# Early Careers Conference 2025

## *Resilient Soils for a Sustainable Future*

Monday 1 - Tuesday 2 December 2025

King's House Conference Centre, Manchester, UK

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# Day 1 Itinerary – Monday 1 December

| Time | Main Auditorium | Parallel Room |
|---|---|---|
| 9:00am | Registration | |
| 10:00am | Welcome<br>*BSSS President, Prof. Paul Hallett* | |
| 10:05am | Introduction from Committee<br><br>*[Chair – Danni Robb]* | |
| 10:15am | Workshop 1: Speed Networking and Human Bingo<br><br>*[Chair – Liv Hoyland]* | |
| 11:15am | Oral Presentation Session – Soils For Climate [1]<br><br>***(10 mins per talk, 5 mins for Q&A each)***<br><br>1. *Soil amendments for greenhouse gas removal: a holistic assessment of biochar and enhanced rock weathering in an agricultural cropping system* – ***Elisabeth Appleton***<br>2. *Optimising Organo-Mineral Fertiliser Use for Soil Health and Climate Resilience in Wheat Systems* – ***Parveen Rupani***<br>3. *From Coal to Carbon Sinks: Recovery and Climate Mitigation in UK Restored Mining Landscapes* – ***Kaydee Barker***<br>4. *Green Carbon Sequestration: Using Plants to Fix C(O2) Deep Under Ground* – ***Catherine Martinez***<br><br>*[Chair – Tanya Trott]* | |
| 12:15pm | Lunch | |
| 1:15pm | Poster session 1 – Soils for Climate<br>(Exhibition Area) | |
| 2:15pm | Oral Presentation Session – Soils for People<br><br>***(10 mins per talk, 5 mins for Q&A each)***<br><br>1. *Hidden communities of afforestation: Revealing the mycorrhizal fungal communities of natural colonisation and plantations using a space for time chrono-sequence of post-agricultural sites in lowland England* – **Rosemary Gooda** | Oral Presentation Session – Advances for Soils<br><br>***(10 mins per talk, 5 mins for Q&A each)***<br><br>1. *Identifying Arsenic Mobility Control Zones in Soils Using the Global Dataset: Machine Learning Insights from pH–OC Interactions Across Textural Classes* – **Jajati Mandal** |

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|---|---|---|
| | 2. *Soil pH as a Key Driver of Microbial Function and Nutrient Cycling: Insights from Long-term pH Manipulation Experiments* – **Jack Horne**<br>3. *The influence of phosphorus fertiliser addition on soybean nitrogen fixation and yield* – **Hannah Walling**<br>4. *Magnesium Enhances Nitrogen Use Efficiency and Anthocyanin Biosynthesis in Purple-Grained Spring Wheat (Triticum aestivum L.) on Podzolic Soils* – **Zameer Ahmed**<br><br>*[Chair – Jess Brook]* | 2. *A Scalable Framework for Updating and Harmonising Soil Maps in Portugal to Support Sustainable Land Use* – **Samuel Guerreiro**<br>3. *Hybrid AI-enabled impact assessment of sustainable farming on soil health in sub-Saharan Africa* – **Dominik Bittner**<br>4. *Using combined techniques of near-infrared spectroscopy and aerial imagery analysis in predicting soil organic carbon properties across agricultural land types* – **Wing Ng**<br><br>*[Chair – Liv Hoyland]* |
| 3:15pm | Break | |
| 3:45pm | Workshop 2: Effective Communication and Translating Soil Science<br><br>Lizzie Sagoo and Jack Hannam<br><br>*[Chair – Jumana Akhtar]* | Workshop 2 – Soil Classification and Description<br><br>Jay Ryan and Richard Hewison |
| 5:15pm | Summary and Close | |
| 7:00pm | Buffet Dinner at Pendulum Hotel | |

## Day 2 Itinerary – Tuesday 2 December

| Time | Main Auditorium | Parallel Room |
|---|---|---|
| 9:00am | Registration | |
| 9:30am | Invited Lecture – Career Journey<br><br>***(20 mins talk, 10mins for Q&A)***<br><br>Jack Hannam<br><br>*[Chair – Jess Brook]* | |
| 10:00am | Oral Presentation Session – Soils for Water<br><br>***(10 mins per talk, 5 mins for Q&A each)***<br><br>1. *Hydromechanical Drivers of Soil Stabilization Against Erosion: Carbon's Role at the Aggregate Scale* – ***Abdul Walid Salik***<br>2. *Simulation of climate and land use change on soil densification and hydraulic function mediated by soil organic matter* – ***Maud van Soest***<br>3. *Predicting Soil Erosion through Plant–Soil Interactions in Wheat under Different Agronomic and Water Regimes* – ***Sophia Bahddou***<br>4. *Genotypic variation in wheat root architecture, soil pore structure and hydraulic properties* – ***Bartolo Giuseppe Dimattia***<br><br>*[Chair – Jess Brook]* | Oral Presentation Session – Soils for Climate [2]<br><br>***(10 mins per talk, 5 mins for Q&A each)***<br><br>1. *Investigating the Contribution of Common Mycorrhizal Networks to the Drought Tolerance of UK Forests* – **Emily Brooks**<br>2. *Soil and microbial carbon dynamics following conversion of grassland to cropland: stocks, persistence, and susceptibility to extreme heat* – **Christopher Taylor**<br>3. *Woodland creation scheme in the Yorkshire Dales successfully focuses tree planting on soils with a lower carbon stock* – **Francesca Darvill**<br>4. *Banana pseudostem waste-derived biochar amendment revitalizes the tea garden soil health for sustainable cultivation* – **Bhaskar Jyoti Parasar**<br><br>*[Chair – Christina van Midden]* |
| 11:00am | An overview of the AMAST (AMR in Agrifood Systems Transdisciplinary) Network and opportunities to engage with its members<br><br>***(60 mins total, intro, 10 mins per talk, 15 mins for Q&A)***<br><br>Moderator – Professor Ruben Sakrabani<br><br>Panel members: | Poster Session 2 – Soils for Water and Advances for Soils (Exhibition Area) |

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|---|---|---|
| | • Dr Lisa Morgans – Royal Agricultural University<br>• Mr Elwyn Griffiths – Oakland Farm Eggs Limited<br>• Dr Philip Taylor – Centre for Agriculture and Biosciences International (CABI)<br>• Dr Mandy Nevel – Agriculture and Horticulture Development Board<br><br>*[Chair – Liv Hoyland]* | |
| 12:00pm | Lunch | |
| 1:00pm | Workshop 3: Pathways in soil science<br><br>• Kirsty Charles<br>• Kara Marsden<br>• Louise Penn<br>• Ben Butler<br><br>*[Chair – Danni Robb]* | |
| 2:00pm | Poster session 3 – Soils for People (Exhibition Area) | |
| 3:00pm | Oral Presentation Session – Soils for Life<br><br>***(10 mins per talk, 5 mins for Q&A each)***<br><br>1. *Can simple field scanners help farmers monitor soil health?* **– Jessica Underwood**<br>2. *Soil Health literacy and awareness: Insights into needs and gaps identified across Europe through the LOESS project* **– Saurabh Singh**<br>3. *Soil as a Cultural Collaborator: Pigments, Place, and People* **– Phil Lambert**<br><br>*[Chair – Tanya Trott]* | |
| 3:45pm | Break | |
| 4:30pm | Awards and Closing Remarks<br><br>*[Chair – Danni Robb and Jess Brook]* | |
| 5:00pm | Tours and Christmas Markets | |

## Speaker Biographies

### Prof. Paul Hallett – University of Aberdeen

Paul is President of the British Society of Soil Science (2025-2026). He is a Soil Physicist working on solutions to food and environmental security, mainly focussed on the interactions between plants, microorganisms and the physical behaviour of soil. Before joining the University of Aberdeen in 2013 as Professor in Soil Physics, he was Theme Lead of Sustainable Production Systems at the James Hutton Institute, and the Head of the Plant-Soil Interface group at its predecessor, the Scottish Crop Research Institute where he worked since 1997. His work spans from understanding the fundamental processes driving changes in soil physical properties by biology, through to applied research examining soil degradation and the underlying causes.

He has published >160 refereed papers. Paul helped organise the science programme of the World Congress of Soil Science in Glasgow as the vice chair of the International Union of Soil Science (IUSS) Division 2: Soil properties and processes. He is a Core Panel Member of the NERC Peer Review College, Associate Editor of the European Journal of Soil Science and Technical Editor of Soil. He is the programme tutor of the only remaining MSc Soil Science in the UK at the University of Aberdeen, where he also co-ordinates postgraduate research training of over 150 PhD students in the School of Biological Sciences.

### Prof Jack Hannam – University of Greenwich

Professor Jack Hannam is the Head of Agriculture, Health and Environment Department at the National Resources Institute at the University of Greenwich. She was previously Professor in Pedology at Cranfield University leading the Land Information System and Soil Informatics team. Prior to her time at Cranfield, she held research positions at ETH Zurich and the University of Liverpool.

Jack's research focuses on soil data, soil health, land use change, regenerative agriculture and soil policy. It has included digital soil mapping using AI to predict and map soil properties, modelling agricultural land capability under climate change, and developing new frameworks for soil health indicators.

Jack is Past-President of BSSS and is currently chair of the PPDC Policy Subgroup. She works at the science-policy interface providing expert evidence in government inquiries and has co-developed new policy with soil policy teams.

Jack is a member of the Centre for Art and Ecology at Goldsmiths focusing on practice-led interdisciplinary artistic research to support liveable ecosystems. She co-founded Soapbox Science Milton Keynes, a public engagement platform spotlighting women in science, been interviewed on broadcast media and has contributed to podcasts and trade journals.

## Dr Lizzie Sagoo - ADAS

Dr Lizzie Sagoo is President-Elect at the British Society of Soil Science and Associate Managing Director at ADAS. She joined ADAS in 2003 following a PhD on the recycling of biosolids to short rotation willow coppice at the University of Leeds. Lizzie's research at ADAS focusses on agricultural soil science, including on soil quality, nutrient management, recycling organic materials to land, diffuse pollution of the air and water environments from agriculture, and precision farming techniques to improve soil and nutrient management.

Lizzie is experienced in managing complex applied research projects. She currently leads two large (>£1million) Defra funded projects: 'Development and Evaluation of a Free to Use Nutrient Management Planning Tool, and Longitudinal Research' (2023-2027) and 'Understanding rotational 'mob' grazing: Impacts, benefits and trade-offs' (2021-2026). She led the recently completed multi-partner EU Interreg project 'Increasing the speed and uptake of innovation in the field vegetable and potato sectors: defining a new approach for delivering cost effective research (INNO-VEG)'

Lizzie is a STEM ambassador, a Country Trust 'Soil champion' and a 'Form the Future' volunteer ambassador. She has engaged with primary, secondary and sixth form college students on soil science education and careers in soil science. Lizzie has been a member of the Society for over 20 years, and has supported BSSS on the Grants and Awards, Outreach, and SEESOIL committees.

## Prof. Ruben Sakrabani – Cranfield University

Ruben has more than 20 years of experience in determining nutrient dynamics in soils associated with application of organic amendments such as compost, manure, slurry, sewage sludge, biochar and digestates. His work explores the resource efficiency and reliability of organic amendments as alternative sources of fertilisers to reduce demand on inorganic fertilisers to promote regenerative agriculture. His research covers development of novel fertilisers including organo-mineral fertilisers (OMF). Whilst OMFs offer exciting opportunities there are challenges in it related to AMR involving use of manure as part of the feedstock. He is also member of the National Environment Research Council (NERC) Peer Review College and sits within the Advisory Board of Anaerobic Digestion and Biogas Association (ADBA). He is technical committee member for the British Standard Institute CII/37 – Fertilisers and related chemicals and the European Committee for Standardization CEN TC 260/WG 8 – Organic and organo-mineral fertilizers.

## Dr Lisa Morgans – Royal Agricultural University

Lisa began her career in agriculture as a practicing veterinarian where she worked in mixed practice for 4 years and established a successful herd health club with clients. She then moved to Bristol University to complete a PhD exploring a participatory, farmer-led approach to reducing antimicrobial use, which went on to win the Antibiotic Guardian Awards for research. Lisa then had a brief jolly working in New Zealand helping dairy farmers and vets practice responsible medicine use and before becoming Head of Livestock at Innovation for Agriculture, where she ran several knowledge exchange projects at European and local level. Lisa now works at the Royal Agricultural University where she splits her time between teaching and doing applied farmer-led research on sustainable farming methods, such as breeding ruminants, composting slurry and managing wastewater, as well as social science projects on understanding the impacts of cultured meat and improving the sustainability of the broiler sector.

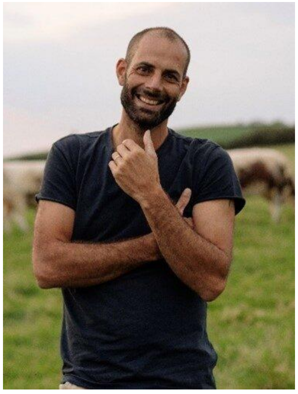
## Mr Elywn Griffiths - Oaklands Farm Eggs Ltd

Elwyn is the chairman of the British Egg Processors association (BEPA) and Chief Financial Officer for Oaklands Farm Eggs Ltd., a company with over 28 years of successful egg production and marketing, recognised internationally as a Centre of Excellence for egg production. In addition to his role at Oaklands Farm, Elwyn is also a Director of Griffiths Family Foods Ltd., Griffiths Green Enterprises Ltd., and other farming businesses. The Griffiths family is now in its third generation of farming, with a proud heritage spanning more than 65 years. The company also operates five rearing sites across the UK, producing day-old chicks under the British lion eggs code of practice; reflecting its commitment to animal welfare and sustainable farming practices.

## Dr Philip Taylor - CABI

Phil Taylor graduated from the University of London Wye college with a first in Plant Sciences. He then did a PhD at John Innes institute before taking on various post docs ultimately landing a permanent post at the University of Hull. However, at the age of 34 his career took a major change and left academic life to become a farmer. He farmed for 15 years growing top fruit, potatoes and combinable break crops both conventionally and organically. Then he underwent another change or career and began working for CABI. At CABI he has been influential in the Plantwise programme providing training and support to agricultural extension services in low and middle income countries and has developed training in crop diagnosis and biosecurity.

## Tim Williams - Regenerative Advisor & Educator



Tim is a farmer turned farm advisor, supporting others on their transition towards regenerative and biological systems of production through his advisory organisation Earth Farmers. He has over twenty years of farming experience under his belt. More recently he transformed a high input conventional arable farm into a thriving regenerative organic system within three years, utilising plants, biology and the management of livestock. His focus is on soil health across the physical, the mineral and the biological.

## Dr Mandy Nevel – Agriculture and Horticulture Development Board (AHDB)


Mandy has had over 30 years of veterinary experience in farm animal work. Initially in farm practice, she then completed a PhD then spent time developing vaccines for farm animals. She established a veterinary pathology service and was a senior lecturer at the Royal Veterinary College. Her expertise, and research focus, is in diseases of farm animals and their control including responsible antibiotic use.

## Kirsty Charles – Natural Resources Wales (NRW)

Kirsty is a Special Advisor in Soil and Land Use at Natural Resources Wales (Cyfoeth Naturiol Cymru).

Kirsty got into soil science when she was studying for her undergraduate masters in environmental science at Bangor University. She completed her undergraduate project on nutrient losses in runoff during rainfall events after manure application to agricultural land. After graduating in 2015, Kirsty worked for a wastewater consultancy for 2 years where she learned a lot about working in industry for a consultancy, but missed the interesting world of soil science.

In 2017, Kirsty returned to academia to study for a PhD in soil science at the University of Sheffield, her research focused on biosolid-soil interactions under different land management practices. Since submitting her thesis, she has moved back into industry and currently works as Specialist Advisor Soil & Land Use at Natural Resources Wales.

Kirsty joined BSSS shortly after starting her PhD and has been an active member of the Society ever since, including an EC committee member since 2018. She was a previous BSSS Early Careers Committee Chair and also joined the WCSS Working Group to represent both BSSS EC members and worldwide EC soil scientists in the run up to the WCSS in Glasgow 2022.

## Louise Penn – Ceres Rural

Louise is a BASIS, FACTS, Soil and Water and Conservation Management qualified agronomist with a portfolio of clients in the Northamptonshire and Oxfordshire area. She is particularly interested in regenerative agriculture and soil health, and believes we have a big opportunity to be more sustainable in our farming practices and still maintain high levels of profitability and productivity. She is involved on her mixed family farm where sheep and grass leys have been integrated into the arable rotation allowing the transition from a plough to a direct drill-based system and improvements in soil health. Providing her technical and practical knowledge across both enterprises.

Louise graduated from Newcastle University with a First Class Honours in Agriculture with Farm Management and then travelled to Western Australia to travel and do a harvest driving a chaser bin on a 10,000 Ha farm. Her career started on a national agronomy programme before joining Ceres Rural, where she has a farm consultancy role offering farm and crop management advice to her clients.

## Kara Marsden - Bangor University

Dr. Kara Marsden is Chair of the Welsh Regional Discussion Group and BSSS Council Member. She is a Lecturer in Soil Science at Bangor University and Marie Curie Fellow alumni.

Her current research interests include sustainable food production in a changing climate, nitrogen cycling in agroecosystems, gaseous emissions from soil (particularly $N_2O$ and $N_2$), methods and techniques for monitoring gaseous emissions from soil and assessing spatial and temporal variability in emissions, rhizosphere processes and plant-soil-microbe interactions

## Ben Butler - Soil Benchmark

Ben Butler is the co-founder and Chief Science Officer of Soil Benchmark, a UK-based startup focused on improving soil health and management. The platform leverages open government data to help farmers make informed decisions regarding soil and nutrient management. Since its launch in November 2023, Soil Benchmark has been utilized by over 700 farms across more than 200,000 hectares, providing tools for compliance with environmental regulations and optimizing agricultural practices. Ben Butler has a strong academic background, having studied Ocean Science, Environmental Chemistry, and Ocean Science, which has equipped him with the skills to develop innovative solutions for soil management.

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# Advances For Soils:
# Oral Abstracts

## Hybrid AI-enabled impact assessment of sustainable farming on soil health in sub-Saharan Africa

By **Dominik Bittner[1,2],** Jo Smith[1], Georgios Leontidis[2], Grant A. Campbell[1], Pete Smith[1], Jeanne Biegel[3], Paul Hallett[1]

*1 School of Biological Sciences, University of Aberdeen, Aberdeen, UK*

*2 Interdisciplinary Institute, University of Aberdeen, Aberdeen, UK*

*3 University of Burgundy, Institut Agro, Dijon, France*

Soils underpin many ecosystem services, including food production, through important soil functions such as the cycling of organic matter. Yet, these functions are increasingly threatened by soil degradation, especially in climate-vulnerable regions such as Sub-Saharan Africa. In these regions, unstable soils are prone to intense erosion and farmers often lack adequate financial resources, so there is a pressing need for accessible tools to assess, restore and improve soil health. However, the tools available for assessing soil health are challenged by the availability of data, transferability across local communities with varying knowledge, and socio-economic challenges of the food, fuel and water nexus that affect rural livelihoods. In this talk we evaluate a variety of practical soil health indicators and field-ready tests tailored to support farmers in sub-Saharan Africa, focussing on Ethiopia. We will discuss a range of models, from process-based to socio-economic and AI-driven approaches, which estimate how nature-based solutions can improve soil conditions and livelihoods. We introduce a novel hybrid approach using smartphones to assess soil health. This integrates a) user-friendly, AI-supported soil health tests to estimate key indicators, such as soil organic carbon and b) smart modelling of the impacts of sustainable practices. The modelling combines: i) the realism of process-based soil models, ii) the scale and adaptability of data-driven AI, and iii) and indigenous knowledge via knowledge-based AI. The platform also utilises remote sensing data to enhance soil health assessments. Together, this approach aims to empower farmers with actionable insights, boosting soil health and securing sustainable livelihoods.

Funded by: UKRI AI Centre for Doctoral Training in Sustainable Understandable agri-food Systems Transformed by Artificial INtelligence (SUSTAIN)

Keywords: Soil health; Soil quality; LMICs; Ethiopia; Sustainable agriculture; Artificial Intelligence;

## A Scalable Framework for Updating and Harmonising Soil Maps in Portugal to Support Sustainable Land Use

By **Samuel Guerreiro**[1,2], Pedro Arsénio[1,3], Vasco Florentino[4], Manuel Madeira[3,5],

*1LEAF—Linking Landscape, Environment, Agriculture and Food Research Centre, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal*

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Soil resilience, sustainable land use, and informed decision-making depend on updated and harmonised soil maps. In Portugal, however, existing soil maps vary in scale (1:25,000 vs. 1:100,000), classification systems (national vs. WRB), and surveying/mapping methodologies, which limits comparability, interoperability, and practical application. This study presents a reproducible and scalable framework to update the inconsistent 1:25,000 legacy soil maps to the 1:100,000 scale using the WRB classification system. The framework integrates soil forming factors with legacy soil data, providing a robust decision-support tool for land managers and policymakers. Applied in three study areas, the methodology involved four key steps: (1) delineation of landscape units (LUs) based on climate, lithology, and relief data; (2) reorganisation and standardisation of the 1:25,000 legacy map legend and its conversion to the WRB system; (3) generation of soil mapping units (SMUs) by overlaying LUs with the legacy map and analysing soil unit distributions; and (4) validation of SMUs against 162 reference profiles using a presence/absence scoring method. The 69 SMUs showed strong agreement with the reference data (76–82%), with lithology emerging as the main factor controlling Reference Soil Groups, while

relief and climate primarily influenced WRB qualifiers. Beyond improving spatial accuracy, the framework enables the derivation of key soil properties often missing from existing maps, including texture, depth, drainage, aeration, erosion risk, carbonate and salt content, and plant-available water capacity. The approach proved effective in a data-scarce Mediterranean context and is potentially transferable to other climatic regions. By integrating environmental factors and legacy data, the framework provides a transparent, process-based workflow that enhances scientific credibility, harmonisation, and practical utility. Overall, it offers a scalable decision-support tool for sustainable soil management, land suitability assessment, and risk mitigation under changing environmental and socio-economic conditions.

Keywords: Digital mapping, WRB, Legacy data, Landscape units, Land suitability, Resilience

Funded by: National funds through FCT – Fundação para a Ciência e a Tecnologia, I.P., under the projects UIDB/04129/2020 of LEAF-Linking Landscape, Environment, Agriculture and Food, Research Unit and LA/P/0092/2020 of Associate Laboratory TERRA; the University of Lisbon – School of Agriculture (ISA), through the "Professor Pedro Aguiar Pinto" Doctorate Incentive Award; and the protocol established between ISA and the General Direction for Agriculture and Rural Development (DGADR).

# Identifying Arsenic Mobility Control Zones in Soils Using the Global Dataset: Machine Learning Insights from pH–OC Interactions Across Textural Classes

By **Dr. Jajati Mandal**

*University of Salford*

Understanding the factors that govern arsenic mobility in soils is essential for effective risk assessment and remediation. Using a globally harmonized dataset and machine learning (ML) models, the combined influence of soil pH, organic carbon (OC), cation exchange capacity (CEC), total arsenic (TAs) and clay content on the mobile arsenic fraction ($PF_1$) has been modelled. The dataset comprised (n = 442), of which 80% was used as the training set (n = 353) and remaining 20% as the testing set (n = 89). Three regression models Random Forest (RF), XGBoost, and Generalized Additive Models (GAM) were trained to predict $PF_1$, with respect to pH, OC, CEC, total arsenic and clay content. Random Forest outperformed others in terms of model matrices. To identify mobility zones a grid of 2,100 OC–pH combinations were generated as per soil textural class, yielding 25,200 total simulation points across 12 texture classes. Mobility zones were defined as OC–pH combinations where predicted $PF_1$ was below 10%, if TAs remained <20 mg/kg. Kernel density estimates (median and mode) were then used to identify the most probable OC–pH combinations associated with mobility control. To further test the robustness of these optimal ranges, a bootstrap simulation with 1,000 iterations was performed.

Results from the Random Forest model indicated that slightly acidic soils (pH 5.5–6.5) with low-to-moderate organic carbon (<2%) minimized arsenic mobility, particularly in clay-rich soils. In contrast, coarse-textured soils exhibited wider "mobility control zones," maintaining $PF_1$ below the 10% threshold, whereas fine-textured soils were more sensitive to variations in pH and OC. These findings provide a framework for targeted remediation. Beyond reducing arsenic concentrations through amendments or stabilization, management practices should also account for soil texture and chemistry, ensuring interventions are tailored to minimize the fraction of arsenic that remains mobile.

Keywords: arsenic, pH, clay, organic carbon, mobile fraction, management

# Using combined techniques of near-infrared spectroscopy and aerial imagery analysis in predicting soil organic carbon properties across agricultural land types

By **Wing Kwan Pauline Ng[1],** Dr Adrian Crew[2], Dr Pete Maxfield[2], Dr Day Teixeira[1], Professor Matt Bell[1],

*1. Hartpury University*

*2. University of West of England*

Soil health monitoring among different agricultural land types is a monitoring task that requires time and human effort. However, by implementing combined techniques of unmanned aerial vehicle (UAV) imagery and near-infrared spectroscopy (NIRS) analysis, real-time measurements on soil organic carbon (SOC) properties can be analysed in a cost-effective, manageable and timely manner. Most importantly, captured aerial data in Red-Green-Blue (RGB) and multispectral (MS) images can be used to predict SOC properties from key calculated vegetation indices with NIRS measures across multiple fields of a farm. The predicted properties can provide farmers and landowners benchmarked SOC data for adjusting agricultural land practice over time. This study aimed to predict key on-farm SOC properties using combined techniques of aerial predictions and NIRS with a multispectral drone and mobile NIRS scanner respectively, and to develop predictive equations for the SOC properties among agricultural land types on Hartpury home farm, UK. In summary, key findings showed that accurate predictions of key SOC properties including carbon stock (in both g/kg and t/ha), SOC/plant organic carbon (POC) ratio and SOC/clay ratio with the vegetation indices green leaf index (GLI), soil brightness index (BI) and normalised green-blue difference index (NGBDI), respectively. The study also developed new predictive linear regression equations that had positive r2 values between carbon stock (g/kg) and BI, SOC/POC ratio and GLI, and SOC/clay ratio and NGBDI (all $r2 \geq 0.2$; all $P < 0.05$). These highlighted results can serve as baseline data for both SOC and vegetation cover predictions across agricultural land types. The results can further allow farmers and landowners to identify potential carbon hotspots on their farms, where suitable land adjustments can be made to restore SOC for soil and plant health in the long-term. Further studies across land types, seasons and locations for quality SOC predictions are recommended.

Keywords: UAV, soil organic carbon, farmland types, real-time, NIRS

Funded by: The John Oldacre Trust of Hartpury University and The Douglas Bomford Trust, UK

# Advances For Soils: Poster Abstracts

# Mapping Soil Degradation Driven by Artisanal Gold Mining in North-East Sudan Using Remote Sensing and Machine Learning

By **Ali Abdelmajeed A. Elrasheed**, Elsadig B. M. Omer, Szilárd Szabó

*University of Debrecen*

Artisanal and small-scale gold mining (ASGM) has expanded rapidly along the River Nile in north-east Sudan over the past decade, posing growing but understudied threats to soil health, vegetation cover, and land sustainability. This study presents an integrative approach combining satellite remote sensing and machine learning to map ASGM expansion and assess associated soil surface degradation between 2016 and 2024. Using Sentinel-2 imagery, we applied a four-stage workflow: (1) comparative band analysis to enhance visual detection of ASGM impacts; (2) computation of key indices Normalized Difference Soil Index (NDSI), Normalized Soil Index (NSI), Normalized Difference Chlorophyll-a Index (NDCI), and targeted band ratios to assess changes in vegetation, soil reflectance, and water quality; (3) feature extraction for classifier training; and (4) supervised classification using Random Forest (RF) and XGBoost (XGB). Results showed a sixfold increase in ASGM-affected land (from 28.2 ha in 2016 to 166.2 ha in 2024), with the RF model achieving the highest classification accuracy (>88%). ASGM expansion was linked to significant vegetation loss (5–15%) and pronounced changes in (NDSI) and (NSI) values, reflecting substantial degradation of soil surface conditions, especially in areas with exposed meta-volcanic bedrock. Field observations confirmed the spatial accuracy of remote sensing outputs. Our study highlights the value of combining spectral indices with Machine learning-based classification as an effective decision-support tool for monitoring soil degradation in mining-impacted regions. Our method supports efforts to safeguard soil health and guide sustainable soil and land management under increasing anthropogenic pressures.

Keywords: Remote Sensing; machine learning; Soil health; land sustainability; Artisanal Mining.

# Porewater ionome responses from organic remediation of salt-degraded paddy using advanced chemical imaging

By **Sayeda Sabrina Ali**[1], Lucas Pellegrini Elias[2], José Lucas Martins Viana[2], Paul N. Williams[1]

[1.] *Queen's University Belfast*

[2.] *São Paulo State University*

The chemo-dynamics/ionome responses of aquatic plant compost (FGC) and cattle/poultry manure compost (CC) on salt affected paddy soils of Bangladesh have been explored. Porewater and standard Diffusive gradients in thin films (DGT) analysis in anaerobically incubated soil were accompanied by novel high-resolution (HR), two-dimensional (2D) chemical imaging in control and compost-amended soils. Specialist DGT probes with ground Chelex® (bead size <100 µm) and TiO2 mixed-binding layers were used for dual cat- and anion mapping. Imaging was performed at two resolutions (100 µm and 20 µm) using 193 nm excimer laser ablation coupled with TQ-ICP-MS detection to capture detailed micro-scale features. Porewater ionome responses were strongest in 5% compared to 1% (w/w) compost treatments, irrespective of amendment type. This enhanced response was observed as FGC and CC could effectively restore salt-degraded soil health by increasing pH of the system, solubilizing more essential nutrients while decreasing the solubility of trace elements, and mobilizing more salt ions (Na, Mg) from soil exchange sites. HR 2D imaging at 100 µm showed that compost amendments created distinct patches of higher nutrient fluxes, especially in macro elements. At 20 µm resolution, FGC's high C:N ratio and lignocellulosic structure promoted uniformly distributed microniches, enabling consistent mobilization of macro- (P, K, Ca, Mg) and micronutrients (Fe, Mn) while minimizing depletion zones. Contrarily, CC enhanced nutrient fluxes but created fragmented hotspots prone to localized deficiencies. Site-specific responses further highlight the complexity: Taltali soils, with lower Fe and moderate redox reactivity, responded more favourably to FGC, whereas Fe-rich Kalapara soils showed more nutrient fixation under CC due to accelerated DOC consumption and Fe–organic complexation. The study provides a robust scientific basis for precision composting strategies tailored to amendment type and soil conditions in salt-degraded agricultural landscapes.

Keywords: Coastal soil, compost, porewater chemistry, Diffusive gradients in thin films (DGT), Laser Ablation (LA)-ICP MS, microbial hotspots, spatial mapping, Bangladesh.

Funded by: Science and Technology Fellowship Trust, Ministry of science and technology, Government of Bangladesh

Link to Poster

# Soil For Climate: Oral Abstracts

# Soil amendments for greenhouse gas removal: a holistic assessment of biochar and enhanced rock weathering in an agricultural cropping system.

By **Elisabeth Appleton**, Stella Linnekogel, Nadine Mitschunas, Morag McCraken, Tim Goodall, Simon Oakley, Pete Levy, Dafydd Elias, Richard Pywell, Niall McNamara

*UK Centre for Ecology and Hydrology*

Greenhouse gas removal (GGR) technologies are essential for meeting net zero targets. Among soil-based GGR technologies, biochar and enhanced rock weathering (ERW) offer promising opportunities for integration into existing agricultural practices, with potential co-benefits such as improved soil nutrient status, enhanced crop yield, and the suppression of soil nitrous oxide (N2O) emissions—a particularly potent greenhouse gas (GHG). Through a holistic study of these two GGR technologies, we assess the wider value of these strategies beyond their GGR potential in a spring barley crop system. Conducting a plot-scale field experiment using a robotic greenhouse gas chamber system (Skyline2D) in conjunction with a high frequency GHG analyser we measured CO2 and N2O emissions, soil nutrient and metal availability, soil moisture, and crop productivity. Our results show biochar application reduces heavy metal availability in soil and can suppress soil N2O emissions by ~33 % when applied at a rate of 10 t ha-1. However, biochar applied at a higher rate of 30 t ha-1 was associated with an increase in N2O emissions under dry soil conditions and a ~2 t ha-1 reduction in crop yield. In contrast, ERW through a single rockdust application of 20 t ha-1 had no significant effect on soil N2O emissions or any other metric measured. Overall, our findings support the integration of biochar and ERW as GGR strategies into cropping systems, but they also highlight possible trade-offs and limitations that must be considered in their implementation.

Funded by: This work was funded by NERC and BBSRC joint research program AgZero+ and NERC project Diurnal Variation in Soil Nitrous oxide Emissions (DIVINE): drivers and mechanisms.

Keywords: Net Zero, rockdust, N2O, crop productivity, nutrient availability, heavy metals.

# From Coal to Carbon Sinks: Recovery and Climate Mitigation in UK Restored Mining Landscapes.

By **Kaydee S. Barker**[1], Jonathan P. Ritson[2], Yue Sun[1], Dael Sassoon[3], Rebecca Self[2], Henry Birt[1], Richard D. Bardgett[4], Clare H. Robinson[1], David Johnson[4]

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Although estimates of total abandoned mines in the UK vary widely, over 1,500 UK coal mines have closed within the last 78 years, leaving more than 25,000 square kilometers affected by coal mining operations. Restoring these sites could enhance biodiversity, create habitats for vulnerable species, increase carbon sequestration, and help meet the UK's biodiversity and climate targets. We investigated plant and soil biodiversity and carbon dynamics across four former colliery spoil sites in Wigan, UK. Each site received an application of 10 cm of topsoil and a native meadow seed mixture, but three have been managed with an annual autumn hay cutting since 2000, 2008, and 2019 respectively, while one site was left to recover without further intervention since 2019. Our results revealed that sites with longer restoration periods demonstrated greater plant functional diversity, increased arbuscular mycorrhizal fungal association, and distinct fungal community assemblages compared to the unmanaged site. Older restoration sites also had accelerated root litter decomposition rates, indicating improved soil ecosystem functioning. All sites functioned as carbon sinks over a 9-month period, with soil carbon concentrations meeting or exceeding typical UK grassland values. However, the oldest restoration site exhibited the highest soil carbon sequestration, suggesting a positive relationship between plant and soil functional diversity recovery and carbon storage capacity. Our findings provide compelling evidence that grassland restoration of post-mining landscapes can simultaneously enhance biodiversity and contribute significantly to climate mitigation efforts if implemented across abandoned coal mines in the UK.

Funded by: Lancashire Wildlife Trust, BBSRC DTP

Keywords: ecosystem restoration, biodiversity, soil carbon, climate migitation, fungi.

## Investigating the Contribution of Common Mycorrhizal Networks to the Drought Tolerance of UK Forests.

By **Emily F Brooks**[1], Dr Nadia Barsoum[2], Dr Thomas Ovenden[2], Professor David Johnson[3], Dr Filipa Cox[1]

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Ectomycorrhizal fungi (EMF) contribute to the health of tree species employed in UK forestry by facilitating resource acquisition and modifying soil quality. EMF frequently link multiple trees to form common mycorrhizal networks (CMNs). Currently, due to the use of varied and limited methodologies, there is no consensus on the contribution of CMNs to forest ecosystem health and stability among researchers. In particular, a paucity of in-vitro studies on water translocation through CMNs hinders understanding of their contribution to the drought tolerance of UK forests. To address this, in a microcosm experiment a donor Pinus sylvestris seedling was separated from two conspecific, neighbouring receivers by mesh barriers which prevent the passage of roots and water, but not hyphae or rhizomorphs. Subsequently, in each microcosm the connections to one of the receivers were severed and the receivers in half of the microcosms underwent a drought treatment. The receivers which had maintained hyphal connections to the donor appeared to be more drought tolerant than those which had severed connections. The experiment was replicated with Betula pendula as the donor, to determine the influence of donor species identity on results. eDNA sequencing of soil samples from forests with the same component tree species as the experiments will dictate the wider relevance of the experimental findings and inform if and how the design and management of drought tolerant forests in the UK should consider CMNs.

Funded by: The DEFRA Nature for Climate Fund

Keywords: Ectomycorrhizal Fungi, Common Mycorrhizal Network, Drought, eDNA, Forest, Pinus sylvestris

# Woodland creation scheme in the Yorkshire Dales successfully focuses tree planting on soils with a lower carbon stock.

By **Francesca Darvill**[1], Dominick Spracklen[1], Catherine E. Scott[1], Pippa J. Chapman[1], Tamba Komba[1], John Crawford[2], Alec Pue[2], Robert Mills[3], Robyn Wrigley[1]

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Tree planting is a key climate mitigation strategy, but afforestation on organo-mineral soils may cause soil organic carbon (SOC) losses, limiting long-term ecosystem carbon gains over decadal timescales. In upland areas, where soils are highly variable, woodland design increasingly aims to avoid high-carbon soils to protect existing SOC.

2. We measured topsoil SOC stocks (0–15 cm) at a new native woodland site in the Yorkshire Dales, UK. The woodland design was based on peat depth, vegetation type, archaeological features, and bird breeding data. Five replicate 10 × 10 m plots were established for each of three treatments: unplanted, low-density, and high-density tree planting. Each planted plot was paired with a topographically similar unplanted control. Fieldwork occurred 9–13 months after planting began.

3. The study had two primary aims. First, to test whether the woodland design resulted in tree planting in areas with lowest SOC stocks at a site scale. Second, to assess whether low-disturbance, hand-planting techniques avoided high SOC at the 10 m plot scale.

4. We found SOC stocks were significantly lower in high-density plots (median = 75.60 t C $ha^{-1}$; IQR = 66.44–87.95; n = 5) than in unplanted (97.70 t C $ha^{-1}$; 80.74–115.59; n = 8) and low-density plots (91.47 t C $ha^{-1}$; 78.67–99.98; n = 5; $p < 0.05$) indicating that woodland planning preferentially targeted lower carbon soils. No evidence was found to suggest avoidance of higher carbon soils at the 10 m plot scale.

5. Practical Implications: Our results show that careful woodland design can avoid tree planting on high carbon organo-mineral soils. Our work suggests new woodland creation guidelines in England may reduce the potential for SOC losses.

Funded by: Sowerby Foundation, United Bank of Carbon

Keywords: SOC stocks, Native woodland creation, upland restoration, Woodland expansion, carbon

## Green Carbon Sequestration: Using Plants to Fix C(O2) Deep Under Ground

By **Catherine Martinez**[1], Sharif Ahmed[2], Daniel Evans[3], Luis Carlos Colocho Hurtarte[4], Tom Sizmur[1]

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Soil is the largest terrestrial sink for carbon with over half the soil carbon being stored below 30cm depth, however, subsoils are still a potentially undersaturated sink for carbon storage. Plant roots secrete an array of organic compounds, including organic acids, into the rhizosphere, altering the mineralogy of the surrounding soil, which may affect its carbon storage potential. We anticipate that organic acids weathering iron oxide minerals from crystalline to amorphous mineralogies will increase the capacity of subsoils to store more carbon, more securely and for greater periods of time, decreasing or delaying the release of carbon into the atmosphere and improving the overall soil composition and health. However, most of the current understanding of soil carbon storage dynamics is based on studies in topsoils and the impact of organic acids on mineral-associated organic matter degradation or protection is still debated. Here we demonstrate the potential of a common plant root exudate (citric acid) to induce subsoil mineral weathering in an artificial rhizosphere. Results from an initial study showed that increasing citric acid concentrations between 1000 - 1 μM, did increase ammonium oxalate-extractable Al and Fe (a common proxy for weathered amorphous minerals)- with greater concentrations of citric acid inducing greater availability – compared with UD Water and CaCl2 controls., However, this increase was not statistically significantly different to deionised water or CaCl2 control treatments. This preliminary experiment will inform future research to simulate the effect of organic acids on iron oxide mineralogy and thus the potential of subsoils to form mineral associated organic carbon complexes. Further, a better understanding of subsoils will emerge allowing more effective interventions that facilitate subsoil carbon sequestration

based on knowledge of subsoils rather than assumptions based on observations made in topsoils.

Funded by: Natural Environment Research Council (SCENARIO Doctoral Training Programme)

Keywords: Subsoil, Rhizosphere, Exudate, Mineralogy, Mineral Weathering, Iron Oxides, Organic Acids.

# Banana pseudostem waste-derived biochar amendment revitalizes the tea garden soil health for sustainable cultivation.

By **Bhaskar Jyoti Parasar**, Niraj Agarwala

*1. Department of Botany, Gauhati University, Gopinath Bordoloi Nagar, Guwahati, Assam-781014, India*

Tea plantation overburdened with excessive and prolonged use of chemical fertilizers and pesticides has contributed to the degradation of soil health, including reduced functional microbes and nutrient imbalance. Two major challenges in long-term tea monoculture systems: nutrient depletion, particularly potassium loss due to continuous harvesting and progressive soil acidification can be effectively mitigated through green alternative such as application of banana pseudostem biochar (BPB), endowed with high potassium content. Further characterization revealed its microporous structure with particles ranging from micro to nanoscales, with high number of functional groups in its increased surface. Our study investigated concentration and duration dependent effects of BPB amendment on the physicochemical characteristics of tea garden soil properties and subsequently its impact on microbial diversity associated with it. Results have shown that BPB amendment induces key changes in soil health indicators such as pH, organic carbon, micro- and macro nutrient status, enzyme activities and nutrient availability. Improvement in soil condition subsequently aid in tea plants growth and increasing plant traits such as photosynthetic pigments, antioxidant activities and leaf enzyme activities. In conclusion, BPB amendment induces a distinct temporal and concentration dependent changes in soil physicochemical responses and improves tea plant health, affirming BPB as a promising green alternative for sustainable tea cultivation. Further, this study attempts to tackle challenges in sustainable agriculture and mitigate environmental issues to achieve carbon sequestration and nutrient retention, envisaging healthy tea garden soil ecosystem.

Funded by: ANRF INDIA

Keywords: Soil, degradation, nutrient, acidification, microbes, enzymes, genes, sustainable, carbon, health.

## Optimising Organo-Mineral Fertiliser Use for Soil Health and Climate Resilience in Wheat Systems

By **Parveen Fatemeh Rupani**, Wilfred Otten, Ruben Sakrabani

*Faculty of Engineering and Applied Sciences, Cranfield University, UK*

Modern agriculture faces a dual challenge: feeding a growing population while safeguarding soil health and mitigating climate impacts. Mineral fertilisers, though essential for crop productivity, contribute significantly to greenhouse gas (GHG) emissions through energy-intensive production and post-application losses. These inputs also risk undermining long-term soil function and ecosystem service delivery. This study contributes to the search for sustainable nutrient strategies by exploring organo-mineral fertilisers (OMFs) as an alternative that supports both crop nutrition and soil resilience.

OMFs combine digestate with ammonium nitrate, aiming to synchronise nutrient availability with crop demand while reducing environmental losses. Although interest in these hybrid inputs is growing, their GHG emission profiles—particularly for $N_2O$, $CO_2$, $CH_4$, and $NH_3$—remain underexplored. This research offers new insights by quantifying gaseous fluxes under controlled conditions, contributing to climate-smart nutrient management.

A replicated glasshouse lysimeter experiment (24 units, 220 L each) was conducted across two seasons using spring and winter wheat. Treatments included 45%, 60%, 75%, and 90% OMF rates, alongside mineral and unfertilised controls. GHG fluxes were measured using a Gasmet GT5000 Terra FTIR analyser and processed via Calcmet Professional software. Soil chemistry was monitored across three depths, and above-ground biomass was assessed to evaluate fertiliser performance.

Results showed $CO_2$ fluxes from OMFs (0.4–1 g $m^{-2}$ $h^{-1}$) were comparable to mineral fertilisers, with elevated emissions at lower OMF rates likely driven by microbial respiration and shifts in soil C:N ratios. $NH_3$ emissions peaked post-application, highlighting the importance of timing. $N_2O$ fluxes fluctuated with soil moisture and root development, underscoring dynamic soil–plant interactions. While OMF emissions were not consistently lower, they contributed organic matter that may enhance long-term soil health. Further research is underway to refine application strategies and assess ecosystem service impacts.

Funded by: Innovate UK through the Defra Farming Innovation Small R&D Grant and CCm Technologies Ltd

Keywords: Organo-mineral fertiliser (OMF), Greenhouse Gas Emissions, Gasmet, fluxes, Wheat growth

# Soil and microbial carbon dynamics following conversion of grassland to cropland: stocks, persistence, and susceptibility to extreme heat.

By **Christopher Taylor**, Adam Bilton,Deon Lum, Kaydee Barker, Ainara Leizeaga, Deborah Ashworth, Georgiana Păun, Richard Bardgett

*Lancaster University*

The conversion of grasslands into arable agriculture can lead to considerable losses of soil organic carbon (SOC) stocks, with much of this lost carbon irrecoverable on timescales relevant to climate change mitigation. Yet, through changes to soil biological and physicochemical properties, grassland to cropland conversion may also reduce the stability of remaining SOC, potentially increasing its susceptibility to degradation by soil microorganisms and extreme climate events that may exacerbate microbial catabolism (e.g. heatwaves).

Here we use grassland and cropland sites from rural Transylvania, Romania, to explore how the conversion of species-rich grassland to arable agriculture affects soil carbon dynamics. We quantified changes in SOC stocks (to 30 cm depth) using an equivalent soil mass approach for 68 paired grassland and arable sites (n = 272 cores) that shared the same soil type and underlying geology. Soils were then fractionated into mineral associated organic carbon (MAOC) and particulate organic carbon (POC) to provide an estimate of the stability of soil carbon forms (MAOC:POC ratio). Finally, we conducted a lab-based incubation experiment on separate fresh samples to assess how microbial carbon cycling was affected by heatwave conditions (+15 oC for 1 week).

Across sites, SOC stocks in arable soils were approximately 20% less than their grassland counterparts, equivalent to a loss of 18.7 tonnes of C per hectare. Microbial functioning differed significantly between arable and grassland soils, with arable soils being characterised by lower microbial biomass but a relatively greater potential for carbon catabolism, particularly of more labile forms. Responses of carbon cycle functions to heatwave conditions were similar between grassland and arable soils.

Our work suggests that in addition to significant and substantial losses of carbon stocks, converting grassland to arable agriculture may also increase the susceptibility

of soil carbon to decomposition by microbes, which could be worsened by climate extremes.

Funded by: British Ecological Society

Keywords: Soil organic carbon, grassland, arable agriculture, heatwave, microbial functioning

# Soil For Climate:
# Poster Abstracts

## AI enabled climate smart fertiliser practice.

By **Max Davis**, Yu Zhang, Gaoshan Bi, Yang Li, Qing Xue, Po Yang, Simon Jeffery

*Harper Adams University*

Fertilisers are an important component of highly productive arable production systems. However, they are linked to the production of Nitrous oxide ($N_2O$) a potent greenhouse gas (GHG) with 273 times the global warming potential of carbon dioxide ($CO_2$). Agricultural soils and the application of fertiliser contribute 68% of $N_2O$ from the agricultural sector. Optimising fertiliser inputs to improve agricultural sustainability is therefore necessary. AI has enhanced management in arable systems, but approaches to balance fertiliser input and GHG emissions have been constrained by the availability of suitable data. Cutting edge research methods utilising tensor multi task learning, agricultural process-based models and graph neural networks aim to bridge this gap and provide AI enabled fertiliser recommendations.

To validate this AI approach and compare it to conventional fertiliser practice (RB209), field trials in winter wheat systems across three different soil textures were undertaken. During periods of fertilisation GHG emissions were captured using a static chamber approach and cumulative emissions of $CO_2$, $CH_4$, and $N_2O$ were calculated. Data were collected on yield and grain protein following harvest to compare NUE and cumulative GHG emissions. Results from this study will aim to identify where fertiliser application can be optimised using AI-enabled tools.

Funded by: Innovate UK (UKRI)

Keywords: GHG, Nitrous oxide, AI, Fertiliser, Arable, Yield, Agriculture, Sustainability, Wheat

# Engineered biochar for sustainable soil amendments and resilience.

By **Adam El-Aradi**[1], Daniel J. Nowakowski[1], David J. Webb[2], Tala Kasim[3]

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Biochar has shown great potential to enhance nutrient retention, microbial activity, and soil carbon storage; however, its effectiveness depends strongly on its physicochemical properties and the specific soil challenges it is intended to address. By tailoring these properties through targeted modification, engineered biochar can be designed to overcome particular soil constraints and optimise its impact on soil function.

Unmodified biochar samples, derived from different feedstock and pyrolysis conditions, were initially produced, characterised, and tested in preliminary soil incubation experiments to identify key parameters that could be improved through modification. Pinewood-derived biochar exhibited a high carbon content of 85.1%, suggesting strong potential for long-term carbon sequestration, whereas wheat straw biochar contained higher concentrations of essential nutrients, indicating its potential to enhance soil fertility and microbial activity. These findings highlighted the influence of feedstock type and production conditions on biochar functionality and guided the selection of samples for modification.

Selected biochar samples were subsequently subjected to targeted chemical modification treatments to improve their surface chemistry, porosity, and cation exchange capacity. Traditional chemical reagents, including sulphuric acid, hydrochloric acid, acetic acid, and phosphoric acid, were used as benchmarks to evaluate modification effectiveness. Alongside these conventional treatments, the aqueous-phase pyrolysis liquid produced during the same process will be employed as a sustainable chemical modifier, offering a circular approach to biochar enhancement. Rich in organic acids and phenolic compounds, this by-product can functionalise biochar surfaces while reducing the need for external reagents and minimising waste.

Key process variables such as mixing method, liquid concentration, contact time, and post-treatment removal will be optimised to enhance biochar functionality for soil applications. This research aims to establish practical, scalable methods for producing engineered biochar that maximises both its physicochemical performance and its contribution to soil health and climate resilience.

Funded by: ESRC Doctoral Training Partnership (EPS – Aston University)

Keywords: biochar, chemical modification, soil amendment, carbon sequestration.

# Curtis and The Three Beres: root-soil interface traits in modern and landrace barley genotypes differ in the lab but not the field.

By **Sean Graham**[1,2], Timothy S. George[1,2], Maria Marin[2], Paul D. Hallett[1].

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Crops have valuable root-soil interface traits pertaining to nutrient and water use efficiency, and remediation of degraded soil structure, but it is not known if these have been 'bred out' in modern cultivars. Landraces are ancient crop genotypes locally adapted to environmental and management conditions and may provide a valuable source of genetic diversity and agronomic traits. Within Scotland, the "Bere" barley landrace is a multipurpose crop with cultural importance and evidence of advantageous root-soil adaptations to micronutrient deficiency.

In previous controlled studies, we found that early seeding Bere genotypes had up to 32 % larger total and specific rhizosheath (g/cm) than the elite cultivar KWS Curtis ($p<0.001$) despite having similar root lengths. The next step was to validate the differences in the field by selecting KWS Curtis and the largest rhizosheath forming Bere genotype "Unst". This was conducted in two different Scottish Cambisols during the 2025 growing season which was the driest in 30 years. The most profound effect of these suboptimal conditions was in the above ground portion of the plant: plants grown in sandy loam soil had 4 times greater yield and 1.7 times greater above ground biomass than plants grown in loam soil ($p< 0.001$) and showed no significant difference in fresh root or total rhizosheath mass.

Additionally, whilst the fresh root mass of both genotypes at the early seedling stage were comparable between controlled and field conditions, the total rhizosheath mass was about 4 times smaller under field conditions. These results are intriguing and possibly explained by the heterogeneity of the seedbed and lower soil moisture content resulting in poor root-soil contact. A repeat of the experiment in spring 2026, coupled with more in-depth measurements of root-soil interface properties, aims to gain further understanding of Bere rhizosheath formation under field conditions.

Funded by: Anthony and Margaret Johnston CDT in Plant Sciences

Keywords: Bere Landrace Rhizosheath Barley Sustainable Agriculture Field Root Soil Interface

# Climate-Smart Nitrogen Management: Sensor-based Insights into Legume-based Crop Rotations

By **Emily Guest**[1], Jaqueline Hannam[1], Wilfred Otten[1], Nicholas Girkin[2]

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*2. Nottingham University*

The ‘Nitrogen Climate Smart’ (NCS) project is a four-year initiative aiming to increase pulse and legume cropping in UK arable rotations from 5% to 20% (one in five years). This shift could reduce greenhouse gas (GHG) emissions by 3.4 Mt CO2e annually, equivalent to 7% of UK agricultural emissions, mainly through reducing nitrogen (N) fertiliser usage and replacing imported soybean meal in livestock feed.

This presentation reports initial findings from a glasshouse experiment using large soil modules with root cameras to study soil-plant-atmosphere interactions in legume-based crop rotations in greater detail than possible under field conditions.

Early results indicate that higher bean yields are associated with increased nodulation and more extensive root systems, providing insights into below-ground N contributions. Bean crops also enhanced soil N availability, particularly in upper soil profiles, and data from novel nitrate-ion-sensing blades will provide further information on the temporal and spatial availability of this soil N.

In the following wheat, a bean previous crop supported deeper and more prolific rooting, with ongoing analyses quantifying how these benefits will impact wheat grain and protein yields.

Gantry-based imagery is being evaluated alongside 15N isotope analysis to assess whether plant physiological and canopy-level indicators (i.e., yield, biomass, NDVI) can act as low-cost proxies for better estimating biological N fixation, enabling more precise fertiliser recommendations in crops following legumes, rather than the current blanket minimal reduction suggested in the RB209 nutrient management guide.

Future experiments will investigate the mechanisms underpinning prolonged wheat greenness following legumes observed in NCS field trials, exploring whether legumes alter soil physical, chemical and biological properties to improve nutrient retention and water holding capacity.

Collectively, this research provides actionable insights for optimising legume-based rotations to improve N management and deliver meaningful GHG mitigation to reduce the impact of UK agriculture on the climate.

Funded by: Defra's Farming Innovation Programme, delivered by Innovate UK.

Keywords: Legumes, crop rotations, nitrogen fixation, greenhouse gas, nitrate sensing, roots

## Restoring soil physical conditions and erosion resistance with indigenous plants.

By **Jacques Holford**

*University of Aberdeen*

Soils stripped of native plants can become physically unstable and erode easily, especially in vulnerable regions like sub-Saharan Africa. Ethiopia is a mountainous country with two periods of intense rainfall annually, interspersed between severe dry periods, creating the perfect conditions for one of the most eroded landscapes globally. Driving this soil degradation is increasingly harsh conditions due to climate change, the reduction of carbon inputs, and reduced mechanical reinforcement of plant roots.

As part of the African Forest Landscape Restoration Initiative (AFR100), the Ethiopian government has pledged to restore 7 million hectares of degraded land by 2030 through the establishment of exclosures. Exclosures are traditionally communal areas where wood cutting, grazing and other agricultural activities are now forbidden or strictly limited to promote restoration and natural regeneration. However, research is required to promote effective restoration in these degraded landscapes to ensure these targets are met.

One solution to this problem could be utilising native plants to restore the physical and biological components of soil through sequestering carbon, covering the bare landscape to minimise erosion and increasing soil organic matter content. Frequently overlooked native plants have adapted to this environment and their root traits could improve soil health whilst providing increased climate change resilience.

In this project, I will be primarily researching the root-soil interactions that restructure soils and improve soil health. The main aims of this project are i) to explore root growth and other root traits of native plants from Sub-Saharan Africa and their impact on soil carbon and structure dynamics, ii) to disentangle mechanical and hydrological processes that affect soil structure dynamics due to plant root interactions, and iii) to investigate how changes in soil structure and its interaction with soil carbon and root growth affects soil erosion.

Funded by: Quartiles

Keywords: Sub-Saharan Africa, Soil Erosion, Underutilised Plants, Restoration, Roots, Soil-Root Interactions

# Transforming Spent Coffee Grounds (SCG) into an Environmental Asset- Its Characterization and Optimization for Soil Amendment and Remediation Applications

By **Prudence Mhlophe**, Prof Jaime Toney, Dr Adrian Bass and Prof John Crawford

*University of Glasgow*

Global coffee consumption continues to escalate rapidly, significantly increasing spent coffee grounds (SCG) produced. An estimated 18 million wet tonnes were produced worldwide in 2021 (Kim et al., 2024). SCG are an abundant organic waste stream with potential for soil remediation; however, their direct application, without processing, can cause more problems. This study investigates the potential of SCG and SCG-derived biochar as amendments to soil for immobilizing heavy metals in contaminated urban soils. The SCG were oven-dried at 40°C for 48-hours. Half the grounds were stored, and the other half were pyrolyzed at 550°C. Six small batches resulted in average yields between 20.5 and 23.3%. These were then modified with H2O2 solution (30%) at a rate of 1: 20w/v. The resultant substrates were analysed before use in a soil column experiment. The analyses show that pyrolysis increased pH in the pristine biochar, as expected, while those modified with H2O2 decreased in pH in both SCG and biochar. BET (Brunauer-Emmett-Teller) analysis revealed a 42% increase in surface area due to pyrolysis. Modification of SCG resulted in a 6% reduction in surface area, while biochar modification resulted in a 14% increase in surface area. FTIR and NMR analyses showed that SCG contains some oxygen-containing functional groups, such as carboxyl (COOH), hydroxyl (-OH), carbonyl (C=O), and phenolic groups, which are essential for pollutant remediation. Modification with H2O2 enhanced these, especially on the biochar, where they had been lost through pyrolysis. These findings suggest that SCGderived materials offer a promising, circular economic approach to urban soil remediation, converting coffee waste into valuable environmental remediation agents while reducing heavy metal mobility. Next steps in this research will analyse the efficacy of these on naturally contaminated soils.Raw SCG and SCG biochar 550°C were incorporated into clay loamy soil at application rates of 1% and 3% (w/w), respectively. Soil columns were leached every 7 days for 28 days, and the leachate was collected and analysed. Raw SCG application resulted in decreased leachate pH and significantly elevated EC values, likely due to the release of soluble salts and organic acids. In

contrast, SCG biochar increased leachate pH and showed lower EC values compared to raw SCG treatments. The physicochemical properties of SCG changed as a result if the modification, pyrolysis showed a reduction in the oxygen-containing functional groups, which were restored by the oxidation. The pore sizes and distribution also increased due to the modifications, with important implications for use in soil remediation and amendment. Understanding these effects is critical for the optimization of coffee waste valorisation strategies in both agricultural and urban soils.

Funded by: UoG James McCune Smith Scholarships and NERC'S GALLANT PROJECT

Keywords: Spent coffee grounds, biochar, heavy metals, waste valorisation, surface area

Link to Poster

# Mineralogical Characterisation of Wildfire Affected Forest Soils in Southern Western Ghants, India

By **Athira Saleevan**, S. Sandeep

*Kerala Forest Research Institute, India*

Forest ecosystems of Western Ghats have witnessed accelerated wildfire occurrences amidst rising temperature and climate change events. High intensity wildfires can bring up imbalances in ecosystem structure when compared to the transient changes and benefits of prescribed fire. Series of wildfire outbreaks followed by heavy rainfall can increase the possibilities of landslides and floods. Considering the fragile nature of Western Ghats, mineralogical transformations in post fire scenario is critical. Frequently fire affected areas in moist deciduous forests of Peechi-Vazhani wildlife sanctuary was selected for the study. Soil samples were collected at five equal depths (0-20, 20-40, 40-60, 60-80 & 80-100) up to 1m in toposequence (low, medium and high elevations). Mineralogical extractions were carried out in three different fractions (Clay, Silt and Sand) by gravity sedimentation, centrifugation and wet sieving. Soils were with sandy clay loam texture and the organic carbon content decreased from top to bottom layer (2.13 ± 0.39 to 0.62 ± 0.19). XRD spectra of analysed samples revealed quartz as the most abundant mineral followed by Gypsum, Haematite, Calcite, Chlorite, Goethite and Kaolinite in all three fractions. Magnetite was present in all fractions except Coarse sand. Gypsum was found in all except Clay fraction. Mica and vermiculite were observed in Silt fraction.

Keywords: Forest fire, Climate change, Soil degradation, Mineralogy.

# C: N ratio of biochar determines nitrogen cycling dynamics and emission outcomes in different soil textures.

By **Muhammad Tauseef Jaffar**[1], Jianguo Zhang[1], Muhammad Ahmed[1], Nicholas Girkin[2]

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Although the impact of biochar on soil nitrogen (N) cycling is widely acknowledged, the specific biological and chemical mechanisms influenced by biochar with varying C:N ratios across different soil types remain poorly understood. We investigated alterations in N cycling following the application of N-enriched biochar (NB) with different C:N ratios to loamy and sandy soils. Our experiment consisted of nine treatments: three NB types (NB1, NB2, NB3), a pristine biochar (PB), each applied at two rates [20 t $ha^{-1}$ (L1) and 40 t $ha^{-1}$ (L2)], and a control (CK, no biochar). NB significantly increased N fractions by effecting nitrification, ammonification, mineralization, and soil enzyme activities, with more pronounced effects in loamy soil than in sandy soil. Peak levels of $NH_4^+$-N and $NO_3^-$-N were observed in NB treatments within the first 15 days, whereas $NO_3^-$-N concentrations were higher in the control during later stages. NB also led to significant increases in total nitrogen (TN), soil organic matter (SOM), available potassium (AK), and available phosphorus (AP) in both soils compared to PB and CK. In loamy soil, NB raised cumulative $N_2O$ emissions by 157.3% to 229.5%, while PB at the higher application rate (L2) decreased emissions by 14.7%. Conversely, in sandy soil, both PB and NB substantially lowered cumulative $N_2O$ emissions, with the most significant reduction (39.2% to 86.1%) occurring at L2. Structural equation modeling revealed that N fractions were key drivers of N transformations in loamy soil, whereas both soil properties and N fractions jointly influenced N pathways in sandy soil. Our results highlight the importance of tailoring biochar C:N ratios to soil type for optimizing N cycling and mitigating $N_2O$ emissions, offering practical guidance for sustainable soil management across diverse global agroecosystems.

Funded by: Agricultural-Photovoltaic Complementary Project of China Datang Dali New Energy Co., Ltd. (DTDL-XNY-2023-025), Yulin Science and Technology Bureau (2023-CXY-219), and the Key R&D Program of Shaanxi Province (2022ZDLNY02-03).

Keywords: Biochar, C:N ratio, N2O emissions, N-enriched biochar, Nitrogen cycle.

Link to Poster

## Resistance and resilience of the grassland soil microbiome to drought.

By **Christopher Taylor**[1,2], Ainara Leizeaga[1,2], Louison Dumond[1,2], Deon Lum[2], Katie Journeaux[2], The Nutrient Network[3], Richard Bardgett[1]

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*2 - Soil and Ecosystem Ecology, University of Manchester*

*3 - NutNet HQ, University of Minnesota*

Soil microorganisms underpin ecosystem functioning, and dictate the direction and magnitude of carbon and nutrient fluxes both within and between ecosystems. Soil microbiomes face concomitant threats from anthropogenic activities and increasingly frequent and intense climate extremes. Nutrient enrichment, for example, may shift soil microbial communities toward less stress-tolerant states, potentially rendering them more susceptible to climate extremes (e.g. drought).

We know little about the characteristics of an ecosystem or the communities therein that may determine the ability of soil microorganisms to resist and recover from climate extremes, or how other anthropogenic stressors, such as nutrient addition, modify their response.

As part of the 'SoilResist' project, we utilised a coordinated global-scale grassland experiment (Nutrient Network) to investigate the responses of soil microbial communities and their functioning to drought and test how responses are modified by nutrient enrichment. We exposed nutrient-enriched (NPK+ micronutrients) and unfertilised soils from 30 grasslands worldwide to a laboratory dry-wet cycle, and quantified changes in soil microbial communities and their functioning.

Responses to drought varied considerably across sites, and nutrient enrichment modified the resistance and resilience of microbial communities across grasslands. We further explored how responses were moderated by vegetation, edaphic and climatic attributes across wide environmental gradients.

Funded by: European Research Council

Keywords: Drought, Grasslands, Microbial functions, Nutrient enrichment, NutNet, Resistance, Resilience

## Effects of Vining Peas on Soil Nitrogen and Soil Carbon in a Crop Rotation.

By **Lauren Tribbeck**[1], Paul Hallett[1], James Mason[2], Sarah Shaw[3], Sylvia Vetter[1]

1. *University of Aberdeen*
2. *Birds Eye*
3. *University of Hull*

Adding legumes, such as vining peas, into a crop rotation has a known benefit in mitigating the response to climate change, due to their nitrogen fixation abilities, reducing the need for artificial fertilisers. Whilst this benefit is well known, nitrogen addition by legumes could also improve soil carbon sequestration.

From field measurements of the effect of peas on soil carbon and nitrogen dynamics in a crop rotation, this study aims to explore this potential added benefit to soils. Eight fields across East Yorkshire and northern Lincolnshire were sampled post-pea harvest and one-year later. In each field, three replicates in the pea growing area, and three replicates in an area left fallow during the pea rotation (control) were sampled. Soil cores and bulk samples were taken at three depths (0-10, 10-20 and 20-30cm) to measure bulk density, pH, total carbon and nitrogen. The data were analysed in consideration of the management to understand the effects vining peas have in the soil. The results show no significant differences in the first year between planted and unplanted fields, however variation across fields and depths can be seen. This may suggest that legacy effects of previous pea crops are being seen in the fallow samples, however the second-year data which will be available for the conference is needed to confirm this conclusion. These data will be used to shape a future more in-depth study into the effects of peas across the rotation, with an alternative control selected to avoid these potential legacy effects.

Funded by: Eastbio, Birds Eye

Keywords: legumes, carbon sequestration, nitrogen fixation, peas, soil measurements, crop rotation

## Linking riparian soil hydrology and carbon dynamics: towards improved resilience to climate change.

By **Sara Trojahn**, Marc Stutter, Mark Wilkinson, Carol Taylor, David Riach

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Riparian zones are critical interfaces between soils, water, and atmosphere, providing ecosystem services central to climate resilience and water security. They regulate hydrological connectivity, sustain river flow, and act as dynamic stores and sources of carbon (C), nutrients, and greenhouse gases (GHG). Yet, the relative contributions of riparian soils to water quality regulation, carbon sequestration, and GHG losses remain poorly quantified, especially as soil–water biogeochemistry studies often neglect the atmospheric dimension. This research explicitly links soil, water, and atmosphere to capture GHG fluxes alongside C cycling and water table fluctuations.

As part of the NERC-funded Change at the Reactive Riparian Interface (CARRI) project, riparian observatories were established in north-east Scotland representing distinctive land uses (semi-natural and managed grassland) and catchment scales revealed how soil wetness and redox fluctuations shape carbon–nitrogen–phosphorus solubility and export. A new observatory in a headwater with mixed land-use extends the scope of this network whilst contributing to the AiM NBS project (Achieving multi-purpose nature-based solutions). Continuous monitoring of water tables and river flow through the UK Environmental Change Network, coupled with monthly soil solution chemistry and GHG fluxes, enables assessment on how soil wetness and temperature control C turnover, dissolved organic carbon (DOC) quality, and GHG emissions.

This work emphasises process understanding - highlighting the novel links between DOC quality, gas exchanges, and soil moisture-temperature dynamics. These insights provide a basis for extrapolating beyond short-term observations and for improving the way riparian C cycling is represented in predictive models.

By combining these observational datasets, the study generates process-based evidence that can underpin modelling of riparian C storage, export, and GHG balances. The findings highlight the dual role of riparian soils as regulators of climate processes (sequestration vs. emissions) and water resources, supporting their role as multi-purpose, nature-based solutions for climate change mitigation, adaptation, and sustainable water management.

Funded by: NERC/UKRI; Scottish Government (RESAS)

Keywords: Riparian soils; Carbon; GHG; Climate resilience; Water Quality; Nature-based solutions

Link to Poster

# Soil For Life:
# Oral Abstracts

## Soil as a Cultural Collaborator: Pigments, Place, and People.

By **Phil Lambert**

*Independent*

Phil Lambert's practice positions soil not only as a subject of study but as a cultural collaborator, a material with multiple identities: scientific, historical, ecological, aesthetic and more. Across human history, soil has served as pigment, building substance and food source, informing artworks from prehistoric cave paintings to the contemporary works of Herman de Vries and the varied approaches of the artists gathered at this conference. Working with site-specific soils processed into paint, Lambert's work uses this layered identity to invite conversations about place, perception, and the overlooked fundamentals of life.

Often working plein air and in response to specific locations, Lambert's methods draw on "attentive seeing" in a sense a form of field sketching and observation informed by Goethean science. The aim being to encourage alternative ways of knowing, emphasising open-ended exploration and resisting fixed conclusions, and reframing soil as a partner in enquiry. Adapting the processes and sharing the work in a playful, open-ended way creates opportunities for participants and audiences to explore the tactile experience and different meanings of soil. Ultimately helping them to create their own relationship with soil.

Lambert believes that related arts practices can create the space for genuine two-way dialogue where participants' interpretations hold equal weight to expert perspectives. This resists the limitations of message-driven outreach and allows scientific knowledge and personal experience to meet on equal terms. This talk will reflect on Lambert's 15 years of public involvement and widening access experience alongside his arts practice and extensive work in Primary Schools. In the context of current environmental challenges, such approaches can foster curiosity, empathy, and perhaps most importantly, a renewed love for the very ground beneath our feet.

Keywords: soil-pigment, open-ended, field-sketching, interdisciplinarity, cultural-material, observation, public-engagement, Goethean-science, New-Materialism

# Soil Health literacy and awareness: Insights into needs and gaps identified across Europe through the LOESS project.

By **Saurabh Singh**[1,2], Claire McDonnell[2]

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Soil Health Literacy and awareness are critical to long term sustainability, addressing climate change, food security and biodiversity loss. Systematic gaps persist in how soil-related concepts are addressed across formal and informal education systems. The EU Horizon funded LOESS (Literacy Boost through an Operational Educational Ecosystem of Societal actors on Soil health) project has 16 partner countries, including Ireland and the United Kingdom with the aim of bridging this gap. This involves three stages- mapping current soil health education and identifying what is needed; co-creating and piloting aligned educational tools and resources; and implementing these tools widely and promoting their use among stakeholders.

We are currently in phase three, implementation of the educational resources co-created, but this presentation will focus on the first stage. During this, soil health education needs were identified through combined curriculum mapping, stakeholder interviews, and focus groups across 15 partner countries. Primary, secondary and university education as well as vocational education and training (VET) and awareness raising for the general public were considered. The LOESS team identified the extent to which soil health objectives from EU Mission Soil and related SDGs were embedded in curricula as well as the way in which soil health education is taking place (Purpose, Process, Activities, Location, Extent of Collaboration and Paradigm). The study also explored the future vision for soil health to establish what is needed.

Key findings include the demand for hands-on, outdoor activities encouraging personal connections to soil and emphasising interconnections between ecological systems. Facilitation of collaboration between disciplines and sectors is also required. Awareness of EU Mission Soil objectives remains limited likely because of relatively short timeframe since their establishment.

This important research has led to the co-creation of a range of soil health education tools and resources. More information on this study is available at; loess-project.eu/wp-content/uploads/2024/10/Deliverable-2.2_Report-on-awareness-needs-and-vision-for-soil-education_with_disclaimer.pdf

Funded by: European Union

Keywords: Soil health literacy, Stakeholder engagement, Curriculum mapping, EU Mission Soil

## Can simple field scanners help farmers monitor soil health?

By **Jessica Underwood**[1], Christopher Collins[2], Aidan Keith[3]

1. *University of Reading*

2. *University of Plymouth*

3. *Centre for Ecology and Hydrology*

Soil is the largest terrestrial store of carbon, and provides vital ecosystem services to humankind. The health of the soil greatly impacts its ability to provide these services, and is negatively impacted by intensive agricultural systems . Farmers in the UK are being encouraged to move to sustainable farming practices which amongst other things improve soil health and soil carbon. There is a need for simple methods to monitor soil properties under these changing practices to help track changes, and allow farmers to make informed land management decisions. Our research investigates near infrared spectroscopy scanners. How well do they work compared to laboratory soil tests? Are commercial options for farmers effective? We will present results for measuring soil carbon comparing our own soil spectral library and model to a commercial scanner and laboratory data; alongside insights into farmer attitudes towards soil scanners and carbon monitoring.

Funded by: NERC, Affinity Water

Keywords: spectroscopy, scanner, carbon, monitoring, farming, NIR, sustainable, survey, land management

# Soils For People: Oral Abstracts

# Magnesium Enhances Nitrogen Use Efficiency and Anthocyanin Biosynthesis in Purple-Grained Spring Wheat (Triticum aestivum L.) on Podzolic Soils.

By **Zameer Ahmed**

*Russian State Agrarian University - Moscow Timiryazev Agricultural Academy*

Sustainable nutrient management is critical for optimizing crop productivity and resilience, particularly in nutrient-deficient soils. This study investigates the synergistic role of magnesium (Mg) in improving nitrogen (N) use efficiency (NUE), grain yield, and anthocyanin content in purple-grained spring wheat (Triticum aestivum L. 'Pamyati Konovalov') cultivated in acidic podzolic soils of the Moscow region. A randomized complete block design field experiment tested N rates (40–120 kg/ha) with/without Mg supplementation (20 kg Mg/ha as $MgSO_4$).

Key findings demonstrate that Mg co-application significantly enhanced NUE by 15–20%, with the highest agronomic NUE (27.5 kg grain/kg N) achieved at 40 kg N/ha on fertile soil backgrounds. Mg supplementation increased grain yield by 0.3–0.5 t/ha and protein content by 1.3–1.5% across N levels, attributed to improved chlorophyll synthesis (15–20% higher SPAD values) and N assimilation. Notably, Mg boosted anthocyanin concentrations by 25–30% (peaking at 2.31 mg/g dry weight under moderate N + Mg), linked to enhanced phenylalanine ammonia-lyase activity and sugar availability. Physiological assessments revealed Mg-mediated resilience to heat stress, with treated plants maintaining 15–20% higher photosynthetic rates during thermal extremes.

This study underscores Mg's dual role in sustainable agriculture: as a catalyst for N efficiency, reducing environmental losses (18–20% lower N surplus), and as a promoter of functional food quality through anthocyanin enrichment. The results advocate for integrated Mg-N fertilization strategies to reconcile yield, quality, and climate resilience in wheat systems, offering actionable insights for nutrient management in temperate acidic soils.

Keywords: Nutrient interactions, nitrogen use efficiency, sustainable fertilization, soil health

# Hidden communities of afforestation: Revealing the mycorrhizal fungal communities of natural colonisation and plantations using a space for time chrono-sequence of post-agricultural sites in lowland England.

By **Rosemary Gooda**[1,2,3], Dr. Laura Martinez-Suz[2], Prof. Martin Bidartondo[1], Elena Vanguelova[3]

1. *Imperial College London*

2. *Kew Gardens*

3. *Forest Research*

Background: Mycorrhizal fungi (MF) play important roles in the creation and maintenance of biodiversity, above-ground productivity and health, carbon and nutrient cycling and ecosystem resilience to perturbation. UK afforestation programs engineer the transition from agricultural ecosystems into woodland. This transition involves a shift from an ecosystem dominated by arbuscular-mycorrhiza forming plants to one dominated by ectomycorrhiza forming trees. While tree planting is most widely used, there is growing interest in the use of natural successional processes (natural colonisation) to generate woodland. UK afforestation guidelines incorporate both tree planting and natural colonisation and EWCO financial incentives to landowners are provided for both. However, an understanding of how these practices influence the development of MF communities belowground throughout afforestation is lacking. Furthermore, subsequent effects on the resilience and belowground biodiversity of resulting woodlands are poorly understood and difficult to predict.

Aims: Here, we address the question of how mycorrhizal fungal communities develop under natural colonisation and plantations across eleven sites in lowland England ranging in age from 18 to over 100 years of afforestation, using local mature woodlands as a reference and potential source community. We incorporate both EcM and AM fungi, distinct functional groups often studied separately, in order to capture the breadth of mycorrhizal diversity and function in these successional habitats.

Methods: We generated MF community data through PacBio sequencing of soil, and both Sanger and PacBio sequencing of roots to identify EcM and AM fungal taxa. We examine impacts of afforestation practice, host plant community and soil physical-chemical properties on MF community composition, functional traits and taxonomic diversity across woodland age.

Impact: Our findings will help to inform policy guidelines on afforestation practices, shed light on the role of MF communities in natural colonisation of UK agricultural land and develop mycorrhizal diversity metrics inclusive of EcM and AM fungi.

Funded by: Forest Research, DEFRA Nature for Climate Fund

Keywords: Mycorrhizal Fungi, Community ecology, Natural colonisation, Regeneration, Afforestation, Plantation, Policy

# Soil pH as a Key Driver of Microbial Function and Nutrient Cycling: Insights from Long-term pH Manipulation Experiments.

By **Jack Horne**[1], Fiona C. Fraser[2], Ashish A. Malik[3], Graeme I. Paton[1], Nicola Holden[2], Christine A. Watson[2]

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*2. SRUC*

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Soil health is a critical metric for understanding the state of ecosystems and is crucial to integrate when assessing the sustainability of conservative land management practices to ensure food security. Microbial genetic indicators for soil health are poorly defined, and as such, soil health assessments fail to capture a holistic picture of the status of the soil ecosystem.

Soil pH is a critical factor in the composition of the soil microbiome, and thus its functional capacity. The ACE Platform in Craibstone, Aberdeen, provides a unique opportunity to investigate the effects of both long- and short-term pH adjustments on the capacity of soil microbiomes to execute critical functions. This platform features soil plots that have had their pH altered for 63 years, paired with newer plots that have undergone pH manipulation for just 3 years at the time of sampling. This study aimed to identify critical pathways behind the microbiome's capacity for resource acquisition and core functions that could serve as indicators of a healthy, functioning microbiome.

The study revealed several important insights, such as where nitrogen acquisition strategies of the soil microbiome change across the pH range. Ammonia transferase (amt) functional transporter genes increased concurrently with pH while nitrate/nitrite transferase (ntt) functional transporter abundance showed an inverse relationship. Furthermore, read counts in methionine and cobalamin biosynthesis functional pathways demonstrated strong, significant relationships with soil pH. Methionine and cobalamin represent critical intersections of metabolism, nutrient cycling, and environmental adaptation. Cobalamin is also a rate-limiting vitamin in soil, which demonstrates this pathway as a potential metric for biological soil health

assessment. These findings contribute to our understanding of the complex interplay between soil pH and microbial community function. By elucidating the pH-dependent shifts in microbial functional pathways, this study provides valuable insights for developing more comprehensive soil health assessments.

Funded by: UKRI BBSRC

Keywords: Soil health, microbiome, microbial function, pH, metagenomics, nutrient acquisition

# The influence of phosphorus fertiliser addition on soybean nitrogen fixation and yield.

By **Hannah Walling**[1,2], Shane Rothwell[1], Mariana Rufino[1,3], John Quinton[1], Phil Haygarth[1]

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It is hypothesised that phosphorus fertiliser addition can optimise nitrogen (N) fixation processes and increase soybean yield globally. Global meta-analysis showed seed yield increasing by 25% following P fertiliser addition, whilst highlighting the complexity of soybean yield response to P fertiliser under differing environmental and management conditions. Large proportions of soils in top soybean producing countries can be estimated to be P limited for soybean. If yield increases could be replicated at the field scale of global production, it would make large contribution to closing existing yield gaps and improving food security. However, ineffective P fertiliser use, leading to the oversaturation of soils and negative environmental and economic costs. As a result this work aims to improve our understanding pf mechanisms driving the response of soybean to P fertiliser addition, including the improvement to key nodule traits to improve N fixation, and partitioning and remobilisation of resources to improve yield. Controlled environment studies revealed that whilst P addition significantly increased N fixation through increased beneficial nodule traits, nodule function was not influenced by P fertiliser addition because of plant regulatory mechanisms. The uptake and remobilisation of P within the plant was found to increase seed yield and seed P concentration following P fertiliser addition.

Funded by: Lancaster University, Corteva Agriscience (Pioneer Hi-Bred International)

Keywords: Soybean, Phosphorus, Fertiliser, Nitrogen fixation

# Soils For People: Poster Abstracts

## On-farm sampling suggests extensive soil physical degradation in Scotland.

By **Jessica Brook**[1], Paul Gaffney[2], Josie Geris[1], Peter Gilbert[3], Rebecca Hall[4], Alan Lilly[5], Nikki Baggaley[5], Paul Hallett[1]

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2. *Chinese Academy of Sciences*

3. *RSPB Scotland*

4. *Teagasc*

5. *The James Hutton Institute*

Soil structural degradation is widespread across many countries, with compaction and erosion posing serious threats to agricultural productivity. This research explored the extent of soil structure degradation in winter across 42 agricultural fields in Scotland, comparing visual and quantitative methods. The 42 fields, across three river catchments, were sampled in winter 2022-23 and in each field three replicate samples were taken from in-field locations, three from degraded areas with visible soil surface damage, and three from less disturbed field margins. At each sampling location, Visual Evaluation of Soil Structure (VESS) was undertaken, and it was hypothesised that VESS scores would relate to quantitative soil physical data of penetration resistance, and bulk density, hydraulic conductivity and water retention characteristics from intact soil cores (2-7 cm depth).

From VESS scores, 59.5% of in-field and 78.5% of margin locations had good soil structure (Sq 1-2), compared to 11.1% for visibly degraded soils. This pattern continued for the quantitative core data. For bulk density, in-field soils were 8.3% denser, and visibly degraded soils were 12.7% denser than margins, which was also reflected in porosity. Furthermore, organic carbon content was 10.6% less for in-field and 11.3% less for degraded compared with field margins. The majority of in-field soils had no degradation indicated from VESS scores, but quantitative soil data indicated erosion and structural damage. Land use also significantly impacted soil structure, as grasslands presented the least degraded structure, with significantly greater porosity compared to stubble, ploughed soils and winter cereal cropland.

Although we found VESS to be a valuable and rapid tool, quantitative data found more structural degradation, demonstrating that VESS scoring alone may not provide a holistic assessment of soil structural health. These results emphasise the need for improved land management practices in Scotland to maintain good soil structure and agricultural productivity.

Funded by: SUPER DTP

Keywords: VESS, visual assessment, soil structure, agriculture, structural degradation, physical degradation

## Monitoring the Impact of Plastic and Non-Plastic Microfibre degradation on Soil.

By **Emily Donaghy**[1], Geoffrey D. Abbott[2], Anh Phan[3], Kelly Sheridan[1], Jakub Olewski[4], Miranda Prendergast-Miller[1]

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One of the main pathways of microfibre pollution release into the environment is from textile laundering into waterways via waste-water treatment plants [1]. In these waste-water treatment plants, microfibres also make their way into sewage sludge [2]. Sewage sludge is then applied to agricultural land as fertiliser, introducing microfibres to terrestrial environments. Microfibre pollution is often categorised as part of the microplastic problem, however, studies have shown that cotton microfibres are more prevalent in the environment than plastic microfibres [3]. Non-plastic microfibres often have chemical dyes and finishes applied so pose a potential risk to soil environments.

The aim of this project is to investigate the impact that degradation of plastic and non-plastic microfibres, dyed and undyed, have on soil environments. A soil degradation experiment has been set up comparing dyed and undyed swatches of cotton and wool (examples of non-plastic textile microfibres) with virgin polyester, recycled polyester from PET bottles and recycled polyester from sea waste (examples of plastic textile microfibres). These fabric swatches and soil samples will be monitored over 18 months using pyrolysis-GC-MS and LC-MS to trace chemical changes over time, as well as monitoring impacts of fibre degradation to soil properties and soil function. Here we present preliminary data from the first 6 months of the experiment, focussing on the changes to fabric and soil properties.

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Keywords: Degradation, Microfibre, Pollution, Soil, Agriculture

Link to Poster

## Advancing Soil Health with Biochar - Effects on Soil Microbial Activity and Diversity.

By **Adam El-Aradi**[1], Agnieszka A. Nowak[2], Daniel J. Nowakowski[1]

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*2. Institute of Biology, Biotechnology and Environmental Protection, Faculty of Environmental Science, University of Silesia in Katowice, Katowice, Poland.*

Improving soil quality is essential for sustainable agriculture and long-term soil resilience. Biochar, a carbon-rich material derived from biomass pyrolysis, is increasingly recognised for its potential to enhance the physical, chemical, and biological properties of soils. This study evaluated the effects of two biochar samples, produced from pinewood (PWBC) and wheat straw (WSBC), on soil microbial activity and functional diversity during a six-month incubation experiment.

Both biochar samples met international safety standards for heavy metals and other parameters, confirming their suitability for agricultural application. WSBC exhibited higher ash and nutrient contents than PWBC, resulting in more pronounced changes in soil properties. The addition of WSBC increased soil pH from 6.6 to 7.1, electrical conductivity from 300 to 570 μS $cm^{-1}$, and plant-available potassium from 289 to 849 mg $L^{-1}$. PWBC, with lower ash and nutrient contents, produced minimal effects on these parameters, indicating its role as a more stable carbon source.

Microbial responses varied with both feedstock and incubation time. Total heterotrophic bacterial counts declined by approximately three log units across all treatments after 30 days, suggesting no immediate biochar effect on microbial abundance. Dehydrogenase activity peaked after 90 days, with 5% WSBC-amended soil exhibiting nearly four times the activity of the control, compared to a twofold increase under PWBC. By six months, activity levels in WSBC-amended soil returned to control values, whereas PWBC remained slightly lower.

Both biochar samples maintained microbial functioning without disrupting soil biochemical balance. Nutrient-rich WSBC enhanced short-term microbial activity

and nutrient availability, while recalcitrant PWBC contributed to long-term carbon sequestration. Their complementary characteristics offer a balanced approach to improving soil health, microbial resilience, and sustainable agricultural productivity.

Funded by: Biochar CleanTech Accelerator (West Midlands Innovation Accelerator)

Keywords: biochar, soil amendment, microbial activity, dehydrogenase activity, substrate utilisation profiling

## Salt Chemistry Impacts on Soil Physical Conditions for Root Growth and The Response of Cereals with Differing Salt Tolerance.

By **Faraj Elsakloul**, Maria Marin, Gareth. J. Norton, Paul Hallett

*The University of Aberdeen*

Saline-sodic soils were most compacted, with clay loam penetration resistance rising from 0.65 MPa to 2.73 MPa, compared with 1.84 MPa in saline soils under drier, high-compaction conditions. Root elongation was strongly restricted in saline-sodic soil (32% in barley, 20% in wheat) compared to the control, while reductions were smaller in saline soil. At wetter conditions (-5 kPa), air-filled porosity was lowest in saline-sodic clay loam, again driving the largest decline in root growth. Across treatments, penetration resistance correlated well with barley elongation but less so for wheat, suggesting combined physical and chemical stresses. Overall, salt-affected soils limited growth through altered physical conditions, which needs to be factored in when exploring plant tolerance or mitigation practices.

Funded by: The University of Sirte

Keywords: Barley, wheat, penetration resistance, air-filled porosity, root elongation, water content.

Link to Poster

## Assessing regenerative agricultural practices in mineral-rich soils using carbon and nitrogen stable isotopes

By **Flora Gray,** Prof. Darren Gröcke, Dr Catherine Hirst

*Durham University*

Agriculture produced ~15% of global greenhouse gas emissions in 2021, despite being one of the most at-risk sectors to climate change. However, agriculture has the potential to mitigate climate warming through system-wide changes. Southwest England produces 29% of the UK's maize, despite sloping landscapes exacerbating its already harmful impact on soil health and regeneration. Trials in Europe have tried to counter ramifications by planting living mulches under maize to reduce soil respiration, fallow ground, increase soil carbon flux and improve soil structure. Elston Farm began farming regeneratively in 2021, implementing systems such as leguminous cover crops and silvopasture. Samples were collected from 16 different sites, including soil profiles up to 20cm in depth and individual plant species. Stable isotope ratios of carbon and nitrogen were measured in the Stable Isotope Biogeoeochemistry Laboratory (Durham); also producing wt% carbon and wt% nitrogen concentrations. Isotopic and elemental data was compared against land use. The iron-rich soils showed no statistical difference in soil carbon and nitrogen, indicating that regenerative agricultural practices had made little positive benefit to an agricultural soil that had previously been intensely used. Although there were some positive indications that regenerative agriculture was slightly improving the soil (e.g., leguminous N-fixation and/or silvopasture), more positive results in this mineral-rich soil system would require longer time to recover.

Keywords: Stable isotopes, Regenerative farming, Silvopasture, Nitrogen fixers, Cover cropping

# The effects of genotypic variation in maize on nitrification and associated shift in soil microbial functional diversity are strongly regulated by nitrogen regime.

By **Jackson Kilonzi**[1], Jackson B[1], Paterson E[2], Giles M[2], Baggs E[1]

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Soil biogeochemical processes including N cycling are driven by plant-soil-microbes interactions making them highly dynamic, complicating our understanding on N transformation mechanisms. Differences within crop species have showed ability to shift soil microbial communities mediating N cycling. However, subsequent feedbacks from soil management relating to the modulation of assembly plant specific microbiome mediating nitrification is not well understood. We aimed to investigate effects of contrasting tropical maize (Zea mays) genotypes in mineralizing soil organic carbon (SOC) (ranked as high medium and low from previous study) on nitrification activity under different N fertilizer regime (50 and 100 kg N ha-1) representing low and high N regime respectively). We also examined whether this is linked to changes in soil functional diversity. MicroRespTM assays and 16S rRNA and amoA gene copies were used to assess the relationship between net nitrification and soil microbial activities. N fertilizer suppressed soil respiration (CO2-C), amoA gene copies corresponding to decreased net nitrification in the first 11 days of application, but at the end of experiment, high N regime increased net nitrification, soil microbial respiration and gene copy numbers of amoA and 16S rRNA. While differences among the genotypes in influencing net nitrification was not significant under high N regime, net nitrification and soil respiration showed negative relationship with SOC mineralization ability of the maize genotypes under low N regime. Clustering of community level physiological profiles (CLPPs) as a function of substrate induce respiration was driven by the effect of the contrasting maize genotypes at the end of the experiment. Our findings suggests that N regime strongly drives soil biological processes and that the effect of maize genotype can be observed when N concentrations are low. This can used to explore priming effect linked with the maize genotypes to increase our knowledge on nitrogen management.

Funded by: Commonwealth commission and University of Edinburgh

Keywords: rhizosphere, maize genotypic variation, Nitrogen, soil functional diversity and MicroRespTM

# The effect of wildflower alleyways on soil fungal populations in English vineyards.

By **Joseph Leaper**[1], Kate Ashbrook[1], Duncan Westbury[2]

*1. University of Worcester*

*2. Royal Agricultural University*

Wildflower strips are increasingly introduced into agricultural systems to enhance biodiversity and support ecosystem. However, their effects are often studied in isolation, and little integrated research has been conducted in UK vineyards on their combined impacts on biodiversity, soil health, and fungal communities.

In spring 2024, wildflower strips were established at four sites across three commercial vineyards in Sussex and Surrey. At each site, two plots of sixteen 75 m alleyways were selected: one sown with a mix of native perennial wildflowers in the central 1.5 m of each alleyway, and one maintained as a control under standard vineyard management. Soil fungal communities were assessed over time by extracting DNA from 112 soil samples and conducting amplicon sequencing of the ITS2 region.

Comparative analyses of fungal diversity and community composition between wildflower and control alleyways are ongoing, and results will be presented at the conference. This study will provide new insights into how vineyard groundcover management influences soil fungal biodiversity and, ultimately, soil health in UK viticulture.

Funded by: University of Worcester, Perry Foundation, Bumblebee Conservation Trust

Keywords: viticulture, soil biodiversity, fungi, microorganisms, land management, wildflowers, soil health

# Colne Valley Western Slopes: Resilient Soils for a Sustainable Future.

By **Eve Martindale**[1], Matthew Hobbs[1], James Rowson[1], Jane Rickson[2], Ceri Spears[3]

*1. Jacobs*

*2. Cranfield University*

*3. Tim O'Hare Associates*

Introduction and context:

The Colne Valley Western Slopes (CVWS) is a large-scale green infrastructure project, part of Section C1 of the HS2 Phase One Scheme. The design vision is to establish a 127ha biodiverse chalk downland mosaic, accessible to the public from over 4 km of new recreational routes.

Our presentation will demonstrate how putting soils at the centre of the design and delivery strategy helped maximise opportunities and value for biodiversity, public amenity and environmental improvement.

Design strategy – soil profiles:

The habitat creation designs were led by the inherent properties of the soil and substrate materials, following ecological succession and niche principles in the design of soil profiles to maximise the potential for biodiversity net gain.

Soil profile and landscaping trials:

A key technical challenge for the project was creating the optimum ground conditions to establish biodiverse calcareous grassland using the available site-won resources. A research project and landscaping trials were therefore undertaken to help resolve uncertainties and limit risks for the habitat creation.

Delivery – sustainable soil management:

Pre-construction planning, delivery phase support and verification protocols have all been critical to ensuring soils are sustainably managed. This has involved close collaboration between design and construction teams together with surveys, modelling and inspections to help meet the project objectives.

Outcomes:

The CVWS habitat creation is currently ~50% complete, and will ultimately provide:

• ~127 ha of high-value habitats and a 81% gain in biodiversity units

• high public amenity value through its accessibility to recreational users

• enhanced soil carbon storage potential, with an additional 54,317 $tCO_2e$ predicted to be sequestered over a 40-year period (vs. baseline conditions)

• circular economy and carbon footprint benefits through the retention of site-won materials and minimisation of off-site exports.

Funded by: HS2 Ltd and Align JV

Keywords: habitat creation, soil management, circular economy, biodiversity, carbon, calcareous grassland

# Plastic Degradation Under Realistic Agricultural Conditions.

By **Liberty O'Brien**, Charlotte Lloyd, Ian Bull, David Withall, Robert Dunn, Martin Blackwell

*University of Bristol*

Plastic mulch films (PMFs) are increasingly considered an essential component of future agricultural systems due to their proven proficiency in improving crop yield whilst reducing agrichemical inputs by improving growing conditions. Growing concern over the negative health and environmental implications of the input of conventional microplastics and additives to soils, however, has prompted environmental and commercial interest in biodegradable PMFs (BMFs). Biodegradable plastics are designed to degrade in soil to $CO_2$, $H_2O$ and biomass by microbial action. EU regulation EN17033 defines BMFs as plastics that undergo 90% conversion to $CO_2$ within 2 years in soil incubated between 20 – 28 °C.

However, agricultural conditions in the UK differ to those of the regulatory definition by variations in temperature, soil properties, microbial activity and agrichemical input, all of which may impact BMF degradation. In this study, the impact of UV exposure and soil type on BMF degradation are investigated under field conditions to identify the key drivers of degradation, and to quantify realistic degradation rates. BMF and soil have been sampled regularly to quantify the relative degradation of the 3 polymers in the film, quantify microplastics in soil, extract phospholipid fatty acids (PLFAs) to characterise microbial populations. In addition, novel analytical techniques for the accurate quantification of BMF degradation in soil are in development in order to increase resolution of results, towards a thorough understanding of the relationship between soil properties and BMF degradation.

As well as producing valuable data for environmental and agricultural policy making, this project contributes towards enabling farmers to predict the degradation of BMFs in different soil types and under different agricultural management systems, ultimately making important steps towards realistic solutions for improving the sustainability of large-scale food production.

Funded by: BBSRC (SWBio DTP)

Keywords: Biodegradable plastic, microplastic, degradaton, soil health, GC-MS, food security

# Contribution of biological nitrification inhibition to soil restoration.

By **Sofia Palacio**, Prof. Cecile Gubry-Rangin, Prof. Paul Hallett

*University of Aberdeen*

Nitrogen (N) fertilisation causes many environmentally damaging cascades. N can leach into waterways and evaporate into the atmosphere as a greenhouse gas. The main cause of these cascades is through nitrification by ammonia oxidisers. One aspect of soil health important to modern agriculture and sustainability is the capture of nitrogen into plants, more specifically crops. Plant roots can manipulate the characteristics of the surrounding soil environment, called the rhizosphere. They can alter the chemical, biological and physical properties of the soil. One of these processes is to inhibit nitrification through Biological Nitrification Inhibition (BNI) compounds.

Biological nitrification inhibition is a plant derived process that enables the plant roots to manipulate the levels of absorbable ammonia within the rhizosphere through root exudates. BNI compounds are a relatively new area of research within the global scientific community. BNI compounds are responsible for interacting with the ammonia oxidisers within the soil to inhibit the loss of ammonia into nitrite and nitrates. There is a large effort in understanding the role of BNI compounds in many aspects of plant, soil and microbial interactions. However, BNI compounds have not been widely applied into the field and their role in reducing the impact of N fertilisation on soils has not been established.

In this poster I will primarily focus on the roles of BNI compounds within the rhizosphere. The main objectives of this poster are to:

1. Define BNI

2. Illustrate current knowledge on how BNI interacts with the soil environment

3. Show BNIs effectiveness against N loss to the environment

Funded by: The Anthony & Margaret Johnston Centre for Doctoral Training in Plant Sciences at the University of Aberdeen

Keywords: Root exudates, BNI, plant traits, Soil restoration, Degraded soils, Environmental stress, Microbial activity, Crops

## Unearthing Ancient Grasslands: Identifying eDNA and Geochemical Indicators in Soil Profiles.

**By Bradley Powell,** Gareth Griffith

*Department of Life Sciences, Aberystwyth University*

This study develops new methods for identifying ancient, undisturbed grasslands through biological and geochemical evidence in soils. Although these habitats support distinctive and often threatened communities, including IUCN Red List waxcap fungi, they remain poorly defined within conservation policy and vulnerable to loss. To address this, the project integrates environmental DNA (eDNA) metabarcoding with soil chemical analyses to test whether these indicators can reliably distinguish sites with long-term ecological continuity.

Churchyards and cemeteries form the core study sites, representing key refuges for ancient grassland biodiversity due to their long, low-intensity management and limited soil disturbance. Stratified soil cores will be collected to examine diagnostic vertical patterns in eDNA and soil chemistry. In addition, composite samples will be obtained from grassland sites managed by local authorities in Rhondda Cynon Taf and Carmarthenshire, and from unimproved upland grasslands within the Forest of Bowland. These provide valuable contrasts in land-use intensity, soil type, and management history for assessing the characteristics of ancient grasslands.

Laboratory analyses will quantify fungal and plant eDNA alongside soil organic matter, pH, and nutrient status. The poster will outline how these combined approaches can underpin large-scale identification of ancient grasslands where historical documentation is lacking. The potential application of radioisotopes ($^{14}C$, $^{137}Cs$) and optically stimulated luminescence (OSL) dating is discussed as future work to establish chronological evidence of soil stability and disturbance history.

Together, these methods form an integrated framework for generating reproducible, evidence-based criteria to recognise and protect ancient grasslands as irreplaceable habitats within land-use and biodiversity policy frameworks.

Funded by: Rhondda Cynon Taf County Borough Council, Carmarthenshire County Council, Forest of Bowland National Landscape Team (Lancashire County Council)

Keywords: Ancient grassland; eDNA metabarcoding; waxcap fungi; soil biodiversity

Link to Poster

## Rhondda Cynon Taf County Borough Council, Carmarthenshire County Council, Forest of Bowland National Landscape Team (Lancashire County Council)

By **Abbie B. Rogers**, Miranda T. Prendergast-Miller, Matthew J. Pound

*Department of Geography and Environmental Sciences, Northumbria University, NE1 8ST, Newcastle upon Tyne, United Kingdom*

Research on microplastics has focused heavily on aquatic environments, leaving a gap in understanding their presence and effects in terrestrial ecosystems, particularly woodlands which are crucial for the health of many species and ecological functions. One overlooked source of microplastic pollution is woodland management tools such as tree guards and cable ties. This research aims to address this gap by assessing the impact of microplastics from these sources on U.K. woodland soil to support the creation of policies to better regulate plastics use and waste management. This research is timely given the increase in tree planting initiatives to meet climate change mitigation targets.

To do this, a 15-month burial experiment is being conducted to explore how varying concentrations, types, sizes and shapes of microplastics affect woodland soil chemistry and microbial respiration. The impact of the soil on the microplastics physical and chemical properties is also being monitored. The findings will be shared with woodland management organisations and woodland management tool manufacturers to raise awareness of microplastics as a potential pollutant in woodland ecosystems.

Funded by: Natural Environment Research Council (NERC) funded One Planet Doctoral Training Partnership, and Northumbria University's Research Development Fund Studentship Scheme.

Keywords: Pollution, Terrestrial, Soil, Biota, Forest, Microplastic

Link to Poster

# Soils For Water:

# Oral Abstracts

# Hydromechanical Drivers of Soil Stabilization Against Erosion: Carbon's Role at the Aggregate Scale

**By Abdul Walid Salik,** Jo Smith, Paul Hallett

*University of Aberdeen*

Organic carbon in soil can improve stability, reducing structure collapse and erosion under erosive force, yet the hydromechanical mechanisms remain poorly quantified. This study assessed erosion resistance in sandy loam soil with two treatments: no organic amendment (control) and amended soil receiving 200 t $ha^{-1}$ compost. Simulated rainfall events of 30 and 60 minutes were applied to soil core filled with undisturbed soil aggregates, with structural change quantified via X-ray µCT and image analysis. Raindrop-scale hydromechanical measurements revealed the mechanistic drivers of structural collapse. Soil hardness and elasticity were measured with a 3 mm spherical indenter. The water sorptivity and repellency index were measured using a miniaturized infiltrometer device with a 1.2-mm tip radius. After 60 minutes of rainfall, control soils exhibited 32% greater surface slumping, a 42% reduction in total porosity, and 5% lower cumulative infiltration compared to compost-amended soils, which lost only 13% porosity. The pronounced structural collapse in the control corresponded with pore network degradation and surface sedimentation, indicating weaker aggregate stability and reduced water retention capacity under erosive stress. Soil hardness in the control exceeded that of the compost treatment by 41% at 30 minutes and 30% at 60 minutes of rainfall, indicating that lower organic carbon limited aggregate deformability and reduced resilience to erosive forces. Water sorptivity was initially 37% higher in the control at 30 minutes rainfall. Results demonstrate that compost-derived carbon reduces hardness, maintains sorptivity, and limits pore structure collapse at the aggregate scale, thereby decreasing slumping and erosion during prolonged rainfall. These findings highlight the mechanistic role of organic carbon in sustaining hydromechanical function and structural resilience in sandy loam soils.

Keywords: Soil erosion, Organic carbon, Simulated rainfall, X-ray µCT, Hydromechanical drivers

# Genotypic variation in wheat root architecture, soil pore structure and hydraulic properties

**By Bartolo Giuseppe Dimattia[1],** Maria Hernandez-Soriano[2], Silvio Salvi[1], Roberto Tuberosa[1], Marco Bittelli[1]

1. *University of Bologna, Bologna, Italy*
2. *John Innes Centre, Norwich, United Kingdom*

Plant roots play a crucial role in maintaining soil health by influencing physical structure and hydraulic properties. This study investigates relationships between root morphology of wheat genotypes and their impacts on soil structure and hydraulic characteristics. Using shovelomics, we characterized root systems of wheat cultivars (Paragon, Bologna) and landraces (Senatore-Cappelli, Watkins238) selected for contrasting root morphologies. X-ray computed tomography (CT) was applied to examine soil pore networks at cylinder and aggregate scales, while soil hydraulic properties were measured using Wind evaporation and dew point techniques.

Results demonstrated significant genotype-driven differences in soil morphology and hydraulic functions. Structural analyses (Minkowski functionals, percolation theory) showed significant variability in bioporosity and pore connectivity among genotypes compared to bare soil. Senatore-Cappelli exhibited notably larger biopores (>1 mm diameter). Hydraulic characterization using a van Genuchten bimodal model revealed statistically significant differences in soil water retention curves and hydraulic conductivity among genotypes. Root traits, including total root length, branching frequency, lateral root length, and root diameter, significantly correlated with soil pore size distribution and hydraulic parameters.

This analysis underscores the importance of root architecture in modulating soil structure and water dynamics, highlighting the potential of specific wheat genotypes to affect soil health, water retention, and agricultural sustainability.

Funded by: EJP SOIL, MISAF

Keywords: agricultural sustainability, water retention, soil health, wheat genotypes, water dynamics

# Simulation of climate and land use change on soil densification and hydraulic function mediated by soil organic matter.

**By Maud van Soest,** Fabrizio Albanito, Laura Bentley, Els Dhiedt, Alejandro R. Dussaillant, Sabine Reinsch, Amy Thomas, David A. Robinson

*UK Centre for Ecology & Hydrology*

In the UK, climate change is projected to lead to drier summers and warmer, wetter winters. Moreover, the climate is expected to become increasingly more extreme. Given these projected conditions, it remains uncertain how the land surface will respond regarding the partitioning of rainfall between infiltration and runoff. We developed a framework to investigate how various interconnected soil processes may affect hydraulic function in response to these changes. We examined the response of soil organic matter to changes in land use, how this modifies bulk density and compaction, and how these factors subsequently influence infiltration and alter the partitioning between what infiltrates and what runs off. We evaluate this sequence through simulations using large, simulated storm events of 25 mm and 50 mm across different soil types to determine potential runoff thresholds. By doing so, we can begin to understand how changes in land use can indirectly modify water storage behaviour, trigger local runoff and increase the risk of soil erosion. The UKCEH Countryside Survey provides a national-scale dataset including land use, soil organic matter and bulk density, while storms are simulated using engineered storm events. The results indicate that a runoff threshold is reached when the bulk density consistently measures approximately 1.5 g cm-3 across various soil textures. The national data shows that such high bulk densities are predominantly observed in cropland areas. An analysis of the national data will determine the percentage of cropland that is at risk of exceeding the bulk density threshold of 1.5 g cm-3. Moreover, modelling efforts will facilitate predictions regarding the changes in soil organic matter required to transition soils into this runoff category. The implications of our results are discussed within the framework of land use change and climate change and their potential to alter the organic matter-compaction-moisture storage-runoff-erosion continuum.

Funded by: EU-Horizon AI4SoilHealth

Keywords: Flood management, Soil compaction, Storm events, Runoff

## Predicting Soil Erosion through Plant–Soil Interactions in Wheat under Different Agronomic and Water Regimes

**By Sophia Bahddou[1,2,3],** Wilfred Otten[3], R. Jane Rickson[3], Richard Whalley[2], Kamrun Suravi[2], Ho-Chul Shin[2], Mohamed El Gharous[1], Adnane Beniaich[1], W. Hannah V. Cooper[2,4]

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Soil erosion poses a significant threat to agricultural productivity, environmental sustainability, and food security. Accurately assessing the factors influencing erosion processes is crucial for developing effective soil conservation strategies and ensuring the long-term viability of agricultural systems. This research aims to study the effect of different wheat lines subjected to different sowing densities and water regimes on soil physical properties and plant traits. The subsequent effect on runoff and soil loss was predicted using the modified Morgan-Morgan Finney (mMMF) model. The outcome of this study shows that the dwarf wheat line exhibited better drought tolerance, maintaining plant height under water stress, and demonstrated higher root density, particularly at higher sowing densities and under dry conditions. It exhibited superior erosion control capabilities (reduced soil loss by 25%) compared to the wild-type wheat line, particularly at later growth stages, due to its higher canopy cover and ground cover providing better soil protection. Higher sowing densities reduced soil loss by 31%, compared to lower sowing densities, through increased root length density, canopy cover, and ground cover, and improved soil physical properties. Drought stress significantly impaired plant growth, reducing canopy cover, tillering, plant height, aboveground biomass, and root length density, which led to increased predicted erosion risks. In contrast, well-watered conditions promoted plant growth and soil protection, resulting in a 23% reduction in soil loss compared to drought conditions. The presence of plants significantly reduced runoff and soil loss by 38% and 41%, respectively, compared to bare soil, underscoring their importance in erosion control. These findings emphasize the need for integrated management approaches that consider plant genetics, sowing practices, and environmental factors for sustainable soil conservation and erosion control.

Funded by: OCP group

Keywords: Drought, mMMF model, Runoff, Shoots, Soil loss, Roots, Soil properties

# Soils For Water: Poster Abstracts

## Evaluating the phosphorus release efficiency of duo-biochar to spring wheat

**By Christina Van Midden**[1], Suzanne Higgins[1], Deb Jaise[2], Pavlo Ivanchenko[2], Rajan Ghimere[3], Juan Frene[3], David O'Connell[4], Sofia Vitsa[4], Nitesh Kasera[5], Sushil Adhikari[5]

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High legacy soil phosphorus inputs from slurry and organic manures are an issue in intensively managed agricultural areas within Northern Ireland, Ireland and North America, reducing water quality. Since much of this phosphorus is in a form that is not available to plants, fertilisers are used to meet plant requirements, but rapid fixation to soil constituents results in 70-90% of applied phosphorus becoming plant unavailable. Therefore, solutions are required to both retain excess phosphorus in the soils, thereby protecting freshwater and coastal habitats, and act as a slow-release fertiliser to provide plants with sufficient phosphorus during growth. Biochar, a carbonaceous material produced from the thermochemical conversion of biomass, is capable of absorbing phosphorus, and its capacity to do so can be increased by modification with metals, such as iron. This experiment aimed to test the effects of Fe-doped biochar versus unmodified biochar on crop production and water quality, whilst also using stable isotope-P labelling to quantify the phosphorus release from biochar into the plant.

Fe-modified and pristine biochar were loaded with isotope labelled P and applied in a pot scale experiment at a rate equivalent to 10 t ha-1 and compared to a biochar-free control. At 40-, 80- and 120- days following sowing, pots were leached with deionised water and the leachate measured for total and soluble reactive phosphorus. Following leaching, crop and soil samples were taken and biochar separated from the soil, to measure the total and bioavailable phosphorus in each fraction. Analysis of stable isotope on these samples was also measured to quantify the amount of P released by the biochar and determine the proportions that are lost to leaching, soil fixation or taken up by the crop.

Data collection is currently underway therefore no results available to provide a discussion

Funded by: Biobased Products Program, US Department of Agriculture's National Institute of Food and Agriculture, the Department of Agriculture, Environment and Rural Affairs (NI) and the Department of Agriculture, Food and the Marine (ROI) through the US-Ireland R&D Partnership.

Keywords: Biochar, Leaching, Stable isotope-P, Soil available P, Soil amendment

Link to Poster

# Copper and zinc from slurry applications shape grassland microbial community structure

**By Coalain McCreanor[1,2],** Paul Williams[1], Selvakumar Dhandapani[2], Andrew Meharg[1], Caroline Meharg[1], Manus Carey[1], Wanqi Jia[1], Jonathan Holland[2], Jonathan McComb[2]

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Soil microbes are crucial in maintaining soil health and enhancing agronomic productivity. This study investigates long-term cow and pig slurry applications on soil microbial community structures, soil chemistry, and herbage yield in a ~50-year Long-Term Slurry (LTS) experiment on a permanent grassland located in County Down, Northern Ireland. Illumina and PacBio rRNA sequencing (analysing 16S and ITS genera) were used to investigate soil samples from the experiment's treatments to depths of 15cm. Slurry type and application rate were found to alter the relative soil microbial community. In comparison to the non-amended control treatment and inorganic fertiliser treatment, higher slurry rates had the greatest log2 fold change of relative microbial abundance, alongside increasing soil pH and total carbon. Soil pH, copper and zinc concentrations were found to be significant key drivers of soil microbial community shifts (permutation test, $P<0.001$). More specifically, copper primarily influenced 16S and zinc was the greatest influence on ITS genera. CAP analysis revealed that relative abundance changes of 16S genera diverged depending on slurry type and rate, with ITS genera only distinguished by rates of slurry.

Funded by: Department of Agriculture, Environment and Rural Affairs

Keywords: Nutrient treatments, Slurry, Carbon, Copper, Zinc, Soil microbes, Grasslands

Link to Poster

## Interaction between mucilage and organic acids on rhizosphere physical behaviour: a model study using pectin and oxalic acid

**By Hui Ao,** Graeme Paton, Paul Hallett

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Roots excrete mucilage and organic acids as rhizodeposits, which due to their distinct physicochemical properties have gelling and dispersion effects on soils. Along a growing root, these different rhizodeposits will interact, but their combined impact on soil physical behaviour has received limited study. Here pectin simulated mucilage, and oxalic acid simulated organic acids, both of which have been identified in natural root exudates. By controlling different water potentials and compression loads, we investigated the effects of these rhizodeposits on soil mechanical properties (compression characteristics, hardness, elasticity, and penetration resistance) and soil water properties (water content, sorptivity and repellency).

The results showed that at 200 kPa compression (tractor wheel–like) and -50 kPa water potential, pectin and the combined treatment of oxalic acid and pectin had the most significant effects on mechanical parameters. Pectin decreased soil hardness by 25.6%, which increased to 36.1% for pectin and oxalic acid in combination, while oxalic acid on its own reduced it by 13.9%. Similarly, pectin and oxalic acid decreased penetration the most, by 47.5%, where pectin on its own only caused a 32.4% decrease, and oxalic acid on its own a 34.6% decrease. There was a large impact of pectin, either on its own or mixed with oxalic acid, on retaining more water in soil at a given water potential. This suggests hydrogel behaviour, which others have observed for mucilage. In dry soils, oxalic acid decreased water repellency, suggesting a surfactant effect. The influence of root exudates on soil physical properties may become more pronounced with more negative (dryer) water potential and compression load, demonstrating the increased importance of rhizodeposits on relieving environmental stresses from drought or compaction. Mucilage and organic acids have different impacts, and when mixed the net effect was less than of each compound acting on its own.

Keywords: Root exudates; Pectin; Oxalic acid; Soil mechanical properties; Water potential

Funded by: China Scholarship Council

# Understanding how diverse root traits of underutilised crop species physically stabilise Ethiopian agricultural soils

**By Kate Whitehouse**

Shifts in Ethiopia's agricultural systems from traditional native crops to modern arable species has resulted in a reliance on a narrow range of crops, reducing agricultural plant diversity and altering the complex below-ground root networks which previously bound soils together. Consequently, intensive crop production combined with a rise in severe rainfall and drought periods has physically destabilised agricultural soils in Ethiopia, leading to increased erosion.

Underutilised crops have untapped potential to physically stabilise soils, improve nutrition and enhance the climate resilience of agricultural systems. The importance of adopting these species is becoming increasingly apparent, with these crops being recognised as 'Future Smart Foods' by the FAO. Underutilised plant species can contribute to more diverse root systems, enhancing soil physical stability and hence erosion resistance by mechanical reinforcement and aggregation via root exudation.

However, the root traits of underutilised crops and their effects on soil physical stability have been subject to little research compared to the well-characterised root systems of staple crops. The specific soil-structural benefits provided by these species remain poorly understood, as well as the mechanical and biochemical mechanisms behind these soil-structural impacts.

This research aims to conduct field and laboratory measurements to understand how root traits of underutilised crop species influence soil properties related to erosion resistance. It will establish experimental methods to effectively disentangle the effects of root reinforcement, exudate and carbon input impacts on soil stabilisation, giving better understanding of root-soil mechanisms from both micro and macro-scale perspectives. These findings will contribute to practical soil conservation strategies which integrate underutilised plants into diverse mixed cropping systems to enhance soil physical stability and erosion resistance within Ethiopian agricultural systems.

Keywords: Ethiopia, erosion, root-soil interactions, underutilised crops, physical stability, root reinforcement

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