rainfall
- average daily temperature (max)
- average daily temperature (min)

Range precipitation:
275-1000 mm

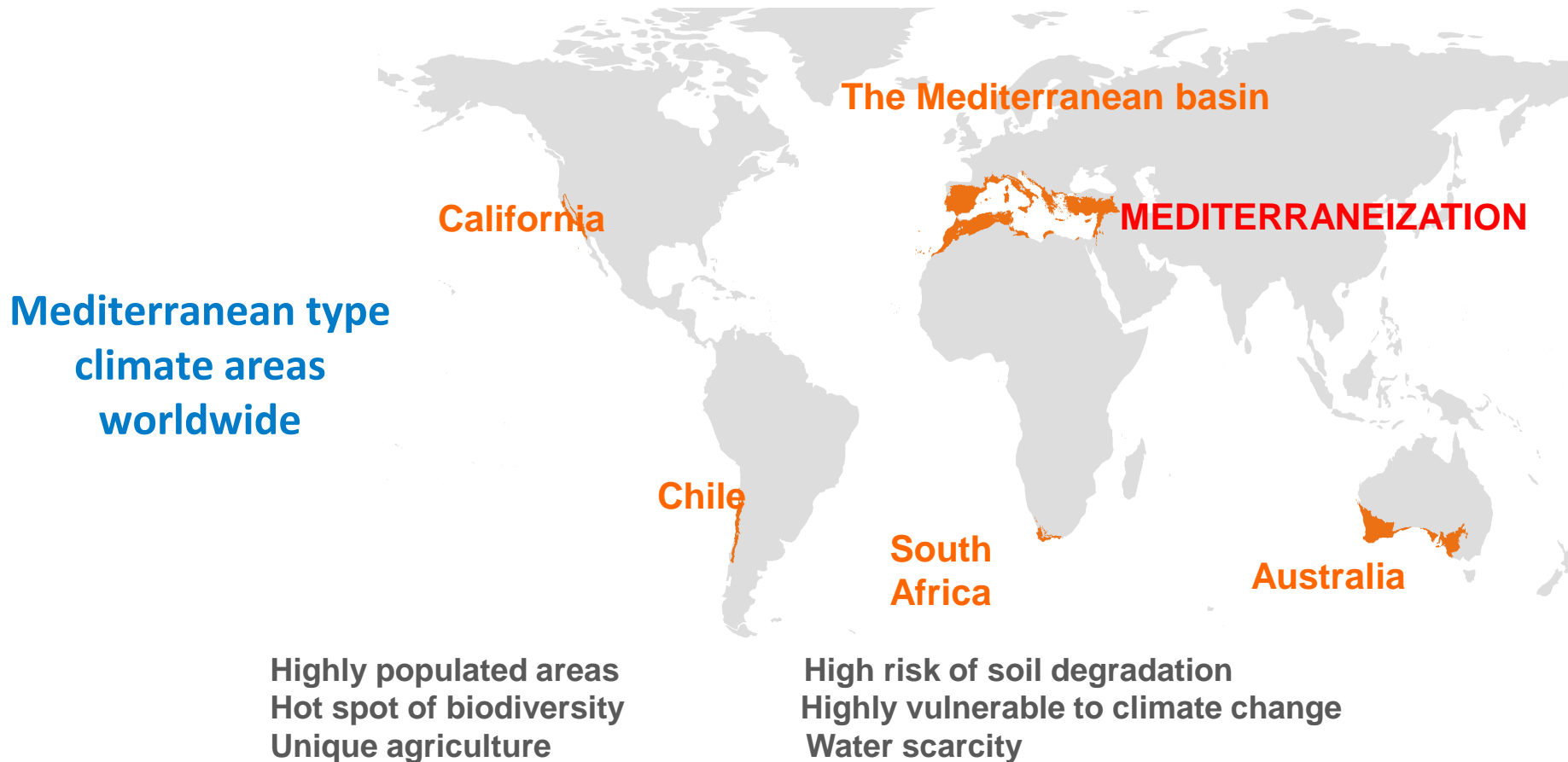
Need for irrigation



Water scarcity

Future actions: proposal of GRA/IRG case study in Mediterranean countries for (e.g.) inventories development/improvement

Particular dynamics in the Mediterranean region

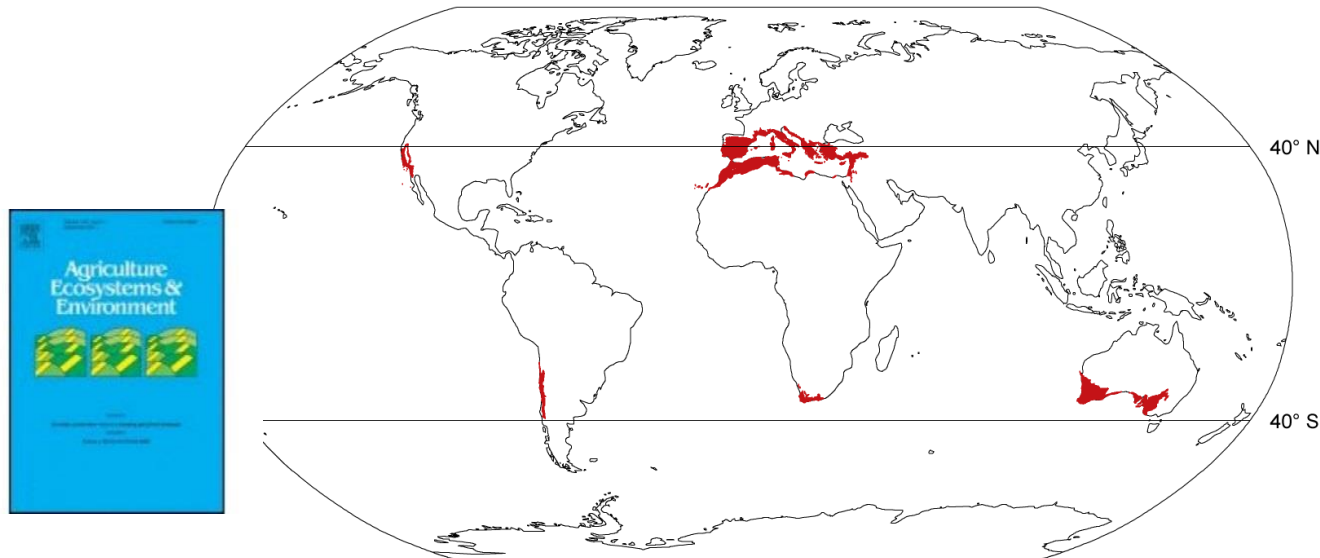


Research work already carried out: (e.g.) AGEE Special Issue on GHG mitigation in Mediterranean cropping systems

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Regions with a Mediterranean climate



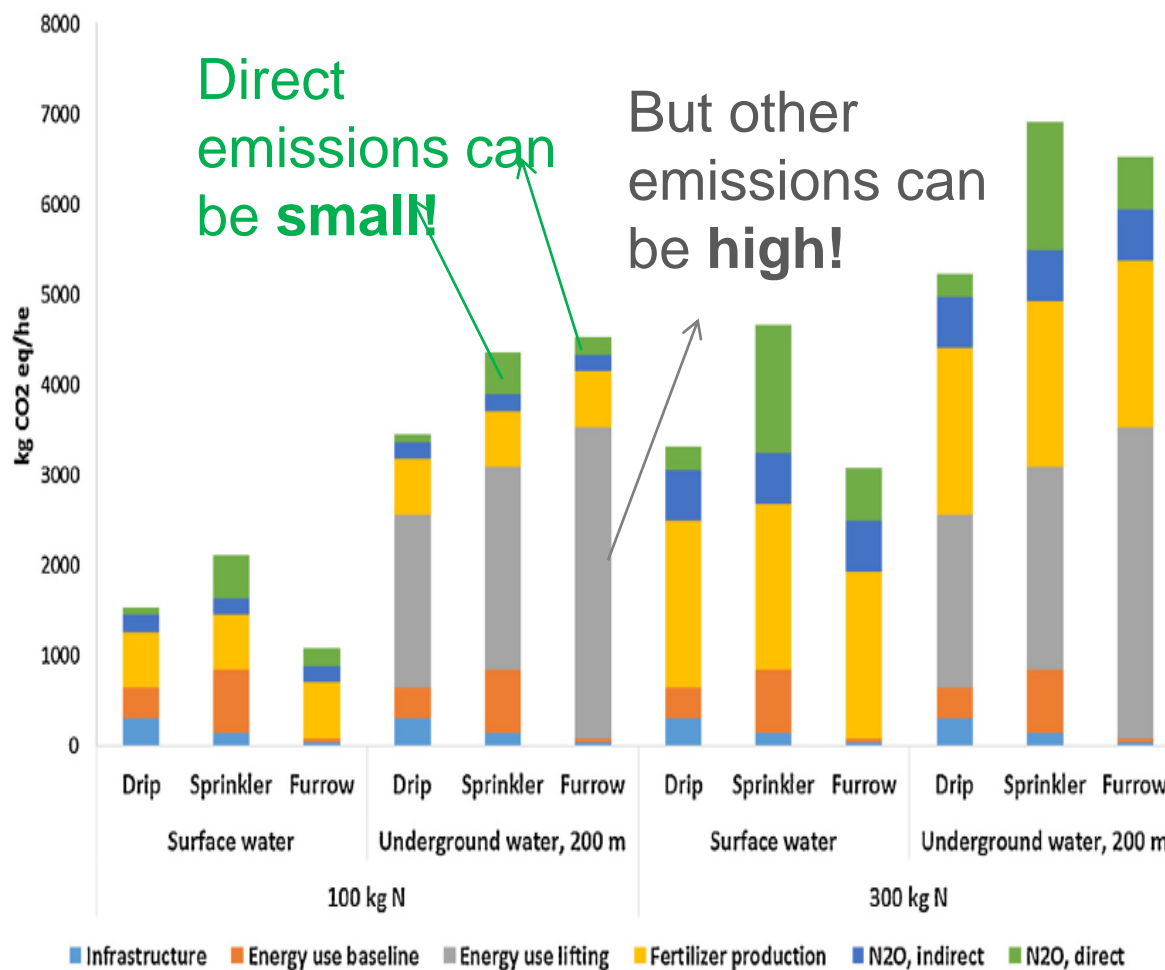
Special Issue: "Mitigation and Quantification of GHG in Mediterranean cropping systems"

Alberto Sanz-Cobena, Luis Lassaletta, Josette Garnier and Pete Smith. Eds.

***Agriculture, Ecosystems & Environment* Vol 238 (Feb-2017)**

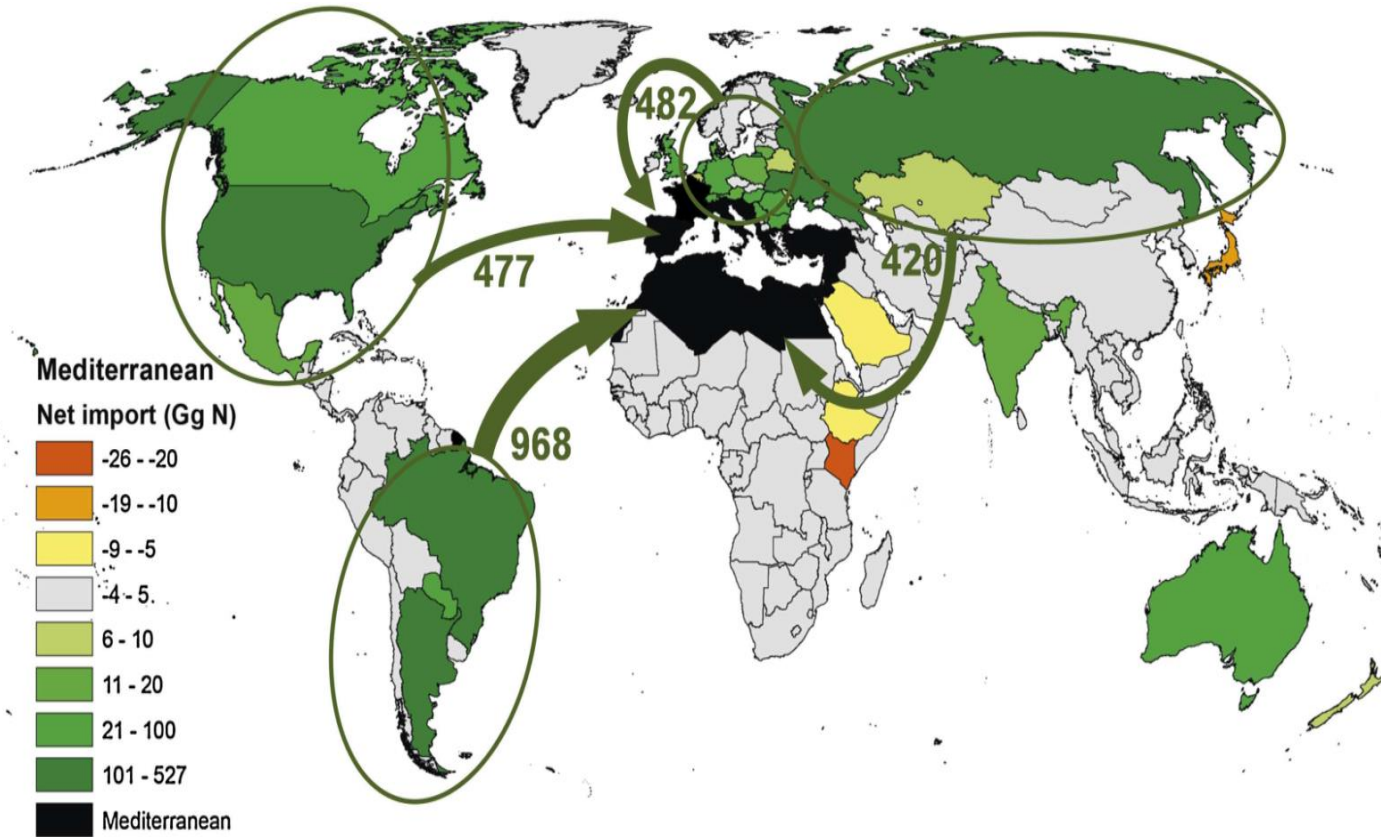
14 contributions

AGEE Special Issue on GHG mitigation in Mediterranean cropping systems: Indirect and induced GHG emissions



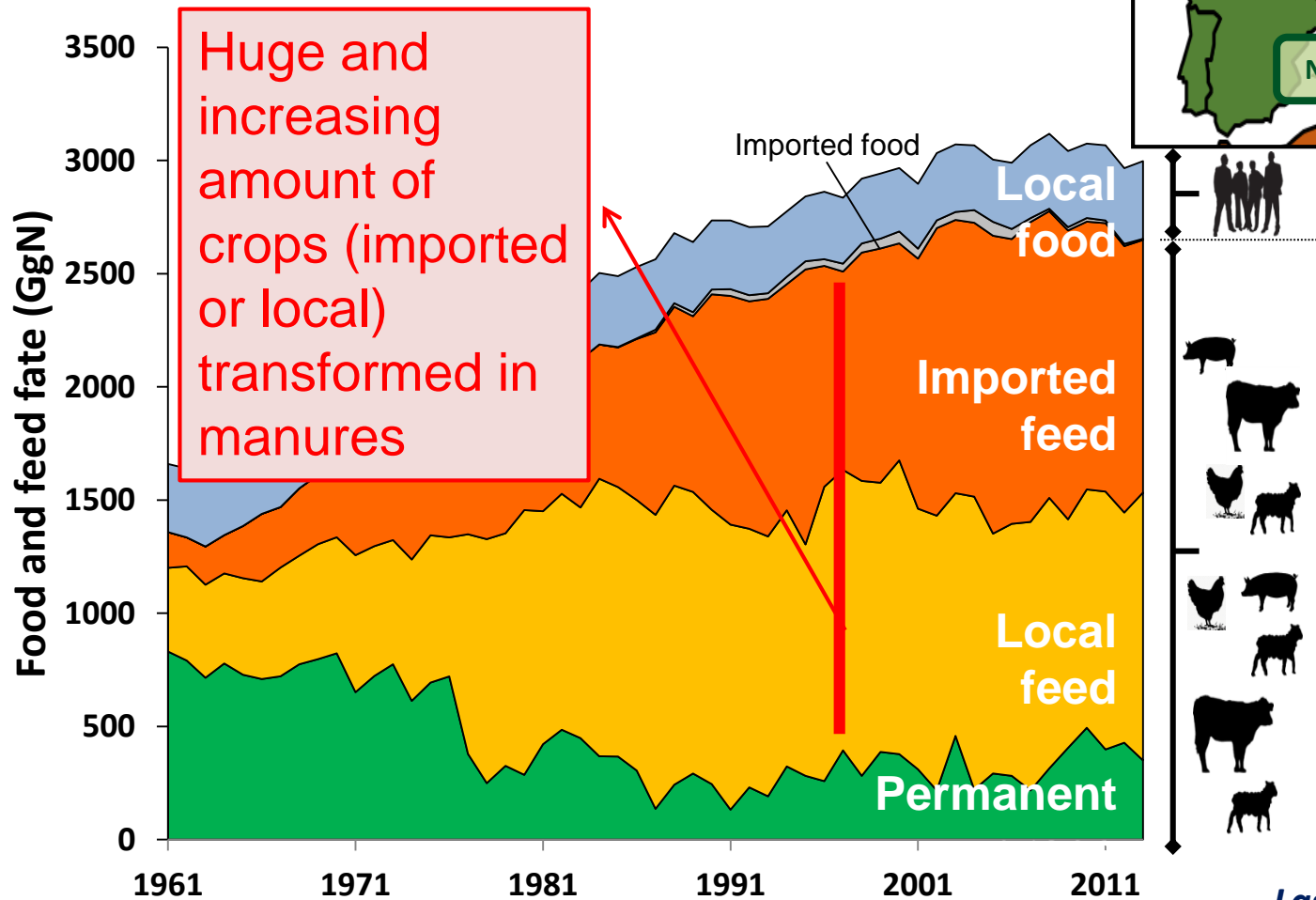
Sanz-Cobena et al. 2017 (Agric. Ecosyst. & Environ.)

AGEE Special Issue on GHG mitigation in Mediterranean cropping systems: Significant net import of protein-rich crops for feed



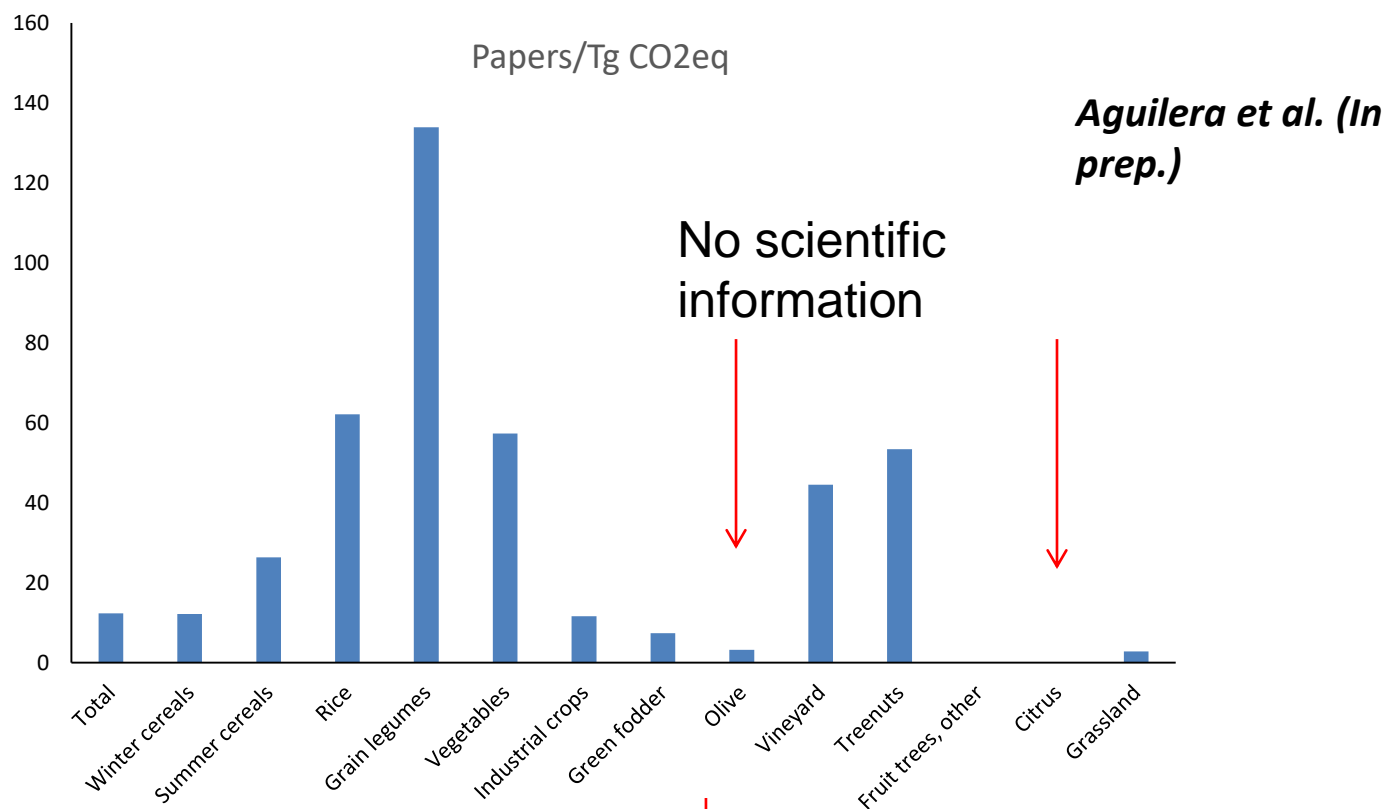
Research work in progress

Huge amount of manure over the crop needs: direct and indirect increase of emissions



Research work in progress

Research gaps: Number of papers considering **N₂O emissions in Mediterranean areas per Tg N₂O emitted (CO₂eq) by crop type in Spain**



E.g. Total emissions in Spanish grain legumes lower than in olive orchards

Transference and dissemination

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ON AGRICULTURAL GREENHOUSE GASES



Advanced Course

GREENHOUSE GAS ASSESSMENT AND MITIGATION IN AGRICULTURE: CONCEPTS, METHODS AND SIMULATION TOOLS

Zaragoza (Spain), 12-16 March 2018

VIEW

Lectures are complemented by applied examples, practical work and debates. Practical sessions will be devoted to improving the skills of participants in the use of process-based models and the interpretation of their outputs. Furthermore, during the course participants will work in groups to discuss and apply the methodology for national inventories of GHG emissions based on case studies.

Participants will be invited to provide a brief report about GHG mitigation initiatives in the cropping systems of their specific regions. These reports will be distributed to all participants and lecturers.

8. Programme

1. Context (1 hour)

- 1.1. Agricultural sector and climate change with a focus in the Mediterranean area: feedback and feedforward interactions
- 1.2. Potential role of agriculture to meet Paris Agreement expectations
- 1.3. Sustainable intensification, how greenhouse gases (GHGs) fit in this definition

2. Sources and drivers controlling GHG emissions at different scales: from the soil aggregate to the agri-food system (2 hours)

- 2.1. Basic processes underlying emissions of CO₂, N₂O, CH₄

3.1. Options on reducing non-biogenic GHG emissions

- 5.2. Options for reducing non-biogenic GHG emissions
- 5.3. Enhancing CO₂ removals
- 5.4. Options for reducing indirect GHG emissions (N₂O-leaching, NH₃ and NO_x)

6. National GHG Inventories (7 hours)

- 6.1. The importance of the IPCC National Inventories
- 6.2. Existing IPCC-based methods
- 6.3. Drawbacks, limitations and uncertainty
- 6.4. Improving national inventories
- 6.5. Practical work based on a case study

7. Socio-economic assessment of GHG mitigation (5 hours)

- 7.1. The marginal abatement cost curve methodology (MACC)
 - 7.1.1. Key steps of the process
 - 7.1.2. Examples from different countries
- 7.2. Barriers for mitigation implementation
- 7.3. Debate on how MACC can help decision making

8. Decision-making oriented tools (2 hours)

- 8.1. Decision support systems
- 8.2. User-friendly tools
- 8.3. Open-access databases

9. Round table discussion (2 hours)

- 9.1. Priorities on GHG research
- 9.2. How to incentivize the implementation of mitigation measures

GUEST LECTURERS

J. ÁLVARO-FUENTES, EEAD-CSIC, Zaragoza (Spain)
M. BERNOUX, FAO, Roma (Italy)
K. BUTTERBACH-BAHL, IMK-IFU, KIT,
Garmisch-Partenkirchen (Germany)
L. CÁRDENAS, Rothamsted Research, Devon
(United Kingdom)

L. LASSALETTA, IMBE-CNRS, Aix-en-Provence (France)
E. MILNE, CSU, Fort Collins (USA)
S. PELLERIN, INRA, Bordeaux (France)
A. del PRADO, BC3, Leioa (Spain)
A. SANZ-COBENA, UPM, Madrid (Spain)
R. TEIXEIRA, MARETEC, IST-Univ. Lisboa (Portugal)



Transference

CIHEAM IAN ZARAGOZA

40 ICARDA Science for Better Livelihoods in Dry Areas

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Advanced Course

GREENHOUSE GAS ASSESSMENT AND MITIGATION IN AGRICULTURE: CONCEPTS, METHODS AND SIMULATION TOOLS

Zaragoza (Spain), 12-16 March 2018

GLOBAL RESEARCH ALLIANCE

ON AGRICULTURAL GREENHOUSE GASES

LECTURERS

J. ÁLVARO-FUENTES, *EEAD-CSIC, Zaragoza (Spain)*

M. BERNOUX, *FAO, Roma (Italy)*

K. BUTTERBACH-BAHL, *IMK-IFU, Garmisch-Partenkirchen (Germany)*

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L. LASSALETTA, *UPM, Madrid (Spain)*

E. MILNE, *CSU, Fort Collins (USA)*

S. PELLERIN, *INRA, Bordeaux (France)*

A. del PRADO, *BC3, Leioa (Spain)*

A. SANZ-COBEÑA, *UPM, Madrid (Spain)*

R. TEIXEIRA, *Universidade de Lisboa, Lisboa (Portugal)*



Tra



40

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RED CENTRADA DE MITIGACION DE EMISIONES
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SECTOR AGROPECUARIO

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Advanced Course

GREENHOUSE GAS ASSESSMENT AND MITIGATION
IN AGRICULTURE: CONCEPTS, METHODS
AND SIMULATION TOOLS

Zaragoza (Spain), 12-16 March 2018

PARTICIPANTS

31 Participants (selected from >100 applications) from **10 countries**:

- Algeria
- Egypt
- Italy
- Morocco
- Malta
- Panama
- Portugal
- Spain
- Tunisia
- Turkey



Transference and dissemination

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ON AGRICULTURAL GREENHOUSE GASES

Strong support from GRA (NZ) with 10 grants for students in developing countries

Advanced course

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

Zaragoza (Spain), 11-15 February 2019

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Organisation



Transference and dissemination

5. Scholarships

Candidates from Mediterranean CIHEAM member countries, FAO member countries, institutions of GRA member countries in Africa, Latin America and the Caribbean, and ICARDA Middle East and North Africa partners may apply for scholarships covering registration fees and for scholarships covering the cost of travel and full board accommodation.

Candidates from other countries who require financial support should apply directly to other national or international institutions.

6. Insurance

It is compulsory for participants to have medical insurance valid for Spain. Proof of insurance cover must be given at the beginning of the course. Those who so wish may participate in a collective insurance policy taken out by the Organization, upon payment of the stipulated sum.

7. Teaching organization

The course requires personal work and interaction among participants and with lecturers. The international characteristics of the course favour the exchange of experiences and points of view.

Lectures are complemented by applied examples, practical work and debates. Practical sessions will be devoted to improving the skills of participants in the use of guidelines and models for GHG emission calculation, mitigation assessment and carbon sequestration (including for National Inventories). In a final round table discussion participants will have the opportunity to put forward policies and action plans for mitigation and adaptation in the Mediterranean region.

Participants will have to provide before the course a brief document about the situation, perspectives and challenges within their countries regarding mitigation and adaptation strategies for livestock systems. These reports will be distributed to all participants and lecturers and will be the basis for joint discussion.

8. Programme

1. Context (3 hours)

- 1.1. Livestock and climate change with a focus on the Mediterranean area: sector trends, contribution to Greenhouse Gases (GHG) emissions and mitigation strategies
- 1.2. Climate change scenarios: impacts on Mediterranean livestock and adaptation strategies
- 1.3. Importance of IPCC National GHG Inventories and methodologies
- 1.4. Potential role of livestock to meet Paris Agreement expectations under Nationally Determined Contributions (NDCs). Koronivia Joint Work on Agriculture (COP23 2017)
- 1.5. Discussion based on the situation, perspectives and challenges in participants' countries

2. Greenhouse gases from livestock systems (3 hours)

- 2.1. Livestock systems, components and interactions
- 2.2. Emitting processes and reduction
 - 2.2.1. Animal level

- 2.2.2. Manure level
- 2.2.3. Feeding and feed production level
- 2.2.4. Carbon sequestration
- 2.2.5. Energy use

3. Measuring and monitoring livestock GHG emissions and sinks (4 hours)

- 3.1. What should we measure and why?
- 3.2. Methodological challenges: spatial/temporal variability, sampling issues, uncertainty, etc.
- 3.3. Review of field and laboratory methods: limitations and opportunities. Low cost procedures and new developments
- 3.4. Data collection, management, standardization and reporting

4. Main strategies for mitigation (4 hours)

- 4.1. Productivity gains and efficiency
- 4.2. Better integration of livestock in circular bioeconomy
- 4.3. Enhancing carbon sinks/offsets
- 4.4. Practical work on the estimation of soil carbon sequestration
- 4.5. Demand-side approaches

5. Climate change adaptation strategies for livestock (3 hours)

- 5.1. Review of impact and existing adaptation strategies/options by regions and production systems
- 5.2. How to include livestock in National Adaptation Plans?
- 5.3. Case study on responses to drought (early warning systems, index based approach and feed emergency)
- 5.4. The issue of establishing feed balances
- 5.5. Discussion on climate change adaptation opportunities

6. Modelling approaches for assessing GHG emissions and mitigation measures at different scales (11 hours)

- 6.1. What should we model and why?
- 6.2. Types of models: overview, data requirement, limitations and opportunities, applications and outputs
- 6.3. Life cycle assessment (LCA): products footprints
- 6.4. Synergies and trade-offs between mitigation and adaptation measures. Examples of successful practices
- 6.5. Practical work on modelling
 - 6.5.1. A simple field scale model for grassland systems: NCYCLE
 - 6.5.2. Livestock GHG National Inventories: basic calculation of Tier I emissions based on a country case
 - 6.5.3. Global to subnational scale and LCA approach: FAO Global Livestock Environmental Assessment Model interactive (GLEAM-i)

7. Socio-economic assessments and policies (4 hours)

- 7.1. The marginal abatement cost curve methodology (MACC)
 - 7.1.1. Key steps of the process
 - 7.1.2. Examples from different countries
- 7.2. Adaptation cost curves
- 7.3. Accounting for multi-functionality
- 7.4. Policy mechanisms available to address livestock and climate change issues

8. Round table discussion (2 hours)

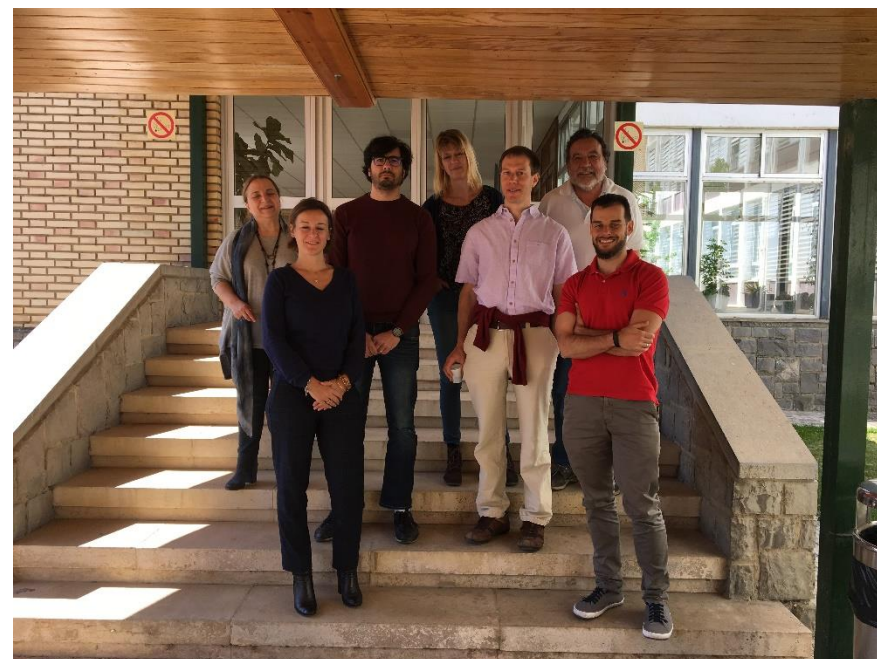
- 8.1. Priorities on knowledge for mitigation and adaptation
- 8.2. Barriers for mitigation and adaptation implementation in Mediterranean countries
- 8.3. How to incentivize the implementation of mitigation and adaptation measures

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coordinators



WP or TF based on the IRG of GRA focused on GHG inventories in Mediterranean areas.

Case study: Spain

- Momentum: institutional support for N₂O inventory; REMEDIA Network, others.
- Countries under Mediterranean climatic conditions (fully or partially): Australia, Chile, Egypt, France, Italy, South Africa, Spain. Number of **Mediterranean countries** from (e.g.) **north Africa** involved in GRA could be increased and the development/improvement of national GHG inventories achieved.
- Climatic and crop management particularities affecting GHG mitigation (and adaptation). **Risk of Mediterraneanization**
- **Vulnerable area** where mitigation and adaptation need to be addressed *coordinately*
- Less explored systems than other regions although **relevant research initiatives already taken** (recently) **and planned**
- Relevant **capacity building initiatives** and transference activities carried out and planned (with the support of GRA)

Thanks for your attention

