ISCRAES Book of Abstracts Series 1

1st International Symposium on Climate-Resilient Agri-Environmental Systems

ISCRAES 2020

- Contributing to the United Nations Sustainable Development Goals

Virtual Interactive, 04-06 November 2020

BOOK OF ABSTRCATS

Edited by

Mohammad I. Khalil and Bruce A. Osborne

This book contains all abstracts presented at the ISCRAES 2020

ISSN No. 2737-727X

Published in 2020 by the CRAES Group, University College Dublin and Prudence College Dublin, Ireland.

Organizing Committee

Convenor

Dr. M. Ibrahim Khalil, University College Dublin and Prudence College Dublin, Ireland.

Members

Prof. Bruce Osborne, University College Dublin, Ireland.
Prof. Mary Kelly-Quinn, University College Dublin, Ireland.
Dr. Jon Yearsley, University College Dublin, Ireland.
Dr. Brian Tobin, University College Dublin, Ireland.
Ms. Sinead McGinley, University College Dublin, Ireland.

Scientific Committee

1	Prof. Christoph Müller	Justus-Liebig University, Giessen, Germany
2	Prof. Pascal Boeckx	Ghent University, Belgium
3	Prof. Stefaan De Neve	Ghent University, Belgium
4	Dr. Katja Klumpp	Institut national de la recherche agronomique (INRA), France
5	Dr. Bart Kruijt	Wageningen University & Research (WUR), The Netherlands
6	Dr. Anna Walkiewicz	Institute of Agrophysics, Polish Academy of Sciences, Poland
7	Dr. Jagadeesh Yeluripati	The James Hutton Institute, United Kingdom
8	Dr. M. Rosa Teira-Estmatges	University of Lleida, Spain
9	Dr. Gary Lanigan	Teagasc, Ireland
10	Dr. James Humphreys	Teagasc, Ireland
11	Dr. Matt Saunders	Trinity College Dublin, Ireland.
12	Prof. Vincent O'Flaherty	National University of Galway, Ireland
13	Dr. Chaosheng Zhang	National University of Galway, Ireland
14	Dr. Ken Byrne	University of Limerick, Ireland
15	Dr. Klara Finkele	MetEireann, Dublin, Ireland
16	Prof. Tommy Boland	University College Dublin, Ireland
17	Prof. Barry J. McMahon	University College Dublin, Ireland
18	Prof. Michael Wallace	University College Dublin, Ireland
19	Dr. Lisa Ryan	University College Dublin, Ireland
20	Dr. Tamara Hochstrasser	University College Dublin, Ireland
21	Dr Helen Sheridan	University College Dublin, Ireland
22	Prof. Bruce Osborne	University College Dublin, Ireland
23	Prof. Mary Kelly-Quinn	University College Dublin, Ireland
24	Dr. Jon Yearsley	University College Dublin, Ireland
25	Dr. M. Ibrahim Khalil	University College Dublin & Prudence College Dublin, Ireland

CONTENTS

Edited by M.I. Khalil and B.A. Osborne, ISCRAES Book of Abstract Series 1; Published in 2020 by the CRAES Group, University College Dublin and Prudence College Dublin, Ireland.

CRAES TO ISCRAES

The Climate-Resilient Agri-Environmental Systems (CRAES) group was formed by Dr. M. Ibrahim Khalil in co-operation with other University College Dublin (UCD) colleagues through a UCD Earth Institute Strategic Priority Award. The main aim was to foster agri-environmental research, modelling and technology development, with an emphasis on the need for carbon-neutral and pollution-free agricultural systems that do not compromise food security. These objectives also link to the provision of strategic education and training, and addresses the global challenge associated with climate change and environmental degradation by harnessing UCD's multidisciplinary expertise and engaging with national and international collaborators and stakeholders.

The specific objectives were to:

a. Form a multidisciplinary research group initially with experts from various academic/research disciplines within UCD.
b. Publicise the group in general and its research expertise to attract national and international academics/researchers for collaborations/partnerships.
c. Demonstrate the importance of the group's activities to other academics/researchers and stakeholders for strengthening their engagements and cooperation.
d. Develop the group by co-opting and/or collaborating with relevant experts from national and European academic and research organizations.
e. Arrange quarterly meetings for discussion on project activities, and exchange research ideas, address knowledge gaps and explore collaborative opportunities within and outside UCD.
f. Provide the critical mass that is required to response to national and international research calls for securing funding for innovative research and the development of integrated system models for researchers, policy makers and end users.

As an important contribution to these activities, the CRAES group has organized this International Symposium on Climate-Resilient Agri-Environmental Systems (ISCRAES 2020). The key theme of this symposium is "Contributing to the United Nations Sustainable Development Goals (UN-SDGs) through the Development of Climate-Resilient Agri-Environmental Systems". Addressing the central goals of the UN-SDGs requires a multi-disciplinary approach involving academic, industrial, and policy-related collaborations for scientific knowledge advancement and the exploration of ways for their practical implementation. This symposium provides a platform to discuss the scientific and technical aspects of the range of cross-cutting issues associated with the environmental impact of agriculture, including public perception, and regulatory and socio-economic factors.

SYMPOSIUM THEMES

The main objective of the symposium is to bring academics, researchers, and stakeholders together to provide creative and innovative ideas that could provide a basis for the testing and subsequent adoption of strategic ways for implementing sustainable GHG mitigation and environmental solutions taking into account the need for:

- coherent environmental solutions, through a systems-based approach.
- economically viable and socially acceptable options.
- a systems-based decision-support tool.

Arable cropping systems

Globally, there are a large number of arable cropping systems based mainly on climate and land types/topography (e.g., dryland/upland, wetland-dryland/upland, and wetland) that have resulted in the adoption of different cropping patterns (e.g., cereal only, cereal-legume, and cereal-vegetable). Arable crops are mainly associated with tillage-related cultivation systems, which vary from region to region, and are among the most important land uses influencing soil properties and causing environmental and ecological degradation. Land use (cereals, vegetables, etc.), soil/land types and management practices (inorganic and organic fertilizers, as well as addition of organic residues) within a system controls the extent of emission of GHGs, air pollution and leaching losses. Inappropriate cropping and cultivation techniques, as well as excessive use of fertilizers, can exacerbate these problems. Many soils may be susceptible to erosion, and the loss of organic matter leading to poor structure, biodiversity loss, and pollution due to pesticides and herbicide residues and the accumulation of heavy metals. This session will therefore focus on research work in arable cropping systems that have assessed potential solutions to coupled air, water, and soil pollution.

Grassland Systems

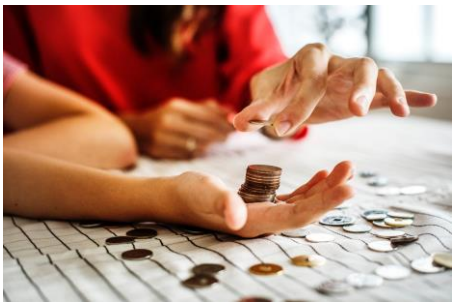
Grasslands (pasture, hay and silage) dominate the total global agricultural area. Livestock is grazed mostly on pasture and meadows. Grazing intensity and fertilizer (organic and inorganic) management play an important role in soil health and productivity while also contributing to a large share of total agricultural GHG emissions and pollutants (e.g., NH_3, NOx, NMVOCs and particulate matters and/or water (e.g., NO_3^- and PO_4^-) through leaching, volatilization and runoff. Livestock itself accounts for about half of all anthropogenic emissions, i.e. a quarter of methane emissions through gut fermentation and the

decay of excreta. The projected increase in livestock numbers will not only impact on the production of manure by ~60% by 2030 but also methane emissions. These environmental pressures warrant adoption of sustainable management for grassland systems that depend not only on livestock numbers but also on fertilizer form and amount, that are linked to climate conditions, available resources, ecosystem/biodiversity services, and avoidance of events leading to environmental pollution. In this session there will be a focus on solutions to coupled air, water, and soil pollution, in both grazed and un-grazed grassland systems.

Agro-Silvo-Pastoral Systems

Mixed farming systems are very popular in both developed and developing nations, and are generally divided into four systems (i) Agro-pastoral system (arable ley), (ii) Agro-Forestry system, (ii) Silvo-pastoral system, and (iv) Agro-Silvo-Pastoral system. Other than agro-forestry, livestock (cattle, sheep and goats) grazing is common in mixed farming systems. The number of agro-silvo systems associated particularly with beef/meat and dairy production has been increasing globally. In these mixed systems, as in grassland, the application of organic and inorganic fertilizers to improve crop/biomass production may increase GHG emissions and environmental pollution. Yet, these systems are thought to increase the use of crop by-products resulting in improved nutrient recycling and reduced methane production. Accordingly, mixed farming as an approach to satisfy the global demand for food, meat and milk could have some advantages in reducing the environmental and carbon footprint. However, applied research and extension are of critical importance if the environmentally compatible elements of the system are to be adequately exploited. Considering the fundamental changes required and the inclusion of livestock as a mechanism to promote system flexibility, identification of technologies and policies for simultaneous reduction of GHGs and environmental pollution will be the focus of this session.

Socio-Economic Costing



Current economic and structural changes in agriculture are associated with both the intensification of existing land uses as well as land use change. Management practices associated with agricultural systems and the resultant environmental consequences for soil, water, air, and biodiversity must be addressed in a sustainable manner and socioeconomically viable ways. Compared to single measures, integration of several measures and/or whole farm or systems approaches might be necessary to maximise any benefits, but a clear understanding, as well as the environmental and agricultural benefits of the proposed measures is still limited. In addition to mitigation options for GHGs and environmental pollution, the implications of cross-compliance measures relating to the impact on farming systems and economic costs are also unclear. System-based long-term research is required to directly compare different management and mitigation strategies, identify the key environmental drivers and their socio-economic implications. There are substantial economic challenges facing the farming community, requiring assurance of continuing financial benefits while imposing a less detrimental impact on the quality of the environment. Therefore, a clear socially acceptable and effective way to improve farm incomes while protecting the environment, is required and this will be the focus of this session.

Decision Support Tools

Limited field measurements and excel-based national inventory methods (IPCC Tiers), focussed mainly on the developed nations, are being used for accounting, and form the basis for mitigating the environmental consequences of GHGs, air pollutants and leaching losses. However, these approaches often struggle with an adequate assessment of the impact of agricultural management practices, particularly for mixed farming systems. There are substantial difficulties in incorporating any mitigation strategies and often these are unable to provide immediate feedback on the consequences of management actions/decisions. As measurements covering all ecosystems and soils are not feasible, the use of model-based decision-support tools could be an alternative option to cover diverse agricultural systems. Any verified and validated model should be used as a decision support tool to provide assessments at a unit level but should also be applicable to the regional scale. This would help raise local awareness, provide prospects for actions, aid in refining and implementing emission mitigation techniques, and demonstrate the effects of innovative actions. A further benefit is that they can help to identify environmental hotspots, evaluate indicators of sustainability, provide alternative management scenarios, identify practices having a positive impact on net GHG emissions and the environment and provide options for assessment of the economic effects of interventions at all scales. This will be the topic of this session.

Agrometeorology

This session of the symposium will address weather and climate related impacts on agriculture, as well as the processes that mediate these impacts. In this session, interdisciplinary studies underlying soil-vegetation-atmosphere transfer (SVAT) of greenhouse gases and water, as well as research on adaptation to extreme weather and novel risks (e.g. from insect pests and disease) due to climate change will be addressed. This session is organised by the Joint Working Group on Applied Agrometeorology (AGMET) of Ireland. Research under this theme addresses the challenges of integrating climate and meteorological insights into agricultural management and adaptation to climate change. The session features research on extreme weather events, adaptation to climate change, soil-vegetation-atmosphere transfer (SVAT), weather-related soil processes as well as research that showcases the use of meteorological or climate data for applications in land management and risk assessment (e.g. for disease or insect pest spread). Research on forecast systems, and other weather-related decision support approaches will also be addressed. To develop a place-based understanding of meteorological impacts on farming systems, farmer involvement in the collection of meteorological data will also be discussed as well as the modelling of the spatio-temporal variation in meteorological conditions to fill in sparse weather data (as e.g. done in the MÉRA: climate re-analysis dataset produced by MetEireann). A well-developed understanding of climate drivers of soil and vegetation processes as well as a good understanding of how an altered climate may affect agriculture is needed for sustainable agricultural and effective land-based energy systems.

SYMPOSIUM PROGRAMME

	13:45-14:00	**Jonckheere Inge** and Esther Mertens: On the use of (geo) spatial tools for support on national GHG-inventory reporting. (O-2)	**Barron-Gafford Greg,** Alyssa Salazar, Isaiah Barnet-Moreno, Moses Thompson, Blue Baldwin, Patrick Murphy and Jordan Macknick: Dryland Agrivoltaics: Co-locating food and renewable energy production creates a climate-resilient agri-environmental system for maximizing food production and water savings. (O-10)
	14:00-14:15	**Kruijt Bart,** Reinder Nouta, Cor Jacobs, Merit van den Berg, Christian Fritz, Ronald Hutjes, Wietse Franssen, Katja Klumpp and Bruce Osborne: Towards operational quantification of GHG exchange in heterogeneous agricultural landscapes and experimental plots. (O-3)	**Ishola Kazeem A.,** Reamonn M. Fealy, Gerald Mills and Rowan Fealy: Vegetation response to local surface-atmosphere feedbacks during 2018 summer heatwaves and droughts in Ireland. (O-11)
	14:15-14:30	**Vanrespaille Helena**, Mia Tits and Annemie Elsen: Developing carbon accounting at farm level to monitor C-storage and NO2-volatilization in agricultural soils. (O-4)	**Logakrishnan Mohana Priya,** Stuart Green, Tamara Hochstrasser and Reamonn Fealy: Assessing the impact of seasonal weather extremes on farm feed use in Irish dairy farms. (O-12)
	14:30-14:45	**Yeluripati Jagadeesh,** Ina Pohle and Miriam Glendell: Development of DNDC-meta-model to estimate GHG emissions from Norwegian organic soils. (O-5)	-
	14:45-15:00	**Shine Philip**, Michael Breen, John Upton and Michael D. Murphy: A decision support system for energy efficient and renewable energy technologies on dairy farms. (O-6)	**Raymond Joanna,** Stephen Dorling, Andrew Lovett, Ian Mackay, Haidee Philpott and Steven Penfield: Weatherproofing for a smarter, resilient and more sustainable agri-sector. (O-14)
	15:00-15:15	**Thomas Ian,** Eva Mockler, Chris Werner, Fiachra O'Loughlin, Per-Erik Mellander and Michael Bruen: Next-generation national mapping of soil moisture deficits, runoff and diffuse phosphorus losses in Irish agricultural catchments for decision support. (O-7)	**Mellander Per-Erik** and Philip Jordan: Wicked problems and extreme weather: changing perspectives for nutrient pollution management. (O-15)
	15:15-15:30	Giannakopoulos Christos, **Anna Karali**, Christina Papadaskalopoulou, Giannis Lemesios, Konstantinos V. Varotsos, Despoina Charchousi, Marco Moriondo, Maria Papadopoulou, Marinos Markou and Maria Loizidou: LIFE ADAPT2CLIMA tool: A decision support tool for adaptation to climate change impacts on the Mediterranean islands' agriculture. (O-8)	**Jarmain Caren**, Eunice Avenant, Adriaan Van Niekerk, Pascalina Mohlotsane, Henry Jordaan, Carlos Poblete-Echeverría and Garth Stephenson: Water footprint as a sustainability indicator for table and wine grape production. (O-16)
	15:30-16:00	Coffee break and networking	
	16:00-16:05	**Decision Support Tools** (Sponsor: GFZ-Potsdam, Germany/GHG-Manage) **Co-Chair:** Dr. Inge Jonckheere (FAO, Italy)	**Agrometeorology** (Sponsor: AGMET, Ireland) **Co-Chair:** Prof. Owen Fenton (Teagasc, Ireland)
		Theme 1, Session II (Flash)	**Theme 2, Session II (Flash)**
	16:05-16:14	**Nieuwenhuis Maarten** and Anders Lundholm: Alternative management models for Ireland's western peatland forests to improve the provision of Ecosystem Services. (F-1)	**Minoli Sara**, Femke Lutz and Christoph Müller. Do climate change impacts and adaptation modify the potential for agricultural intensification? (F-10)
	16:14-16:23	**Ktenioudaki Anastasia**, Haley Inselberg, Alyssa Smith, Natalia Peres, Colm O'Donnell and Maria Cecilia Do Nascimento Nunes: Innovative systems approach to address supply chain waste in strawberries. (F-2)	**McAdam Jim,** Steffi Carter, Anne Jungblut, Matt Aitkenhead, Chris Evans, Sergio Radic and Matthew McNee: A science-based policy response to predicted climate change in the Falkland Islands (52°S). (F-11)
	16:23-16:32	**Khalil Mohammad I.** and Bruce A. Osborne: Potential of the DNDC model to predict long-term changes in N2O emissions and SOC in permanent grassland. (F-3)	-
	16:32-16:41	**Moral Francisco J.,** Francisco J. Rebollo and Joao Serrano: Hazard assessment of pasture soil fertility from an objective and probabilistic approach. (F-4)	**Guisado Fulgencio Honorio,** Abelardo García Martín, Carina de Nóbrega Barcelos, Adélia Oliveira de Sousa and José Rafael Marques da Silva: Analysis of meteorological variables and the vegetation index in vine cultivation: Adaptation and trend in the context of climate change. (F-13)
	16:41-16:50	**Tsyrybka Viktar**, Hanna Ustsinava and Ilya Lahachou: The agrophysical properties of soils as the basis of soil protection agriculture (based on the example of the Braslaŭ region of the Republic of Belarus). (F-5)	**Murphy Rachael,** Karl Richards, Dominika Krol, Amanuel Grebremichael, Luis Lopez-Sangil, James Rambaud, Nicholas Cowan, Gary Lanigan and Matthew Saunders: Eddy covariance and static chamber nitrous oxide emissions from grassland silage production. (F-14)
	16:50-16:59	**Del Rio Duque Martha Lilia**, Michelle Bonatti, Katharina Löhr, Marcos Lana, Tatiana Rodriguez and Stefan Sieber: Scaling out sustainable land use systems in Colombia: Some insights and implications from two regional case studies. (F-6)	**Hochstrasser Tamara,** Klara Finkele, Paul Murphy, Owen Fenton, Karl Richards, Eve Daly, Matthew Saunders and Agmet Group: Towards an Irish National Soil Moisture Measurement Network. (F-15)

Day 1:	Time	Category	
Wednesday 4th Nov 2020	09:00-09:10	**Welcome speech:** Prof. Mark Rogers, Registrar, Deputy President and Vice President for Academic Affairs, University College Dublin, Ireland.	
	09:10-09:20	**Introduction of CRAES: A potential journey to ISCRAES:** Dr. M. Ibrahim Khalil, Coordinator (CRAES) and Convenor (ISCRAES 2020).	
	09:20-09:35	**Opening speeches:** 1. Minister Eamon Ryan, Department of Environment, Climate and Communications (DECC), Ireland.	
	09:35-09:50	2. Prof. Takashi Kosaki, President, International Union of Soil Sciences (IUSS). Japan	
	09:50-10:05	3. Prof. Roslyn Gleadow, President, Global Plant Council (GPC), Australia.	
	10:05-10:30	Coffee break	
Plenary speeches (25 min talk+5 min questions)			
	10:30-11:00	Dr. Federica Matteoli, FAO, Rome, Italy.	Global Perspectives and Inter-linkages of FAO's Climate-Smart Agriculture with UN SDGs. (P-1)
	11:00-11:30	Prof. Nina Buchmann, ETH Zurich, Switzerland.	Agroecosystems today and in the future: Drivers of or driven by climate change. (P-2)
	11:30-12:00	Prof. Alan Matthews, Trinity College Dublin, Ireland	Promoting Climate-Resilient Agri-Environmental Systems in the EU's Common Agricultural Policy. (P-3)
	12:00-12:15	Ms. Laura Giappichelli, EASME, European Commission, Belgium (Invited)	LIFE and Climate Action in Agriculture (I-1)
	12:15-13:00	Lunch break and Networking	
Parallel sessions: Keynote (20 min talk+ 5 min Q&A), Oral (12 + 3) and Flash (6 + 3)			
	13:00-13:05	**Decision Support Tools** (Sponsor: GFZ-Potsdam, Germany/GHG-Manage) **Chair:** Prof. Christoph Müller (J-L Univ. Giessen, Germany)	**Agrometeorology** (Sponsor: AGMET, Ireland) **Chair:** Dr. Klara Finkele (Met Eireann, Ireland)
		Speaker / Title of presentation	Speaker / Title of presentation
	13:05-13:30	**Keynote address:** Dr. Jon Hillier, Edinburgh University, Scotland, UK. — Decision support tools for environmentally sustainable farming: How do they help? (K-1)	**Keynote address:** Dr. David Boorman, Cent. Ecol & Hydrol., UK. — Establishing a national soil moisture monitoring network for the UK – the good, the bad and the completely unexpected. (K-2)
	13:30-13:45	**Theme 1, Session I (Oral)** **Gottschalk Pia,** Syed Faiz-Ul Islam, Jon Hillier, Mohammad I. Khalil and Bruce Osborn: Evaluating aspects of the Cool-farm-tool: model assessments versus measurements. (O-1)	**Theme 2, Session I (Oral)** **Maier Regine,** Lukas Hörtnagl, Markus Staudinger, Valentin H Klaus and Nina Buchmann: Measuring nitrous oxide fluxes with a mobile eddy covariance system: First results across three Swiss croplands. (O-9)

Continues

	16:59-17:08	**Lessire Francoise** and Isabelle Dufrasne: Evolution of grazing practices in Belgian dairy farms: Results of two surveys. (F-7)	Simón Luis L. Paniagua, Abelardo García-Martín, Mª Engracia Guerra Velo and **Francisco J. Moral García**: Winter chilling trends in the southwest of the Iberian Peninsula for plum tree hybrids under a climate change context. (F-16)
	17:08-17:17	**Moral Francisco J.,** Francisco J. Rebollo and Joao Serrano: Management zones delineation on grazed permanent pastures using low cost geophysical surveys. (F-8)	**Martín Abelardo García,** Luis L. Paniagua Simón, Fulgencio Honorio Guisado and Mª Engracia Guerra Velo: Aridity seasons and climate change in main crop areas of template fruit tree in southwest of Iberian Peninsula (Spain). (F-17)
	17:17-17:26	**O'Rourke Sharon M.**, Robert H. Foy, Catherine J. Watson, Suzanne Higgins and Peter A. Vadas: Impact of increasing the time interval between manure application and the first rainstorm event on phosphorus concentrations in runoff. (F-9)	**Walkiewicz Anna**, Piotr Bulak, Mohammad Ibrahim Khalil and Bruce Osborne: Seasonal variability of CH4 uptake by various forest soils - the effect of temperature and precipitation. (F-18)
	17:26-17:35	**Wackerhagen Carolina**, Ragnar Leming, Nicolas Metayer, Trötschler Patrick and Vanessa S. Ortega. LIFE AgriAdapt Webtool for Sustainable Adaptation of European Agriculture to Climate Change. (F-9a)	

Day 2:	Time	Category			
Thursday 5th Nov 2020		**Parallel sessions:** Keynote (20 min talk+ 5 min Q&A), Oral (12 + 3) and Flash (6 + 3)			
		Speaker	Title of presentation	Speaker	Title of presentation
	9:00-9:05	**Arable Cropping Systems** **Chair**: Prof. Kazuyuki Inubushi (Chiba Univ., Japan)		**Grassland Systems** **Chair:** Dr. Katja Klumpp (INRAE, France)	
	9:05-9:30	**Keynote address** Prof. Jørgen E. Olesen, Aarhus University, Denmark	What does it take to realize sustainable arable cropping systems? (K-3)	**Keynote address** Prof. Klaus Butterbach-Bahl, Karlsruhe Institute of Technology, Germany	Drivers of greenhouse gas footprints in grassland production systems. (K-4)
	9:30-9:45	**Theme 3, Session I (Oral)** **Inubushi Kazuyuki**, Hidetoshi Taira, Junya Baba, Satochi Togashi and Jollibekov Berdiyar: Chemical characteristics of degraded soils and remediation by cyanobacteria. (O-17)		**Theme 4, Session I (Oral)** **Balasingham Nathan and Usha Amaranathan:** A molecular pattern recognition receptor signalling compound (Biozest) presents an economically advantageous pastoral greenhouse gas emissions reduction solution. (O-25)	
	9:45-10:00	**Boeckx Pascal**, Eunice A. Mutuku, Dries Roobroeck, Bernard Vanlauwe and Wim Cornelis: Maize production under combined Conservation Agriculture and Integrated Soil Fertility Management in the Sub-humid and Semi-arid regions of Kenya. (O-18)		**Finn John:** Species richness increased yield stability in intensively managed grasslands subjected to experimental drought. (O-26)	
	10:00-10:15	**O'Neill Macdara**, Gary Lanigan, Dermot Forristal and Bruce Osborne: Effect of tillage practice and nitrogen rate on nitrous oxide emissions and emission factors in winter oilseed rape. (O-19)		**Suter Matthias**, Olivier Huguenin-Elie and Andreas Lüscher: Multifunctionality of sown grassland is enhanced by species diversity: a contribution to sustainable agriculture. (O-27)	
	10:15-10:30	**Collins Chris**, Sarah Duddigan, Zakir Hussain, Henny Osbahr, Vijay Thallam and Grady Walker: Understanding the biophysical processes and extension mechanisms of Zero Budget Natural Farming (ZBNF) to support its wider application. (O-20)		**Yearsley Jon,** Hannah White, Lupe León-Sánchez, Dinara Sadykova, Maja Ilic, Mathew Magilton, Mark Emmerson, Paul Caplat and Willson Gaul: The resilience of plant productivity at a landscape scale using remotely sensed data. (O-28)	
	10:30-10:45	Banerjee Hirak, Sukamal Sarkar, **Sudarshan Dutta**, Sourav Gorai, Krishnendu Ray, Shamie Zingore and Kaushik Majumdar: Nitrogen management for hybrid rice: Trade-offs between productivity, profitability, carbon sustainability and energy efficiency. (O-21)		**Bracken Conor,** Gary Lanigan, Karl Richards, Christoph Müller, Saoirse Tracy and Paul Murphy: Effect of grassland sward composition and N fertiliser management on N2O emission, NO3- leaching, sward yield and N uptake. (O-29)	
	10:45-11:00	**Khalil Mohammad I.** and Bruce A. Osborne: The mitigation potential of key gaseous nitrogen and the role of soil organic carbon for offsetting in arable cropping systems. (O-22)		**Grange Guylain**, Caroline Brophy and John Finn: Multi-species grasslands open pathways for improving productivity and sustainability under intensive management. (O-30)	
	11:00-11:30	Coffee break and Networking			
	11:30-11:45	**O'Reilly Alison** and Dara Stanley: Do pollinator communities differ between early and late flowering varieties of a mass-flowering crop? (O-23)		**Larkin Michelle and Dara Stanley:** Does management at a local or landscape scale impact pollinator communities in semi-natural grasslands? (O-31)	
	11:45-12:00	**Manstretta Valentina**, Vittorio Rossi, Giorgio Ragaglini, Alessandro Bosso, Gabriele Canali, Giovanni Laidò, Paola Cutillo and Pierlugi Meriggi: LIFE AGRESTIC – Reduction of Agricultural GReenhouse gases EmiSsions Through Innovative Cropping systems. (O-24)		**Mavrommatis Alexandros**, Christina Mitsiopoulou, Thomas Bartzanas, Eleni Tsiplakou, George Zervas and Maria Teresa Pacchioli: Evaluation of the greenhouse gases emitted by different sheep and goat farming systems in Greece. (O-32)	
	12:00-12:05	**Arable Cropping Systems** **Co-Chair**: Prof. Pascal Boeckx (Ghent University, Belgium)		**Grassland Systems** **Co-Chair:** Dr. Mhairi Coyle (James Hutton Institute, United Kingdom)	
	12:05-12:14	**Theme 3, Session II (Flash)** **Siddique M.N.E Alam** Lisa L. de Bruyn, Yui Osanai and Chris N. Guppy: Field-scale quantification of SOC and nitrogen dynamics in rice-based cropping systems. (F-19)		**Theme 4, Session II (Flash)** -	
	12:14-12:23	**Sato Makiba**, János Kátai, Miwa Yashima and Kazuyuki Inubushi: Effect of pellet compost on CO_2 and N_2O production and plant growth in Andosol and Chernozem. (F-20)		**Coyle Mhairi**, Jonathon Holland, Fiona Fraser, Madeline Giles, Roy Neilson, Helaina Black, Clare Cameron, Jagsdeesh Yeluripati, Dale King and Susan Mitchell: Impacts of liming on soil biodiversity and GHG emissions from permanent grassland in the heart of Scotland. (F-28)	
	12:23-12:32	**Breil Nicolas L.,** Nathalie Jarosz-Pellé, Vincent Bustillo, Benoit Coudert, Solen Queguiner, Nicole Claverie and Thierry Lamaze: Heterogeneity of soil respiration on agroecological and conventional maize crops. (F-21)		**Mitsiopoulou Christina**, Alexandros Mavrommatis, Eleni Tsiplakou, George Zervas and Maria Teresa Pacchioli: Dietary nitrogen efficiency in dairy small ruminants under different farming systems. (F-29)	
	12:32-12:41	**Bakacsy László**, Henrietta Kovács, Lilla Sípos, Anita Barta, Dóra Stefkó, Andrea Vasas and Ágnes Szepesi: Potential application of phenanthrenes from rushes as organic compounds for sustainable agriculture. (F-22)		**McNee Matthew,** Myrtille Lacoste, Simon Cook, Jim McAdam, Wesley Tourangeau and Kate Sherren: Farmer-based research in rangeland grazing systems on the Falkland Islands. (F-30)	
	12:41-12:50	-		**Bracken Conor**, Gary Lanigan, Karl Richards, Christoph Müller, Saoirse Tracy, James Grant, Dominika Krol, Helen Sheridan, Bridget Lynch, Cornelia Grace, Rochelle Fritch and Paul Murphy: N_2O emission and N cycling in mixed composition grassland swards with contrasting soil moisture conditions post urea fertiliser application. (F-31)	
	12:50-12:59	**Szepesi Ágnes**, László Bakacsy, Henrietta Kovács, László Kredics, Tamás Marik, Péter Pálfi, Réka Szőllősi and Laura Zsigmond: Catabolism of polyamines as biostimulant plant growth regulators for improving salt stress tolerance of tomatoes. (F-24)		**Cliquet Joséphine** and Alice Poilane: Herby : Carbon storage and grazing management. (F-32)	
	12:59-13:08	**Peixoto Leanne**, Lars Elsgaard, Jørgen Eivind Olesen, Jim Rasmussen and Yakov Kuzyakov: Carbon deposition and partitioning in the soil microbial biomass from three deep-rooted crops in 4-meter rhizoboxes. (F-25)		**Jimenez Lizbeth E. Robles**, Arni Xochitemol, Mohamed Benaaouda, Jorge Osorio Avalos, Luis Corona, Epigmenio Castillo, Octavio Castelan Ortega and Manuel Gonzalez-Ronquillo: Concentrate supplementation on milk yield, methane and CO_2 production in crossbred dairy cows in tropical climate regions. (F-33)	
	13:08-13:17	**Wesolowska Monika**, Piotr Baranowski and Lech Schimmelpfennig: Slow-release fertilizers as a way to reduce ammonia and GHG emissions from agricultural sources. (F-26)		**Klumpp Katja,** Frederique Louault and Isabelle Bosio: Risk analysis of N leaching from grasslands under different management practices. (F-34)	
	13:17-14:07	Lunch break and Networking			
		Parallel sessions: Keynote (20 min talk+ 5 min Q&A), Oral (12 + 3) and Flash (6 + 3)			
	14:07-14:12	**Socio-economic Costing** **Chair:** Dr. Laurence Shalloo (Teagasc, Ireland).		**Agro-Silvo-Pastoral Systems** **Chair:** Prof. Gerardo Moreno (Univ. de Extremadura, Spain)	
	14:12-14:37	**Keynote address:** Dr. Stephane De Cara, INRA-AgroParisTech, France.	Mitigation of greenhouse gas emissions from agriculture: An economist's perspective. (K-5)	**Keynote address:** Prof. Jim McAdam OBE, AFBI, NI, UK.	The potential of agro-silvo-pastoral systems to address climate resilience and mitigation. (K-6)

Continues

	11:00-11:30	Coffee break and Networking	
	11:30-11:45	**O'Reilly Alison** and Dara Stanley: Do pollinator communities differ between early and late flowering varieties of a mass-flowering crop? (O-23)	**Larkin Michelle and Dara Stanley:** Does management at a local or landscape scale impact pollinator communities in semi-natural grasslands? (O-31)
	11:45-12:00	**Manstretta Valentina**, Vittorio Rossi, Giorgio Ragaglini, Alessandro Bosso, Gabriele Canali, Giovanni Laidò, Paola Cutillo and Pierlugi Meriggi: LIFE AGRESTIC – Reduction of Agricultural GReenhouse gases EmiSsions Through Innovative Cropping systems. (O-24)	**Mavrommatis Alexandros**, Christina Mitsiopoulou, Thomas Bartzanas, Eleni Tsiplakou, George Zervas and Maria Teresa Pacchioli: Evaluation of the greenhouse gases emitted by different sheep and goat farming systems in Greece. (O-32)
	12:00-12:05	**Arable Cropping Systems** **Co-Chair**: Prof. Pascal Boeckx (Ghent University, Belgium)	**Grassland Systems** **Co-Chair:** Dr. Mhairi Coyle (James Hutton Institute, United Kingdom)
		Theme 3, Session II (Flash)	**Theme 4, Session II (Flash)**
	12:05-12:14	**Siddique M.N.E Alam** Lisa L. de Bruyn, Yui Osanai and Chris N. Guppy: Field-scale quantification of SOC and nitrogen dynamics in rice-based cropping systems. (F-19)	-
	12:14-12:23	**Sato Makiba**, János Kátai, Miwa Yashima and Kazuyuki Inubushi: Effect of pellet compost on CO_2 and N_2O production and plant growth in Andosol and Chernozem. (F-20)	**Coyle Mhairi**, Jonathon Holland, Fiona Fraser, Madeline Giles, Roy Neilson, Helaina Black, Clare Cameron, Jagsdeesh Yeluripati, Dale King and Susan Mitchell: Impacts of liming on soil biodiversity and GHG emissions from permanent grassland in the heart of Scotland. (F-28)
	12:23-12:32	**Breil Nicolas L.,** Nathalie Jarosz-Pellé, Vincent Bustillo, Benoit Coudert, Solen Queguiner, Nicole Claverie and Thierry Lamaze: Heterogeneity of soil respiration on agroecological and conventional maize crops. (F-21)	**Mitsiopoulou Christina**, Alexandros Mavrommatis, Eleni Tsiplakou, George Zervas and Maria Teresa Pacchioli: Dietary nitrogen efficiency in dairy small ruminants under different farming systems. (F-29)
	12:32-12:41	**Bakacsy László**, Henrietta Kovács, Lilla Sípos, Anita Barta, Dóra Stefkó, Andrea Vasas and Ágnes Szepesi: Potential application of phenanthrenes from rushes as organic compounds for sustainable agriculture. (F-22)	**McNee Matthew,** Myrtille Lacoste, Simon Cook, Jim McAdam, Wesley Tourangeau and Kate Sherren: Farmer-based research in rangeland grazing systems on the Falkland Islands. (F-30)
	12:41-12:50	-	**Bracken Conor**, Gary Lanigan, Karl Richards, Christoph Müller, Saoirse Tracy, James Grant, Dominika Krol, Helen Sheridan, Bridget Lynch, Cornelia Grace, Rochelle Fritch and Paul Murphy: N_2O emission and N cycling in mixed composition grassland swards with contrasting soil moisture conditions post urea fertiliser application. (F-31)
	12:50-12:59	**Szepesi Ágnes**, László Bakacsy, Henrietta Kovács, László Kredics, Tamás Marik, Péter Pálfi, Réka Szöllősi and Laura Zsigmond: Catabolism of polyamines as biostimulant plant growth regulators for improving salt stress tolerance of tomatoes. (F-24)	**Cliquet Joséphine** and Alice Poilane: Herby : Carbon storage and grazing management. (F-32)
	12:59-13:08	**Peixoto Leanne**, Lars Elsgaard, Jørgen Eivind Olesen, Jim Rasmussen and Yakov Kuzyakov: Carbon deposition and partitioning in the soil microbial biomass from three deep-rooted crops in 4-meter rhizoboxes. (F-25)	**Jimenez Lizbeth E. Robles**, Arni Xochitemol, Mohamed Benaaouda, Jorge Osorio Avalos, Luis Corona, Epigmenio Castillo, Octavio Castelan Ortega and Manuel Gonzalez-Ronquillo: Concentrate supplementation on milk yield, methane and CO_2 production in crossbred dairy cows in tropical climate regions. (F-33)
	13:08-13:17	**Wesolowska Monika**, Piotr Baranowski and Lech Schimmelpfennig: Slow-release fertilizers as a way to reduce ammonia and GHG emissions from agricultural sources. (F-26)	**Klumpp Katja,** Frederique Louault and Isabelle Bosio: Risk analysis of N leaching from grasslands under different management practices. (F-34)
	13:17-14:07	Lunch break and Networking	
Parallel sessions: Keynote (20 min talk+ 5 min Q&A), Oral (12 + 3) and Flash (6 + 3)			
	14:07-14:12	**Socio-economic Costing** **Chair:** Dr. Laurence Shalloo (Teagasc, Ireland).	**Agro-Silvo-Pastoral Systems** **Chair:** Prof. Gerardo Moreno (Univ. de Extremadura, Spain)
	14:12-14:37	**Keynote address:** Dr. Stephane De Cara, INRA-AgroParisTech, France. Mitigation of greenhouse gas emissions from agriculture: An economist's perspective. (K-5)	**Keynote address:** Prof. Jim McAdam OBE, AFBI, NI, UK. The potential of agro-silvo-pastoral systems to address climate resilience and mitigation. (K-6)

Day 3:	Time	Category	
Friday 6th Nov 2020		**Workshop** (Sponsor: GHG-Manage)	
		Facilitators/Rapporteurs Dr. Bart Krujt (WUR, Netherlands), Dr. Jon Yearsley (UCD, Ireland), Dr. Anna Walkiewicz (IP, Poland) and Dr. Syed Islam (UCD, Ireland).	**Land Use Mosaics and Greenhouse Gas Mitigation** Roundtable multidisciplinary teams to discuss and explore scientific & technological ideas/thoughts and innovation policy for reducing GHGs from different landscape mosaics.
	9:00-9:10	Opening speech	Dr. Frank O'Mara, FACCE ERA-GAS Coordinator and Director Research, Teagasc, Ireland.
	9:10-10:30	Workshop	
	10:30-10:50	Coffee break and Networking	
	10:50-13:00	Workshop	Continues
	13:00-13:30	Lunch break and Networking	
		Panel discussion	
	13:30-15:30	**Moderator** Prof. Bruce Osborne (UCD, Ireland) **Rapporteurs** Prof. Mary Kelly-Quinn, Dr. Brian Tobin and Ms. Sinead McGinley (UCD)	**Agricultural Systems as a Holistic Approach to Mitigate Climate Change and Environmental Pressures** Panel members: • **Dr. Frank O'Mara,** FACCE ERA-GAS and Teagasc, Ireland. • **Mr. Bill Callanan,** Department of Food, Agriculture and the Marine, Ireland. • **Dr. Bernard Hyde,** Environmental Protection Agency, Ireland. • **Dr. Andreas Pacholski,** Institute for Climate-Smart Agriculture, Braunschweig, Germany. • **Mr. Andy Doyle,** Irish Farmers Journal, Ireland • **Dr. Helene Chambaut**, Technical Livestock Institute (IDELE), France.
	15:30-15:45	Coffee break and Networking	
	15:45-17:30	Panel discussion	Continues
	17:30-17:40	Closing speech	Prof. Tasman Crowe, Director, UCD Earth Institute, University College Dublin, Ireland.
	17:40	Wrap-up	

PLENARY SPEAKERS

Dr. Federica Matteoli

Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

Ms. Federica Matteoli has 15 years of experience in the field of climate change, political science and participatory approaches in international agencies such as FAO and the World Bank and government agencies. She has been a member of the Facilitation Unit of the Global Alliance for Climate Smart Agriculture since 2014. She is Leader of the CSA Team in the Office of Climate Change, Biodiversity and Environment (OCB) at FAO and she is coordinator of a project that supports FAO knowledge activities on CSA and projects at the field level in Botswana and Ecuador. She coordinated a FAO project on Communication for Development on climate change in Bolivia, Democratic Republic of Congo and in the Caribbean. She worked for the World Bank on climate change matters. She has a degree in Law, a Master on International Cooperation and a PhD on science and management of climate change.

Prof. Nina Buchmann

ETH Zurich, Switzerland

Nina Buchmann is Professor of Grassland Sciences at ETH Zurich. Her main research topics include (1) plant and ecosystem physiology, (2) biogeochemistry of terrestrial ecosystems, i.e., forest, grassland and cropland, particularly the response of soil and ecosystem carbon, nitrogen and water dynamics to climatic conditions and management regimes, and (3) interactions among biodiversity, ecosystem functions/services, and sustainable resource use. She published more than 260 refereed original journal papers and 28 books and book chapters and is a member of the National Academy of Sciences in Germany. In 2018 she was elected as Fellow of the American Geophysical Union and identified as a "Highly Cited Researcher".

Prof. Alan Matthews

Trinity College Dublin, Ireland.

Alan Matthews is Professor Emeritus of European Agricultural Policy at Trinity College, Dublin, Ireland. He is a former President of the European Association of Agricultural Economists and is currently a member of Ireland's Climate Change Advisory Council. His research interests are in the areas of agricultural policy and international trade policy, including their implications for development and food security. He completed a large number of assignments commissioned within Ireland by the ministries and the Joint Oireachtas Committee on State-Sponsored Bodies; and abroad by the European Commission (DG Budget, Trade and Agri), European Parliament, FAO, IEEP, OECD, UNECE,UNIDO and the World Bank. He is a regular contributor to the blog capreform.eu on issues relating to the EU's Common Agricultural Policy.

ABSTRACTS: PLENARY SPEAKERS

Global Perspectives and Inter-linkages of FAO's Climate-Smart Agriculture with UN SDGs (P-1)

Matteoli Federica*

*Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. *Corresponding author: Federica.matteoli@fao.org*

The world's food and agriculture systems are under ever-increasing pressure from social, economic and environmental stressors. Climate change represents one of the major stressors and is, in turn, driven by greenhouse gas emissions from food and agriculture systems. FAO's climate-smart agriculture (CSA) approach seeks to address this challenge and reconcile sustainable gains in productivity and producers' incomes with resilience, climate change adaptation and mitigation. Thereby, CSA constitutes an important tool to support countries' efforts to achieve the Sustainable Development Goals (SDGs) and deliver their nationally determined contributions (NDCs). In particular, CSA contributes to SDG 2 on 'Zero hunger' and SDG 13 on 'Climate action'. However, these goals and related targets are intimately interlinked with the SDGs and, therefore, cannot be achieved sustainably without considering these interactions. A detailed mapping of interlinkages between CSA and the SDGs identified a multitude of potential synergies and trade-offs between CSA objectives and targets across all 17 SDGs. This mapping provides entry points to enhancing synergies and reducing trade-offs between sustainability goals in the transformation of food and agriculture systems from the outset. Furthermore, opportunities for the integration of CSA implementation with SDG and NDC related processes at national and sub-national levels were identified in correspondence with the key aspects of CSA implementation: expanding the evidence base; supporting enabling policy frameworks; strengthening national and local institutions; enhancing financing options; implementing practices in the field; and monitoring, evaluation and reporting.

***Keywords**:* Climate-smart agriculture, Sustainable Development Goals, Synergies, Trade-offs, Integrated implementation.

Agroecosystems today and in the future: Drivers of or driven by climate change (P-2)

Buchmann Nina*

*ETH Zurich, Switzerland. *Corresponding author: nina.buchmann@usys.ethz.ch*

Management of agroecosystems, i.e. arable as well as grassland systems, is critical for the provisioning of ecosystem services (e.g., food and feed production, climate regulation, erosion control, cultural services) and the sustainable development globally. How agroecosystems are

affected by climate change, but also to what extent they contribute to climate change or can actually mitigate it, are important research questions. Within the Swiss FluxNet, a network of ecosystem flux measurement sites in Switzerland (http://www.swissfluxnet.ch/), greenhouse gas (GHG) fluxes and carbon sequestration have been measured at one arable and three grassland sites of different management intensities for more than a decade. At an intensively managed grassland site on the Swiss Plateau, legumes are currently tested as a N_2O mitigation option. Overall, environmental conditions as well as management events have clear impacts on net ecosystem fluxes. Particularly during a restoration year (which included ploughing, harrowing, resowing, fertilisation), the grassland turned into a large GHG source, driven by very high N^2O and CO_2 losses. On the other hand, increasing the legume fraction in the sward, thereby substituting organic nitrogen fertiliser, reduced N_2O emissions while still maintaining yield and forage quality levels. Thus, management strongly affected the climate regulation service provided by the grassland, offering potential win-win solutions. In contrast, the arable site, with the longest time series of flux measurements globally, has been losing C over the last decade, with pronounced differences among crop species, despite the counteracting agricultural practice of manure applications. Climate impact studies, but also agroeconomic assessments complemented these long-term GHG measurements. All three grasslands were surprisingly resilient to severe droughts, both simulated and naturally occurring. Feed production, but also sward composition did not show any legacy effects of preceding droughts. Thus, management of agroecosystems offers sustainable, climate-smart and climate-resilient solutions towards the UN SDGs.

***Keywords**:* Greenhouse gas exchange, Soil carbon sequestration, Resilience, Drought, Switzerland.

Promoting Climate-Resilient Agri-Environmental Systems in the EU's Common Agricultural Policy (P-3)

Alan Matthews*

*Trinity College Dublin, Ireland. *Corresponding author: alan.matthews@tcd.ie*

The EU Commission in its Clean Planet for All roadmap to a net zero emissions economy by 2050 envisaged that agricultural emissions should be halved over this period compared to 2015. It also saw potential for additional carbon sequestration in the LULUCF sector. At the same time, climate change and more extreme weather events are having a greater impact on EU agricultural production and these impacts will intensify in the coming decade. The imperatives to reduce emissions and increase resilience will require significant changes in agricultural practices, including those to be announced by the Commission in its Farm to Fork Strategy in May 2020. This presentation will take as its starting point the latest position of the EU co-legislature on the Commission's proposal announced in June 2018 for the Common Agricultural Policy (CAP) post 2021. This proposal aims to achieve a higher level of environmental and climate ambition in the future CAP, as well as giving Member States greater flexibility to reach this objective by designing national CAP Strategic Plans. Since then, the incoming Commission has announced plans for a European Green Deal, which proposes to increase the EU's greenhouse gas emission reduction targets for 2030 and which envisages an important role for agriculture in meeting this goal. Two key targets for the new CAP are that 40% of the overall budget will be climate-relevant and at least 30% of spending on rural development programmes should target natural resource conservation, biodiversity protection and climate change. The presentation will critically examine progress to date in using the CAP to promote climate-resilient agri-environmental systems. It will further discuss how Member States must intensify their interventions to support farmers in this green transition when drawing up their CAP Strategic Plans.

***Keywords**:* Common agricultural policy, Agri-environment-climate schemes, Green transition.

Abstract of the Invited Speaker

LIFE and Climate Action in Agriculture (I-1)

Fetsis Panos[1], Mara Mendes[1] and **Giappichelli Laura[2,*]**

*[1]Neemo EEIG, Belgium; [1]EASME, European Commission, Belgium. *Corresponding author: laura.giappichelli@ec.europa.eu*

Since 1992, LIFE has supported the development of innovative technologies and practices which pave the way to meaningful reductions in carbon, methane and nitrous oxide emissions as well as to increased climate change resilience in the agricultural sector. Therefore, LIFE strongly contributes to the implementation of the EU's climate commitments, including those under the Paris Agreement, the 2030 climate and energy package, the EU adaptation strategy and the Green Deal and the recently unveiled Farm to Fork Strategy. LIFE projects have managed to cut nitrous oxide and methane emissions, for instance, by optimising nitrogen application through precision farming as well as through livestock management respectively. Proper soil and land management, diversification of crop rotation and restoration of peatlands, grasslands and degraded soil has shown how to enhance carbon sequestration levels. Recently, LIFE projects have focused on the development of monitoring tools and calculation models for measuring GHG emissions from agriculture as well as soil carbon loss. These tools also support climate-smart agribusiness that rewards farmers for reducing emissions or drawing down carbon from the atmosphere into soils and plants. LIFE has assisted Member States in testing and demonstrating effective adaption methods for restoring degraded soil using a range of techniques for increasing soil fertility and reducing erosion, such as no-tillage, crop rotation and reduced grazing. Other methods have helped to optimise the use of water, for example, precision farming as a means of adapting agriculture to higher temperatures and less rainfall or optimisation of groundwater use in rural coastal areas by diverting it to different locations. Finally, the involvement of stakeholders such as farmers and agronomists through on-site demonstrations of these tools, training and workshops is helping to raise awareness of climate change adaptation and mitigation measures in agriculture.

Keywords: LIFE, climate action, agriculture, funding instrument

ABSTRACTS: PARALLEL SESSIONS

Theme 1: Decision Support Tools

Keynote presentation

Decision support tools for environmentally sustainable farming: How do they help? (K-1)

Hillier Jon*

*Edinburgh University, Scotland, UK. *Corresponding author: Jonathan.Hillier@ed.ac.uk*

The impacts of agricultural production on our environment are increasingly recognised. Agriculture is, for example, responsible for around one third of global greenhouse gas emissions, two thirds of freshwater use, and has been associated with a dramatic decline in biodiversity in recent years. The farming sector, and those businesses (e.g. food and drink sector, processors and retailers) that depend on it are generally aware of the need to identify and establish sustainable farming practices. This need arises both from the perspective of social responsibility and also because, for example, climate change, aquifer depletion, and loss of ecosystem services provided by those organisms present in agricultural environments present a threat to the security of supply of agricultural produce. But the science regarding the environmental impacts of agriculture is fast evolving, and non-academics do not have access to this or the time to assimilate emerging evidence first-hand. There is therefore a role for science-based decision support tools, which translate scientific knowledge connecting in a practical way farm management into sustainability metrics for farmers. There are many such tools available to farmers across the globe. In this presentation I will talk about a number of tools which have been developed to support farmers and businesses in enabling more sustainable farming practice. I will describe what I believe to be important features of such tools, where they have been successful, and where they have yet to achieve their desired impact and why. I will finish by making general recommendations for future initiatives to develop decision support for sustainable farming.

Keywords: Decision support tools, Greenhouse gases, Agricultural farming systems, Sustainability.

Session I: Oral presentations

Evaluating aspects of the Cool-farm-tool: model assessments versus measurements. (O-1)

Gottschalk Pia[1], Syed Faiz-Ul Islam[2], Jon Hillier[3], Mohammad I. Khalil[2,4] and Bruce Osborne

[1]Helmholtz Centre Potsdam, German Research Centre for GeoSciences, Germany; [2]University College Dublin, Ireland; [3]The University of Edinburgh, UK; [4]Prudence College Dublin and [2]University College Dublin, Ireland and [2]University College Dublin, Ireland. Corresponding author: pgottsch@gfz-potsdam.de

The 'Cool-Farm-Tool' is one of the most important online greenhouse gas (GHG) calculators for agricultural products at the whole farm scale worldwide. It is used by many global food producing companies to assess the baseline GHG-footprints of their supplier products, to delineate GHG-mitigation potentials and thus refine their companies' sustainability targets. The tool was established in 2011 (Hillier et al., 2011) and comprises several modules to calculate N2O, CH4 and CO2 emissions from on-farm emission sources (e.g. crops, dairy, soil inputs, fuel & energy, irrigation, land use and land management change, and transport). It is thus composed of modules of different complexity, ranging from regression functions to emission factors or a combination of the two. However, scientific findings are moving on, new data becomes available and new guidelines for state-of-the-art inventories are being published, such as the IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas accounting. We attempted to evaluate different aspects of the tool by means of published plot scale data, analyze the plausibility of tool sensitivities in the perspective of the overall emission results, and try to rate the tool's uncertainty, as opposed to measurement uncertainty. In doing this we emphasize evaluation and uncertainty aspects, for example, for the soil C stock change module, which is based on the IPCC method and the results of Ogle et al. (2005).

Keywords: Whole farm model evaluation, Cool-Farm-Tool, Decision support tool.

Literature

Hillier, J. (2011). "A farm-focused calculator for emissions from crop and livestock production." Environmental Modelling 26(9): 1070-1078.
Ogle, S. M., et al. (2005). "Agricultural management impacts on soil organic carbon storage under moist and dry climatic conditions of temperate and tropical regions." Biogeochemistry 72(1): 87-121.

On the use of (geo) spatial tools for support on national GHG-inventory reporting. (O-2)

Jonckheere Inge G.C.[1] and Esther Mertens[2]

[1]Food and Agriculture Organization of the United Nations, Rome, Italy, [2]South Pole, Amsterdam, the Netherlands. Corresponding author: inge.jonckheere@fao.org

Under the COP Paris Agreement, countries need to prepare their GHG inventories with emissions by source and removals by sinks. In order to meet the UNFCCC quality standards, those inventories should be transparent, accurate, comparable, consistent and complete. For the LULUCF sector, emissions are a result from a change in one of the five IPCC carbon pools (e.g. aboveground biomass, etc.). The change in the carbon stock is not easily directly measured, but usually estimated using proxies of land area and area change and the average carbon stocks in

the area. Countries encounter several challenges when collecting forestry and land use data information on land related to the inherent complexity of the measurement and monitoring of LULUCF sector and limited by their institutional arrangements. The REDD+ program of the UN (tri-partnership between UNEnvironment, FAO and UNDP) has a long history of supporting developing countries on setting up the forest (and land use) monitoring system which has supported several countries to produce regular data and make it publicly available, even using web-geoportals. In this work, we discuss the challenges of land data collection and demonstrate the potential leading role of REDD+ countries in the context of reporting regular GHG estimates for the LULUCF sector and the preparation of GHG baselines for the NDC progress reporting under the Paris Agreement using geospatial tools.

Keywords: Land monitoring, LULUCF, NDCs, Sustainability, Mitigation.

Towards operational quantification of GHG exchange in heterogeneous agricultural landscapes and experimental plots (O-3)

Kruijt Bart[1*], Reinder Nouta[2], Cor Jacobs[3], Merit van den Berg[4], Christian Fritz[4], Ronald Hutjes[1], Wietse Fransen[1], Katja Klumpp[5], Bruce Osborne[6]

[1]Wageningen University, Water systems and Global Change, PO box 47, 6711AA, Wageningen, Netherlands; [2] Wetterskip Fryslân (Frisian Water Authority), Leeuwarden, Netherlands; [3]Wageningen Environmental Research, Wageningen, Netherlands;[4] Radboud University, Aquatic Ecology and Environmental Biology, Nijmegen, Netherlands; [5] INRA, Grassland Ecosystem Unit, Clermont-Ferrand, France; [6] UCD School of Biology & Environmental Science, University College Dublin, Dublin 4, Ireland.
**Corresponding author: bart.kruijt@wur.nl*

With the increasing need to mitigate rising atmospheric greenhouse gas (GHG) concentrations more attention is being directed at the quantification of the GHG exchange characteristics of heterogenous landscape assemblages that vary in land cover and land use. Whilst emission-limiting or uptake-enhancing management actions are often being proposed for specific land use most remain to be experimentally tested and validated at the landscape scale. This is a challenge because the typical size of different landscape elements (fields, afforested areas and unmanaged land at hectare scale) or experimental fields where emission reduction measures are being tested, is at the lower limit of what micrometeorological techniques such as eddy covariance measurements can deal with. With large heterogeneity the use of chamber measurements is also limited. The investments to be made in equipment are a challenge for operational monitoring of GHG budgets. To address this, we assess the feasibility of several options to acquire appropriate data in a way that is achievable for stakeholders, such as land managers and regional authorities. We use existing and new flux data from an agricultural landscape in the North of the Netherlands to: 1) compare paired eddy covariance (EC) data and automatic chamber (AC) data to test the representativity of small footprints. Results from a test site on drained meadows show almost identical CO2 fluxes. Future research should compare grass length and soil moisture of EC- and AC footprints; 2) test simplified alternatives to EC, such as those relying on concentration variances. Data from the peat meadow site suggest that time-averaged fluxes can be estimated in an empirical way with reasonable accuracy from concentration variances; 3) analyse the value of information gathered with mobile, roving/temporary EC approaches interpolated with gap filling models. The indications are that the values and variability of fluxes is largely conserved and predictable within seasons In all these analyses, we will consider the trade-offs between the need for accuracy and pragmatism in operational practice.

Keywords: CO_2 exchange, landscape elements, low-cost flux measurements, peat meadows.

Developing carbon accounting at farm level to monitor C-storage and NO_2-volatilization in agricultural soils (O-4)

Vanrespaille Helena E.[1,*], Mia Tits[1] and Annemie Elsen[1]

[1]*Soil Service of Belgium, Leuven, Belgium. *Corresponding author: hvanrespaille@bdb.be*

Soils store 1580 Gtonnes of carbon, more than twice the amount in the atmosphere (750 Gtonnes), having a potential for capturing extra CO_2 from the air in the short and long term. Yet, carbon levels in agricultural soils in Flanders are declining since the nineties, causing a net CO_2-emission. Natural processes as nitrification and denitrification of ammonia and nitrate from N-fertilisation lead to the side production of N_2O, a greenhouse gas with a 289 times stronger warming potential than CO_2. Storing carbon in soils is not only a matter of climate mitigation, it also improves the physical, chemical and biological characteristics of soils, making them more robust in a changing climate with dryer summers. But even though farmers are aware of the positive effects of carbon in the soil in the long term, they are not sufficiently encouraged to take action in the short term. Monitoring carbon storage and NO_2 volatilization at farm level gives better insight to the farmers about the effects of their management. Data of crop rotation, crop residues, (organic) fertiliser use, fuel use and living trees and hedgerows of the farm are collected to quantify effective organic carbon stored in the soil and biomass and to estimate the amount of N_2O volatilization. The calculations are based on the protocol of IPCC (2006) and have been improved by detailed research data collected by the Soil Service of Belgium. The effect of measures -such as improved crop rotation, incorporating crop residues, compost or other organic amendments like shredded wood- can be predicted at farm level, stimulating farmers to sustainably improve the carbon content of their soils. Also, monitoring greenhouse gases at farm level could provide a tool for policy makers and companies to financially support CO_2 storage and avoided N_2O volatilization, for example to compensate for emissions elsewhere.

Keywords: Carbon sequestration, greenhouse gas, monitoring, soil quality, Flanders.

Development of DNDC-meta-model to estimate GHG emissions from Norwegian organic soils. (O-5)

Yeluripati Jagadeesh*, Ina Pohle and Miriam Glendell

*The James Hutton Institute, UK. *Corresponding author: jagadeesh.yeluripati@hutton.ac.uk*

National assessments of greenhouse gas (GHG) emissions often are based on results of process-based models. However, these models are often very complex and have high data and computational demands. Meta-models capturing the essence of complex model can thus be advantageous for large scale applications due to lower data and computational demands and furthermore lower expertise required once meta-models are developed. We present a meta-modelling framework for the DNDC biophysical model to predict greenhouse gas emissions from Norwegian soils. Regression-based and random forest-based meta-models are developed to estimate annual N2O and CH4 emissions based on full DNDC model simulations. For meta-model parameterisation and validation, a total of 5000 full DNDC model simulations have been carried out for stochastically generated internal DNDC model parameters (e.g. soil characteristics) representative for Norwegian conditions and meteorological data covering entire Norway. Annual

N_2O emissions have been satisfactorily simulated (R^2 between model and meta-model results > 0.7 for a calibration and an independent validation data set) by a random forest-based meta-model considering annual air temperature, bulk density, and precipitation as most important predictors. Contrastingly, regression-based models have not been able to capture the strongly non-linear responses of N_2O emissions to model parameters and input variables. Both regression-based and random forest-based meta-models perform well with respect to annual CH_4 emissions (R2 > 0.7) with topsoil organic carbon, bulk density, and air temperature as most important predictors. The identification of important predictors in the meta-models corresponds well with findings of the sensitivity analysis carried out prior to meta-model construction. Future work will include the development of crop-, management- and region-specific metamodels allowing for a detailed regionalization of greenhouse gas emissions across Norway.

Key words: Decision support tool, Random forest, N_2O emission, CH_4 emission, Organic soils.

A decision support system for energy efficient and renewable energy technologies on dairy farms (O-6)

Shine Philip[1], Michael Breen [2], John Upton [3], Michael D. Murphy[1],

[1]Department of Process, Energy and Transport Engineering, Cork Institute of Technology, Cork, Ireland; [2]Department of Mechanical, Biomedical, and Manufacturing Engineering, Cork Institute of Technology, Cork, Ireland; [3]Animal and Grassland Research and Innovation Centre, Teagasc Moorepark Fermoy, Co. Cork, Ireland. Corresponding author: philip.shine@cit.ie

Agricultural activities are responsible for 33% of overall greenhouse gas (GHG) emissions in Ireland, forecasted to increase due to ambitious targets aiming for overall production increases and an 85% increase in exports by 2025. This increased production must be met with consideration regarding GHG emissions to ensure compliance with EU GHG emission allowances. However, it is projected that Ireland's 2030 GHG emissions will be far below the targeted 30% reduction. As no immediate solution is available to reduce methane production from livestock, increasing energy efficiency and the utilisation of renewable energy systems on dairy farms may serve as an effective measure to offset GHG emissions. However, as energy consumption varies from farm-to-farm, farmers run the risk of increasing production costs if these technologies are not managed and sized correctly. Concurrently, overall return on investment will be impacted by factors such as: grant aid, feed-in-tariff availability, electricity demand profile and farm location. Thus, the Agricultural Energy Optimisation Platform (AEOP) was developed as an online portal providing dairy farmers and policy makers with decision support related to the installation of these systems. AEOP (available at: https://messo.cit.ie/dairy) combines state-of-the-art dairy energy modelling and optimisation functionality to provide agricultural stakeholders: 1) access to energy use, cost and CO2 emissions data on dairy farms, 2) monetary, energy and environmental information related to the installation of plate coolers, variable speed drives, heat recovery systems, solar thermal water heating systems, solar photovoltaic systems and wind turbines, and 3) the ability to autonomously identify optimum management strategies in conjunction with the installation of a solar photovoltaic system to either maximise return on investment or minimise CO2 emissions. It is anticipated that AEOP will be used extensively in the future to assist farmers, farm managers and policy makers with decisions pertaining to dairy farm energy, costs and CO2 emissions.

Keywords: Dairy, Energy, Renewables, Sustainability, Ireland.

Next-generation national mapping of soil moisture deficits, runoff and diffuse phosphorus losses in Irish agricultural catchments for decision support. (O-7)

Thomas, Ian A.[1,2*], Eva Mockler[2], Chris Werner[3], Fiachra O'Loughlin[1], Mellander, Per-Erik[4], and Michael Bruen[1]

*[1]Dooge Centre for Water Resources Research, University College Dublin, School of Civil Engineering, Dublin, Ireland;[2] Catchment Science and Management Unit, Environmental Protection Agency, Dublin, Ireland; [3]Irish Centre for High-End Computing, Dublin, Ireland; [4]Environment, Soils and Land-Use Department, Teagasc, Johnstown Castle, Wexford, Ireland. *Corresponding author: ian.thomas@ucd.ie*

In the context of climate change, farmers, catchment managers and policymakers need up-to-date, high spatiotemporal resolution maps of soil moisture deficits (SMDs), runoff, and critical source areas (CSAs) of diffuse pollution from agricultural land to waterbodies, for informing land management decisions, targeting mitigation measures, and predicting future change. To achieve this, the DiffuseTools project is currently updating the Environmental Protection Agency's Catchment Characterisation Tool with the latest SMD modelling approaches, to improve CSA delineations and predictions of phosphorus losses via surface runoff and leaching. The Hybrid Soil Moisture Deficit Model 2.0 is being used with national daily Met Éireann re-analysis (MÉRA) weather data from 1980-2016 (2.5km2), a new national soil drainage class map, and a new national 5m Topographic Wetness Index map derived from a hydrologically corrected 5m NextMap Digital Elevation Model, to account for flow accumulation and slope, and improve the quantification of SMDs, surface runoff and water drainage volumes. A new sub-model also identifies delivery points of runoff and diffuse source pollutants to waterbodies across the country, and calculates attributes such as CSA size, runoff volume and receiving waterbody status, to increase prioritisation and cost-effectiveness of targeting mitigation measures, and inform design requirements. The next-generation SMD, runoff and P CSA maps aim to improve agricultural sustainability, functional land management, and facilitate predictions and analysis of the effects of climate change on soil moisture budgets, diffuse pollution and water quality.

***Keywords*:** Soil Moisture, Mapping, DiffuseTools, Runoff,Critical Source Area, High resolution.

LIFE ADAPT2CLIMA tool: A decision support tool for adaptation to climate change impacts on the Mediterranean islands' agriculture (O-8)

Giannakopoulos Christos[1,*], Anna Karali[1], Christina Papadaskalopoulou[2], Giannis Lemesios[1], Konstantinos V. Varotsos[1], Despoina Charchousi[3], Marco Moriondo[4], Maria Papadopoulou[3], *Marinos Markou[5] and Maria Loizidou[2].*

*[1]National Observatory of Athens, Greece; [2]School of Chemical Engineering, National Technical University of Athens, Greece; [3]School of Rural & Surveying Engineering, National Technical University of Athens, Greece; [4]Institute of Bioeconomy, National Research Council of Italy, Italy; [5]Agricultural Research Institute, Cyprus. *Corresponding author: cgiannak@meteo.noa.gr*

Agriculture is one of the most vulnerable economic sectors to climate change, since it directly depends on climatic factors such as temperature, solar radiation, and precipitation. The EU LIFE ADAPT2CLIMA project aims to facilitate the development of adaptation strategies for agriculture by deploying an innovative decision support tool (https://tool.adapt2clima.eu/en). The ADAPT2CLIMA tool will make it possible to simulate the impacts of climate change on crop

production and the effectiveness of selected adaptation options in decreasing vulnerability of agriculture to climate change in three Mediterranean islands, namely Crete (Greece), Sicily (Italy), and Cyprus. The tool construction was closely monitored by the project steering committees comprising of climate and crop scientists, policy makers and farm association executives, who were interacting to tailor make the final product perfectly suited to their needs. The tool provides in an interactive way (web-GIS platform): i) current and future projections of climatic indicators relevant to agriculture; ii) ground water level and drought index projections; iii) vulnerability indicators relevant to crops' biomass (e.g. yield), phenology (e.g. day of flowering) and physiology (e.g. potential evapotranspiration); (iv) socio-economic indicators; (v) impact assessments for each crop together with an evaluation of the proposed adaptation options. The main climate change scenarios examined refer to the average climatic conditions expected for the period 2031-2060 under RCP4.5 and RCP8.5 and therefore, the tool may serve for long-term adaptation planning. Additionally, extreme climatic scenarios (dry, wet, hot, cold) under RCP8.5 are examined in order for the tool to be used for short-term adaptation planning by farmers, in case such extreme climatic conditions occur in the near future. The tool is currently applied in Cyprus, Crete and Sicily but it may be used by everyone wishing to develop a regional adaptation strategy for the agricultural sector of Italy, Greece and Cyprus, through the relevant tool feature.

***Keywords*:** Adaptation planning, Mediterranean, Agriculture, Climate resilience.

Session II: Flash talks

Alternative management models for Ireland's western peatland forests to improve the provision of Ecosystem Services (F-1)

Nieuwenhuis Maarten* and Anders Lundholm

*University College Dublin, Ireland. *Corresponding author: maarten.nieuwenhuis@ucd.ie*

Large areas of blanket peat were afforested in western Ireland in the 1970s and 1980s, utilising extensive drainage and fertilisation. With certification rules and sustainable forest management now encompassing environmental and social consideration, fertilisation of many of these forests during reforestation is no longer allowed and buffer zones must be incorporated to protect water bodies. A linear programming model that optimizes Net Present Value (NPV) and accounts for several Ecosystem Services (ESs) was developed in Remsoft Woodstock, a Decision Support System (DSS) used for strategic forest planning. Alternative forest management models (aFMMs) with low environmental impacts were developed, comprising low-stocked lodgepole pine, Sitka spruce and downy birch mixtures, and bog restoration. These aFMMs were modelled in the DSS over 100 years in three different global development scenarios. These aFMM results were compared with those based on the use of current FMMs. We found that the aFMMs resulted in a higher NPV, due to more efficient land management, as well as reduced phosphorous emissions to water bodies, and higher biodiversity values, e.g. a greater area of old forests, more large trees, and more broadleaf volume. The aFMMs also lead to a landscape with higher recreation and aesthetic values, due to more open forests. However, the use of these lower-stocked forests resulted in lower future harvest volumes and less carbon being stored in the forest and in harvested wood products. The aFMMs were used less in the scenarios with low levels of climate change, because these scenarios also included higher timber prices as a result of increased mitigation efforts and an expanded bioeconomy. Given the changed societal demands, it is necessary to revaluate and redefine the management objectives for many western peatland forests, the

alternative management models that should be used, and the mixture of ecosystem services that these forests should provide.

Keywords: Decision support system, Alternative forest management models, Ecosystem services, Peatland forests.

Innovative systems approach to address supply chain waste in strawberries (F-2)

Ktenioudaki Anastasia[1,2,*], Haley Inselberg[2], Alyssa Smith[2], Natalia A. Peres[3] Colm P. O'Donnell[1], Maria Cecilia do Nascimento Nunes[2]

*[1]School of Biosystems & Food Engineering, University College Dublin, Belfield, Dublin 4, Ireland; [2]Food Quality Laboratory, Department of Cell Biology, Microbiology, and Molecular Biology, University of South Florida, Tampa, Florida, 33620, USA; [3]Gulf Coast Research and Education Center, University of Florida, Wimauma, FL 33598, USA. *Corresponding author: anastasia.ktenioudaki@ucd.ie*

European Union is committed to reduce food waste by 50% per capita by 2030. Current fresh produce waste reducing strategies (FIFO, first-in-first-out and FEFO, first-expired-first-out) fail to consider the fluctuating postharvest conditions and disregard pre-harvest environment, as shelf-life is estimated from the time of packaging. The main objectives of this study were: i) study the interaction of pre-harvest and postharvest conditions on shelf-life of strawberries ii) deliver a robust shelf-life prediction model to be used in a decision support system. Weather stations and sensors established in two growing sites were used to record air temperature, relative humidity, rainfall, light intensity and soil temperature. Upon harvest, strawberries were stored at 1°C (Control) and at fluctuating temperatures (3-25°C) (Simulation) simulating supply chain conditions, for eight days. Shelf-life was determined based on appearance (shrivelling, colour, and decay). Additionally, weight loss, texture, colour, ascorbic acid, sugar, anthocyanin and total phenol content; pH, soluble solids, titratable acidity and total microbial count, were determined by quantitative analysis. The experiment was replicated twice (two harvests). Preliminary results showed significantly higher daily temperatures and total rainfall during harvest 2. Strawberries from harvest 2 during storage exhibited significantly higher amount of yeast and moulds, greater weight loss, and received lower scores on colour and shrivelling. Strawberries from harvest 2 had shorter shelf-life based on their acceptability scores. Greater impact was observed for the samples in simulation conditions. This possibly indicates that the pre-harvest conditions observed on harvest 2, negatively affected key quality factors during storage that resulted in shorter shelf-life. The results show for the first time the implication of pre-harvest environment on shelf-life. Further analysis will allow for the pre- and postharvest environment interactions to be examined and combined into a shelf-life prediction model. A connection to the degradation of biochemical properties of strawberries will also be established.

Keywords: Shelf-life, Strawberries, Food waste, Modelling, Agriculture.

Potential of the DNDC model to predict long-term changes in N_2O emissions and SOC in permanent grassland (F-3)

Khalil Mohammad I.[1,2,*] *and Bruce A. Osborne*[1]

*[1]University College Dublin, Ireland; [2]Prudence College Dublin, Ireland. *Corresponding author: mi.khalil.dr@gmail.com*

Modelling approaches can minimise the largescale variability of greenhouse gases (GHGs), particularly nitrous oxide (N_2O) emissions , as well as estimates of soil organic carbon (SOC) in agricultural soils. Their precise quantification and reporting using higher tiers remains a complicated challenge and the identification of an advanced tool to simulate the net balance and potential of GHGs and SOC for mitigation, offsetting and policy formulation is a global concern. We tested the Denitrification-Decomposition (DNDC95) model, a process-based model, to simulate both N_2O emissions and SOC density (SOCρ), and their annual changes in soil under moist temperate grass silage managed with inorganic and organic fertilizers over 45 years. The model performed well for urea, cattle slurry and pig slurry applied at variable rates with N_2O emission factors (EFs) of 0.35±0.02, 1.80±0.28 and 1.53±0.41%, respectively, which are close to national and IPCC estimates. The measured data for SOCρ at a 0-15 cm depth for unfertilized and urea-fertilized fields (73-77 t-C-ha^{-1}) were significantly higher than the simulated ones (54-55). However, the model-estimates showed good agreement with the measured values (R^2=0.66), and revealed increased C sequestration with increasing added-C (0.46±0.06 vs. 0.37±0.01 t-C-ha^{-1}-yr^{-1}). Variations in the derived-EFs and simulated-SOCρ could be explained mainly by differences in nitrogen inputs (49%) and added-C (62%), respectively, where the impact of rainfall (15-16%) and temperature (10-11%) was identical. Commonly, N_2O EFs and SOCρ were sensitive to soil texture, pH, bulk density and organic carbon (R^2=0.77-0.99) but ΔSOCρ decreased with the latter two (R^2=-0.99). Strategic replacement of slurry either after the second or third silage cuts by urea decreased N_2O EFs significantly and autumn applications of slurry resulted in more C being sequesteredThese findings show that DNDC95 could provide an accurate representation of the key drivers influencing both N_2O fluxes and SOCρ.

Keywords: DNDC model, Greenhouse gas, SOC density, Sensitivity analysis, Grass silage.

Hazard assessment of pasture soil fertility from an objective and probabilistic approach. (F-4)

Moral Francisco J.[1,*], Francisco J. Rebollo[2], and Joao M. Serrano[3]

*[1]Departamento de Expresión Gráfica, Escuela de Ingenierías Industriales, Universidad de Extremadura, Badajoz, Spain. [2]Departamento de Expresión Gráfica, Escuela de Ingenierías Agrarias, Universidad de Extremadura, Badajoz, Spain. [3]Departamento de Engenharia Rural, Instituto de Ciências Agrárias e Ambientais Mediterrânicas (ICAAM), Escola de Ciências e Tecnologia, Universidade de Évora, Portugal. *Corresponding author: fjmoral@unex.es*

Although different algorithms have been used to delineate areas with similar properties (e.g., texture or levels of macronutrients) within agricultural fields, there are few applications in pasture systems. A new approach based on the formulation of an objective and probabilistic model, the Rasch model, integrates a number of key soil properties, providing measures of pasture soil fertility that can be used to analyse spatial pattern in the field. To illustrate the proposed approach, a study was performed in a pasture field. The study comprised 76 soil samples of different sampling locations along a gradient of soil fertility, in a depth range of 0–0.30 m, considering the maximum

depth of the roots in the pasture, approximately 0.2–0.3 m. Samples were analysed for ten key soil properties: sand, silt, and clay contents, moisture content, pH, organic matter, nitrogen, phosphorus, potassium, and soil apparent electrical conductivity. These data were processed according to the Rasch model and, as the main results, all sampling locations were classified according to their soil fertility, as the Rasch measure, and it was highlighted the influence of each soil property on the pasture soil fertility. Thereafter, a geostatistical algorithm was used to generate probability maps in order to delineate management zones. Doing so, we could identify zones where inputs might be changed (e.g., decrease of inputs in less fertile and less productive areas) and where input costs (e.g., chemical substances) can be minimised, allowing to obtain more cost-effective field management, which additionally provides environmental, economic, and energetic benefits.

Keywords: *Management zones, Soil fertility, Rasch model, Kriging.*

The agrophysical properties of soils as the basis of soil protection agriculture (based on the example of the Braslaŭ region of the Republic of Belarus) (F-5)

Tsyrybka Viktar*, Hanna Ustsinava and Ilya Lahachou

*RUE Institute for soil science and agrochemistry, Minsk, Belarus.*Corresponding author: m029@yandex.by*

The introduction of soil-protective farming systems provides for spatial accounting of natural conditions that limit agricultural activities. Soil conditions of agrolandscapes, presented by the parameters of soils' physical properties, is an important justification for land use design. Objects of the research are the soils of agricultural land in the Braslaŭ region. This region is characterized by diversity and complexity of landscapes. Slopes with steepness of more than 5° predominate on arable land, which leads to widespread erosion process. Bulk density is the main indicator for the physical condition. Intervals of values have been developed to illustrate the need for the introduction of soil-protective farming systems, on the basis of which three groups of agricultural land have been identified: 1 – not requiring changes in land use, 2 – it is desirable to introduce soil-protective measures, 3 – it is critically necessary to introduce soil-protective land use. The latter attribute to approximately 20%, and since the main negative factor affecting the soil cover is erosion, the first step of soil protection measures is the anti-erosion organization of the territory. This includes assessment of all soils according to the degree of erosion hazard. Taking into account the complexity of calculating potential soil erosion using the proposed approach to soil-protective organization of agriculture can be useful in agroecological grouping of lands. Some groups are set for pasture, others for cultivating crops using certain soil protection measures, and for some, special measures are not required. Automated processing of data on agrophysical conditions, performed on the example of the Braslaŭ region, provides the creation of cartographic materials reflecting the state of the soil cover taking into account the actual anthropogenic influence, to justify the differentiation of soil-protective farming systems. The results obtained indicate the generally unfavorable agrophysical conditions of land use in the Braslaŭ region, as the density values are at their allowable maximum.

Keywords: Bulk density, Erosion, Modelling, Agriculture, Braslaŭ.

Scaling out sustainable land use systems in Colombia: Some insights and implications from two regional case studies (F-6)

Del Río Duque Martha L.[1*], Michelle Bonatti[1, 2], Katharina Löhr[1, 3], Marcos Lana[4], Tatiana Rodríguez[1], Stefan Sieber[1, 2]

*[1]Leibniz Centre for Agricultural Landscape Research (ZALF), Sustainable Land Use in Developing Countries (SusLAND), Müncheberg, Germany; [2]Humboldt Universität zu Berlin, Agricultural Economics, Berlin, Germany; [3]Humboldt Universität zu Berlin, Urban Plant Ecophysiology, Berlin, Germany; [4]Swedish University of Agricultural Sciences, Department of Crop Production Ecology, Uppsala, Sweden. *Corresponding author: delrio@zalf.de*

Nowadays, most agricultural practices can reduce the ability of ecosystems to provide goods and services. To enhance environmentally friendly food production and to maximize social and economic benefits, sustainable land use systems (SLUS) are one of the most critical strategies increasingly/strongly promoted by donor organizations, international agencies, and policymakers. As SLUS are context-specific strategies, diffusion and replication of successful SLUS in cocoa and livestock sector within peacebuilding territories in Colombia, specifically, in Cesar and Caqueta region required the identification of main factors that facilitate this scaling out process. These two regions are contrasting, but both have a current trend of increasing land degradation. Presently in Colombia, Caqueta is one of the most deforested departments, and Cesar has some of the most degraded soils. Following a qualitative research approach, 19 semi-structured interviews and 2 focus groups were conducted with agroforestry experts in both regions to analyze (1) what does it mean a sustainable land use system in Cocoa/Livestock sector, specifically in Caqueta or Cesar and (2) to identify the key elements at the level of the following dimensions: biophysical, economic and profitability, market, social, policy and institutions that can explain how and why SLUS are replicated and spread among more producers. The interviews were coded and analyzed using MAXQDA to identify, analyze and report patterns (themes) within data. As the results show, key themes, among which: premium markets, solid regional markets and price stability, water availability and management, generational renewal, land use knowledge and diversification, producer organization and certifications are crucial to understand how the SLUS can have an impact across large-scale landscapes and how the scaling out process can be set up best in order to be successful across different contexts. The analysis further reveals which key factors might affect SLUS efficiency.

Keywords: Agroforestry**,** Colombia**,** Cocoa growing, Livestock farming, Sustainable agriculture.

Evolution of grazing practices in Belgian dairy farms: Results of two surveys (F-7)

Lessire Françoise[1*] and Isabelle Dufrasne[12]

[1] Centre des Technologies Agronomiques, rue de la Charmille, 16, 4577 Strée, Belgium; [2] Department of Veterinary Management of Animal Resources, Faculty of Veterinary Medicine, University of Liege, 4000 Liège, Belgium. **Corresponding author: flessire@cta-stree.be*

Grassland preservation is widely recognized as crucial to mitigate greenhouse gas emissions of the agricultural sector. Indeed, grasslands potentially store carbon in the soil. However, this potential depends on several factors, including the type of grasslands and the importance of human management. For example, soil carbon storage was estimated at 90t carbon/ha in high altitude pastures and at less than 45t C/ha in land under annual crops (Soussana et al., 2004). Grazing

can have both positive and negative impacts. However, in a well-managed grazing, the negative impact (i.e., removal of C by cows' eating) and the positive aspect (i.e., increase in soil C by plant growth) are balanced (Soussana et al., 2004). In this background, we organized, in dairy farms of Southern Belgium, 2 surveys (2016 – 2019) aiming to describe grazing practices and their evolution in a context of farm intensification. Following these surveys, around 96.5% of lactating dairy cows grazed in Wallonia. However, grazed grass % in cows' ration was about 43%, due to high complementation. Perceptions of farmers on grazing were questioned regarding several topics. More than 90% and 80% of farmers considered that grazing had a positive impact on animal welfare and landscape conservation, respectively. The opinion was less consensual regarding the effect on environment, with only 76.6% recognizing a positive impact. In 2019, the climatic factors complicated grazing management, so that about 50% of non-grazing farmers cited them as a reason for stopping. On the contrary, the requirements of the dairy industry and authorities were incentives to keep grazing, with a marked interest in the promotion of a label with 83% of farmers interested. Only 11.4% farmers expected to decrease or stop grazing. These results seem indicate that grazing could be maintained with the involvement of farmers stimulated by authorities and stakeholders.

Keywords: Grassland, Grazing, Dairy, Agriculture, Belgium.

References

Soussana, J.-F.; Loiseau, P.; Vuichard, N.; Ceschia, E.; Balesdent, J.; Chevallier, T.; Arrouays, D. Carbon cycling and sequestration opportunities in temperate grasslands. *Soil Use Manag.* **2004**, *20*, 219–230.

Management zones delineation on grazed permanent pastures using low cost geophysical surveys (F-8)

Moral Francisco J.[1,*], Francisco J. Rebollo[2], and Joao M. Serrano[3]

[1]Departamento de Expresión Gráfica, Escuela de Ingenierías Industriales, Universidad de Extremadura, Badajoz, Spain. [2]Departamento de Expresión Gráfica, Escuela de Ingenierías Agrarias, Universidad de Extremadura, Badajoz, Spain. [3]Departamento de Engenharia Rural, Instituto de Ciências Agrárias e Ambientais Mediterrânicas (ICAAM), Escola de Ciências e Tecnologia, Universidade de Évora, Portugal. Corresponding author: fjmoral@unex.es

Spatial variability of soils used for grass-based livestock production is as high as soils used for agricultural production. Thus, site-specific management (e.g., fertilisation or grazing intensity) might be implemented after assessing the spatial distributions of the main soil properties (e.g., texture and macronutrients). However, to do so, cheap and reliable techniques are needed to delineate zones of similar production potential in order to improve profitability of low-income farms. In this sense, the use of soil apparent electrical conductivity (ECa) measurements from a contact sensor is one of the most promising approaches. ECa technique was evaluated for a grassland site (2.3 ha) in Évora (Portugal), where important soil properties, such as clay, silt and content, cation change capacity, organic matter and macronutrients content, related to soil fertility and topography were known. For comparison, 10 soil samples were taken throughout the field at different sites, in a depth range of 0–0.30 m, considering the maximum depth of the roots in the pasture, approximately 0.2–0.3 m. Analyses showed that ECa results as independent variable, were significantly correlated to some of the main soil variables, allowing to visualise the spatial distributions in a geographical information system (GIS). Moreover, the delineation of management zones through a clustering algorithm revealed, after a principal component analysis, that the most important contributing properties to soil variability were elevation and clay content. Accordingly, the proposed approach, using a low-cost ECa surveys, can be used to implement precision farming

for permanent pastures. This may allow to apply more cost-effective field management and additional environmental, economic, and energetic benefits.

Keywords: Site-specific management, Contact sensor, Soil apparent electrical conductivity, Montado or Dehesa ecosystems.

Impact of increasing the time interval between manure application and the first rainstorm event on phosphorus concentrations in runoff

(F-9)

Sharon M. O'Rourke[1]*, Robert H. Foy[2], Catherine J. Watson[2], Suzanne Higgins[2] & Peter A. Vadas[3]

*[1]UCD School of Biosystems & Food Engineering, University College Dublin, Dublin 4, Ireland. [2]Sustainable Agri-Food Sciences Division, Agri-Food & Biosciences Institute, Belfast, Northern Ireland. [3]Agricultural Research Service, U.S. Department of Agriculture, Wisconsin, USA.*Corresponding author: sharon.orourke1@ucd.ie*

In Northern Ireland manure phosphorus (P) losses to surface water bodies need careful management in the context of soil P surpluses and changing patterns in rainfall. This requires climate-smart P management measures. Increasing the time interval between manure application and the first rainstorm event is a known practice to reduce P loss in runoff. However, the risk period for elevated P concentrations in runoff can extend for weeks after manure is spread. This study investigated the impact of increasing the time interval between manure application and the first rainstorm event on P concentrations in runoff. Simulated rainfall (40 mm hr^{-1}) was applied at 2, 4, 10, 18, 30 and 49 days after dairy manure was surface applied to a grassland sward. Increasing time to runoff resulted in a stepwise decrease in dissolved reactive P concentrations from 5.0 to 1.0 mg P L^{-1} and a P signal in runoff for 18 days. Beyond 18 days, elevated P concentrations were observed in runoff collected from natural rainfall that preceded the day 49 rainstorm event. The SurPhos model (Surface phosphorus and runoff model) was used to understand the manure P dynamics controlling P interaction with runoff. The model predicted dissolved reactive P well (R^2 0.89) and was unaffected by adding natural runoff as a model input. The SurPhos model demonstrated that manure P mineralisation was occurring during the experimental period, most evident when the soil began to dry, which resulted in a small spike in P concentrations beyond the defined risk period. This study shows that the experimental data has the potential to be extrapolated for different weather scenarios using SurPhos and could add value by testing when and where manure P could be most safely spread to grassland in Northern Ireland.

Keywords: Manure, Phosphorus, Runoff, SurPhos model.

LIFE AgriAdapt Webtool for Sustainable Adaptation of European Agriculture to Climate Change (F-9a)

Wackerhagen Carolina[1*], Ragnar Leming[2], Nicolas Métayer[3], Patrick Trötschler[1] and Vanessa Sánchez[4]

*[1]Lake Constance Foundation, Radolfzell, Germany, [2] Estonian University of Life Sciences, Tartu, Estonia, [3]Solagro, Toulouse, France, [4]Fundación Global Nature, Las Rozas de Madrid, Spain. * carolina.wackerhagen@bodensee-stiftung.org*

The partners of the LIFE AgriAdapt project have developed a methodology to assess the climate risk at farm level using past weather data and climate projections (by Agri4Cast). This methodology was tested on 126 pilot farms across Europe. Essential parts of this methodology and the main monitoring results of the 126 pilot have been made accessible with the development of AWA - the AgriAdapt Webtool for Adaptation. AWA offers three successive modules to strengthen the agroclimatic knowledge of the users and to support their decisions towards a more resilient agriculture. Information Module - FARM VULNERABILITY AND ADAPTATION QUIZ: With thirty questions, the users will be able to test their knowledge of climate change, agricultural impacts of the climate on different agricultural productions and possible adaptation measures at farm scale. Data Module - YIELD & CLIMATE (OBSERVATIONS AND PROJECTIONS): This module consists of a map entry proposing the consultation of agronomic (yields) and climatic (observations and projections) data for different geographic locations throughout Europe. For each grid point, a compilation of annual yields from different crops (2000-2017) first shows the yield variability. Then, the description of the past climate (observations 1987-2016) is presented for several variables: temperature, precipitation, number of days of freezing, etc. Finally, climate projections illustrate in the form of 10 graphs the climate changes for the near future period (2017-2046), then supplemented by 19 agroclimatic indicators specific to arable crops, fodder, animals, vineyards and orchards. Measures Module - SUSTAINABLE ADAPTATION MEASURES: This module is devoted to sustainable adaptation measures at farm scale. For all 3 agricultural systems studied, sustainable adaptation measures are classified according to 4 components of farm vulnerability. The proposed measures are distinguished according to the possibility of implementation in the short, medium or long term – and they specific to each of the 4 climate zones proposed (South, Atlantic, Continental, North).

Keywords: Sustainable Adaptation, Vulnerability assessment at farm level, Agro-climatic indicators, Farm vulnerability components, Interactive webtool for Europe

Theme 2: Agrometeorology

Keynote presentation

Establishing a national soil moisture monitoring network for the UK – the good, the bad and the completely unexpected (K-2)

Boorman David B.*

*United Kingdom Centre for Ecology and Hydrology (UKCEH).*Corresponding author: dbb@ceh.ac.uk*

Since 2013 a new soil moisture monitoring network has been established in the UK and now comprises 49 sites. The Cosmic-ray Soil Moisture Observing System UK (COSMOS-UK) exploits the cosmic-ray neutron sensor (CRNS) to derive soil moisture over an area of up to 12 hectares and to a depth of up to 70cm. Soil moisture data at this scale have the potential to support many scientific and business applications. The journey from conception through implementation to delivery has been challenging, with many technical, logistical and financial problems to overcome, and yet ultimately rewarding as more users access the data. To enhance the usefulness of the soil moisture data, each COSMOS-UK site in equipped with a range of other instruments that provide associated soil and hydrometeorological information. The majority of these data are available at 30-minute resolution. With time, additional derived data have been added including snow water equivalent and potential evaporation. As well as the numerical data, a pair of wide-angle lens cameras provide a photographic record of the landscape and weather. In addition to describing the COSMOS-UK instrumentation and data, the presentation will recall the highs and lows of implementation, the key factors that led to the success of COSMOS-UK, and therefore the lessons that other starting out on a similar journey may wish to embrace.

Keywords: Soil moisture, Cosmic-rays, COSMOS-UK, United Kingdom.

Session I: Oral presentations

Measuring nitrous oxide fluxes with a mobile eddy covariance system: First results across three Swiss croplands (O-9)

Regine Maier[1]*, Lukas Hörtnagl[1], Markus Staudinger[1], Valentin H Klaus[1], and Nina Buchmann[1]

[1]*Department of Environmental Systems Science, ETH Zürich, Switzerland. *Corresponding author: regine.maier@usys.ethz.ch*

The intensive use of fertilizers in agriculture is one of the main reasons for the observed increase in nitrous oxide (N_2O) concentrations in the atmosphere. Thus, quantification and understanding of diel and seasonal N_2O fluxes are of major interest to develop strategies for sustainable agricultural practices. However, continuous high-resolution measurements from croplands at ecosystem scale are still scarce and often limited to a single site. Our main objective was to quantify the exchange of N_2O between soil and atmosphere across three croplands in Switzerland

using a mobile eddy covariance system. In early summer 2018, we set up the mobile system equipped with a sonic anemometer, an infrared gas analyser and a N_2O laser spectrometer (LGR), providing continuous flux measurements recorded at 20 Hz at the long-term research site in Oensingen (FLUXNET CH-Oe2; Switzerland). In spring 2019, we moved the mobile system for several months to two additional sites. With this, we covered a complete growing season of peas including several management activities i.e. fertilization, sowing and harvest, followed by fallow.Overall, our results show that during crop growth across all cropland sites N_2O fluxes are very low compared to periods without vegetation on the field. At CH-Oe2, approximately 1.39 kg N_2O-N ha^{-1} and 1.43 kg N_2O-N ha^{-1} were lost to the atmosphere during fallow in 2018 (91 days) and 2019 (77 days), respectively. N_2O fluxes during pea growing season in spring 2019 were dominated by a single peak event over four days resulting in nitrogen losses of approximately 1 kg N_2O-N. The occurrence of such peak events was mainly driven by a combination of simultaneous increases in soil temperature and soil water content. We conclude that sustainable agriculture needs to consider environmental conditions during management events and should avoid fallow periods by using cover crops to reduce N_2O emissions.

Keywords: Eddy covariance, Greenhouse gas, sustainable agriculture, Switzerland

Dryland Agrivoltaics: Co-locating food and renewable energy production creates a climate-resilient agri-environmental system for maximizing food production and water savings (O-10)

Barron-Gafford Greg[1,*], Alyssa Salazar[1], Isaiah Barnet-Moreno[1], Moses Thompson[1, 2], Blue Baldwin[2], Patrick Murphy[1] and Jordan Macknick[3]

*[1]University of Arizona, USA; [2]Tucson Unified School District, USA; [3]U.S. Department of Energy National Renewable Energy Laboratory. *Corresponding author: gregbg@email.arizona.edu*

The vulnerabilities of our food, energy, and water systems to projected climatic change make building resilience in renewable energy and food production under an increasingly stressful climate a fundamental challenge. We investigate a climate-resilient agri-environmental system to solve this problem within dryland environments by creating a hybrid of co-located agriculture and solar photovoltaic (PV) infrastructure to maximize agricultural and energy production, all while reducing demand for irrigative waters and the greenhouse gas (GHG) emissions related to energy use. We take an integrative approach - monitoring microclimatic conditions, PV panel temperature, soil moisture and irrigation water use, plant ecophysiological function, and plant biomass production within this “agrivoltaics” ecosystem compared to traditional agricultural settings (control plots) - to quantify synergies and tradeoffs associated with the systems involved in this arrangement. We find that shading by the overstory PV panels provides multiple additive and synergistic benefits. In terms of water, levels of soil moisture remained higher after each irrigation or rain event within soils under the agrivoltaics installation than the traditional agricultural setting, indicating that less irrigation is required to maintain adequate moisture conditions for food production. As a result, we find reduced drought stresses on photosynthetic capacity, daily carbon uptake and sequestration from the atmosphere, and water use efficiency in plants grown within an agrivoltaics system. Ultimately, we have found efficient food production in the agrivoltaic installations relative to the control plants – a clear climate-resilient adaptation. Combined with localized cooling of the PV panels resulting from the transpiration from the vegetative “understory”, which reduces heat stress on the panels and boosts their performance, we are discovering a win-win-win at the food-water-energy nexus.

Keywords: Water-saving, Eco-engineering, Drought resilience.

Vegetation response to local surface-atmosphere feedbacks during 2018 summer heatwaves and droughts in Ireland (O-11)

Ishola Kazeem A.[1,2*], Reamonn M. Fealy[2], Gerald Mills[3] and Rowan Fealy[1]

[1]Irish Climate Analysis and Research Units, Maynooth University; [2]Teagasc AgriFood Research Center, Ashtown, Dublin; [3]Department of Geography, University College Dublin. Corresponding author: kazeem.ishola.2018@mumail.ie

The combined occurrence of heatwaves and droughts is a critical weather phenomenon that poses major threats to agriculture, water resources and socio-economic wellbeing of an area. Due to the projected rise in such extreme weather events associated with climate change, it is pertinent to understand how the conditions regulate local ecosystem-atmosphere feedback processes. This study employs a land surface parameterization scheme to quantify land-atmosphere feedbacks during hot summer (from May to August) of 2018. The land surface scheme is forced by routine weather observations and soil metadata from ten independent synoptic stations at hourly timescale. Copernicus Global Land Service (CGLS) satellite-derived Soil Water Index (SWI) and Leaf Area Index (LAI) were also employed to analyse how changes in surface flux densities induced changes in natural physical environment in Ireland. Relative to the reference periods of 1999 – 2017 for CGLS LAI and 2008 – 2017 for SWI, the study highlights strong negative perturbations of satellite-derived soil moisture and vegetation greening for 2018 June and July spreading mostly to the South, Midlands and East. This coincides with the locations and periods of positive anomalies in surface energy exchange and a substantial precipitation deficit. The knowledge of environmental control on surface energy partitioning is essential to monitor vegetation response under severe weather conditions. The study further analyse and discuss how the surface energy exchange under different environmental stress scenarios impact vegetation during this event.

***Keywords*:** Heatwaves; Droughts; Surface energy exchange; Vegetation.

Assessing the impact of seasonal weather extremes on farm feed use in Irish dairy farms (O-12)

Logakrishnan Mohana P.[1,2,*], Stuart Green[1], Tamara Hochstrasser[2,3] and Reamonn Fealy[1]

*[1] Agrifood Business and Spatial Analysis, Teagasc, Ashtown, Dublin-15, Ireland; [2] School of Biology and Environmental Science, University College Dublin,Dublin-4,Ireland; [3] Earth Institute, University College Dublin, Dublin 4, Ireland. *Corresponding author: mohana.logakrishna@ucd.ie*

Grass productivity is a key to farm profitability in Irish livestock farms. The increase in the frequency of weather extremes in recent years is a considerable threat to pasture production, and thus to farm competitiveness and animal performance. This research aims to understand and quantify the relationship between variations in supplementary feed usage in response to seasonal weather extremes on Irish dairy farms. Understanding the impacts of extreme weather on farm costs will help to adapt to climate change. We used the National Farm Survey (NFS) and meteorological data (MERA) in a geographic panel analysis for the period 2001-2015. The result of the panel fixed effect model reveals that weather alone explains less than 10% in the variation of concentrate feed usage on Irish dairy farms. Nevertheless, we found that for every very cold day in a spring month (< 5th percentile of the minimum temperature of that month), the concentrate feed use increases by 8.76 kg/Livestock Unit (LU), which is equivalent to 438kgs for a farm of 50 cows. For every very warm day in spring, the concentrates feed use goes down by 6 kg/LU. Besides that, the previous

year's summer and autumn weather conditions play a significant role in influencing the concentrate use. This is significant as the purchase of concentrate feed on Irish dairy farms constitutes 37% of direct farm costs. However, the results of the panel fixed effect bulky feed model show that neither the previous summer nor current spring weather has an effect on bulky feed purchase. These explanatory models can be expanded to develop a forecast model to quantify and anticipate the fodder needs for the national herd, thus allowing better preparation for fodder shortages as a result of extreme weather and development of more robust spatio-sectoral farming strategies to adapt to weather variations.

Keywords: Extreme weather, Panel Model, MERA data, National Farm Survey (NFS), Farm profitability, Climate change adaptation.

Weatherproofing for a smarter, resilient and more sustainable agri-sector (O-14)

Raymond Joanna[1]*, Stephen Dorling[1], Andrew Lovett[1], Ian Mackay[2], Haidee Philpott[3] and Steven Penfield[4]

*[1] School of Environmental Sciences, University of East Anglia, Norwich, UK; [2]IMplant Consultancy, 14 Queens Road, Chelmsford, UK; [3]National Institute for Agricultural Botany, Huntingdon Road, Cambridge, UK; [4]John Innes Centre, Norwich Research Park, Norwich, UK. *Corresponding author: joanna.raymond@uea.ac.uk*

Over the last 1-2 decades, the UK has been one of many countries observing plateaus in key crop yields, despite farming practice innovations such as the adoption of precision agriculture and advanced plant breeding programmes. The agricultural industry also continues to witness strong yield impacts arising from inter-annual weather variability. Evidently, identification and development of climate-resilient crop varieties is a key priority. We are quantifying the specific impact of weather variability on wheat, sugar beet and oilseed rape production with a focus on process understanding through crop modelling. Given that the UK imports almost half of its food each year, our focus extends to international supply chains. We present examples of the development of 'best in class' historical time-series records of key agro-meteorological variables by inter-comparing and combining different types of in-situ and remotely sensed observational and re-analysis products (including MÉRA). We will showcase early findings of the added value of applying these datasets to the (a) modelling of UK crop yield, (b) interpretation of inter-annual crop production data, and (c) production of long-term UK agro-climatological averages, such as drilling dates.

Keywords: Agroclimate, Modelling, Climate variability.

Wicked problems and extreme weather: changing perspectives for nutrient pollution management (O-15)

Mellander Per-Erik[1,*] and Philip Jordan[2]

[1]Teagasc, Ireland; [2]Ulster University, UK. Corresponding author: Per-Erik.Mellander@teagasc.ie

Assessments of current weather extremes are useful to better understand future challenges to water management. For example, as important agricultural nutrients can cause water quality pollution (a wicked problem for resource management) a more detailed appraisal is required due to connections with hydrological processes. The Teagasc Agricultural Catchments Programme provides this detail by monitoring hydro-chemometrics at sub-hourly timescales in six ca. 10 km2 intensively farmed catchments. Ten years of river monitoring have coincided with oceanic-scale weather changes and captured a number of weather extremes. This was particularly clear in 2018, when Ireland experienced a series of extreme weather events. The influence of large-scale weather shifts on nitrogen (N) and phosphorus (P) loss was identified and quantified using concentration-discharge analyses on time-series data. Furthermore, examples of how short-term extremes could offset the baseline conditions for both N and P loss were assessed. Catchments with different physical settings responded differently. For example, one catchment with mostly arable land on well-drained soils, which is generally “N loss risky”, was exposed to a large autumn rain event when soils were already saturated. This resulted in a loss of 0.406 kg total P/ha over two days (more than the annual average total P loss). Another catchment with mostly grassland on poorly drained soils, which is generally “P loss risky”, reached its highest nitrate-N concentrations (13.6 mg/l) during autumn recharge after a summer drought (annual average 2.6 mg/l). In November that year the nitrate-N loss was 6.6 kg/ha higher than normal (54% of annual average). The drought also emphasised local point source activities during low flows. To facilitate targeted mitigation measures, and an adaption for future climate conditions, we need a clearer understanding of how future weather may influence nutrient loss in the agricultural landscape. This will help to reshape the thinking on future nutrient management.

Keywords: Water-quality, Nutrients, Weather, Agriculture, Catchments.

Water footprint as a sustainability indicator for table and wine grape production (O-16)

Jarmain Caren*, Eunice Avenant, Adriaan Van Niekerk, Pascalina Mohlotsane, Henry Jordaan, Carlos Poblete-Echeverría and Garth Stephenson

*Stellenbosch University, South Africa; University of the Free State, South Africa. *Corresponding author: cjarmain@gmail.com*

In recent years, the available water resources in the Western Cape (WC) Province of South Africa (SA) have been severely constrained due to below-average rainfall, resulting in an extensive and prolonged drought. This ongoing pressure on water initiated renewed discussions on the sustainable and efficient use of water for crop production, as well as the crop water footprint (WF) as an indicator of sustainable water use. The WF provides a measure of the amount of water used to produce crops, goods or services. It can be expressed in different ways, for example, a litre of water used per kg of crop produced (L/kg), or litre of water used to produce a litre of wine (L/L). The WF considers both direct and indirect water uses needed to produce a crop or product and are often expressed in its colour components: green, blue and grey. Given the importance of the

available water resources and its use in the production of table grapes and wine in SA, the WF of wine and table grapes produced in SA was studied as an indicator of sustainability. The WF assessment was done for selected case studies in three important production regions. Large spatial datasets on crop water use, large production databases and lookup tables were successfully used in the WF calculations. The study illustrated how large numbers of field level WF estimates can be integrated into a final product WF estimate, capturing production and WFs variation related to a production unit (like a packhouse or cellar). The research highlighted the complexities of investigating the WF of extensive areas involving 1000s of field records and explains why many WF studies often focus on single fields. The WF results for the 2018–19 season provide a basis for future WF assessments of SA table grape and wine production.

***Keywords**:* Water footprint, Sustainability indicator, Remote sensing, Table grapes, Wine, South Africa.

Session II: Flash talks

Do climate change impacts and adaptation modify the potential for agricultural intensification? (F-10)

Minoli Sara*, Femke Lutz and Christoph Müller

*Potsdam Institute for Climate Impact Research, Germany. *Corresponding author: sara.minoli@pik-potsdam.de*

Global food demand is expected to strongly rise in future decades, pushing farming systems to increase their crop productivity. Increasing total crop production by further expanding cropland is not seen as a viable option as land availability for cultivation is becoming scarce. Instead, enhancing productivity per unit of land through intensification is a widely proposed strategy to meet future crop demands, because yields in many world regions are much below their potential. This is mainly a consequence of deficits in soil water and macro-nutrients. Agricultural management (e.g. irrigation, nitrogen fertilization) could thus be employed for increasing yields. Yet, the rapid changes in atmospheric composition (CO2) and climate (temperature and precipitation) are also modifying the environmental conditions of global agricultural systems, resulting in variable effects on crop yields and demanding for adaptation strategies. Recent findings indicate that relatively simple adaptive management (e.g. sowing dates, cultivars) could partially compensate for negative impacts of climate change on yields and aid exploiting the benefits due to e.g. CO2 fertilization. Overall, climate change is expected to modify yields of future cropping systems, but how this could affect their intensification potential remains unexplored. Here we use a global gridded crop model (LPJmL) to study climate change impacts and adaptation of major crops under different management intensities. First, we estimate yields under present-day management and their intensification potential, by varying individual management inputs. We analyze how current intensification potentials would be impacted under future climate, if there was no change in agricultural management. In a second step, we test the effect of adaptation strategies by adjusting crop growing periods under climate change and whether these affect global patterns of intensification potential. The results will help identifying, across the different world regions, which strategically should be prioritized between intensification and adaptation, in order to increase global crop production.

Keywords: Intensification, Adaptation, Global scale, Crop modelling.

A science-based policy response to predicted climate change in the Falkland Islands (52°S) (F-11)

McAdam Jim[1*] Steffi Carter[2], Ann Jungblut[3], Chris Evans[4], Matt Aitkenhead[5], Sergio Radic[6] and Matt McNee[7]

*[1]School of Biological Sciences, Queen's University of Belfast, Belfast BT71NN, Northern Ireland [2]South Atlantic Environmental Research Institute [3]Natural History Museum [4] Centre for Ecology and Hydrology; [5]James Hutton Institute; [6]University of Magallanes; [7]Department of Agriculture, Falkland Islands.*Corresponding author: jim.mcadam100@outlook.com*

Small oceanic islands are particularly vulnerable to climate change given their isolation, biodiversity and self -reliance. Although the Falkland Islands (52°S, population 3000) are relatively small (12,000km^2 , around 90% of the land area of Northern Ireland) they are an important peatland resource, but given the dry (400-800mm), windy climate and shallow soil cover, are susceptible to erosion and loss of soil carbon. Climate change predictions for the Falklands-warmer and drier summers leading to increased soil moisture deficit- pose a significant threat to the sustainability of peat cover in the archipelago. This could be exacerbated by land-use activities, notably sheep grazing. The Falkland Islands Government's prioritised climate change mitigation action plan considers soil erosion, soil carbon content vulnerability and climate change assessments at policy level as having high to medium priorities. The islands already invest heavily in renewable energy technologies (nationally over 50% of energy is generated from wind) and all renewable resources (wind, sun, rainfall) are mapped for incorporation into business plans for individual settlements to select best possible options. Changing national livestock farming strategies are reducing Green House Gas emissions. To support these mitigation policies a baseline survey of the peatlands to quantify erosion extent/risk is being carried out and the results will be conveyed on an online data system to assist policy makers, conservation officers and land managers in deciding which actions are needed for long term mitigation measures against climate change effects. We propose that the Falkland Islands are an exemplar of climate change risk assessment and potential adoption into a government policy which is underpinned by the best scientific evidence available to mitigate impacts across a range of scenarios. Although relatively small in area, the Falklands is recognising its global obligations to climate change mitigation by adopting best evidence-based mitigation and adaptation practice.

Keywords: Peatlands, Evidence-based policy, Peatland resource mapping; Small-island state.

Analysis of meteorological variables and the vegetation index in vine cultivation: Adaptation and trend in the context of climate change (F-13)

Guisado Fulgencio H.[1*], Abelardo G. Martín[1], Carina de N. Barcelos[2], Adélia O. de Sousa[2] and José R.M. da Silva[2]

*[1]Engineering Department of the Agronomic and Forestry Environment (Agricultural Engineering School); Extremadura University, Badajoz, Spain; [2] Departament of Agricultural Engineering, School of Sciencie and Tecnology; Institute of Mediterranean Agricultural and Enviromental Sciencies (ICAAM) University of Évora, Évora, Portugal. *Corresponding author: fhguisado@unex.es*

The present research was carried out in Extremadura, a region located in the southwest of Spain, with the largest grapevine growing area in the southwest Iberian Peninsula, 86,361 ha. In this region, the largest concentration of vineyards, 40,680 ha, are in Tierra de Barros area. Most of the

cultivated area was managed in rainfed conditions, being very affected by changing climatic variables, such as temperature and precipitation, with great influence on grape production and wine quality, causing a high variability between years. Remote sensing has allowed satellite monitoring of crops. Among the tools available for the satellite, crop indices have shown the most interest in recent years. The normalized difference vegetation index (NDVI) has been proposed as an indicator of the adaptation of crops to climatic conditions, expressing the vigor of them and therefore is an integrator of the effects of climate on crops. Through the measurements of the NDVI (2000-2018) of two vine varieties in a traditional dry farming area in Extremadura, the evolution of the index and its relationship with climatic variables was analyzed. To determine monotonic trend, the Mann-Kendal test and the Senst slope estimator were used and to obtain correlation between variables the Pearson test was used. The results indicated that the NDVI showed a significant tendency towards increases in the value of the index. This increase was different according to the variety. The value of the index was related to rainfall as well as temperatures. So this index is a good indicator to detect the state of the vineyard in the climate change scenario.

Keyword: NDVI, Meteorological variables, Vine, Spain.

Eddy covariance and static chamber nitrous oxide emissions from grassland silage production (F-14)

Murphy Rachael M.[1,2], Karl Richards[2,*], Dominika Krol[2], Amanuel Grebremichael[2], Luis Lopez-Sangil[2], James Rambaud[2], Nicholas Cowan[3], Gary Lanigan[2] and Matthew Saunders[1]

*[1]Department of Botany, Trinity College Dublin, Dublin 2, Ireland; [2]Teagasc Johnstown Castle, Wexford, Ireland; [3]UK Centre for Ecology and Hydrology, Bush Estate, Penicuik, Midlothian, UK. *Corresponding author: karl.richards@teagasc.ie*

Global atmospheric concentrations of nitrous oxide (N_2O) emissions have reached unprecedented levels, increasing at a rate of 0.73 ± 0.3 ppb/yr^{-1} over the last three decades. The primary cause for increases in atmospheric N_2O are from the excessive application of nitrogen (N) fertilizer in agriculture. To date, static chamber (SC) measurements are the most commonly used method for quantifying field scale fluxes of N_2O. More recently, micrometeorological techniques, such as eddy covariance (EC), have become more widely available to quantify ecosystem scale fluxes of N_2O. However, due to the highly variable nature of N_2O (both in time and space), large uncertainties still exist in flux estimations from intensively managed silage pastures. Background flux measurements and measurements following four fertilization events over 2019, of 40, 70, 80 and 40 kg/N/ha^{-1} CAN, were used to compare fluxes measured from both EC and SCs. Bayesian statistics was used to account for the log normal behaviour of the data and to calculate mean values and uncertainty ranges for SC flux measurements. Daily averaged flux measurements from both techniques showed the greatest correlation (R^2 = 0.8) when comparing EC fluxes during the time of chamber closure against SC fluxes (both Bayesian and arithmetic) measured within the footprint of the EC tower. The weakest correlation (R^2 = 0.36) existed when all EC measurements over 24 hrs were compared with SC measurements within the EC footprint calculated by the Bayesian method. Strong, positive correlations between both techniques only existed when considering high flux events (>115 µg m^{-2} hr^{-1}), while lower flux events showed weaker correlations (max R^2 = 0.5 between all EC and all SC both arithmetic and Bayesian means). Our results suggest that EC and SC flux measurements are only comparable for high flux measurements, but these flux values make up only 15% of the dataset.

Keywords: Greenhouse Gases, Eddy covariance, Nitrous oxide, Agriculture, Ireland.

Towards an Irish National Soil Moisture Measurement Network (F-15)

Hochstrasser Tamara [1,2], Klara Finkele[3], Paul Murphy[4,2], Owen Fenton[5], Karl Richards[5], Eve Daly[6], Matthew Saunders[7] and the AGMET group

*[1]UCD School of Biology & Environmental Science, University College Dublin, Dublin 4, Ireland; [2]Earth Institute, University College Dublin, Dublin 4, Ireland; [3]Met Eireann, Glasnevin, Dublin 9, Ireland; [4]UCD School of Agriculture and Food Science, University College Dublin, Dublin 4, Ireland; [5]Teagasc, Environmental Research Centre, Johnstown Castle, Wexford, Ireland; [6]School of Natural Sciences, National University Ireland – Galway, Ireland; [7]Botany Department, Trinity College Dublin, Dublin 2, Ireland. *Corresponding author: tamara.hochstrasser@ucd.ie*

A better scientific understanding of soil moisture dynamics is urgently needed, as the amount of water held in the soil influences a wide range of soil and plant processes, as well as the soil-atmosphere energy balance, affecting weather, plant growth and nutrient uptake, nutrient and carbon dynamics, and greenhouse gas (GHG) emissions. Furthermore, knowledge on soil moisture status can support management in a range of areas: forest fire danger, disease spread, timing of land application of nutrients and other agrichemicals, water resource management (floods and droughts). Such information, and the enhanced decision support tools that could be built on this information, could, therefore, help to address a number of key policy priorities, such as enhanced management practices to reduce nutrient losses to water (EU Nitrates and Water Framework Directives) and soil greenhouse gas emissions (international commitments to mitigate GHG emissions) as well as supporting climate change adaptation. The Agmet group, a working group on agro-meteorology, which comprises researchers from Met Eireann, Teagasc and several universities, is designing an National in situ soil moisture monitoring network to fill the knowledge gap regarding soil moisture dynamics in Ireland and to move towards more accurate measurement-based (rather than modelled) real-time reporting of soil moisture status. It is envisaged that this monitoring network will align with a number of national initiatives to implement long-term ecosystem monitoring such as the ICOS (Integrated Carbon Observation System), which measures greenhouse and other gas fluxes and the National Ecosystem Monitoring Network (NEMN), which monitors air pollution. The poster will present the process of stakeholder consultation that the Agmet group conducted over the course of several months, and the basic principles by which the soil moisture network will be designed and instrumented.

Keywords: Cosmic rays, Nutrient management, Water quality, Extreme weather, Decision support.

Winter chilling trends in the southwest of the Iberian Peninsula for plum tree hybrids under a climate change context. (F-16)

Paniagua Luis L.[1*], Abelardo García-Martín[1], Mª Engracia Guerra Velo[2] and Francisco J Moral García[3]

*[1]Escuela de Ingenierías Agrarias, Universidad de Extremadura, Badajoz, Spain; [2]Departamento de Hortofruticultura, Centro de investigaciones científicas y tecnológicas de Extremadura (CICYTEX), Instituto de investigaciones agrarias finca La Orden, Guadajira, Spain; [3]Escuela de Ingenierías Industriales, Universidad de Extremadura, Badajoz, Spain. *Corresponding author: llpsimon@unex.es*

Under the current scenario of climate change, knowledge of climatic conditions and trends on cultivated crops is essential in fruticulture, given the global warming situation. This study has analysed the trends of the chilling hour (temperatures below 7.2ºC, from November 1 to February

28), for the hybrid plum and apricot tree in the main production areas, located in the southwest of the Iberian Peninsula. Data from the most recent period are necessary to make accurate estimates about the suitability of a given area. The winter chilling requirements of the more interesting hybrid varieties for the area have been compiled and characterised in homogeneous groups. Maximum and minimum temperature daily data (1975-2015) from 9 weather stations, in the study area and its boundaries, were used to perform an analysis with the accumulation of winter chilling hours. Trend analysis for time series was performed using the Mann-Kendall method and its magnitude was estimated with the Sen's slope. Average chilling hours are 724 h/year, ranging from 116 h/year (Lisbon) to 1445 h/year (Ciudad Real), with a mean variation coefficient of 32%. The obtained results have allowed to identify significant decreasing trends in Ciudad Real, Beja, Sevilla, and increasing trends in Huelva, with an average relative change of -14.4 % chilling hours in the period analysed (about 25 hours per decade). These changes have been produced by the significant general increase in both the maximum and minimum temperatures in the winter period. Results imply that it is necessary to make varietal changes in all areas. Fortunately, there are plum varieties whose winter chilling requirements agree with the expected conditions in the near future.

Keywords: Winter chilling, Trends, Hybrids, Iberian Peninsula.

Aridity seasons and climate change in main crop areas of template fruit tree in southwest of Iberian Peninsula (Spain) (F-17)

García-Martín Abelardo[1,*], Luis L. Paniagua[1], Fulgencio Honorio Guisado[1] and Mª Engracia Guerra Velo[2]

*[1]Departamento de Ingeniería del Medio Agronómico y Forestal. Escuela de Ingenierías Agrarias, Universidad de Extremadura. Avda. Adolfo Suárez, s/n. 06007 Badajoz, Spain; [2]Departamento de Hortofruticultura, Centro de investigaciones científicas y tecnológicas de Extremadura (CICYTEX). Instituto de investigaciones agrarias finca La Orden, A-V km 374. 060187 Guadajira, Spain. *Corresponding author: abgarcia@unex.es*

Southwest of Iberian Peninsula is a region with a great climatologically contrast in the North-South direction. Numerous studies indicate that a reduction in precipitation due to climate change is expected in the Mediterranean region, especially in the winter season, which is the rainiest one and generates the soil water reserves for most of the crops. In addition to precipitation, usually temperature is the other variable studied in relation to climate change, and the Mediterranean region is also particularly affected by an increase in temperature, which mainly affects summer crops such as temperate fruit trees. These two variables must be analyzed together, because both affect fruit trees grow. Therefore, in this study we analyze the Martone aridity index throughout the historical series of available climatic data. Using temporal series of climatic data (1961-2017) and selecting representative weather stations, the evolution of the aridity, mean temperature, precipitation and evapotranspiration, has been analyzed, as well as its repercussion in template fruit trees. To determine monotonic trend, the Mann-Kendal test and the Sen´s slope estimator were used. Trends show that the winter and summer seasons are increasingly arid, mainly due to an increase in average temperatures that was especially high in the summer and spring seasons (cultivation period). With regard to precipitation, in general, it tends to decrease although the gradient in locations and seasons is different. It should be noted that winters tend to be warmer and less rainy. Finally, the evolution of aridity in Iberian Peninsula, showed a general increase. These results will greatly influence the cultivation of the fruit trees, being necessary a varietal and techniques adaptation, (planting dates, fertilizer doses, irrigation doses, training systems, etc.).

Keywords: Martone aridity index, Climate Trends, Template fruit tree, Iberian Peninsula.

Seasonal variability of CH_4 uptake by various forest soils - the effect of temperature and precipitation (F-18)

Walkiewicz Anna [1]*, Piotr Bulak[1], Mohammad I. Khalil[2,3] and Bruce Osborne[2]

*[1]Institute of Agrophysics, Polish Academy of Science, Lublin, Poland; [2]University College Dublin, Ireland; [3] Prudence College Dublin, Ireland. *Corresponding author: a.walkiewicz@ipan.lublin.pl*

Land use affects the ability of soils to consume methane (CH_4) and forest soils are usually a sink for atmospheric CH_4. However, it is unclear how global climate will influence this making it worthwhile to examine how CH_4 uptake by forest soils depends on meteorological parameters. To examine this, we carried out field experiments of methane fluxes for 10 different forest types (deciduous, coniferous, and mixed) in Poland. Approximately 2 years (2018, 2019) at a monthly interval, and assessed seasonal variations using the chamber method together with concurrent measurements of basic soil parameters and local meteorological conditions. The average monthly temperature in the studied region ranged from about 20°C (in summer) to about -3.5 and 5.3^{o}C (in winter). The studied years were warm and poor in precipitation, 386 mm and 505 mm in 2018 and 2019, respectively. In addition to the increase in the average annual temperature, climate change also increases the risk of extreme weather events and frequent droughts during the summer season have been more common recent years in the studied region. Despite differences in the ability of different soil types to absorb CH_4, all generally showed a positive correlation between CH_4 flux and temperature. Methane uptake rates showed pronounced seasonal patterns with the highest values in summer. Reductions in soil moisture, due to low precipitation, ranged from about 5% to 30% depending on the soil type and CH_4 fluxes were highest at lower soil moisture levels, and were usually accompanied by higher temperatures. If methane uptake increases with lower soil moisture/higher temperature it could mean that forests will become a larger sink for methane in the future.Research was conducted under the project financed by Polish National Centre for Research and Development within of ERA-NET CO-FUND ERA-GAS Programme (ERA-GAS/I/GHG-MANAGE/01/2018).

Keywords: Forest soil, Temperature, Precipitation, CH_4 uptake, Meteorological parameters

Theme 3: Arable Cropping Systems

Keynote presentation

What does it take to realize sustainable arable cropping systems? (K-3)

Olesen Jørgen E. *

*Aarhus University, Department of Agroecology, Blichers, Tjele, Denmark. *Corresponding/presenting author: jeo@agro.au.dk*

Modern agricultural cropping systems have been successful in providing high productivity, but at the expense of biodiversity loss, soil degradation, water pollution, and greenhouse gases (GHG). This poses a massive challenge since agriculture needs to support greater demands for food and biomass while becoming environmentally benign and being resilient to climate change. To increase productivity while preserving ecosystem services requires a fundamental change to cropping systems as well and introduction of novel technologies for managing these systems. The fundamental requirements of sustainable cropping systems are: 1) Complete soil coverage with vegetation or crop residues throughout the year, 2) As little soil disturbance as possible and avoidance of soil compaction, 3) Building of greater biodiversity in the soil, on the soil surface and in the agricultural landscape, 4) Application of effective technologies to reduce nutrient losses and eliminate chemical pesticide use. Current arable cropping systems are largely based on monocultures and often on a narrow genetic basis. This has resulting negative effects on the functioning of agroecosystems and their ecosystem services. There is thus a need to enhance the species-richness of cropping systems is such a way that this enhances soil biodiversity and improves above- and belowground resource capture, productivity and ecosystem services. Species-rich cropping systems are achieved through rotations, multiple cropping, species mixtures and intercropping. Research on developing such systems have started, but they are still very much in their infancy. This also applies to the technologies that are needed to manage such agroecosystems, which will need to be much different from current mechanization that had been developed for large-scale monocultures. Future highly productive and environmentally benign cropping systems that are based on ecosystem interaction will likely need to be managed using advanced digital agricultural technologies with focus on small-scale plant-plant and plant-soil interactions.

Keywords: Sustainability, Arable cropping systems, Diversification, Multifunctionality.

Session I: Oral presentation

Chemical characteristics of degraded soils and remediation by cyanobacteria (O-17)

Hidetoshi Taira[1], Junya Baba[1], Satoshi Togashi[2], Jollibekov Berdiyar[3] and **Kazuyuki Inubushi[1]***

*[1]Graduate School of Horticulture, Chiba University, Matsudo, Chiba, Japan; [2]OISCA Institute of Alashan Ecology, Alashan, InnerMongolia, China; [3]Tashkent State Agrarian University Nukus branch, Uzbekistan. *Corresponding author: inubushi@faculty.chiba-u.jp*

About 20% of the arid area is exposed to soil degradation and 70% is exposed to vegetation degradation, and total of 36 billion hectares are suffered from soil degradation, due to climate change and over-use of soil and water. Salinization, alkalization and excessive irrigation are taken as the cause of soil degradation. Cyanobacteria growing on surface soil under extreme dry conditions have dry and salinity resistances and they can be sources of organic matter and nutrients in degraded grassland area. Inoculation of cyanobacteria to degraded soil is thought to be effective for degraded soil bioremediation. To examine this possibility, we isolated cyanobacteria from soils collected in China and Uzbekistan. Then, we examined soil chemical characteristics, such as water content, pH(H_2O), pH(KCl), electric conductivity (EC), total carbon (TC), total nitrogen (TN), and inorganic nitrogen (NH_4^+-N and NO_3^--N). Three soil samples were taken from 3 places in cotton farm and lakeside of Uzbekistan and 8 soil samples from 5 places in desert and lakeside of China. Water content was varied in range of 0.4-42.0%. All collected soil samples were slightly alkaline [8.12-9.66 in pH (H_2O), and 7.77-8.98 in pH (KCl)], and saline as EC was over 100 mS/m except 1 sample in Uzbekistan. TC in samples of China were 4.3-13.5 g C/kg d.s., while TC in samples of Uzbekistan were 15.23-41.6 g C/kg d.s.. Isolation of cyanobacteria from soil succeeded for 2 samples in Uzbekistan and 2 samples in China. Except 1 sample in Uzbekistan, isolated cyanobacteria grew on the saline soil, suggesting high salinity tolerance of these cyanobacteria and accumulation of organic matter in soil surface. Pot experiment was also conducted with cotton and isolated cyanobacteria, and we could observe that Chl.-a and soluble organic nitrogen contents in soil surface, plant dry matter and plant height increased by adding cyanobacteria.

Keywords: Cyanobacteria, Degraded soil, Saline soil, China, Uzbekistan.

Maize production under combined conservation agriculture and integrated soil fertility management in the sub-humid and semi-arid regions of Kenya (O-18)

Mutuku Eunice A.[1,2,3], Dries Roobroeck,[2] Bernard Vanlauwe[2], Wim Cornelis[1] and Pascal Boeckx[3*]

*[1]Department of Environment, Gent University, Gent, Belgium; [2]Department of Natural Resource management, International Institute of Tropical Agriculture, Nairobi, Kenya; [3]Isotope Bioscience Laboratory – ISOFYS, Department of Green Chemistry and Technology, Gent University, Gent, Belgium. *Corresponding author: Pascal.Boeckx@UGent.be*

Maize (*Zea mays*) production in Kenya is declining as a result of low soil fertility and erratic rainfall. Conservation Agriculture (CA) and "full" Integrated Soil Fertility Management (ISFM) are renowned management practices that could improve yields. An experiment was carried out in two agro-

ecological regions of Kenya, Kibugu, a sub-humid and Machang'a, a semi-arid location, to investigate effects of CA and/or ISFM on soil water content (SWC) and maize grain yield. Rain-fed maize crop was establishment under treatments, CA, ISFM, CA+ISFM and a control (C) in both regions. After four growing seasons, compared to the control yield (1.9 t ha^{-1}), CA, ISFM and CA+ISFM had a significantly higher maize grain yield by 128±116, 106±64) and 156±126%, respectively, in the sub-humid. In the semi-arid, compared to the control yield (0.5 t ha^{-1}), CA, ISFM and CA+ISFM resulted in a significantly higher maize grain yield by 203±129), 171±167) and 175±164%, respectively. We conclude that CA practices, via improved SWC (Fig. 1), improve yields more than "full" ISFM, especially under semi-arid conditions. There is no apparent additive effect of CA and ISFM on maize yields.

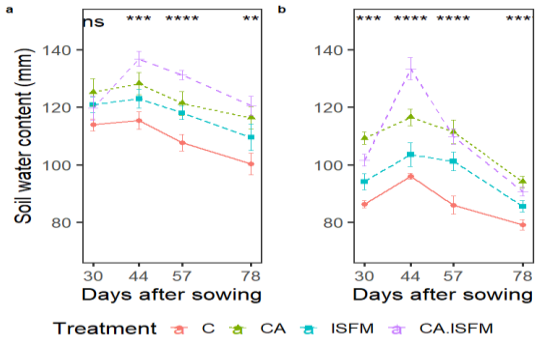


Fig. 1: Soil water content over 0-40 cm depth for sub-humid (a) and semi-arid (b) regions under different practices (C, control, CA, conservation agriculture; ISFM, integrated soil fertility management and CA+ISFM). Significance levels of differences during the growing season are indicated; ****, $p < 0.0001$; ***, $p < 0.001$; **, $p < 0.01$; *, $p < 0.05$

Keywords: Rain-fed, Maize grain yield, Soil water content.

Effect of tillage practice and nitrogen rate on nitrous oxide emissions and emission factors in winter oilseed rape (O-19)

O'Neill Macdara[2], Gary Lanigan[2], Dermot Forristal[3] and Bruce Osborne[1*]

*[1]UCD School of Biology & Environmental Science, University College Dublin, Dublin 4, Ireland; [2] Teagasc, Environmental Research Centre, Johnstown Castle, Co. Wexford, Ireland; [3] Teagasc, Crops Research Centre, Oakpark, Co. Carlow, Ireland. *Corresponding author: bruce.osborne@ucd.ie*

Winter oilseed rape (WOSR) is an important break-crop sown in cereal rotations in Ireland. The crop is established through plough-based methods and requires high quantities of nitrogen fertiliser (≤240 kg N ha^{-1}). Low-cost, low disturbance non-inversion tillage methods are becoming increasingly popular; however, little information exists on how these tillage systems will impact emissions of the greenhouse gas nitrous oxide (N_2O). Two experiments were established to examine the impact of: (i) conventional (CT), minimum (MT) and strip tillage (ST) at 125 mm and 600 row spacing (2015), and (ii) CT and ST at four levels of N fertiliser (0, 160, 240 and 320 kg N ha^{-1}), on N_2O emissions and associated emission factors (EFs), i.e. the proportion of N_2O-N emitted per unit of applied fertiliser (2014/2015). Nitrous oxide was measured using manual closed chambers and analysed by gas chromatography. Seasonal and cumulative N_2O emissions were not significantly greater from the MT and ST treatments compared to CT treatment. A spike in N_2O emissions were observed from the MT and ST treatments 3- and 6-days post-fertiliser application (150 kg N ha^{-1}) stimulated by increases in water-filled pore space, but this had no effect on total N_2O-N losses. Emission factors were lowest for crops receiving 160 kg N ha^{-1} with values ranging from 0.49-0.87% (CT) and 1.00-1.20% in ST (2014), and 0.07-0.55% (CT) and 0.30-1.02% (ST) (2015). The EF values were consistently lower for CT than ST treatments but differences between

CT and ST for equal N fertiliser rates were not significant. Overall, non-inversion tillage did not adversely impact on N_2O emissions, although CT systems tended to result in lower cumulative N_2O emissions.

Keywords: Winter oilseed rape, Reduced tillage, Fertiliser Rate, Nitrous oxide, Emission Factors.

Understanding the biophysical processes and extension mechanisms of Zero Budget Natural Farming (ZBNF) to support its wider application (O-20)

Collins Chris D. [1], Sarah Duddigan[1,2], Zakir Husssain[3] Henny Osbahr[2], Vijay Thallam[3] and Grady Walker[2]

*[1]Soil Research Centre, University of Reading, Reading. RG6 6DW, [1]School of Agriculture, Policy and Development, University of Reading, Reading, Berkshire RG6 6AR, [3]Rythu Sadhikara Samstha, Guntur, 522 220, Andhra Pradesh, India. *Corresponding author: c.d.collins@reading.ac.uk*

ZBNF is a locally and regionally based grass-roots movement as well as a state-government backed extension priority in Andhra Pradesh India. The enthusiastic adoption of ZBNF by farmers has reduced their reliance on purchasing agrochemicals and hence levels of debt, which was a cause of high incidence of farmer suicides, previously. The success of this movement has resulted in recognition and support by Government of Andhra Pradesh with a target of 6 million adopting ZBNF by 2021. Andhra Pradesh provides an excellent research platform as the state has 7 agro climatic zones ranging from temperate coastal plains to arid montane, with red and black soils. It is an ideal entry point to improve existing practice on-farms through evidence-based innovations developed by co-working between UK and Indian researchers. Our research has 4 strands: (1) Understanding whether ZBNF works, how and why it is adapted to suit different contexts, leading to knowledge that can accelerate scaling up and out, (2) Demonstrating the dynamics and outcomes of ZBNF of a) the innovation system b) the socio-economic outcomes and c) the environmental outcomes, (3) Understanding how and why the extension process promoting ZBNF works (and hence leads to adoption) leading to knowledge that can inform the scaling up of the approach, and (4) Predicting and adjusting to possible changes in performance as ZBNF is adopted for longer periods of time and at larger spatial scales. Initial findings suggest that the ZBNF system competes with organic and conventional practices but requires less capital input therefore increasing profitability. Secondly that adoption of ZBNF arises not necessarily purely for financial reasons but also because of perceived improved health outcomes from reduced chemical exposure and higher quality food.

Keywords: Low input agriculture, Nutrient cycling, Extension evaluation, Climate resilience, Yield.

Nitrogen management for hybrid rice: trade-offs between productivity, profitability, carbon sustainability and energy efficiency (O-21)

Banerjee Hirak [1], Sukamal Sarkar[1], **Sudarshan K. Dutta**[2,3*], Sourav Garai[1], Krishnendu Ray[4], Shamie Zingore[2,3], and Kaushik Majumdar[2,3]

*[1]Bidhan Chandra Krishi Viswavidyalaya, Department of Agronomy, West Bengal, India. [2]African Plant Nutrition Institute, Benguerir, Morocco. [3]University Mohammed VI Polytechnic, Benguerir, Morocco. [4]Sasya Shyamala Krishi Vigyan Kendra, IRDM Faculty Centre, West Bengal, India. *Corresponding author: S.Dutta@apni.net*

Field experiments were conducted to evaluate hybrid rice response to nitrogen (N) fertilizer for higher productivity and environmental sustainability under coastal soil of West Bengal, India. Five rates of N (0, 40, 80, 120, 160 and 200 kg-N-ha^{-1}) were applied with four replicates in a randomized complete block design (RCBD) for two consecutive years - 2017 and 2018. Nitrogen application significantly (p≤0.05) influenced on both grain and straw yield of the hybrid rice. Highest two-season average grain and straw yield of 7.7 and 5.7 t ha^{-1}, respectively, were produced at N application of 160 kg ha^{-1} followed by 200 kg-N-ha^{-1}. The relationships between grain yield and N concentrations in stem (R^2=0.98), leaf (R^2=0.91) and grain (R^2=0.99) were significant (p≤0.05), highlighting the high deficiency of N at lower application rates and its role in plant growth and yield improvement. In terms of environmental stewardship indicators, net energy gain (NEG) was highest with 160 kg-N-ha^{-1} followed by the treatment receiving 200 kg-N-ha^{-1}; and thereafter continuously declined with the reducing N-dose. The C efficiency and C sustainability index were significantly (p≤0.05) higher at treatment receiving 200 kg-N-ha^{-1} showing a higher sustainability with increased N doses up to a certain level. The tested hybrid rice cultivar showed superior economic performance at 160 and 200 kg N ha^{-1}, which gave higher net returns and benefit: cost ratio over the other treatments. Based on regression analysis, the economic optimum N level was derived as 176 kg N ha^{-1}. Therefore, the study suggests an N dose of 176 kg ha^{-1} for hybrid rice cultivation at coastal alluvial soil of West Bengal for higher productivity and profitability while maintaining higher C sustainability and net energy gain. The novelty of the study is our focus to provide an assessment of N application for rice cultivation with an integrated approach of yield, economics and environmental sustainability.

Keywords: Carbon efficiency, Carbon footprint, Energy budgeting, Hybrid rice, NUE.

The potential for mitigating gaseous nitrogen and the role of soil organic carbon in offsetting in arable cropping systems (O-22)

Khalil Mohammad I.[1,2,*] and Bruce A. Osborne[2]

*[1]UCD School of Biology & Environmental Science, University College Dublin, Ireland and [2]Prudence College Dublin, Ireland. *Corresponding author: mi.khalil.dr@gmail.com*

The demand for nitrogen-fertilizers to grow more food and feed has been increasing (~3.5% per year) and this has resulted in a rapid rise in gaseous nitrogen (N_2O, NH_3 and NO_x) emissions from agricultural systems. These are directly and/or indirectly causing global warming, undermining global efforts to address the Paris Agreement, and resulting in environmental/ecosystem degradation. Reactive mineral-nitrogen (e.g., ammonium and nitrate) is an indispensable nutrient for agricultural production. Nitrates generally produce higher crop yields than urea, particularly in

temperate regions and *vice-versa* in the tropics. Urea has a lower carbon footprint during production but higher following field applications, releasing CO_2 directly and more gaseous nitrogen compared to other N forms. Applications of inorganic- and organic-fertilizers (animal faeces/slurry) are also important for improving soil health and sustaining agricultural productivity but induce a significant amount of nitrogen emissions. Due to large spatial and temporal variations, the potential to reduce N_2O and NH_3 through management interventions, are often of uncertain benefit. Atmospheric pollution through gaseous nitrogen causes far beyond critical environmental thresholds without mitigation actions. Recent developments and prospects for improving site-specific nitrogen-use-efficiency in arable systems include precise N-fertilization and manuring, matched with the use of the appropriate type/composition of N-fertilizers and other smart-farming techniques. Appropriate timing and distribution of inorganic-fertilizers together with inhibitors can reduce the reactive nitrogen emissions. However, these approaches can have negative effects on SOC density unless supplemented with added or root-biomass-derived C, the extent to which depends on soil, environment, and climatic conditions. Tackling climate change, while attaining food security and sustainability through identification of appropriate management practices and technologies, is a global challenge. Hence, the transition from current practices into highly resource-use efficient agricultural systems, with opportunities to mitigate the emission of reactive gases, and enhance carbon sequestration and greenhouse gas offsetting, is a priority.

Keywords: Reactive nitrogen, Greenhouse gases, Mitigation, Offsetting, Arable cropping systems.

Do pollinator communities differ between early and late flowering varieties of a mass-flowering crop? (O-23)

O'Reilly Alison[1,2*] and Dara A. Stanley[1,2]

*[1]School of Agriculture and Food Science, University College Dublin, Ireland; [2]Earth Institute, University College Dublin, Ireland. *Corresponding author: alison.oreilly@ucdconnect.ie*

Mass-flowering crops grown within arable cropping systems are often dependent on pollination by insects but can also be highly rewarding to pollinators due to the large pulses of pollen and nectar resources they provide in the landscape. Oilseed rape (*Brassica napus*) is the most widely grown flowering crop in Ireland and is likely to be an important food source for Irish bees and other pollinators. Research suggests that oilseed rape also benefits from pollinators and the services they provide in terms of pod production and yield. Management practices in arable cropping systems can affect the abundance and diversity of beneficial insects in agroecosystems. For example, insecticides are often used for pest control and have been shown to have negative consequences on non-target pollinating insects. The aim of this field study was to survey pollinator abundance and composition in sites of varying soil management practices and agrochemical inputs and evaluate whether these communities differ with management intensity. In addition, this study aims to determine how pollinator communities may differ between early and late flowering oilseed rape varieties, which could determine the potential risk of exposure of these beneficial insects to pesticides in the landscape. Pollinator communities were surveyed in a total of 28 winter and spring sown oilseed rape sites during mass-flowering using transect walks and focal observations. The findings show a significantly higher abundance of pollinators in the later flowering crop, and that pollinator community composition may differ between winter and spring sown varieties. How management intensity influences pollinator diversity will also be discussed. These findings suggest that Irish wild bee populations may be at a greater risk to pesticide exposure in mass-flowering crops that flower later in the season and should be discussed in the context of providing solutions for pollinator conservation in agroecosystems, and sustainable agricultural production.

Keywords: Pollinator Conservation, Sustainable Agriculture, Pollination Services, Insecticides, Mass-flowering Crop.

LIFE AGRESTIC – Reduction of Agricultural GReenhouse gases EmiSsions Through Innovative Cropping systems (O-24)

Manstretta Valentina[1]*, Vittorio Rossi[2], Giorgio Ragalini[3], Alessandro Bosso[4], Gabriele Canali[2], Giovanni Laidò[5], Paola Cutillo[6] and Pierluigi Meriggi[1]

*[1]Horta srl, Piacenza, Italy, [2] Università Cattolica del Sacro Cuore, Piacenza, Italy, [3] Scuola Superiore degli Studi Sant'Anna, Pisa, Italy, [4] ART-ER S. cons. p. a., Bologna, Italy, [5] Isea srl, [6] New Business Media Srl, Milano, Italy.*Corresponding author: v.manstretta@horta-srl.com*

The LIFE AGRESTIC project aims at fostering the adoption by EU farmers of innovative and efficient cropping systems with a high climate-change mitigation potential, and spreading innovative views and tools for climate ready and resource efficient agriculture. LIFE AGRESTIC has the following specific objectives: (1) Reduce agricultural GHG emissions and increase soil carbon sequestration by designing and implementing on three demonstration sites N- and C-Efficient Cropping Systems (ECSs) with higher potential of carbon storage and nitrogen efficiency and lower GHG emission rates compared to Conventional Cropping Systems (CCSs), (2) Develop, test and implement an innovative web-based DSS for supporting farmers in a resource-efficient management of ECSs, aiming at reducing GHG emissions and production costs, while maintaining or increasing yield, product quality and safety, and farmer's economic return. (3) Develop and use a prototype for automated and continuous monitoring of soil GHG fluxes, in order to: (i) measure the potential of ECSs in reducing soil emissions compared with CCSs; ii) calibrate and validate a model for estimation of soil GHG emissions, and implement the model into the DSS, (4) Valorise GHG emissions and carbon storage mitigation potential of ECSs through market based and/or policy-based measures, and support national and local policies through the analyses of ECS-based simulation scenarios and providing dataset for more accurate LCA analyses, and (5) Involve national and EU stakeholders to: i) ensure their real needs are met and proposed innovation is feasible and effective; iii) increase the innovation acceptance rate and the future exploitation of the project results; iv) create local agreements and regional collaborations about soil and ecosystem services; and, finally, v) ensure replicability and transferability across EU.

Keywords: *GHG emission, Carbon sequestration, Decision support system, Ecosystem services.*

Session II: Flash talks

Field-scale quantification of soil organic carbon and nitrogen dynamics in rice-based cropping systems (F-19)

Siddique Md. N.E.A.*, Lisa L. de Bruyn, Yui Osanai and Chris N. Guppy

University of New England, NSW, Australia. **Corresponding author: msiddiq5@myune.edu.au*

Rice-based cropping systems (RBCS) evolved in Bangladesh with increasing cropping intensity based on soil physiography, land inundation, and farmer preference. These intensified contrasting land uses were hypothesized to affect soil organic carbon (SOC) and total nitrogen (TN) dynamics. Under smallholder cropping systems and management, the field-scale variability of SOC and TN

in soils under rice cultivation is not fully understood. Therefore, we quantified SOC and TN in agricultural fields collected from a range of RBCS in northern Bangladesh where the farming regime was practised for the past ten years at least. The types of cropping systems of varying cropping intensity were identified by a farmer survey in the study area. The key cropping systems were then soil sampled for a range of soil properties but notably SOC and TN. The study demonstrated significant variability in levels of SOC and TN between the cropping systems. The results indicated that SOC and TN contents over the range of RBCS varied from 5.46 to 16.33 and 0.51 to 1.60 g/kg respectively. The mean content of SOC was highest in triple cropping systems (12 to 16.33 g/kg) whose rotational crops were more diversified with a combination of either maize, potato, mustard, jute and vegetables. In contrast, agricultural lands that are under continuous double and triple cropping with less crop diversity as part of the rotation, and repeated dry and wet season rice recorded between 6.90 to 8.30 g/kg of SOC and 0.63 to 0.83 g/kg TN. It further appeared that the wheat-based system has the lowest SOC (5.46 g/kg) and TN (0.51 g/kg) contents, which could be due to less retention of crop residues and the absence of anaerobic phase during wheat cultivation. We further hypothesized that smallholder management, farmer choice of rotational crops and the management of crop residues might be influential in SOC and TN dynamics. The results suggest that a diversified cropping system, compared with a continuous rice-rice practice, may be the optimal choice for restoration of SOC and TN to maintain the productivity of RBCS in Bangladesh.

Keywords: Soil carbon, Cropping intensity, Paddy soils, Crop residue, Crop rotations.

Effect of pellet compost on CO_2 and N_2O production and plant growth in Andosol and Chernozem (F-20)

Sato Makiba [1], Magdolna Tállai[2], Andrea Balláné Kovács[2],Imre Vágó[2], János Kátai[2], Miwa Yashima Matsushima[1], and **Kazuyuki Inubushi**[1]*

*[1]Graduate School of Horticulture, Chiba University, Matsudo, Chiba, Japan, [2]Institute of Agricultural Chemistry and Soil Science, University of Debrecen, Debrecen, Hungary. *Corresponding author: inubushi@faculty.chiba-u.jp*

Compost is attracted in organic farming as an alternative to chemical fertilizers in the world. Pellet compost consists of a mixture of compost and chemical fertilizer, odorless, easy to handle and adjustable composition. Although it has pointed out that pellet compost generates greenhouse gases such as carbon dioxide (CO_2), and nitrous oxide (N_2O), the mechanism is not clearly understood. To investigate the effect of compost on greenhouse gas generation and plant growth in Hungarian soils, Chernozem and Japanese soil, Andosols, incubation experiments and pot experiment were conducted. Chernozem collected in University of Debrecen, Hungary, and Andosol collected in Chiba University, Japan, were used. Treatments were 1) pellet compost made of pig manure with chemical fertilizer, 2) chemical fertilizer, comparing to 3) no fertilizer. Soils were incubated for 6 weeks at 20℃ in a dark place and analysed for CO_2, N_2O production and content of nitrogen. In similar soils and treatments, pot experiment was conducted with Komatsuna (*Brassica rapa*) to observe the effect on plant growth. Production rate of N_2O with chemical fertilizer in Chernozem was the highest among the three treatments. However N_2O was not detected in Andosol. It was probably due to higher clay contents in Chernozem and higher activity of denitrification bacteria than in other treatments. In Chernozem, as nitrification rapidly progressed in chemical fertilizer, N_2O production was the highest as by-products of nitrification. CO_2 production of Chernozem was higher than that of Andosol. This is attributed to be stimulated decomposition of organic matter by the soil microbial activity. In pot experiment, pellet compost tended to enhance plant growth, followed by chemical fertilizer and control in both soils. These experiments showed

that pellet compost is expected to have carbon storage effect and leading to be a sustainable agriculture by alternative to chemical fertilizer.

Keywords: Greenhouse gases, Horticulture, Japan. Organic farming, Vegetable.

Heterogeneity of soil respiration in agroecological and conventional maize crops (F-21)

Breil Nicolas L.[1*], Nathalie Jarosz-Pellé[1], Vincent Bustillo[1], Benoit Coudert[1], Solen Queguiner[1], Nicole Claverie[2] and Thierry Lamaze[2]

*CESBIO, Université de Toulouse, UPS, CNES, CNRS, INRA, IRD; [1]Auch, France; [2]Toulouse, France. *Corresponding author: nicolas.breil@iut-tlse3.fr*

Soil CO_2 efflux represent one of the largest amounts of natural carbon emissions. It is known that soil respiration, through roots respiration and carbon mineralisation by microorganisms, is mainly controlled by temperature and humidity but its heterogeneity remains complex and poorly understood. Previous studies have demonstrated that crop management, and more particularly reduced or no tillage as well as cover crops, play a key role to mitigate soil respiration, but the mechanisms underlying this mitigation are still unclear. Our study aims to better understand the effect of crop management on soil CO2 efflux. Soil respiration was measured in south-west of France on two joint maize fields using agroecological (no-tillage and cover crops; named AC) and conventional (tillage and bare soil; named TEM) practises in 2018 and 2019. Respiration chamber and soil moisture sensor were spatially used to collect data two times a month, while pedoclimatic variables were monitored continuously on each field. Mean soil respiration rate was greater on AC (0.86 gCO_2 m² h-1) than on TEM (0.50 gCO_2 m² h-1) and was significantly correlated with soil temperature and humidity at TEM and only with soil temperature at AC. Soil organic matter (OM) concentration on the 0-15 cm top soil was greater at AC (23.17 g kg-1) than at TEM (13.72 g kg-1) and a negative correlation was found between OM and elevation in both fields. Our results suggest that soil respiration rates depend less on soil humidity on AC than on TEM. Agroecology management might both keep more water at the surface and store additional soil organic matter, permitting more constant soil C efflux. First spatialized analysis showed that soil respiration rates does not depend on topography but does on crop management and helped identify the main hot spots of CO_2 efflux.

Keywords: Soil respiration, Agroecology, Soil chamber, Maize.

Potential application of phenanthrenes from rushes as organic compounds for sustainable agriculture (F-22)

Bakacsy László[1]*, Henrietta Kovács[1], Lilla Sípos[1], Anita Barta[2], Dóra Stefkó[2], Andrea Vasas[2], Ágnes Szepesi[1]

*[1]Department of Plant Biology, University of Szeged, Hungary; [2]Department of Pharmacognosy, University of Szeged, Hungary. *Corresponding author: bakacsy@bio.u-szeged.hu*

Rush species (*Juncus* sp.) from cosmopolitan *Juncaceae* family have been used by traditional Chinese medicine many hundred years. Phenanthrene derivatives are chemotaxonomic markers of this family. Some research studies have showed the efficacy of *Juncus* extracts against plant

pathogens and the germination of parasitic *Orobanche* species (*O. minor*). Juncusol and effusol, two main phenanthrene metabolites of *Juncus* species show strong antialgal activity in higher concentration, while they have stimulated the growth of algae in lower concentration. There is growing demand to replace chemical pesticides with alternatives owing to concerns related to impacts on human health and the environment. Therefore, EU policy is directed towards significant reductions in pesticide use in the short to medium term. The metabolites of Juncus species can be an effective, sustainable and environmentally friendly method for pest management in integrated pest management (IPM) or organic farming systems. Up to now, these phenanthrene compounds have not been tested for crop plants. In order to investigate the effects of the rush secondary metabolites on plant growth, we used two natural products (juncusol and effusol) which were extracted and purified from *Juncus compressus* (roundfruit rush) collected from Great Hungarian Plain. In this study, *Arabidopsis thaliana* seedlings were used as an oil crop model plant (from the Brassicaceae family) under controlled lab conditions in order to investigate the bioactivity of these two phenanthrenes. Concentration-dependent change was observed in growth parameters after treatments with these phenanthrenes. Our results show that phenanthrenes from *Juncus* species could be good candidates in the future to design efficient alternative and environmentally friendly compounds for sustainable agriculture.

Keywords: *Juncus*, Natural Products, Phenanthrenes, Sustainable Agriculture.

Catabolism of polyamines as bio-stimulant plant growth regulators for improving salt stress tolerance of tomatoes (F-24)

Szepesi Ágnes [1]*, László Bakacsy[1], Henrietta Kovács[1], László Kredics[2], Tamás Marik[2], Péter Pálfi[1], Réka Szőllősi[1] and Laura Zsigmond[3]

*[1]SZTE Department of Plant Biology, University of Szeged, Hungary; [2]SZTE Department of Microbiology, University of Szeged, Hungary; [3]BRC Laboratory of Arabidopsis Molecular Genetics, Institute of Plant Biology, Hungary. *Corresponding author: szepesia@bio.u-szeged.hu*

Salinity is one of the most serious abiotic stress factors threatening agriculture causing enormous economic and yield loss. Combination with other climate change parameters (high evaporation, elevated temperature), it can amplify the risk of yield loss in case of important crop plants, such as tomatoes. Tomato is one of the most important vegetable crops in the world and is fundamental in human nutrition. Irrigation with saline water is an existing agricultural practice for improving the fruit quality of tomatoes in the Mediterranean Region or Carpathian Basin, where salinity level is high in the ground water. However, these strategies can cause stress symptoms in tomatoes which are sensitive for high salt concentrations. During salt stress, some important biostimulant growth regulators like polyamines can synthesize to protect and help plant growth. Polyamines, essential N-containing polycations can act as 'hub' molecules connecting important signal pathways eg. ethylene, nitric oxide or proline during drought and salt stress. Hydrogen peroxide can also synthesize during catabolism of polyamines contributing to the improved abiotic stress tolerance in tomatoes. Our aim was to compare these catabolic processes in tomato cultivars differing growth type or fruit colour in greenhouse conditions to investigate how polyamine degradation can contribute to improved salt tolerance in tomatoes. The level of PA catabolism showed cultivar dependent processes, as the indeterminate cv. Romus had higher levels of free polyamines than the determinate cv. Rio Fuego or cv. Manó, while diamine- and polyamine oxidase enzymes also showed highest activities in cv. Romus. By using L-aminoguanidine for pharmacological inhibition of diamine oxidase, cv. Romus was the most affected providing evidence for the importance of this

enzyme in defence against salt stress. This approach can elucidate the applicability of polyamines as biostimulant growth regulators during salinity stress.

Keywords: Salinity, Tomato, Polyamines, Agriculture, Biostimulants.

Carbon deposition and partitioning in the soil microbial biomass from three deep-rooted crops in 4-meter rhizoboxes (F-25)

Peixoto Leanne [1*], Lars Elsgaard[1], Jim Rasmussen[1], Yakov Kuzyakov[2,3] and Jørgen E. Olesen[1]

*[1]Department of Agroecology, Aarhus University, Tjele, Denmar; [2]Department of Soil Science of Temperate Ecosystems, Georg August University of Göttingen, Germany;[3]Agro-Technological Institute, RUDN University, Moscow, Russia.*Corresponding author: leanne.peixoto@agro.au.dk*

Despite the importance of subsoil carbon (C) dynamics associated with deep-rooted cropping systems in mitigating climate change and improving soil fertility, the quantification of both net rhizodeposition and root C input below 1 m remains unexplored. To extend our understanding of the C dynamics in deep subsoils, the C incorporation into the microbial pools (within both the living and the dead) and the quantification of this C input is required to assess the efficacy of mitigation strategies. 4 m deep RootTowers (functional equivalent to giant rhizoboxes) were used to trace ^{13}C multiple pulse labeled assimilates during the growth period of three deep-rooted perennial plants: lucerne, rosinweed, and kernza. C content and ^{13}C enrichment was detected in the soil and the roots for the determination of C deposition (net rhizodeposition + root C), and the ^{13}C incorporation into phospholipid fatty acids (PLFA) and amino sugars (AS). Overall, the total C input from 360 cm to the topsoil (0-25 cm) ranged from 0.03-1.54, 0.09-1.53, and 0.07-0.98 g C kg^{-1} dry weight soil for kernza, lucerne, and rosinweed, respectively representing a decrease in both the root C input and net rhizodeposition with depth. The partitioned C within the PLFA and AS pools derived from rhizodeposited C declined with depth where the C within the PLFA and AS pool was 73 (540), 40 (53), 20 (44) fold higher in the topsoil compared to 360 cm (deepest soil layer) for lucerne, kernza and rosinweed. This coincides with a larger percentage of C in the AS pool than the PLFA pool suggesting a more stabilized C is likely contributing to the SOC formation in these deeper soil layers.

Keywords: Carbon deposition; Stable isotope probing; Amino sugars; PFA; Deep subsoil

Slow-release fertilizers to reduce ammonia and GHG emissions from agricultural sources (F-26)

Wesołowska Monika M. [1,2*], Piotr Baranowski[1] and Lech Schimmelpfennig[2]

*[1]Institute of Agrophysics, Polish Academy of Sciences, ul. Lublin, Poland; [2] GRUPA AZOTY Zakłady Azotowe "Puławy" S.A., Puławy, Poland. *Corresponding author: monika.wesolowska @grupaazoty.com, mwesolowska@ipan.lublin.pl*

Nutrient losses from mineral fertilizers have persisted at a high level for several years. This adverse phenomenon has not only for economic implications, i.e. the loss of the main components of costly fertilizers enhancing plant development, but also environmental consequences, i.e. emissions of gaseous nitrogen derivatives into the atmosphere as greenhouse gases, thus contributing to

progressive climate change. The problem of irretrievable nutrient loss has recently aroused increasing interest due to the ongoing attempts at reduction of environmental pollution. These considerations have resulted in legal regulations introduced at national and European levels, for instance the Act introducing changes in the National Emission Ceilings of 2016 for greenhouse gases [NEC Directive, 2016]. Apparently, the new emission limits may result in a reduction or even a complete ban on the use of urea-based fertilizers. An exception to this law, however, is the use of slow release urea. The research is aimed at developing new urea fertilizers with limited ammonia emissions, as well as developing measuring methods confirming the reduction of emissivity. A possible path to increase the efficiency of fertilization without loss of nitrogen and to avoid the adverse impact of ammonia on the environment is to adapt the rate of nutrients uptake by plants. Currently conducted research enabled to obtain urea fertilizers, whose granules are surrounded by biodegradable polymeric material. Several variants of the shelled fertilizer have been designed, which were aimed to slow down the release of nutrients. The results of the incubation tests for chosen prepared fertilizers enabled to distinguish the differences in their efficiencies in regard to slowing down the gas emissions (ammonia and GHG).

***Keywords**:* SRF, NH_3 emissions, emissions measurements

Theme 4: Grassland Systems

Keynote presentation

Drivers of greenhouse gas footprints in grassland production systems (K-4)

Butterbach-Bahl Klaus[1*], Na Wang[1] and Ralf Kiese[1]

*[1]Karlsruhe Institute of Technology, Institute of Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU), Germany. *Corresponding author: Klaus.butterbach-bahl@kit.edu*

Grassland systems cover approx. 40% of the global terrestrial surface, storing approx. 12% of the global soil C stocks and functions as sinks/ sources for CO_2, CH_4 and N_2O. To study the effect of climate change and management intensity (cutting/ manuring) on C and N fluxes we excavated 36 intact grassland soil cores (area, 1 m^2; depth, 1.4 m) and transferred those along an altitudinal/climate gradient (MAP: 900-1400 mm yr-1; MAT: 6.5-8.6°C). Gaseous as well as hydrological exchange of C and N compounds are measured continuously since 2012 with automated robot systems for gas flux measurements and lysimeters for quantifying leaching losses. In addition, soil N_2 fluxes are measured using small intact soil cores. Among others, our studies show that significant mineralization pulses occur under simulated climate change conditions and that increased SOC mineralization seems to drive the observed net ecosystem C loss at all sites, ranging from 1.4 - 3.4 t C ha^{-1} yr^{-1}. This is a very alarming finding as it calls for changes in montane grassland management regimes, e.g. maintaining or even increasing already high rates of slurry applications while reducing number of cuts. Compared to C losses and the CO2 greenhouse footprint, climate change effects on N_2O fluxes (flux range: 0.09-3.11 kg N_2O-N ha^{-1} yr^{-1}) were less pronounced and marginal for CH_4 (-1.99 and -0.25 kg CH_4-C ha^{-1} yr^{-1}). High N_2O fluxes were observed following slurry applications and rainfalls or during freeze-thaw events. With regard to the latter, N_2O losses increased under warmer but drier conditions, which could be directly related to increased mineralization and nitrification activities during freeze-thaw periods. Given the observed significant interannual differences in C and N fluxes, driven by differences in weather conditions, long-term observations are needed to identify management options, which allow to maintain C stocks, minimize environmental N losses, and ensure productivity of these grasslands under climate change.

Keywords: TERENO, NEE, N_2O, CH_4, Management.

Session I: Oral presentations

A molecular pattern recognition receptor signalling compound (Biozest) presents an economically advantageous pastoral greenhouse gas emissions reduction solution (O-25)

Balasingham Nathan[*] and Usha Amaranathan

*Zest Biotech Ltd, Auckland, New Zealand.*Corresponding author: nathan@zestbiotech.co.nz*

There are three pathways of methanogenesis in ruminants: the acetoclastic pathway from cellulosic carbohydrate digestion, and the hydrogenotrophic and methylotrophic pathways from

deamination of protein to ammonia. Acetoclastic methnogenesis can be reduced by increasing soluble carbohydrates in forage. Hydrogenotrophic and methylotrophic methanogenesis can be reduced by protecting some of the proteins from rapid degradation to ammonia. A biogenic agricultural compound trademarked Biozest™, sprayed on pasture, enables pasture to synthesise more soluble sugars and delivers the benefits attributable to bioactive molecules; phenylpropanoids. Phenylpropanoids are plant secondary compounds that can help plants overcome pest, disease and environmental stress to increase pasture quality and yield. When consumed by ruminants phenylpropanoids can protect proteins from rapid degradation to ammonia and improve the conversion efficiency of pasture protein to milk and meat. The effect of Biozest™ on both pasture and ruminant efficiency was evaluated via split block trials followed by full-scale, full life cycle, on-farm trials. Aspects measured include pasture resilience, quality and productivity, livestock productivity (milk production, live weight) and urea excretion. Biozest™ was found to improve pasture resilience, quality and yield (by over 75%). The soluble sugars content of the pasture increased (18%). When livestock grazed Biozest™ treated pasture urea excretion was reduced (20–48%) and milk and meat production increased (30%). During carbohydrate digestion, the higher content of soluble sugars in treated pasture is expected to favour production of propionate rather than methane, acetate and butyrate. Acetoclastic methanogenesis is therefore expected to be reduced. Urea excretion is reduced so it follows that nitrous oxide production from urine and dung patches will be reduced. The reduction in urea excretion is a result of a reduction in deamination. Therefore, it is expected that methylotrophic and hydrogenotrophic methanogenesis are reduced. Future, work may include quantification or modelling of the increased sequestration of carbon dioxide and the reduction in nitrous oxide and methane emissions. However, the productivity and urea benefits of Biozest have been clearly established via this series of trials proving the compound to be an economically smart and climate-smart choice.

Keywords: Pastoral, Greenhouse-gas, Urea, Abatement, Sequestration.

Species richness increased yield stability in intensively managed grasslands subjected to experimental drought (O-26)

Finn John A.[1]*, Matthias, Suter[2], Eamon Haughey[1,3] and Andreas Lüscher[2]

[1]*Teagasc, Environment Research Centre, Wexford, Ireland;* [2]*Agroscope, Forage Production and Grassland Systems, Zürich, Switzerland;* [3]*Botany Department, School of Natural Sciences, Trinity College Dublin, Ireland. *Corresponding author: john.finn@teagasc.ie*

Climate change is expected to cause an increase in the frequency and intensity of drought events. Over two years we investigated the effects of experimentally imposed drought on intensively managed grassland communities (5 m x 6 m plots) of varying richness (1, 2 and 4 species), and comprising four species (Lolium perenne L., Cichorium intybus L., Trifolium repens L., Trifolium pratense L.). In each year a summer drought period of nine weeks with complete exclusion of precipitation was simulated, inducing severe drought stress at Reckenholz (Zürich, Switzerland), and extreme drought stress at Wexford (Ireland). Mean yield and plot-to-plot variance of yield were measured across harvests during drought and after a subsequent post-drought recovery period. At both sites, there was a positive relationship between species richness and yield under both the rainfed control conditions and under drought. At both sites, four-species communities had lower plot-to-plot variance of yield compared to monoculture or two-species communities under both rainfed (-49% smaller standard deviation) and drought conditions (-24%), which demonstrates higher yield stability in four-species communities. At the Swiss but not the Irish site, a high degree

of species asynchrony could be identified as a mechanism underlying increased temporal stability in four-species communities.

Keywords: Drought, Stability, Grassland, Yield, Mixtures.

Multifunctionality of sown grassland is enhanced by species diversity: a contribution to sustainable agriculture (O-27)

Suter Matthias[1]*, Olivier Huguenin-Elie[1] and Andreas Lüscher[1]

*[1]Forage Production and Grassland Systems, Agroscope, Zürich, Switzerland. *Corresponding author: matthias.suter@agroscope.admin.ch*

We investigated species diversity effects and multifunctionality in an intensively managed grassland. A diversity experiment was set up with sown monocultures and mixtures comprising *Lolium perenne*, *Dactylis glomerata*, *Trifolium pratense*, and *Trifolium repens*, and was maintained for three years at 150 kg·N·ha^{-1}·year^{-1}. Ten functions were measured that represented i) forage production (aboveground biomass yield (μ), standard deviation of yield (σ), temporal stability (μ/σ), weed biomass), ii) N cycling (symbiotic-N_2-fixation, N-efficiency, NO_3 in soil solution), and forage quality (crude protein content (CP), organic matter digestibility (OMD), metabolisable energy (ME)). We applied a multivariate linear mixed-effects regression framework to estimate simultaneously species identity and diversity effects for the ten functions, and used the mean log response ratio (LRR) across all functions to evaluate the diversity-multifunctionality relationship. Across the three years, all functions regarding production and N cycling revealed significantly enhanced performance in the four-species equi-proportional mixture (used as a reference) compared to averaged monocultures ('overyielding'). The reference mixture had 61% more biomass yield, 8% less variation, a 68% increase in stability, 81% less weed biomass, 96% and 46% higher symbiotic-N_2-fixation and N-efficiency, respectively, and a 87% reduction in NO_3. CP, OMD (g·kg^{-1}·yield), and ME (MJ·kg^{-1}·yield) did not significantly differ between the reference mixture and averaged monocultures. This, however, resulted in significant overyielding between 49% and 68% in all three forage quality functions on a hectare basis (kg or MJ·ha^{-1}·year^{-1}). On average across functions, the four-species reference mixture had 1.8 times the performance of averaged monocultures, indicating enhanced multifunctionality in mixtures. The multivariate framework in combination with the mean LRR as a measure of overall multifunctionality proved an effective tool for the comprehensive evaluation of the diversity-multifunctionality relationship. We conclude that sown grass–legume mixtures at moderate N fertilisation sustain high multifunctionality and, compared to monocultures, enhance levels of individual functions that jointly promote sustainable forage production.

Keywords: Diversity experiment, Positive species interactions, Diversity-multifunctionality relationship, Log response ratio, Sustainable intensification

The resilience of plant productivity at a landscape scale using remotely sensed data (O-28)

Yearsley Jon[1,2*], Hannah White[1,2], Lupe León-Sánchez[3], Dina Sadykova[3], Maja Ilic[3], Mathew Magilton[3], Willson Gaul[1,2], Mark Emmerson[3,4] and Paul Caplat[3,4]

*[1]School of Biology & Environmental Science, University College Dublin, Ireland; [2]UCD Earth Institute, University College Dublin, Ireland; [3]School of Biological Sciences, Queen's University Belfast, UK; [4]Institute of Global Food Security (IGFS), Queen's University Belfast, UK. *Corresponding author: jon.yearsley@ucd.ie*

Food security is underpinned by ecosystem functioning that is resilient in the face of environmental perturbations, such as extreme weather events. This is recognised in Target 2.4 of the UN Sustainable Development Goal 2 (Zero Hunger) which states "By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather …". Plant productivity is one important component of ecosystem functioning. The resilience of plant productivity has been studied experimentally at the field scale. However, variation in the resilience of plant productivity is also expected at a larger spatial scale, across a landscape, due to changes in agricultural practices and environmental conditions. Ecosystem resilience at a landscape scale has been little studied. We present an approach that uses remotely-sensed data of the enhanced vegetation index to calculate resilience measures of plant productivity, and apply this approach to improved grasslands across Ireland. We use our approach to investigate the association between the resilience of Ireland's grassland productivity at the landscape scale with a range of potential landscape drivers: biodiversity, land cover and climate history. We find that climate history (primarily extreme precipitation) has an important association with the resilience of grassland productivity in Ireland. Locations with a history of greater extreme precipitation generally show reduced resilience. We compare our results with biodiversity-stability relationships from field scale experiments and discuss the implications of considering ecosystem resilience at a landscape scale.

Keywords: Ecosystem stability, Ecosystem resilience, Grassland, MODIS, Remote-sensing.

Effect of grassland sward composition and N fertiliser management on N_2O emission, NO_3^- leaching, sward yield and N uptake (O-29)

Bracken Conor J. [1, 2, 3*]; Gary J Lanigan[3]; Karl G Richards[3]; Christoph Müller[2, 4, 5]; Saoirse R. Tracy[1, 2] and Paul N.C. Murphy[1, 2]

*[1]UCD School of Agriculture and Food Science,, University College Dublin, Ireland; [2]UCD Earth Institute, University College Dublin, Ireland; [3]Teagasc, Environmental Research Centre, Wexford, Ireland; [4]Institute of Plant Ecology, Justus-Liebig University Giessen, Germany; [5]UCD School of Biology and Environmental Science, University College Dublin, Ireland. *Corresponding author: conor.bracken.1@ucdconnect.ie*

Minimising N loss to the environment, particularly as nitrate (NO_3^-) leaching to water and nitrous oxide (N_2O) emissions to air, is crucial to improving the efficiency and sustainability of grassland agriculture. Multispecies swards containing plants of differing functionality (grasses, legumes and herbs) have been considered as a potential mitigation strategy. A lysimeter experiment was carried out over a full year to compare N_2O emissions and NO_3^- leaching from four sward types: perennial ryegrass (PRG, *Lolium perenne*); PRG and low white clover (PRG + LWC, *Trifolium repens*); PRG

and high white clover (PRG + HWC); PRG, WC and ribwort plantain (PRG + WC + PLAN, *Plantago lanceolata*). These swards received fertiliser N at 250, 90, 0, and 45 kg N ha^{-1} yr^{-1}, respectively. Fertiliser N was applied as urea in splits at appropriate timings to meet grass growth demands. Daily N_2O fluxes were measured using the static chamber technique and these were summed to quantify cumulative N_2O loss per month (g N_2O-N ha^{-1}). Leachate was collected from the base of the lysimeters. Composite monthly samples were then analysed for NO_3^- concentration and monthly NO_3^- fluxes were extrapolated (kg NO_3^--N ha^{-1}). Herbage was harvested each month to measure DM yield and total N (%) and N yield (kg N ha^{-1}). This paper reports on the cumulative N_2O emissions over a full year and the total NO_3^- leached over that period for each sward type. This work also details the annual and seasonal DM yield and N uptake from these swards.

Keywords: N_2O, nitrate leaching, *Lolium perenne, Trifolium repens, Plantago lanceolata*.

Multi-species grasslands open pathways for improving productivity and sustainability under intensive management. (O-30)

Grange Guylain[1*], Caroline Brophy[2] and John Finn[1]

*[1]Teagasc, Wexford, Ireland; [2]Trinity College Dublin, Ireland. *Corresponding author: guylain.grange@teagasc.ie*

Multi-species grasslands mixtures offer an opportunity to increase sustainable production from intensively managed European grasslands. However, more extreme weather event such as summer drought are to be expected due to climatic changes. We investigate the effects of mixing species and functional groups with the aim of improving forage yield and nitrogen use efficiency under two contrasting climatic scenarios. A simplex design including six species monocultures and 13 mixtures is sown in 2017 in a field experiment in the south-east of Ireland. Three functional groups are represented: grasses (Lolium perenne L., Phleum pratens L.); legumes (Trifolium repens L., Trifolium pratense L.) and herbs (Cichorium intybus L., Plantago lanceolata L.) and combined to create monocultures of all six species, as well as 2-, 4-, 5- and 6-species mixtures within 1, 2, and 3 functional groups respectively. All experimental plots receive 150 kg ha-1 of nitrogen fertiliser per annum and a Lolium perenne monoculture with 300 kg ha-1 of nitrogen included as a comparison represents standard Irish management. Each plot is split in two halves. A 2-month experimental drought is applied to one randomly chosen half, using a rainout shelter ; other half acts as a control. Aboveground biomass is harvested following a simulated grazing protocol. We measure dry matter yield and nitrogen content of the exported biomass. Total annual aboveground yield and nitrogen fertilizer use efficiency is compared between each community, over the two climatic treatments. We investigate the effects of plant diversity as a management tool for improving productivity and sustainability over a changing environment. Results from two years measurements showed a strong positive effect of plant diversity on yield (+2 t ha-1 yr-1 DM from 6-species mixtures compared to average monoculture), mainly explained by functional group interaction. Diversity effect was limited on nitrogen fertiliser efficiency, mostly driven by legume content.

Keywords: Multi-species, Grassland, Annual yield, Drought resistance, Nitrogen use efficiency.

Does management at a local or landscape scale impact pollinator communities in semi-natural grasslands? (O-31)

Larkin Michelle[1*] and Dara A. Stanley[1,2]

*[1]School of Natural Sciences, National University of Ireland Galway, Ireland; [2]School of Agriculture and Food Science, University College Dublin, Ireland. *Corresponding author: m.larkin102@gmail.com*

Pollinators provide a vital ecosystem service by ensuring successful pollination of wildflowers and many commercially important crops. Despite this, pollinators are experiencing increasing global population declines due to agricultural intensification, parasites and climate change. In response, agri-environmental schemes were introduced in Europe to mitigate further declines by offering financial incentives to farmers to protect and enhance biodiversity. However, traditionally farmers are paid for applying measures regardless of environmental outcomes, therefore these schemes have varying levels of success. The Burren Programme is an award-winning Results-Based Agri-Environmental Payment Scheme which has been developed in the diverse Burren region. It has been highly successful in conserving and enhancing habitat quality and diversity as farmers are rewarded based on the environmental results they deliver. However, it is important to understand whether these schemes work for taxa such as pollinators. In this project, we evaluated whether insect pollinators are effected by a results-based scheme in the Burren at local and landscape scales. Results in regard to the impacts of local and landscape management on pollinator communities and insect pollinator interactions with plant species are discussed. Our results will help advise whether there are any modifications to the scheme which would benefit pollinators and in informing agri-environmental measures and pollinator conservation more widely.

Keywords: Burren, Pollinator, Agri-environment scheme, Grassland, Bees.

Evaluation of the greenhouse gases emitted by different sheep and goat farming systems in Greece (O-32)

Mavrommatis Alexandros[1], Mitsiopoulou Christina[1], Bartzanas Thomas[2], Tsiplakou Eleni[1*], Zervas George[1], Pacchioli M. Teresa[3]

*[1]Department of Nutritional Physiology and Feeding, Agricultural University of Athens, Greece; [2]Faculty of Natural Resources & Agricultural Engineering, Agricultural University of Athens, Greece, [3]C.R.P.A. Centro Ricerche Produzioni Animali S.p.A, Italy. *Corresponding author: eltsiplakou@aua.gr*

Greenhouse gases (CH_4, CO_2 and N_2O) contribute to climate change, which is expected to affect animal metabolism, health and welfare, reproduction and performance. Among these gases, methane, which is emitted by ruminants, is orchestrated by various factors, such as: feeding level, milk yield, diets chemical composition, feed digestibility, forage to concentrate ratio, environmental temperature and animal age. Animals excreta (faeces, urine, manure), are also emit greenhouse gases (CH_4, CO_2, NH_3 and N_2O), which amount is depended by their production process and management. In the framework of the European Programme: LIFE "Forage4Climate" were performed experimental trials in the facilities of the Department of Nutritional Physiology and Feeding, in which, the goats and ewes' greenhouse gases emissions (CH_4 and CO_2) were evaluated under the implementation of different forage to concentrate ratios, corresponding to the various farming systems in Greece. More specifically, the forage to concentrate ratio (F:C) in experimental diets were 40:60, 50:50 and 60:40 for the intensive, semi-intensive and extensive systems, respectively. Ewes' methane emissions, expressed as g/day, were proportional to diet

F:C ratio, however, the results were not statistically significant. The extensive farming system (F:C=60:40) in both ewes and goats gave significant higher methane emissions when expressed as g/Kg of milk. However, CO_2 emissions were not affected significantly by the farming system. In conclusion, the small ruminants' intensive farms are emitting less methane compared to semi-intensive, and even less than extensive ones, when the results expressed in g/Kg milk.

Keywords: forages, methane, ruminants

Session II: Flash talks

Impacts of liming on soil biodiversity and GHG emissions from permanent grassland in the heart of Scotland (F-28)

Coyle Mhairi[1,4*]Jonathan Holland[2]; Fiona Fraser[3]; Madeline Giles; Roy Neilson; Helaina Black[1,2]; Clare Cameron[1]; Jagadeesh Yeluripati[1]; Dale King[1]; Susan Mitchell[1]

*[1]The James Hutton Institute, Craigiebuckler, Aberdeen, UK; [2]The James Hutton Institute, Invergowrie, Dundee, UK; [3]University of Aberdeen, Institute of Biological and Environmental Sciences, Aberdeen, UK; [4]UK Centre for Ecology & Hydrology Edinburgh, Midlothian, UK. *Corresponding author: mhairi.coyle@hutton.ac.uk*

Agronomic management practices can impose structural change within soil biotic communities that may change soil processes such as function and biodiversity with subsequent impacts on emissions of greenhouse gases such as N_2O. Liming is a management intervention to mitigate soil acidification with a generally positive effect on crop biomass and potential increases in net carbon storage and reductions in GHG emissions. The application of lime changes soil pH, a known driver of microbial community composition, but it is unknown whether pH derived shifts in bacterial communities result in altered nematode communities or have a significant impact in GHG dynamics. A randomized block field trial with four treatments (control and three liming applications to incrementally increase pH), was undertaken on permanent grassland at the JHI Glensaugh research farm in Aberdeenshire. Liming had a limited effect on nematode and microbial communities but there were indications of shifts in some functional groups that could impact microbial N_2O and CO_2 soil -atmosphere exchange.

Keywords: Grassland, Liming, GHG, Microbial genetics.

Dietary nitrogen efficiency in dairy small ruminants under different farming systems (F-29)

Mitsiopoulou Christina, Alexandros Mavrommatis, Eleni Tsiplakou, George Zervas and Maria Teres Mitsiopoulou Christina[1], Mavrommatis Alexandros[1], Tsiplakou Eleni[1]*****, Zervas George[1], Pacchioli M. Teresa[2]

*[1]Department of Nutritional Physiology and Feeding, Faculty of Animal Bioscience, Agricultural University of Athens, Greece, [2]C.R.P.A. Centro Ricerche Produzioni Animali S.p.A., Reggio Emilia, Italy. *****Corresponding author: eltsiplakou@aua.gr*

Livestock is considered to be responsible for important share of N_2O and volatile NH_3 global emissions, which are produced by fertilizers, feed utilization process, and waste (manure) management. Nowadays, the main livestock challenge is the optimization of energy and protein utilization index, primarily for a sustainable global resources' management, and secondarily for mitigating the environmental burden. Thus, in the framework of the European Programme; LIFE" Forage4Climate", for the determination of dietary nitrogen (N) efficiency in dairy small ruminants were performed experimental trials in the facilities of the Department of Nutritional Physiology and Feeding, in which, the goats and ewes' diet digestibility and N balance were evaluated under the supplementation of different forage to concentrate ratios, corresponding to the various farming systems in Greece. More specifically, the forage to concentrate ratio (F:C) in experimental diets were 40:60, 50:50 and 60:40 for the intensive, semi-intensive and extensive systems respectively. Among other factors, were determined: the digestible N (g/Kg BW*), the retained N (g/Kg BW), the N balance [diet N (g)-milk N (g)-faeces N (g)-urine N (g)], the N utilization for productive purposes [milk N (g)/ diet N (g)], and N efficiency (%){100-[faeces N (g)+urine N (g)/diet N (g)]}. Briefly, the results showed that: (**a**) in F:C= 40:60 ratio (intensive systems) both in goats and ewes' diets, the digestible N was significantly higher compared to other systems, (**b**) the ewes were fed with F:C ratio 40:60 had significantly higher retention of N compared with those of 50:50 and 60:40, and (**c**) the N utilization for productive purposes (milk) was significantly higher in diets F:C= 40:60 and 50:50. * BW = body weight

Keywords: Forages, Nitrogen, Ruminants.

Farmer-based research in rangeland grazing systems in the Falkland Islands (F-30)

McNee Matthew[1], Myrtille Lacoste[2], Simon Cook[3], **Jim McAdam**[4*], Wesley Tourangeau[5], Kate Sherren[6]

*[1]Department of Agriculture, Falkland Islands; [2,3]Curtin University, Western Australia; [4]Queen's University Belfast & Falkland Islands Trust; [5]Dalhousie University, Halifax, Canada; [6]Saint Mary's University, Halifax, Canada. *Corresponding author: jim.mcadam100@outlook.com*

Farmers are an often-untapped source of adaptation and innovation knowledge. The agricultural service in the Falkland Islands has undertaken a program called Farmer-based Research to tap into this valuable resource. Here, we report on early investigations that have uncovered significant interest in an approach that is new for the islands' farmers. The aims of the program are to: (1) support farmers to build knowledge within the specific context of their own farm and individual circumstances (2) develop new insight on processes for continuous improvement on farms (3) highlight opportunities for experts to add value to farmer's own research and; (4) evaluate if and

where digital technologies could upscale information from pooled On-Farm Experiments (OFEs) to provide insight at landscape scales. Experimentation is understood here as a deliberate process of exploration by the farmers to support their learning. In the first three months of the program, 17 of the 83 farms on the islands were visited. Enthusiasm for the program was demonstrated by 10 farmers (i.e. 58% positive response) who proposed a total of 17 OFE projects. Approximately 30% of these were concerned with continuous observation or comparison of management in native pastures, with the remaining OFEs distributed across six other areas of research such as soil, livestock and improved pastures. There were no proposed experiments involving digital technology though there was a call for support with landscape monitoring tools to inform possible changes in grazing strategies. There was also some interest in experimentation with native species in land conservation and restoration efforts. Further investigations should build on these early results to confirm whether interest in Farmer-based Research is sustained, what barriers to implementation exist, and the scope of economic benefits to be expected from this brand-new approach for the Falkland Islands.

Keywords: Farmer-based, Farmer-led, On-farm experiment, Rangelands, Falkland Islands.

N_2O emission and N cycling in mixed composition grassland swards with contrasting soil moisture conditions post urea fertiliser application (F-31)

Bracken Conor J. [1, 2, 3]*; Gary J. Lanigan[3]; Karl G. Richards[3]; Christoph Müller[2, 4, 5]; Saoirse R. Tracy[1, 2]; James Grant[6]; Dominika Krol[3]; Helen Sheridan[1, 7]; Bridget Lynch[1, 7]; Cornelia Grace[1, 7]; Rochelle Fritch[1, 7] and Paul N.C. Murphy[1, 2]

*[1]UCD School of Agriculture and Food Science, University College Dublin, Ireland; [2]UCD Earth Institute, University College Dublin, Ireland; [3]Teagasc, Environmental Research Centre, Wexford, Ireland; [4]Institute of Plant Ecology, Justus-Liebig University, Giessen, Germany; [5]UCD School of Biology and Environmental Science, University College Dublin, Ireland; [6]Teagasc, Food Research Centre Ashtown, Dublin 15, Ireland; [7]UCD Lyons Farm, , Naas, Co. Kildare, Ireland. *Corresponding author: conor.bracken.1@ucdconnect.ie*

Reducing N_2O emissions associated with grassland agriculture systems is imperative to improving food production sustainability. Multispecies swards could help reduce such emissions. Soil emitted N_2O is produced from various N transformation processes. N_2O isotopomers (Site Preference: $\boldsymbol{\delta}^{15}N^{\alpha}$ - $\boldsymbol{\delta}^{15}N^{\beta}$) can be useful indicators of production pathways. A short-term field experiment was undertaken to determine the effects of sward composition (various proportions of perennial ryegrass, white clover and ribwort plantain) and soil water filled pore space (WFPS) (conditions favouring either nitrification or denitrification) on N_2O emissions and N cycling. Urea was prepared with a 2% ^{15}N label and applied to experimental plots at a rate of 40 kg N ha^{-1}. N_2O fluxes and isotopomers were measured by GC and CRDS. Surface soil was periodically sampled to estimate soil mineral-N concentrations. Increasing white clover content from 0% - 60% resulted in a significant increase in cumulative N_2O emissions; 22.3 to 96.2 g N_2O-N ha^{-1} (WFPS < 60%) and from 59.0 to 219.3 g N_2O-N ha^{-1} (WFPS > 60%). Total Oxidisable Nitrogen (TON) concentrations reduced significantly over time, while perennial ryegrass and ribwort plantain had a significant diversity effect on TON concentrations. There was no significant change in NH_4^+ concentrations over time; however, there was a significant white clover and ribwort plantain diversity effect. Results suggest that denitrification mostly drove N_2O production, particularly under wet soil conditions, and that ribwort plantain had an inhibitory effect on nitrification. Results emphasise the importance of managing N fertiliser appropriately for swards containing white clover and that

ribwort plantain in multispecies swards could biologically inhibit nitrification which may be a useful mitigation strategy for N loss to the environment either as nitrate leaching or N_2O.

Keywords: N_2O, Soil N cycle, *Lolium perenne, Trifolium repens, Plantago lanceolata*.

Herby: Carbon storage and grazing management (F-32)

Cliquet Joséphine[1,*] and Poilane Alice[1]

*[1]CAVEB (Coop), France. *Corresponding author: jcliquet@caveb.net*

The Herby® method is a method of grazing based on knowledge of the physiology of grazed pastures. Thanks to a system of fences, animals enter the plot at the 3-leaf stage and leave without having grazed the grass stem. The LIFE+ project, carried out by the cooperative CAVEB from 2014 to 2020, has made it possible to test the sustainability of Herby grazing management. The method has been implemented on more than 130 commercial farms (beef cattle, sheep, dairy cattle) in western France and evaluated by technical and scientific experts (INRAE, CIRAD, CNRS among others). Among the indicators measured, carbon storage has been measured on a sample of 35 pasture plots over three horizons. Over the 5 years, the average storage rate is 1.34T CO2/hectare/year, particularly on the 25-50 and 50-75 cm horizons. The energy performance of the grazing method has been evaluated on a sample of 50 farms. Whatever the livestock system, the energy performance (intensity equivalent litre of fuel oil per hectare and efficiency equivalent litre of fuel oil per unit of production) improves when the share of Herby grazing increases. The impact of Herby on the bocage landscape has been evaluated among 35 farmers through a questionnaire and an in-situ rating. Implementation of the Herby pasture allows the farmer to better understand the benefits of hedges for grazing animals. Samples have been taken from 35 plots of soil and earthworms. Despite a high instantaneous charge, Herby has no negative impact on earthworms or the soils' microbiological life. The Herby method is a lever for the energy and climate transition in the years to come.

Keywords: SOC density, Agriculture, France, Grazing, Grassland.

Effects of concentrate supplementation on milk yield, methane and CO_2 production in crossbred dairy cows in tropical climate regions (F-33)

Robles Jimenez L.E[1]., Xochitemol H. A.[2], Benaaouda M[3], Osorio Avalos, J[1]., Corona G. L[2]., Castillo G. E[2], Castelan Ortega O.A[1]. and González-Ronquillo M[1]*

*[1]Facultad de Medicina Veterinaria y Zootecnia, Departamento de Nutrición Animal. Universidad Autónoma del Estado de México, Mexico; [2]Facultad de Medicina Veterinaria y Zootecnia. Universidad Nacional Autónoma de México. Av., México; [3]INRA France, Unité Mixte de Recherche sur les Herbivores, Saint-Genès-Champanelle. France. *Corresponding author: mrg@uaemex.mx*

The objective of this study was to evaluate the level of concentrate supplementation on the production and chemical composition of milk from 12 crossbred F1 dual-purpose cows (½ *Bos taurus* – ½ *Bos indicus*), and estimate the emission of CH_4, N_2O and CO_2 gases using the Tier II methodology (IPCC, 2006), additionally calculating a Ym factor for tropical environments

(Montoya-Flores et al., 2020) and comparing the emission values. The study included 12 crossbred F1 dual-purpose cows over 60 days of lactation. The cows grazed on 28% tropical native grassland and 72% *Brachiaria spp.* and *Cynodon neumfluensis,* supplemented with 0, 150, 300, and 450g of concentrate per kg daily milk production, during three experimental periods of 15 days each in a crossover design. Pasture and concentrate samples were collected, and were analyzed for dry matter, crude protein, neutral detergent fiber, and acid detergent fiber. Milk production (kg d^{-1}) was recorded daily, nitrous oxide (N_2O), and emissions from excreta and daily CH_4 production were calculated. Results were analyzed with the SAS MIXED procedure. Concentrate supplementation in tropical crossbred dairy cows did not improve milk yield but increased CH_4 and N_2O production ($P < 0.0001$) per cow as the concentrate increased in the diet; the Ym factor from the tropical region yielded less CH_4 than the IPCC Ym model ($P < 0.0001$). In conclusion, the calculation of CH_4 using specific emission factors for the tropical climate region is better than the IPCC default emission factors in order not to overestimate the CH_4 emissions.

Keywords: Tropical pastures, Supplementation, CH_4, N_2O.

Risk analysis of N leaching from grasslands under different management practices (F-34)

Klumpp Katja*, Frederique Louault, Isabelle Bosio, Laurence Andanson and Olivier Darsonville

INRAe, VetAgro Sup, Université Clermont Auvergne, UMR Ecosystème Prairial, Clermont Ferrand, France. Corresponding author : katja.klumpp@inrae.fr

The European regulations require additional information such as indicators, in particular under grazed and fertilised grasslands, in order to reduce nitrate levels in water while maintaining production. On farm level, the nitrogen cycle is particularly complex, due to the diversity and importance of involved regulatory factors (i.e. inputs, recycling, and uptake) and their interactions such as fertilization practices and use, type of vegetation cover, grazing animals, as well as soil and climatic characteristics. Nitrogen (?) losses under grassland may range from 0 (properly fertilized hay meadows) to more than 100 kg $ha^{-1}yr^{-1}$ under intensely fertilized grazing grasslands. These losses and the associated risks are significant when vegetation cover is damaged due to trampling, excessive biomass removal, or following climatic events (severe, intense droughts). The French observatory on permanent grasslands (SOERE ACBB) is dedicated to study long-term effects of management on ecosystem functioning, in particular on biogeochemical cycles and biodiversity. Setup in 2003, the observatory allows *in situ* monitoring of grassland fields (32 in total) subjected to contrasting management (mowing, grazing with low and high use, high and low level of nitrogen inputs). The fluxes of C and N toward the atmosphere (N_2O emission) and hydrosphere (leaching) have been monitored since 2010. Analyses of long-term data series showed strong variations in leached N (3 to 50kg N ha^{-1} yr^{-1}) among climatic years and soil types. Concerning climatic years, dry climatic years affected more (i.e. higher losses) in intensively managed grazed grasslands and fertilised paddocks compared to extensive grazing. Likewise, paddocks on volcanic soil had higher losses than under granitic soil even though some fields received high N inputs. Accordingly, there are needs to better include year-to-year seasonal climate evolution, biomass growth and soil properties, when aiming to reduce N losses.

Keywords: N leaching, Animal stocking rates, Fertiliser rates.

Theme 5: Socio-economic Costing

Keynote presentation

Mitigation of greenhouse gas emissions from agriculture: An economist's perspective (K-5)

De Cara Stéphane*

Economie Publique, INRAE, AgroPArisTech, Université Paris-Saclay, France. Corresponding author: stephane.decara@inrae.fr

Agriculture plays a substantial role in the accumulation of greenhouse gas (GHG) emissions in the atmosphere. This sector will also be pivotal in meeting the objective of keeping the global temperature increase below 2°C. Yet, agricultural emissions are often excluded from the scope of climate policies, leaving the mitigation potential in this sector largely untapped. We explore various reasons that may explain the reluctance of policymakers to implement policies incentivizing cost-effective mitigation in this sector. Among the possible reasons, we focus on those related to (i) the technical feasibility of GHG mitigation options in the agricultural sector, (ii) the costs of reducing agricultural GHG emissions relative to mitigation costs in other sectors, (iii) the administrative costs related to the control and monitoring of GHG emissions and abatement, (iv) the regressive distributional impacts that market-based instruments may have on farmers' income. We review the recent literature in applied economics that addressed these issues in the European and global contexts. Based on this review, we argue that, from an economic perspective, none of these reasons alone justifies the exclusion of agricultural emissions from the scope of climate policies. Technical mitigation options do exist in agriculture, and many of them can be deployed at costs that are found to be lower or comparable to those prevailing in other sectors. Given the mitigation potential associated with current estimates of the social cost of carbon, the inclusion of agriculture could substantially reduce overall mitigation costs. Monitoring and other transaction costs may be a barrier to the implementation of market-based instruments, but this difficulty can be overcome through adjustments in the policy design, e.g. through an emission tax targeting only the largest emitters. Similar adjustments, combined with appropriate transfers, can also mitigate the regressive impacts of an emission tax on agricultural GHG emissions.

Keywords: Marginal abatement costs, Design of climate policies, Agricultural economic models, Monitoring costs, Distributional impacts.

Session I: Oral presentations

Untangling the social ecological dynamics of soil carbon management in dryland agricultural systems of Australia (O-33)

Amin Md N.[1,3*], Lisa L. de Bruyn[1], Md S. Hossain[2], Andrew Lawson[1] and Brian Wilson[1]

[1]School of Environmental and Rural Science, University of New England, Australia; [2]Institute of Geography, University of Bern, Switzerland; [3]Department of Environmental Science, Patuakhali Science and Technology University, Bangladesh. Corresponding Author: mamin8@myune.edu.au

Recent research evidence supports the importance of understanding the linkages between the social-ecological system (SES) variables of soil carbon management (SCM) in Australian agriculture for sustainable production in a changing climate. This study attempted an interdisciplinary approach (e.g. Ostrom's SES framework) to explore the relationships of the social-ecological variables for SCM of the dryland agricultural system of New South Wales Australia. The relationships between variables and their associated indicators were explored by farm-level interviews (N=25) in terms of resource systems, the environment, the governance systems, and actors. Through participatory workshops with scientists and farmers, the causal relationships (e.g. interactions, feedbacks) of SES indicators of SCM were examined. Initial results suggest that farmers choose management practices to build carbon for a number of reasons but the information on soil properties, climatic conditions, and landscape characteristics have limited influence on their choices. However, these environmental variables have been shown in the literature to predominantly influence the long-term sequestration of soil carbon in grazing lands. More than half (69%) of the interviewed farmers were aware about uncertainty of the government carbon policy (e.g. climate solution funds). Farmers' social network informally established information on carbon building processes, focused on increased production, good soil health and adverse climate adaptations. This study developed a more comprehensive SES framework of SCM based on farm level information on the variables and their relationships. The formative SES framework is instructive to policymakers and farmers to understand the SES dynamics of the dryland argi-environmental systems of Australia to achieve the Sustainable Development Goals 2, 13 and 15.

***Keywords*:** Social-ecological dynamics; Agri-environmental systems; Soil carbon management, Dryland grazing.

The potential impact of an EU-wide agricultural mitigation target on the Irish agriculture sector (O-34)

Adenaeuer Lucie[1]*, James Breen[1], Peter Witzke[2] and Monika Kesting[2]

*[1]UCD School of Agriculture and Food Science, University College Dublin, Ireland;[2] EuroCARE, Nussallee 21, Bonn, Germany.*Corresponding author: lucie.adenaeuer@ucd.ie*

The international Paris agreement on limiting global warming has increased the pressure to reduce total national GHG emissions or at least slow the growth. The recently published Irish Climate Action Plan has outlined the leading role which the agriculture sector will have to take. We use the agricultural sector model CAPRI to investigate the impact of an EU-wide agricultural mitigation target (-15% for Ireland) on Irish agriculture production levels and prices as well as the likely consequences for trade in agricultural outputs. A range of mitigation technologies, implemented in

the model under the EcAMPA2 project, can be chosen endogenously. Three scenarios developed under the EcAMPA2 project will show the range of possible impact that such a policy target could have. In all three scenarios, a reduction of agricultural GHG emission is achieved either through a reduction in activity levels and/or the application of mitigation technologies. The biggest changes take place in the Irish livestock sectors. For the beef sector, all policy scenarios indicate some considerable efficiency gains, as meat production decreases less than the herd size. Due to a decrease in supply and to the restrictive EU border measures, producer prices for meat increase. In the dairy sector, milk production increases in all scenarios while herd size decreases only moderately. Producer prices for milk are projected to increase for all three scenarios. Changes in other sectors are moderately positive. This adaptation leads to an increase in Irish farmers' income due to higher producer prices and subsidies paid. As structural change is not considered in CAPRI, changes in the number of farmers is unknown. These findings suggest that even though the impact on the main Irish agricultural sectors is significant, supporting the implementation of mitigation technologies through subsidies can buffer the impact while at the same time reducing Irish agricultural GHG emissions to the set target.

Keywords: Irish agriculture, GHG emission, Agricultural mitigation, CAPRI model.

Exploring farmer preferences for insurance against extreme weather events: Results from a discrete choice experiment study of Irish farmers (O-36)

Doherty Edel*

*National University of Galway, Ireland. *Corresponding author: edel.doherty@nuigalway.ie*

Agriculture is facing significant challenges in responding to changing weather patterns caused by climate change. One of the key challenges is the increasing frequency and intensity of extreme weather events. Climate resilient insurance has been discussed as a key mechanism to overcome financial losses posed by extreme weather events and enable long-term farm planning. Despite this, few studies in developed countries have examined preferences for climate-related insurance amongst farmers. In this paper, we use the discrete choice experiment (DCE) method to assess farmers' preferences for insurance to protect against agricultural losses caused by extreme weather events. Within the DCE, we assess farmers' preferences for the length of insurance contracts, the type of damage assessment (traditional on-farm inspection versus weather- indexed insurance) and insurance costs. We use data collected from a representative sample of 270 farmers in Ireland in 2019. Our results show that farmers' value insurance against extreme weather events at approximately €220 per year and approximately 70% of farmers indicated a willingness to buy climate-related insurance. Moreover, a significant proportion of farmers favoured certain on-farm adaptation measures to extreme weather events

Keywords*:* Agriculture, Severe weather events, Insurance, Adaptation strategies.

Recycling-derived phosphorus fertilizers as replacement for triple superphosphate – Impact on soil microbiota functions and plant growth (O-38)

Deinert Lea[1*], Israel Ikoyi[1] and Achim Schmalenberger[1]

*[1]Department of Biological Sciences, Faculty of Science and Engineering, University of Limerick, Limerick. *Corresponding author: lea.deinert@ul.ie*

Phosphorus (P) is an essential macronutrient for all living organisms and is applied as fertilizer in agroecosystems to improve crop growth. Currently mineral P fertilizers are produced from phosphate rock, which is sourced from mines mainly located in Morocco, USA, Algeria and needs to be imported to Europe. Meanwhile, disposal of nutrient-rich waste poses a threat to the environment, causing eutrophication of surface waters. Recycling-derived fertilizers (RDFs) have been developed for nutrient recovery from Europe's largest waste streams as a sustainable alternative to this finite resource. The impact of four RDFs (two ashes, two struvites) on the soil microbiome in comparison with a P-free control and triple super phosphate (TSP) as mineral fertilizer was investigated in a pot trial and microcosm trial. For both experiments perennial ryegrass was cultivated for 54 days. The pot trial was conducted at P fertilization rates of 20 and 60 kg P ha^{-1} in quadruplicates. Bulk soil from the pot trial was then re-used in microcosms (control, TSP, two ashes at 60 kg P ha^{-1}) in six replicates. Pot trial results showed highest P bioavailability from struvites at high P rates, also resulting in higher biomass yield on average. Furthermore, bacterial P solubilization capabilities from tri-calcium phosphate was enhanced in the RDFs treatments, while the TSP treatments were negatively affected. For the microcosm trial, most probable number (MPN) analysis showed that phytate-utilizing bacterial abundance was significantly increased in one of the ashes, while the MPN values had been similar for all treatments in the pot trial. Understanding the effects of fertilizer application on the soil P cycle and the development of alternative sources for P fertilizer production are vital foci for a more sustainable, environmental-friendly agriculture.

***Keywords*:** Bio-based fertilizers, Grassland soils, Microbial mineralization, Nutrient-recycling, Phosphorus.

Session II: Flash talks

Integral resilience of traditional home gardens in the face of climate change to contribute to sustainable development in Mexico (F-35)

Rajagopal Indumathi[1*], Jesús A. C. Sánchez[1], José L.R. Lozano[1], Teodoro G. Hernández[1] and Julio B. del Moral[1]

*[1]Doctoral Program of Multifunctional Agriculture for Sustainable Development, Department of Fitotecnia, Universidad Autónoma Chapingo, Mexico.*Corresponding author: indhu16r@gmail.com*

Climate change is one of the human-induced global environmental challenge diminishing the ability of the existing traditional agroecosystems such as homegardens to withstand expected and unexpected disturbances, and consequentially endangering the livelihood of indigenous people

who depend on them in many rural parts of Mexico. Measuring ecological and cultural resilience mechanism of these systems, at different spatial and temporal scales could provide valuable insights to re-design and develop coping adaptation strategies that contribute to achieving sustainable development. In this context, the objective of this study is to assess the role of agrodiversity to enhance the integral resilience of the existing traditional homegardens in the face of climate change. A risk analysis of extreme climatic events was conducted for the period of 1998-2018, in Santiago Ecatlan, an indigenous community with Totonac culture in the Municipality of Jonotla, State of Puebla. A total of 12 households were selected to assess the existing agrodiversity in it. Semi-structured interviews, participant observation, and ethnobotanical exploration were employed for data collection. Also, the diversity index was calculated using the software Excel and PAST 4.0 (Paleontological statistics software package for education and data analysis). Until now, the results showed that a total of 101 plant species belonging to 44 families, 92 genera and 10 species with 24 varieties were recorded. The maximum value of species richness according to Margalef and Menhinick index was 10.06 and 49 respectively. Regarding the species abundance in terms of equitability and dominance, the maximum value registered based on Shannon-Wiener and Simpson index were 3.697 and 0.971 respectively. Around 15 categories of use, as well as more than two forms of use for each species, were recorded. To conclude, homegardens with high species diversity and functional utility contribute to increasing ecological, economic and cultural resilience in face of adverse environmental and socio-cultural challenges.

***Keywords*:** Agrodiversity, Agroecosystem, Biocultural heritage, Conservation, Totonac.

Reducing uncertainty in quantifying and reporting GHG emissions and carbon sequestration from European farming landscapes. (F-36)

Islam Syed F.[1], Mohammad. I. Khalil[1,2] and Bruce A. Osborne[1*]

*[1]UCD School of Biology & Environmental Science, University College Dublin, Ireland; [2]Prudence College Dublin, Ireland.*Corresponding author: bruce.osborne@ucd.ie*

Although IPCC methodologies appropriate for national-level accounting purposes, they lack the farm level resolution and holistic approach required for whole-farm systems analysis. The importance of evaluating greenhouse gas (GHG) emissions from crop production, animal farming and agroforestry within the whole farm setting is being realized as more important than evaluating these emissions in isolation. Here we compare three whole-farm models e.g. FarmSim, Holos and IFSM to simulate the effect of management practices on GHG emissions at the whole farm level and evaluate the carbon sequestration and methane oxidation potential of afforestation as a compensation mechanism for the mitigation of farm-level GHG emissions. Ideally, we would also want information on model performance in predicting GHG emissions in future climatic scenarios. Initial results indicate that these models can accurately predict CO_2 emissions but the accuracy of these models for predicting methane (CH_4) and nitrous oxide (N_2O) emissions is quite low. We found that the most prominent drivers for GHG emissions in a whole farm setting were the enteric CH_4 from animal farming and N_2O emissions from soil management in cropland. Thus, the low prediction accuracy for CH_4 and N_2O emissions in whole-farm models may introduce substantial errors into GHG inventories and lead to incorrect mitigation recommendations, which necessitates further fine tuning of these models. Efforts are ongoing to integrate mitigation potential of farm-level afforestation in the whole farm models. The variation we found in farm system parameters, and the inherent uncertainties associated with emissions can have substantial implications for reported agricultural emissions requiring uncertainty or sensitivity analysis in any modelling approach. Although there is considerable variation among the quality of farm data, boundary assumptions, the emission factors used we suggest that whole-farm systems models are an

appropriate tool to develop and measure GHG mitigation strategies for the European farmed landscape.

Keywords: Greenhouse gas emissions, Carbon sequestration, Modelling, Mitigation, European farming landscapes.

Does the current use of land in Ireland result in feed food competition? (F-37)

Hennessy Donagh P.[1]*, Imke J.M. DeBoer[2], Laurence Shalloo[1], and Hannah H. Van Zanten[2]

*[1]Teagasc, Animal & Grassland Research and Innovation Centre, Fermoy, Co. Cork, Ireland; [2]Animal Production Systems Group, Wageningen University & Research, Wageningen, the Netherlands. *Corresponding author: donagh.hennessy@teagasc.ie*

The objective of this study is to examine whether Ireland's cattle and pig systems and the land they use are positive contributors to the global supply of human edible protein, this is calculated using the Land Use Ratio (LUR). The LUR accounts for feed-food competition; this is when food yields from agricultural land declines as the land-use is redirected into livestock systems that are not as high-yielding. Assessing feed-food competition using the LUR is done by comparing the opportunity cost of the edible protein from the potential crops foregone against the actual animal edible protein provided. As 92% of Ireland's agricultural land is pasture, ensuring that the current ruminant systems are feed-food efficient is important when planning the role of the ruminant systems in Ireland's future-food system. To calculate the area of land used, the complete diet of the animal and its sources were calculated. This nutritional data of the average Irish dairy animal and her beef calf, the suckler-beef animal and their dam, and the pig animal and its sow were sourced to provide a sum of feed consumed in 1 year. The land-area used in the country of origin for feed was calculated, along with the area of pasture used for ruminant fodder which is capable to grow arable crop. To account for the potential crop foregone, an average yield from five sustainable crop rotation in Ireland, and an average yield of the two highest yielding crops from a group of 10 common crops was selected for each country that feed is imported from. This provided the opportunity cost of the edible protein from the crop foregone to provide the edible animal protein for the LUR. The LUR value for dairy beef is 0.54, for suckler-beef is 2.04, and for pig is 1.34. This means that for the dairy beef system, if it was removed then the arable land it used could only replace 0.54 kg of crop sourced edible protein for every 1 kg of animal sourced protein that is produced. This demonstrates that the current grass based dairy beef system is a positive contributor to the global protein supply and should be considered part of a future food system. Further, it demonstrates that livestock systems on grass like the ruminant suckler systems are not necessarily positive contributors to the global supply of human edible protein.

Keywords: Land-use, Feed-food, Competition, Efficiency, Grass.

Supporting the three pillars of sustainability through innovation residencies with Irish and Welsh SMEs in the food and drink sector

(F-38)

Fitzgerald Joanne B.[1]*, Lynne Whelan[1,2], Colin Eyre[1,2], Nicola Dowdle[3], Chris Holtom[3] and Brian Ogilvie[1]

*[1]Institute of Technology Carlow, Ireland; [2] DESIGN+, Dargan Research Centre, Institute of Technology Carlow, Ireland; [3] Creative Industries Research and Innovation Centre, University of Wales Trinity Saint David, Swansea, Wales. *Corresponding author: joanne.fitzgerald@itcarlow.ie*

Food systems are seeing myriad sustainability challenges and the need for transformation is increasingly acknowledged. Primary production has seen a rapid intensification in recent years. However, in tandem with this there has been increased emphasis on local produce, with consumers seeking high quality food that has been produced in a manner that is sympathetic to the environment. Catalyst is an Ireland Wales programme project that fosters sustainable innovation in SMEs in the food and drink sector located in South East Ireland and South West Wales. As part of the Catalyst project, an Innovation Residency programme was developed that saw SMEs conducting R&D with Higher Education Institutes; Institute of Technology, Carlow and University of Wales Trinity Saint David, enabling cross-border collaboration to take place. In Catalyst, a residency is defined as the convergence of a defined group of people with a common objective over a condensed period of time supported by a variety of focused inter-connected activities to build a group dynamic. The residencies aim to identify and address individual opportunities and form a self-retained network. In the residencies, the focus was around live projects with real and current needs and sustainability at the core. In 2019 the participants physically visited Institute of Technology Carlow for an intensive 3-day program. Similar events were planned for 2020 however the program was completely revisited in light of the COVID19 pandemic and changed to online delivery over a period of one month in a combination of short group and 1-1 sessions and seminars. Participants concluded both residency formats with a roadmap towards tackling their identified challenges and a business support network among their fellow participants in Ireland and Wales. Residencies such as this where SMEs collaborate with higher education institutes, and each other, support the resilience and sustainability of rural business.

Keywords: Primary producer, Sustainable supply chain, Rural renaissance.

Theme 6: Agro-Silvo-Pastoral Systems

Keynote presentation

The potential of agro-silvo-Pastoral systems to address climate resilience and mitigation (K-6)

McAdam Jim*

*School of Biological Sciences, Queen's University of Belfast, Belfast BT71NN, Northern Ireland. *Corresponding author: jim.mcadam100@outlook.com*

In Agro -silvopastoral systems, trees are mixed with crops and/or animals on the same unit of land and can deliver a range of ecosystem services resulting from significant ecological, environmental and economic interactions between the components. They are land use systems which are sustainable, prevent environmental degradation and have the potential to reduce greenhouse gas emissions and create resilience to potential climate change impacts. Evidence and examples will be presented for agro-silvopastoral systems delivering ecosystem services such as: food production from crop and pastureland to meet increased population demand, soil zonal exploitation by roots, greater water infiltration and reduced run-off for flood mitigation, earlier turn-out of livestock in wetter climates leading to an extended grazing season and reduced ammonia emissions, reduced fire risk from understorey in seasonally dry areas, reducing evapotranspiration during drought stress, extraction of excess nutrients from soils resulting in reduction in nutrient leaching and better soil nutrient balance, reduced soil erosion, enhanced carbon sequestration over pasture and cropping systems, increased biodiversity and a more welfare-friendly environment for livestock production. Underpinned by the appropriate science and exploiting the range of ways in which woody plants can be incorporated into mixed farming systems, agro-silvopasture has the potential to deliver greater food security and carbon-neutral livestock systems. These can help mitigate the effects of potential climate change and support the retention of a farming and wider rural community which will be capable of delivering more resilient land use systems which will have the potential to deliver nutritional food while creating the opportunity to substantially increase tree cover and meet the policy objectives embodied within this vision.

Keywords: Silvopasture, Carbon-neutral farming, Climate resilient, Ecosystem services delivery.

Session I: Oral presentations

Sustainable agroforestry in a drier world: lessons from Sinai (O-40)

Norfolk Olivia[1*], Markus Eichhorn[2] and Francis Gilbert[3]

[1]*Anglia Ruskin University, UK;* [2]*University College Cork, Ireland;* [3]*The University of Nottingham, UK. *Corresponding author: Olivia.Norfolk@anglia.ac.uk*

Understanding the role agroforestry plays in extreme climates can deliver insights that will allow us to design more resilient and sustainable agricultural systems for future climate change. The

Sinai Peninsula is among the most arid inhabited regions with less than 100 mm rainfall per year, almost all of which falls during irregular downpours. Nevertheless, the Bedouin of central Sinai have maintained permanent cultivation in the wadis which documentary and archaeological records attest to have persisted for over 1000 years. Rainwater collection slows percolation whilst walled gardens create microclimates that enable a combination of fruit trees and crop plants to be grown. In a series of studies over ten years we have mapped a network of gardens in the St Katherine Protectorate of central Sinai, documenting the botanical composition (agricultural, domestic and wild plants), insect pollinators and bird communities in over 40 sites. These demonstrate that the gardens maintain a higher diversity of plants (including native flora) and insects than adjacent unmodified habitat, as well as providing resting sites for migratory birds. By attracting a diverse range of pollinators, often attending non-commercial household plants, production of crops is enhanced. This was tested through pollination trials of almonds, the most common orchard crop, showing enhanced fruit production following pollination by wild species, but no effect of honeybees. Flowering crops also maintain pollinator populations at the landscape scale by providing a succession of floral resources which extend beyond the seasonal availability of wild species. While not suited to extensive production, small but diverse agroforests can therefore play a landscape-level role in supporting regional diversity and enhancing essential ecosystem services.

Keywords: Agroforestry, Silvoarable, Egypt, Drylands

Extensive livestock farming in the Iberia Dehesa agroforestry system: food that mitigates climate change (O-41)

Llorente Mireia* and Gerardo Moreno

*INDEHESA, Universidad de Extremadura, Plasencia, Cáceres, Spain. *Corresponding author: mllorente@unex.es*

The number of agro-silvo-pastoral systems associated particularly with beef/meat and dairy production has been increasing globally. Among these systems, the Iberian Dehesa is a High Nature Value farming system that likely produces food with low carbon (C) emissions. There is still few data on how much of the emissions of extensive livestock that grazes different type of grasslands can be compensated by the carbon sequestration capacity of the system, both in plant biomass and soil organic matter. Field soil monitoring, National Forest Inventory information, spatially-explicit databases of climate, and structured surveys to farmers, allowed us to calculate the Carbon Footprint, based on a Life Cycle Analysis, of some of the principal livestock products (meat, wool and milk) produced in the Iberian Dehesa agroforestry systems. The average emission estimated at farm scale ranged from 1.5 to 3.5 Ton of CO_2-eq/ha/year, depending on livestock type, herd management, size of the farm, off-farm supplies and ecosystem management. On the other side, soil and tree biomass together sequestered an average of 3.3 Ton of CO_2-eq/ ha/year. We also found that the C sequestration capacity seems enhanced by regular grazing. Finally, our data allowed us to estimate that the potential C storage capacity of soils of Dehesa (around 2.8%) is still far from the current average content (1.7%), indicating that the ability of soil of Iberian Dehesa to capture and store C can be maintained for many years. In conclusion, the Carbon Footprint of beef, wool and dairy production derived from extensive livestock that grazes Iberian Dehesa showed that, a proper livestock and grass management, enable to produce low carbon livestock-based foods, and even contribute to the net sequestration of greenhouse gases.

Keywords: Life Cycle Analysis, Carbon footprint, Soil carbon, Tree growth, Dehesa system.

The use of silvopastoral management at farm level to mitigate greenhouse gas emissions (O-42)

Kinsella James[1] and Brian Tobin[2,*]

[1]Coillte, Ireland; [2]University College Dublin, Ireland. Corresponding author: brian.tobin@ucd.ie

The agriculture sector is the largest contributor to Ireland's greenhouse gas (GHG) emissions accounting for 33.3% of national emissions in 2017 (EPA, 2018). Increasing food production or even maintaining current levels, as proposed under FoodWise 2025 policy, will be difficult while reducing emissions to meet 2020 and 2030 reduction targets set by the EU Effort Sharing Decision. A life cycle assessment (LCA) method was used to quantify GHG emissions from a typical Irish beef production system and to evaluate the results of four scenarios incorporating various levels of agroforestry and hedgerow enhancement measures. The scenarios developed examined the impact of converting 15%, 20% and 25% of a representative farm's total land area to silvopastoral management. By scaling total GHG emissions relative to a functional unit (FU) of animal live weight sold per year (kg CO_2 kg LW^{-1} yr^{-1}), it was possible to estimate both the emissions and the potential for emissions reduction by adopting alternative management scenarios. A typical suckler-beef system was estimated to produce on average 13.6 kg CO_2 kg^{-1} LW yr^{-1}. The results of scenario analysis showed that the case study farm would be required to convert just over 25% of their total land area to silvopastoral management in other to mitigate all animal-based GHG emissions on the farm.

Keywords: Silvopastoral system, Life cycle analysis, Trees-on-farms.

Impact of agroecological practices adopted by farmers on soil organic carbon stocks in the central highlands of Madagascar (O-43)

Rakotovao Narindra H.[1]*, Tantely M. Razafimbelo [1], Angelina R. Rondrotsifantenana [1], Alain Albrecht [2]

*[1]Laboratoire des Radiosotopes, University of Antananarivo, Madagascar; [2] IRD, UMR Eco&Sols, Station Ligne Paradis, La Réunion, France. *Corresponding author: n.rakotovao@yahoo.fr*

In the Central Highlands of Madagascar, Itasy Region, agroecological practices were promoted to improve farmers' income while ensuring sustainable management of natural resources. These practices were agroforestry (AF), on-farm tree plantation (TP) and the use of organic fertilizers such as compost and improved manure (CIM). This study aimed to assess the impact of each of these agroecological practices on soil organic carbon (SOC) stocks compared to conventional practices. Soil survey was carried out on 712 farmers' fields in order to know the practices' history of each plot and to define chronosequences expressing the range of agroecological practice duration. Composite soil samples at three depths (0-10, 10-20 and 20-30 cm) were collected from these 712 farmers' plots to evaluate SOC stocks; the two main soil types of the Itasy Region are Ferralsols and Andosols. Results showed that soil type was a main determinant of the spatial variability of SOC stocks. Agroforestry based on fruit species associated with annual cash crops (legume, tomato) aging more than 8 years and fertilized regularly with CIM at a rate of 8.4 t ha^{-1} presented the highest SOC sequestration rate estimated at 2.4 Mg C ha^{-1} yr^{-1} compared to annual crops without fertilization. SOC sequestration rate of 0.4 Mg C ha^{-1} yr^{-1} was observed on growing vegetables for market fertilized with CIM at a rate of 10.2 t ha^{-1}. SOC stocks for TP sites presented no difference compared to traditional practices, because the fields chosen by farmers for TP were

generally already degraded uncultivated plots and TP sites were not fertilized. This study highlighted the capacity of some agroecological practices adopted by farmers to improve SOC stocks. However, the capacity of these practices to actually contribute to climate change mitigation is strongly dependent on the duration of their implementation.

Keywords: SOC sequestration, MIRS, Compost, Agroforestry, Smallholder.

Sustainability of intensified agricultural production in the Boyne catchment (O-44)

Courtney Daniel*

*ICARUS, Maynooth University, Ireland. *Corresponding author: courtneydaniel45@gmail.com*

Food Harvest 2020 was devised as a national plan for intensification of Irish agriculture with specific targets to be delivered by 2020. The plan envisaged increases to output across a range of farm enterprises – dairying, beef, sheep and pigs. The motivation for this study was to examine the environmental sustainability of the Food Harvest 2020 targets. The study was carried out on the River Boyne catchment area in Ireland. A wide-ranging environmental systems analysis was carried out to assess the environmental impacts associated with the intensification of agricultural production envisaged in Food Harvest 2020. The following environmental impacts were assessed using Life Cycle Assessment (LCA) modelling: Global Warming Potential, Eutrophication Potential, Acidification Potential and Primary Energy Use. Following an extensive review of published literature and consultation with expert opinion, the Cranfield LCA Agricultural Systems Model was selected to carry out the analysis. This model proved to be very suitable and it was specifically developed for agri-environmental purposes. The modelling identified significant increases in environmental impacts associated with intensification of livestock production in the River Boyne Catchment. These are presented in the table below.

Table 1: Consequences of intensifying livestock systems (FH2020)

Environmental Impact Category	Change resulting from FH2020
Global Warming Potential	Increase of 10%
Eutrophication Potential	Increase of 7%
Acidification Potential	Increase of 11%
Primary Energy Use	Increase of 23%

Keywords: Sustainability, Global warming, Eutrophication, Acidification.

A delay differential equation approach to modelling the effect of climate variability on smallholder cocoa yield in Ghana (O-45)

Haughey Eamon[1*], Nicholas C. Cryer[2] and Lorna R.M. Wilson[3]

*[1]School of Natural Sciences, Trinity College Dublin, Ireland; [2]Mondelez UK R&D Limited, Birmingham, United Kingdom; [3]Institute for Mathematical Innovation, University of Bath, United Kingdom.*Corresponding author: ehaughey@tcd.ie*

Cocoa (*Theobroma cacao*) is an economically important crop grown by approximately six million of smallholder farmers throughout the tropics and sub-tropics. However, farm level yields are often

low, and sustainable intensification in the sector is urgently required. Assessing the impact of good agricultural practices on yield requires an understanding of the contribution of inter-annual climate variability to cocoa yields. Here, a Delayed Differential Equation model (DDE) was used to simulate the effect of rainfall on cocoa yields. A DDE model is an ordinary differential equation model that incorporates time lags and is therefore able to incorporate the delay in yield response to rainfall due interactions with the cocoa flowering and the pod development processes. The DDE was constructed and based on regional rainfall and farm-level cocoa yield data from 96 farms across the main cocoa growing regions in Ghana (Fig. 1). Model outputs indicate that a good likeness of seasonality in crop production was achieved. There is potential to conduct a detailed parameterisation of this model and to extend it to include parameters such as agrochemical inputs and crop management. Further developing this model could be used to predict and understand variability in cocoa yield and therefore support the sustainable intensification of small holder cocoa farming.

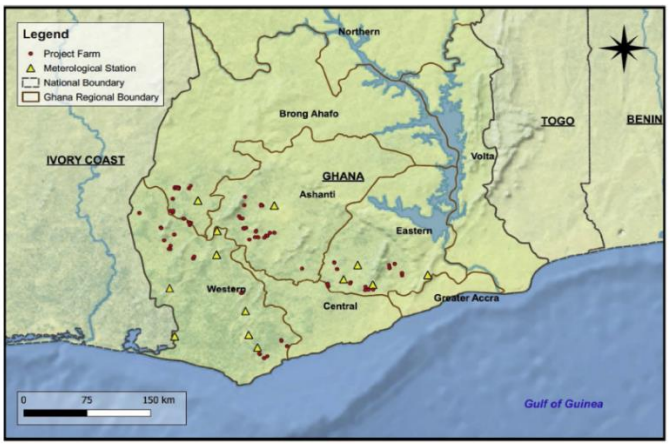


Fig. 1. Map shows the locations of 96 cocoa farms across the four main cocoa growing regions in Ghana (Ashanti, Brong-Ahafo, Eastern and Western Regions) and the locations of 13 meteorological stations.

Keywords: Climate variability, Crop model, Cocoa, Sustainable intensification, Delayed differential equation.

Approximation to the greenhouse gases (GHG) emissions from Mediterranean dryland vineyards (O-46)

Teira-Esmatges M. R.[1]*, F. Herralde[2], X. Aranda[2], C. Biel[2], R. Savé[2] and P. Sànchez-Calderer[2]

*[1]Department of Environment and Soil Science, University of Lleida, Spain; [2]IRTA Torre Marimon, Caldes de Montbui (Barcelona), Spain.*Corresponding author: rosa.teira@udl.cat*

Vineyard is an important crop in Spain (967 234 ha) constituting 4% of the agricultural land, and 2% of that in Europe. The winegrowing Spanish sector creates 7% of the direct employment and 8.5% of the gross value added of the food and drinks industry. Wine has become one of the main exported Spanish agri-food products (10.3% of this industry exports). Vineyard is known to be an important C sink and maintains a valued landscape. The soil physical chemical properties, fertility and microbiology on which vineyards are grown influence greenhouse gases (GHG) emissions. Agronomical practices, as fertilisation or soil green cover will also determine the GHG emissions. This study was conducted with the aim of approximating the emission factor of this crop under the most common agricultural practices in dry land in Spain. The effect of the type of fertiliser and soil green cover on the GHG (N_2O, CH_4 and CO_2) emissions were monitored (1) in spring-summer 2018 at low intensity in a monitored large and variable commercial field, (2) from May to August

2018 on a rhizotron and, (3) twice per week from May 2019 to January 2020 (and on) on a monitored experimental field with organic and mineral fertiliser. Closed semi-static chambers were used for sampling the gases as described in Maris et al. (2015). Its quantification was done by the photoacoustic technique (Innova 1412 Photoacoustic Multigas Monitor). The preliminary results of 2019 show that N_2O-N emissions from vineyard could be disregarded as they are in the order of g ha^{-1} throughout the growing season, CH_4 emissions were also close to zero (from 10 to 60 g ha^{-1}), while CO_2 emissions ranged from 3 to 8 kg ha^{-1}. These results suggest a rethinking of the potential emissions of Mediterranean rainfed woody crops is needed.

Keywords: N_2O, CH_4, CO_2, Cow manure, Woody crops.

Session II: Flash talks

Effects of maize grain or maize silage supplementation on milk yield, methane and CO2 production in dairy cows grazing in temperate regions (F-40)

Robles Jimenez L.E[1], Maria D. Celis-Alvarez [1], **Sergio Radic**[2], Einar Vargas-Bello-Perez[3], Manuel González-Ronquillo[1]*

*[1]Facultad de Medicina Veterinaria y Zootecnia, Departamento de Nutrición Animal. Universidad Autónoma del Estado de México, Mexico; [2]Departamento de Ciencias Agropecuarias y Acuícolas, Universidad de Magallanes, Chile; [3]Faculty of Health and Medical Sciences, University of Copenhagen, Frederiksberg C, Denmark. *Corresponding author: mrg@uaemex.mx*

The Intergovernmental Panel on Climate Change (IPCC) provides default values for the calculated greenhouse gas (GHG) emissions derived from cattle. Those values are based on specific countries where the values have been validated. However, there may be over- or under-estimations derived from different scenarios, i.e. environments, breeds, and feed resources. Thus, the objective of this study was to evaluate the supplementation of maize grain (MG) or maize grain plus maize silage (MG-CS) on the production and chemical composition of milk in dairy cows grazing two different pastures (ryegrass vs. ryegrass with white clover), at three different milk yield levels (14, 21 and 28 L/d), and estimate the emission of CH_4 and CO_2eq gases using the Tier II methodology from IPCC. Data were analyzed in a completely randomized 3 x 3 x 2 factorial design. The study included 15 dairy cows over 60 days of lactation in each scenario (n=18). The lowest predicted g CH_4/day emissions and CO_2eq were observed for the control diet (Grazing rye grass with white clover) with a milk yield of 14L, but the lowest CH_4 emissions per kg of milk produced (g kg^{-1} FCM 3.5%) were found in Grazing ryegrass with white clover + MG, with pastures containing white clover with a milk yield of 28L. In conclusion, CH_4 emissions per kg of milk produced dairy cows grazing ryegrass with white clover, supplemented with MG, producing 28 L/d of milk in temperate regions, showed the lowest CH_4 emissions per kg of milk produced.

Keywords : Supplementation, Grazing, Dairy cows, CO_2, CH_4.

Multi-factorial causes of fodder crisis and risk due to Climate Change (F-41)

Nolan Cathal*

*University College Cork, Ireland. *Corresponding author: cathalgnolan@gmail.com*

The occurrence of fodder crisis in Ireland presents significant challenges to the economic viability of Irish agriculture which remains heavily dependent upon good quality grass as a means of ensuring price competitiveness in an increasingly open global market. Our initial research has demonstrated that throughout the past five hundred years of Irish climatological history Ireland has experienced at least ninety periods in which fodder supplies dipped dangerously low in a given geographical region of Ireland, with varying impacts on agriculture in the affected regions. Of the ninety overall events a total of 32 were considered to be of a high or extreme impact, amounting to a frequency of one high or extreme fodder shortage every fifteen years. Through our analysis of natural climatic variables such as the North Atlantic Oscillation, the Atlantic Multi-decadal Oscillation, ENSO, AMOC, Volcanic forcing and Solar forcing, combined with human induced factors such as anthropogenic Climate Change, increased CO2 composition, over dependence upon fodder, overstocking and soil degradation we have established the multi-factorial drivers of fodder crisis in Ireland. The subsequent literature review provides an overview of the existing school of thought regarding the influences of fodder crisis in Ireland and the likely impacts on the production of quality grasslands in the age of anthropogenic climate change.

Keywords: Fodder, Grassland Systems, Meteorology, Climatology, Climate Change

Silvopasture as a climate-resilient sustainable grassland and forestry option (F-42)

McAdam Jim[1*], Eugene Curran[2] and Ian Short[3]

[1]*School of Biological Sciences, Queen's University of Belfast, Northern Ireland;* [2]*Department of Agriculture Food and the Marine, Ireland* [3]*Teagasc Forestry Development Department, Ireland.*Corresponding author: jim.mcadam100@outlook.com*

The introduction of wide-spaced trees in silvopastoral agroforestry systems can make grassland landscapes more sustainable, livestock production more carbon neutral, deliver a wide range of ecosystem services, particularly biodiversity and align with a climate resilient grassland management strategy. The longer animals can remain on pasture in climates with high, unpredictable rainfall, grassland utilisation will be increased, animal welfare will be enhanced and less ammonia will be emitted from the system. Soil infiltration potential was greater in both developing and mature silvopasture than open grassland from trials in Wexford and Loughgall, Co Armagh respectively. Hence agroforestry has created a soil profile under grassland which is much more resilient to potential flooding and predicted climate change. In the mature silvopasture this extended the grazing season by approximately 13 weeks to help higher grass utilisation and give resilience to grazing during extreme rainfall. This trial has demonstrated the potential exists to introduce trees in a wide range of scenarios to grassland and deliver more climate-resilient, carbon neutral livestock systems. There is an opportunity for a catchment and landscape targeted approach to address flood risk and increase biodiversity and move towards carbon-neutral

livestock systems through measuring and managing trees in agroforestry, hedgerows, riparian planting and small woodland pockets. Silvopasture can be supported as *either* a grassland system to produce nutritious, wholesome food where farms can be made more sustainable, biodiverse, climate resilient and carbon friendly by incorporating trees at a range of levels *or* as a tree-production system whereby a form of forestry, using high-value, appropriately managed trees, can be of great value to the beleaguered farming and forestry industries. It is planned to form an *Agroforestry Ireland* group which will support and encourage tree planting on farms in a range of formats.

***Keywords*:** Soil trafficability, water infiltration, carbon sequestration, reduced ammonia, high-value trees.

Sustainable silvopasture- A potential demonstration site at Dowth Estate, Ireland (F-43)

McAdam Jim[1,*], **John Gilliland**[2] and David Dillon[2]

*[1]Queen's University of Belfast, Northern Ireland; [2] Devenish Nutrition, Northern Ireland. *Corresponding author: jim.mcadam100@outlook.com*

A sustainable grassland strategy focuses on increasing grass utilisation while improving soil health within a potential climate change scenario. The paper will present the role which silvopasture can play in delivering the strategy and focus on a practical demonstration of how the strategy can be achieved in practice. One of the primary aims of the management of the Devenish Lands at Dowth is to increase carbon sequestration through a combination of optimal management of the agricultural lands, hedgerows, silvopasture and continuous cover forestry of the existing woodland resource. The estate also aims to showcase the concept of sustainable intensive agriculture, particularly a carbon neutral bovine production system. The paper will show how the rationale for planting agroforestry is sound, backed by strong scientific evidence and can contribute to the achievement of the wider goals of the Devenish lands at Dowth.

Keywords: carbon neutrality, Livestock system, Trees on pasture, Carbon sequestration.

Irish Agroforestry Forum- promoting trees on farms on the island of Ireland (F-44)

McAdam Jim[1*] Eugene Curran[2] Ian Short [3] Tom Houlihan [3] Liam Kelly [3]John Brennan[4] Jennifer Byrne[4] and Kevin Fagan[5]

*[1]School of Biological Sciences, Queen's University of Belfast, NI; [2]Department of Agriculture Food and the Marine, Ireland; [3]Teagasc Forestry Development Department, Ireland; [4] Leitrim Organics, NI; [5]National Organic Centre Skillnet, Ireland.*Corresponding author: jim.mcadam100@outlook.com*

The potential for planting trees on farmland within a wide a range of options is currently seen as one option to support farming systems in dealing with climate mitigation and adaptation issues in Ireland. Agroforestry is attracting considerable attention in the farming press and in the wider media as offering a viable option to contribute to carbon neutral farming systems. Agroforestry is currently being supported by governments from both jurisdictions as a forestry measure in Ireland and as

an Agriculture measure (under the RDP) in Northern Ireland. There have between 60-70 applicants under each measure, most seeking technical information on the establishment of agroforestry on their farms. There is also a wide body of interest within the farming, forestry and horticulture sector on agroforestry and a specialist interest from poultry producers and the organic farming sector, both of which align well with the agroforestry concept. From the number of requests for information on the technical and practical aspects of agroforestry we have identified the need for a dissemination hub of information tailored to the growing interest in agroforestry. There is also a clear need for a medium to promote agroforestry and scope the amassing literature on agroforesty research and development across Europe which might be of benefit to Ireland. A range of informed individuals have formed a promotion and support group-**Agroforestry Ireland-**which aims to launch a website which aims to amass all currently available appropriate knowledge and experience on agroforestry. The group will act as a conduit for practitioners to share their experiences and as a postbox for events and opportunities for agroforestry across the island of Ireland. The poster will present an outline of the aims and objectives of **Agroforestry Ireland** and encourage suggestions for input and support to the proposal.

Keywords: Decision support tool, Silvopasture, Forestry, Agroforestry website, Agroforestry promotion.

Acknowledgements

We would like to thank all of the organizations that helped to support ISCRAES 2020:

Sponsors:

GHG-Manage FACCE ERA-GAS
Bundesministerium für Ernährung und Landwirtschaft (Federal Ministry for Food and Agriculture)
epaResearch Climate - Water - Sustainability
UCD Earth Institute
UCD Institiúid an Domhain
Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara
burleigh dodds SCIENCE PUBLISHING

Supported by:

International Union of Soil Sciences
The GLOBAL PLANT COUNCIL
DASIM
teagasc
GRAMP
UCD School of Biosystems & Food Engineering
UCD School of Biology and Environmental Science
UCD School of Agriculture and Food Science
Green Sustainability International
Prudence College

Assisted by:

KEYNOTE
V-CUBE

Edited by M.I. Khalil and B.A. Osborne, ISCRAES Book of Abstract Series 1; Published in 2020 by the CRAES Group, University College Dublin and Prudence College Dublin, Ireland.