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New Zealand Society of Soil Science

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Joint NZSSS and SSA Conference "Te Kiri o Papatūānuku"

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POSTER ABSTRACTS

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Impact of Irrigation on Yield and Land Use Efficiency in Intercropping vs. Sole Cropping Systems

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Water availability has extensive consequences for plant growth and yield. With drought events becoming increasingly more common worldwide, crop production will be severely impacted, potentially expediting food shortages and increased food prices. Intercropping has been shown to increase crop production compared to growing the same crops separately (sole cropping) because of more efficient use of nutrients. However, a comprehensive assessment of how intercropping is affected by water availability remains unclear. We assessed how irrigation affected yield in diverse intercropping and sole cropping systems of the component crops, as well as the Land Equivalent Ratio (LER) using a meta-analysis. We analysed a total of 17 papers (287 observations). We found that irrigation increased yield of cereals in intercropping systems more when grown with other cereals than when grown with legumes or grown alone. On the other hand, irrigation had limited effects on the yield of legumes, either grown with cereals or alone. Irrigation increased the LER more in cereal-legume intercropping systems than in intercropping systems with two cereals or with a legume and a non-cereal crop. We further observed that increase in LER with irrigation was greater in systems that also received relatively low amounts of irrigation and high levels of nitrogen fertilisers, but that the LER was not affected by the irrigation method or climate zone. We conclude that cereals are more sensitive to changes in water availability when grown with other cereals, but that an increase in water availability through irrigation could decrease the total land area required for intercropping compared to sole cropping to produce the same yield, particularly for systems where a cereal is grown with a legume.

Keywords: Intercropping, Land Equivalent Ratio (LER), Crop diversification, Sustainable Agricultural Practice

Diffusive gradients in thin films (DGT) methodology for in-situ measurement of imazamox residues in soil

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Imidazolinones (IMI) are one of the major groups of chiral herbicides known for their weed control ability at very low concentrations. However, due to their persistence and residual activity in the soil, IMI herbicide residues can lead to a carryover effect on subsequent crops, resulting in injury to sensitive crops and decreased productivity in severe cases. Conventional extraction techniques only measure the soil's total herbicide concentration to which plants are not necessarily exposed to (i.e. the bioavailable fraction is not quantified). Diffusive gradients in thin films (DGT) is an in-situ passive sampling technique that can predict the bioavailable concentration of different organic and inorganic pollutants, including herbicides. The current study focuses on the development of a DGT methodology to measure imazamox herbicide residues in soil. For selecting an efficient binding phase for the DGT, ten different materials were tested, and from these ten, two were chosen (SepraZT-WAX and Oasis HLB) for incorporation into a polyacrylamide binding gel. The SepraZT-WAX gel showed higher binding and elution efficiency for imazamox than the Oasis HLB gel. Therefore, SepraZT-WAX was selected as the binding phase for further DGT development. The SepraZT-WAX DGT provided a fast imazamox uptake rate (0.24 µg/h) and high binding capacity (4.5 µg/disc). The performance of the SepraZT-WAX DGT was independent of the solution pH (4.0-9.1), dissolved organic matter content (0-20 mg/L), electrical conductivity (1-50 mS/cm), and sulfate concentration (0-600 mg/L). We are now undertaking an in-situ performance validation of the SepraZT-WAX DGT in a range of contrasting Australian soil types.

POSTER ABSTRACTS

Functional soil microbiology in New Zealand pastoral farm systems under regenerative agricultural management

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Regenerative agriculture (RA) is gaining a lot of attention within the farming sector as a sustainable alternative to food production. However, many of its claimed benefits are based on subjective observations and farmer testimonials and have not been tested in New Zealand. It is important that these claims are validated with robust science to ensure food producers and policy makers can make well informed decisions. A core principle of RA is protecting and enhancing soil health. A crucial aspect of soil health is soil biology, especially the microbiome that makes up the base of the soil food-web and carries out many important processes required for healthy, productive soil.

The aim of this research is to determine the effect RA have on soil biology. It is part of the Whenua Haumanu research project, in which a farmlet study with replicated treatments of diverse and standard ryegrass-white clover pasture managed under contemporary and regenerative management is being carried out on a dairy and a sheep farm, at Massey University in Palmerston North.

The effects of these treatments on soil bacterial, fungal and protist activity will be analysed using fluorescence microscopy as well as through soil respiration analysis. Phospholipid fatty acid (PLFA) analysis will be undertaken to determine the total microbial biomass and composition of important microbial groups. Nematodes will be quantified, and nematode-based soil health indices will be used to provide an overview of the early links in the soil food-web. Together, this will provide a comprehensive assessment of the functional biology present in the soil and will show if the farmlet treatments have an impact on the soil biome.

POSTER ABSTRACTS

Improving Soil Quality to Mitigate Nitrate Leaching: insights on Ranzau Soil and carbon management

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The “Waimea Plains”, located northeast of Tasman, holds some of the most fertile and productive lands on the South Island, producing fruits, vegetables, and boutique crops such as hops and grapes. Its eastern portion, covering about 1,600 hectares, is dominated by a distinctive Orthic Brown soil known as “Ranzau”. This soil is predominantly stony with a loamy upper horizon.

While Ranzau soils exhibit moderate to high versatility for horticultural use, stoniness and low water-holding capacity are their main limitations. Therefore, high-tillage farming practices including market gardening, which is a prevalent land use on the Waimea Plains, can lead to organic matter loss and increase the risk of nitrate leaching into the underlying groundwater. This was evident last year by results of (soil) State of the Environment (SOE) monitoring, identifying “market gardens” with the lowest total carbon (2.1%) and total nitrogen (0.21%) levels among five land uses, as shown in Figures 1 and 2.

Although significant efforts are underway to enhance irrigation and fertiliser efficiency, improvement of soil structure itself has largely been overlooked. To address this issue, the Tasman District Council is currently leading a research project to evaluate efficacy of carbon-rich soil conditioners, including biochar. The main advantage of biochar over alternatives such as sawdust is its slow rate of decomposition, owing to its aromatic molecular structure. The outcomes of this research may provide affected farmers with effective strategies to reduce nitrate leaching risk while enhancing soil carbon levels, productivity, and overall yield.

POSTER ABSTRACTS

A GIS-Based Solution to Soil and Catchment Rehabilitation

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A comprehensive catchment assessment project in Northland, New Zealand, addressed community concerns about farming runoff, erosion, spawning habitat, and water quality. The project's primary objective was to develop site-specific recommendations for a large catchment area, culminating in a succinct site-by-site Action Plan for community groups.
This presentation showcases a multi-faceted approach utilising various GIS software programs (GIS Online, ArcPro, Survey123, Experience Builder, Story Maps) to tackle the complex interplay of factors across the catchment. These tools enabled the visualisation of critical aspects such as farming areas, erosion-prone zones, significant natural areas, HAIL sites, etc. By compiling and analysing all the different layers of information together, optimal focus areas for intervention were identified.
A key outcome of the assessment was identifying an ideal location for an ecological corridor. This area is surrounded by farming and bare or poorly vegetated levees, which contributed to poor water quality downstream. The proposed corridor would cover the degraded soils with a 15m riparian strip on either side of the 2m wide permanent stream. The riparian strip was designed to maximise nutrient, contaminant and sediment retention. It includes the recommended sequence of fencing, a 1m grass strip, a row of flaxes, followed by mixed native planting. The proposed restoration plan recommends efforts around the catchment's headwaters to seamlessly integrate new vegetation with existing forest cover.
A 3 to 10m riparian strip would suffice as a sediment filter. However, a 15m strip provides increased sediment retention, slope and soil stability, improved nutrient and contaminant filtration, enhanced soil health and biodiversity, shading and habitat creation for fish and insects.
By emphasising a holistic approach to erosion and soil management, including integrating ecology, water quality, and stream function, the catchment group was given a robust argumentative strategy for landowners to buy in on the wider riparian strip.

Exploring the impact of various ameliorants on soil chromium geochemical distribution and CO2-Carbon efflux

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Contamination of terrestrial ecosystems with potentially toxic elements (PTEs) is a potential pathway of soil health degradation that requires sustainable and effective solutions to immobilize and limit their transfer into the food chain. Among various PTEs, hexavalent chromium (Cr(VI)) is the most toxic and mobile chromium (Cr) species, which is released mainly from tannery industry wastewater into the environment and accumulates in soil. The overarching aim of this study was to examine the potential of six ameliorants (rice husk biochar, vermicompost, sugarcane bagasse, fly ash, gypsum, scrap iron) on the Cr immobilization, geochemical distribution, and CO2-carbon efflux in an incubation trial for 45 days. Chromium-contaminated soil (0-15 cm depth) was taken from Kasur in Punjab, Pakistan where Cr-containing tannery wastewater has been discharged to the soil for several years. Geochemical Cr fractionation showed that the exchangeable Cr pool was significantly reduced with vermicompost (15%), biochar (16%), and gypsum (18%) compared to control (32%), while fly ash (34%), scrap Fe (31%) and sugarcane bagasse (24%) did not show significant soil Cr immobilization. In organic bound soil Cr pool, vermicompost (27%) and biochar (20%) resulted in the highest Cr immobilization. Interestingly, the CO2-C efflux was maximum in vermicompost amended soil (2538 CO2–C mg kg-1) and it was minimum with fly ash (1002 CO2–C mg kg-1). Labile C pool calculated from the CO2-C efflux regression model was significantly higher with vermicompost treated soil (3508 CO2-C mg kg-1 soil), with a minimum decay constant (0.301; R2=0.99) compared to other ameliorants. The current study highlights the significance of ameliorant type, especially vermicompost and biochar, to immobilize readily available soil Cr and simultaneously enhance labile C pool, which is imperative to understand before their application in a large-scale soil remediation and rehabilitation program.

POSTER ABSTRACTS

Superphosphate application did not affect carbon transformations in soil, but likely increased nitrification rate

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Greenhouse gas (GHG) emissions pose a challenge to the modern world and further generations. One possible strategy for climate change mitigation is enhancing soil carbon (C) sequestration by promoting C uptake from the atmosphere and storing it in the form of soil organic matter (SOM) to reduce increases in atmospheric carbon dioxide concentration.

The coupled Carbon-Nitrogen-Phosphorus cycles (CNP) mediate SOM formation and turnover, for example, P is key nutrient for crop growth and its limitation can reduce plant and soil microbial biomass affecting SOC sequestration. In vitro studies have shown that soil P concentration significantly affects emissions of nitrous oxide, N mineralisation, N immobilisation and C fluxes. Varying P level impacts on microbial composition and activity of organisms, which are predicted to control specific transformation pathways within the soil C and N cycles, will influence the stabilisation of GHG emissions, SOC and nutrients. While the stoichiometric constraint of P on plant growth is known, the effect of this constraint on other soil processes at different P levels is uncertain, particularly in relation to GHG emissions and C/N cycling.

Our research aims to explore the impact of long-term P fertilization on the soil C/N cycles and provide baseline characterization of bacterial and fungal communities in soils exposed to long-term P application. We have collected soil samples from the Winchmore site from two P treatments: with 188 kg/ha of super phosphate applied, and with no P applied. To trace ^{15}N, $NH_4{}^{15}NO_3$ and $^{15}NH_4NO_3$ as well as ^{15}N labelled pasture grass roots were added to the soil samples. Although the level of super phosphate applied did not statistically affect C transformations in soil, we revealed that NO_3-N was the dominant source of N_2O emissions. Nitrate accumulation was faster under P treatment, which might be related to increased nitrification rate.

POSTER ABSTRACTS

Lignite mitigates nitrogen loss from broiler litter: Critical to a circular waste economy

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Efficient use and reuse of agricultural nitrogen (N) from farm waste remains one of the most pressing global challenges for agriculture and food production. Intensive animal production systems share the common practice of housing animals through all or part of their productive life. A common issue is that up to half of the N excreted in manure is lost during this animal grow out phase and before waste can be collected for reuse. These concentrated areas of animal waste, result in high N loss, intense odour, detrimental environmental impacts, and health risks. Broilers, like other birds, excrete uric acid in their manure and when deposited on the litter surface undergoes rapid hydrolysis to urea and subsequently ammonia (NH3). The volatilisation and deposition of NH3 into the surrounding environment creates hotspots of N pollution, albeit with lower total N emissions compared to other industries. Importantly, this loss of N reduces the quality of the waste product, its value, and the potential for reuse. Lignite, a low-cost brown coal, abundant in south-eastern Australia, has been studied as a tool to reduce N loss from intensive animal productions systems. When added to animal bedding, N loss, in-house NH3 concentration, odour emissions and litter decomposition were significantly reduced. This increases the potential of this material to be used for sustainable fertiliser and soil amendments. The presntation will outline research activities aimed to reduce N pollution from broiler farms, implement cost-effective waste management and produce high-value fertilisers while increasing agricultural productivity and protecting our soil resources.

Comparing methods of soil biology assessment in a national monitoring programme

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Biology plays a crucial role in the life-supporting capacity of soil yet remains absent from Aotearoa New Zealand's national soil monitoring programme, which primarily focuses on physical and chemical soil properties. To address this gap, our study aimed to evaluate three different soil biology measurement approaches for inclusion in the monitoring programme. We assessed methods that ranged from low to high resource requirements across 15 sites in the Otago region, representing various land uses and soil types:

1. Macroinvertebrate Searches: We conducted 10-minute searches of soil spade cubes, identifying and counting macroinvertebrates.
2. Mesoinvertebrate Extraction: Soil cores underwent a 7-day heat and light extraction process, allowing us to identify and count mesoinvertebrates under a microscope.
3. Microbial and Invertebrate DNA Analysis: Soil cores were extracted and analysed for microbial (bacterial and fungal) and invertebrate DNA.

Preliminary results revealed significant variations in soil invertebrate presence and abundance based on size class, land use, and soil order. Generally, invertebrate groups were more abundant in areas with lower land use intensity. We compared the results of these methods to business-as-usual soil biological proxies currently used in the programme.

Our findings emphasise the importance of incorporating soil biology into national scale monitoring programmes, considering their value added, time and cost. By doing so, we can enhance our understanding of soil biology and its relationship to land management and the environment to better meet the statutory requirement of monitoring and safeguarding the life-supporting capacity of soil.

POSTER ABSTRACTS

The Pacific Soils Portal

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Good quality soil information is available for many Pacific nations, with soil surveys having been completed for most countries. These soil surveys were intended to support better land-use planning and improve soil management. However, they have been under-utilized, being neither easy to obtain, nor easily interpreted, by residing in government hard copy data, soil reports, and scientific publications.

A key component of raising awareness of Pacific soils has been to make the existing legacy soil surveys, integrated with interpretive land resource information, more readily available via websites (rather than physical maps and reports) to farmers, government extension officers, agri-businesses, government policy analysts, and other decision makers.

Funded by the Australian Centre for International Agricultural Research (ACIAR) and developed as part of the CSIRO-led "Soil management in Pacific Islands" project, the Pacific Soils Portal (https://psp.landcarereasearch.co.nz) uses cloud data centres to overcome infrastructure barriers in national agencies and takes advantage of open-source geospatial software and resources to deliver soils knowledge on-line.

The best available published soil maps for six Pacific Island countries (Fiji, Kiribati, Samoa, Tonga, Tuvalu and Vanuatu) have been digitized and combined with a database containing published interpretive information relating to soil classification, soil properties, and crop suitability. The maps are published online as standards compliant web services (e.g. ISO 19128:2005) via a responsive browser-based web site that can be accessed from computer, tablet or smartphone. Currently, over 500 soil profile descriptions and associated soil properties are also published.

The Pacific Soils Portal was 'soft launched' during the Pacific Week of Agriculture in Samoa in October 2019 and subsequently revised and launched publicly in October 2020. Vanuatu has just been added to the portal, with the Cook Island and Niue still being in the pipeline.

POSTER ABSTRACTS

The Land Resources Portal – a new data service for LUC practitioners

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In September 2022 the National Policy Statement for Highly Productive Land (NPS-HPL) was released, which targets the safeguarding of Aotearoa New Zealand's most favourable soils for food and fibre production. It requires regional councils to map and zone highly productive land.

The definition of highly productive land, and the initial mapping of HPL is closely coupled to classes 1, 2 and 3 of the New Zealand Land Use Capability Classification System (LUCCS). Starting in the 1960's the New Zealand Land Resource Inventory (NZLRI) was mapped at a scale of 1:63,360 and was completed for the entire country.
Despite its age and the lack of investment in updating, the NZLRI is still operational as a nationally Significant Database and the basis for much of rural planning in Aotearoa New Zealand.

Manaaki Whenua – Landcare Research and predecessors have played a substantial part in land resource mapping over time and as the custodians of the NZLRI have responded to the increase in attention due to the NPS-HPL's reliance on NZLRI data by creating a new web service for the community of LUC practitioners. Following a stock-take of LUC related materials and the digitisation of relevant items, the 'Land Resources Portal' has been established for convenient information access and download.

But the new service provides more than LUC bulletins and Extended Legends. A 'Topics' section covers a growing number of explanatory texts on aspects of LUC surveys, governance, and history. A 'Tools' section provides quick access to where the NZLRI dataset is already available for online browsing and download, as well as other relevant land and soils data services that Manaaki Whenua has on offer.

The Land Resources Portal can be accessed through https://lrp.landcareresearch.co.nz.

POSTER ABSTRACTS

Direct and indirect biological nitrification inhibition by perennial ryegrass

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Biological nitrification inhibition (BNI) has been observed in different perennial ryegrass (Lolium perenne) accessions including elite cultivars. Preliminary data indicate there are variations in the capacity of perennial ryegrass populations to inhibit nitrification and nitrous oxide emissions, with variations existing both between and within populations. The current research aimed to quantify the mechanisms influencing soil nitrate concentrations under different perennial ryegrass populations with high vs low BNI status. The primary objective was to distinguish between direct nitrification inhibition and indirect effects on other nitrogen transformation processes. After three months of growing contrasting perennial ryegrass plants (high vs low BNI status) in the glasshouse, 15N labelled fertilisers were applied and periodic soil and plant sampling occurred. Using 15N pool dilution technique, gross nitrogen fluxes were calculated and together with supporting soil parameters, the direct and indirect BNI effects were identified/quantified. The results of this experiment will be presented during this conference.

POSTER ABSTRACTS

Evaluation of oat hull ash (OHA) on plant growth and soil properties

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Oat hull ash (OHA), a by-product of oat processing in Australia, is currently disposed of in landfills. OHA has potential benefits as a soil amendment, but little is known about its impacts on soil health, and plant growth. This study applied OHA at rates of 0, 10, 25, and 50 % by volume (equivalent to 2.9, 8.6 and 25.8 t/ha at 10 cm depth) to a sandy, acidic (pH 4.8) soil. Soil chemical properties and growth parameters of sunflower seedlings were measured under glasshouse conditions (25-30 °C). The results showed that OHA significantly altered soil chemistry by initially increasing the pH (1:5 CaCl2) to between 7.2 and 8.8 and raising salinity by 60-150 %. It also substantially increased available phosphorous (P), potassium (K), and micronutrients zinc (Zn) and iron (Fe), but slightly decreased organic carbon, calcium (Ca) and sulfur (S). There were noticeable improvements in plant growth in the 10 % OHA treatment compared to the control, with earlier flowering and an increase in plant height, number of axillary flowers, flower head diameter, leaf area, and fresh and dry flower weights. Additionally, supplemental N further increased the number of axillary flowers and dry root weight but did not significantly interact with OHA for most growth parameters. The benefits of OHA diminished at concentrations higher than 10 %. Plants showed detrimental effects at a 50 % OHA concentration, contrasting with similar studies using 50 % rice husk ash. These findings suggest that OHA has potential as a valuable soil amendment that may improve agricultural sustainability and productivity in acidic soils. Further research is required to confirm whether rates of less than 10% provide beneficial effects, and to determine the effects of OHA on soil chemical properties over the longer term, on plant nutrient content and yield quality on P deficient soils.

POSTER ABSTRACTS

Bridging Soil Science and Industrial Design in Urban Ecosystems: Studying Home-Compostable 3D Printing Materials

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Urban soils comprise a complex interface between humans and the environment, with oft-hidden value in connecting our daily practices with global challenges. Home composting can enhance urban soil health while simultaneously closing the loop on components of urban consumption. 3D printing, while increasingly ubiquitous for assessing product designs, produces significant plastic waste, posing a major urban environmental challenge. Biodegradable biofilaments offer a potential solution, but their impact on soil health remains largely unknown. This study addresses this knowledge gap by assessing the decomposition rate and soil health impact of a novel biomaterial palette for 3D printing in urban home-composting settings.

Adopting a transdisciplinary approach across industrial design and soil sciences, this study evaluates the material's performance in both 3D printing and soil ecosystems. The methodology involved a three-step process: designing material formulas based on urban home composting requirements, creating 3D printed forms guided by composting feedstock needs, and conducting a compost respiration experiment to monitor soil health impact. Using a Cavity Ringdown Spectrometer (Picarro G2301), [SG1] the study measures carbon dioxide and methane emissions, as well as moisture levels, from samples containing mature home-compost and 3D printed objects.

Preliminary results reveal complex relationships between material composition, decomposition rates, and carbon emissions. Contrary to initial hypotheses, materials with organic fillers do not consistently demonstrate faster decomposition or more positive soil impacts. Intriguingly, some materials with slower decomposition rates appear to integrate into urban soil ecosystems without disrupting microbial activity.

These findings challenge conventional notions of compostability and suggest the need for a more nuanced approach to biodegradable material design. This study not only contributes to sustainable practices in additive manufacturing but also serves as a case study for soil scientists, demonstrating how their data and knowledge can be applied beyond the scientific realm to address real-world urban environmental challenges.

POSTER ABSTRACTS

Grazing management and legume impact on SOC in pastoral systems relevant to the ACCU Scheme

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The Australian federal government's emissions trading scheme allows landholders to earn Australian Carbon Credit Units through temporal documentation of soil organic carbon (SOC) over time following the implementation of eligible management activities. A systematic literature review was conducted to assess the impact of grazing management and legume inclusion—two of the eligible activities—on SOC in Australian pastoral systems. This review identified a limited number of relevant studies in Australia (n = 14). Most research was concentrated in New South Wales and Queensland between 2010 and 2020, covering various soil types across different climatic zones. Many studies lacked the ability to determine the impact of these activities on SOC due to experimental design limitations and sampling at one point in time. The legume studies (n = 3) that did show accumulation of SOC were conducted on research stations, sampled before and after treatments were implemented and accounted for equivalent soil mass. Challenges in interpreting management impacts were compounded by insufficient documentation of grazing management history and confounding biophysical factors affecting SOC dynamics. Reassessing sites sampled over a decade ago near the original sampling locations could offer more insights into expected SOC accumulation levels.

POSTER ABSTRACTS

Does irrigation scheduling need to consider both soil-water and soil aeration requirements?

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Plant-available soil-water and adequate soil aeration are essential co-requirements for successful plant growth. Irrigation management in agricultural systems often ensures the soil-water requirements through sensor-based soil moisture measurements without due consideration of soil aeration as a corequisite. This study investigated soil-water characteristic (SWC) measurements in vadose soil profiles (up to 1.5 m depth) in eight pasture soils to examine the combined behaviour of soil-water and diffusion-controlled aeration within the root zone. The soil moisture measurements were made over matric potentials ranging from −1 to −1500 kPa using tension table and pressure plate apparatus. The van Genuchten model was used to parameterize the measured SWC curves, while soil-gas diffusivity was estimated from the Millington-Quirk model using measured soil physical properties. Based on threshold values for both plant-available water and soil–gas diffusivity, we defined a “critical soil-water window” which ensures water and aeration corequisites for plant growth. The results distinguished distinct fingerprints of gravitational, plant-available, and unavailable water across the depth in selected profiles and their responses to soil structural changes. Only 30%– 60% of the plant-available water was able to be used by plants in some soil profiles because the remainder was restricted by inadequate soil aeration for plant growth, emphasizing the importance of considering both soil-water and aeration requirements during irrigation scheduling. Results show a pronounced effect of soil texture and, to a lesser extent of soil structure, on meeting the corequisites. We further proposed an assessment matrix which portrays how a soil satisfies the corequisites for successful plant growth as it progressively drains to different matric potentials upon irrigation

POSTER ABSTRACTS

Soil Mapping in Blind River, Marlborough: Loess to Get Excited About

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Marlborough District Council has enlisted pedologists from Manaaki Whenua – Landcare Research to improve their soil information through new field surveys and updated mapping of several key areas within the region. This contribution showcases key findings from our soil survey in the Blind River catchment, a 7,200-hectare area in northeastern Marlborough, South Island. The region features predominantly soft silt- and mudstone bedrock (Starborough and Upton Formations) and extensive loess coverage, particularly near the coast to the east. A major challenge in the development of our soil landscape model was differentiating between loess and mudstone parent materials—a complexity also noted in a 1950s survey that broadly described the area as loess-like sandstone. To address this, we used airborne radiometrics data and erosion type observations to complement traditional soil survey techniques and aid us in deciphering the boundaries of loess deposits. Notable ancillary findings include the identification of calcareous loess and Kawakawa tephra layers, which were extensive to the east of our survey area. These insights contribute to a more nuanced understanding of soil distribution and support more informed land management decisions in the region.

Farming System and Land Use Type Influence Soil Organic Carbon Stocks of Dairy Farms

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This study aimed to examine the variation in soil physicochemical properties across six common land use practices on commercial dairy farms: improved pasture (IP), natural pasture (NP), mixed pasture-cropping (MPC), continuous forage cropping with no grazing (CFC), tree areas (TA), and built-up areas (BA) with no grazing or cropping, as well as two farming systems (zero-grazing/TMR and extensive). Additionally, the study sought to compare the results of laboratory analyses with data extracted from the Soil and Landscape Grid of Australia (SLGA) map developed using remote sensing and environmental data for variables such as soil organic carbon (SOC), bulk density (BD), total phosphorus (TP), and total nitrogen (TN). A total of 810 soil samples from nine dairy farms were collected to 30 cm depth and analyzed. A mixed-effects model assessed the effects of land use and farming systems with farms as a random factor on soil physicochemical properties, while linear regression evaluated the agreement between lab results and SLGA map data. Both land use type and farming system had a significant ($p < 0.001$) effect on SOC stock. TN stock was significantly influenced by land use type ($p < 0.001$) but was not affected by the farming system ($p > 0.05$). SOC and TN were highest in NP, followed by TA, IP, MPC, and CFC, with the lowest values found in BA ($p < 0.05$). SOC stock was 28% higher in extensive dairy farming systems compared to zero-grazing systems. The R^2 between laboratory analysis and the SLGA map was moderate: 0.77 for SOC stock, 0.67 for TN stock, and 0.75 for BD, but low for TP stock, with an R^2 value of 0.19. Overall, the SLGA map is useful for estimating SOC, TN, and BD at large scales but has limitations, especially for TP, requiring careful use in smaller farm areas.

POSTER ABSTRACTS

Soil bacteria unique habitats along a mega meter transect in Southeastern Australia

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Bacteria are the most abundant living microorganisms in the soil microbial community. Our understanding of large-scale soil bacterial regional patterns and land-use perturbation remains largely undocumented. To bridge this gap, we analysed 141 soil samples extending an approximately 1,400 km transect from east to west in New South Wales, Australia, covering a range of pedo-climatic characteristics. Our results observed that the underground soil bacterial community assembled into three unique habitats (i.e., mean annual precipitation of more than 900 mm, between 900-300 mm and less than 300 mm) along the transect due to soil heterogeneity and climate variations. Notably, mean annual precipitation and pH were the most distinct attributes driving bacterial diversity along the transect, e.g., the bacteria richness decreased significantly when the pH was higher than 7 or lower than 5.5. The regionally enriched species and specifically unique taxa further demonstrated above habitat preferences. In addition to the pedo-climatic factors, the variation in land use management also plays a crucial role in shaping the bacterial diversity and co-occurrence networks. These findings will facilitate a more predictive understanding of soil bacterial community management and the prediction of community assembly across various environmental gradients.

Solute weathering fluxes from catchments in Aotearoa-New Zealand – baselines and Enhanced Rock Weathering scenarios

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Amending agricultural soils with of ground silicate rock material has been suggested as a land management technique to increase CO_2 drawdown from the atmosphere via enhanced silicate weathering by carbonic acid. By grinding the rock and adding it to the most biogeochemically active part of the soil (i.e., the topsoil), the natural process of silicate weathering is accelerated. If the weathering products are removed by drainage water, the increased solute flux of basic cations leads to increased alkalinity and storage of CO_2 as bicarbonate (HCO_3). To understand the potential impacts of this management intervention on soil and freshwater, we present baseline weathering and alkalinity fluxes of more than 240 catchments across NZ based on river chemistry data. Annual HCO_3, Ca and Mg fluxes differ by up to 3 orders of magnitude between the catchments. The highest annual fluxes are linked to high-runoff, mountainous catchments of the western South Island. For catchments within an envelope of relatively low annual runoff rates (<2500 mm), concentrations in rivers in the East Coast/Central North Island are the highest nationally and decrease with runoff, whereas the concentrations of such lower-runoff catchments elsewhere do not vary predictably with runoff. This difference is potentially related to unconsolidated volcanic coverbeds and highly erodible sedimentary rocks dominating the East Coast/Central North Island. Otherwise, catchment lithology (grouped into (ultra-)mafic, felsic, intermediate, and carbonate), had little effect on fluxes and concentrations. Using this baseline data, we simulate the impact of regularly applying rock amendments on agricultural land. Across a range of application and weathering scenarios, we find that if an ecologically healthy stream pH is to be maintained and mineral precipitation in the aquatic environment avoided, the application of rock amendments in NZ has limits that are of practical relevance for catchments with already high solute loads relative to runoff.

POSTER ABSTRACTS

For soil microbial function, can parent material trump climate?

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Climate is a major direct and indirect driver of microbial soil function and community composition (e.g., regulation of moisture/temperature, pH, organic carbon, nutrients). Likewise, shallow subsurface hydrology affecting soil redox conditions has a strong control on the soil as a microbiological habitat. There has been less systematic work on the effects of other factors like parent material, while controlling for climate and hydrology. In Aotearoa-New Zealand, short-distance soil variability (≤100 meters) as recognised by soil taxa changes is common due to geomorphic activity/disturbance or variable parent material. We took advantage of parent material changes across short distances on Banks Peninsula (Canterbury, South Island) in an exploratory investigation on parent material effects on microbial soil functions, while keeping climate, soil drainage and above-ground vegetation similar. We sampled topsoils of well-drained Melanic Soils from basalt and Pallic/Brown Soils from greywacke loess, at paired sites under dry/warm and moist/cool climate conditions (4 sites with 6 repeats each, one pair at ~100 m and a second pair at 600 m altitude, sampled in winter and summer). Aside from pedology-standard soil chemical measurements, we quantified the activities of 8 enzymes relevant for the carbon, nitrogen and phosphorus cycles, and the response of microbial respiration to temperature. Soil parent material alone or in concert with climate was a significant predictor of most soil chemical properties. In contrast, enzyme activities in both winter and summer did not differ significantly between parent materials, while both low-elevation sites showed significantly higher activities, particularly consistently across the measured enzymes in winter. The temperature optimum for microbial respiration decreased with colder ambient temperatures more strongly than observed in other published studies, while temperature also obscured any minor effects of parent material. For topsoils in our study, soil parent material was a negligible driver for changes in microbial function compared to climate.

POSTER ABSTRACTS

Controls on weathering zone thickness in a rapidly eroding mountain range, Southern Alps, Aotearoa-New Zealand

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Mountains disproportionately influence global chemical weathering budgets and the delivery of weathering products to the oceans, and thus have particular importance for global biogeochemical cycles, like the carbon cycle. However, the subsurface patterns of chemical weathering reactions in rapidly uplifting mountains are poorly resolved due to a lack of data. Here we present observations from a 300 m-deep drill core and results from reactive transport modeling (RTM) to assess weathering zone characteristics in the western Southern Alps of New Zealand. The soil is thin and weathering fronts are shallow with only apatite (and likely calcite) weathering extending below the soil-bedrock boundary. RTM simulations demonstrate that observed soil depths are primarily controlled by porosity-generating plagioclase weathering and are consistent with local uplift and precipitation rates. However, simulations also show that if all the local precipitation (6 m) infiltrates bedrock, apatite weathering fronts should extend substantially deeper than observed, whereas simulations with only ~1/6 of the precipitation reproduce observed weathering front depths. This indicates that the porosity contrast between soil and rock limits bedrock fluid flow, and preventing deeper propagation of weathering fronts. Thus, water infiltration into bedrock, and not reaction kinetics governed by short mineral residence times, constitutes the foremost constraint on bedrock weathering depth in the western Southern Alps. A long-term carbon exchange budget for the western Southern Alps that combines our measurements with previously published data supports prior assessments that net consumption of atmospheric carbon occurs in the unglaciated portion of the western Southern Alps, with burial of biomass being the quantitatively most important mechanism. However, in contrast to previous work, our analysis suggests that oxidation of petrogenic carbon has been overestimated. Our results show that infiltration and permeability constraints need to be considered when assessing tectonic and climatic controls on chemical weathering.

POSTER ABSTRACTS

Biogeochemical Functioning of Australian Humus Alpine Soils

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The soil in the Australian Alps underpins plant and animal biodiversity as well as recreation and catchment water provisioning. Loss of this soil can lead to serious environmental problems, threatening the ecosystem's health. This study looks at how Australian Alpine soil quality supports the ecosystem and contributes to mitigating climate change. The main goals are to understand how soil biogeochemical functioning relates to the overall health of the ecosystem by looking at the variety of plant species and soil quality indicators. We explored soil quality using the Biofunctool® Soil Quality Index method, at four different locations across Alpine National Park and Kosciuszko National Park. All sites were Alpine Humus soils. Results showed that Schlink Pass and Perisher Valley had higher Biofunctool® soil quality scores. Cope Hut had lower Biofunctool® soil quality scores and fewer plant species, which could be related to historical land management and ungulate impact. Ruined Castle had the lowest Biofunctool® soil quality scores but the highest number of endangered plant species. This study demonstrated that the Biofunctool® is sensitive to differences in biogeochemical functioning between sites with the same soil type. Future application of the Biofunctool® method to explore seasonal changes in soil biogeochemical functioning, including experimental manipulations with altered soil temperatures and snow regimes, has potential to enhance our understanding of the long-term interactions between ecosystem health and climate change.

POSTER ABSTRACTS

Amplicon Sequencing, a Tool for Monitoring Soil Health, Biodiversity and Microbial Communities.

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Amplicon sequencing is a type of DNA sequencing technique that uses next generation sequencing (NGS) technology to generate data on entire microbial communities from multiple samples simultaneously. There are excellent examples of this technology revolutionizing the fields of human health, animal health and environmental health, but its applications in soil health are only just emerging in commercial settings. There is huge opportunity for amplicon sequencing tools to be used in agriculture to better monitor, understand and improve soils. Here we will discuss what these opportunities are and dive into some real life examples of the how this technology is being used in agriculture. We will also discuss some of the theory behind amplicon sequencing and the advantages and limitations of this technology in relation to agriculture. Lastly we will discuss what role this technology might play in the future of agriculture. Is it possible to develop this technology into soil biology tests that can be read and actioned as easily as a soil chemistry test? Can tests using amplicon sequencing be used to predict disease outcomes or fertilizer requirements? What role might this technology play in the future development, validation and regulation of biological products?

POSTER ABSTRACTS

Land degradation information – enabling better decision making in Queensland

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Land degradation is negative change to land condition and can be accelerated due to poor land management practices. Degradation includes chemical and biophysical changes in land that reduce its quality and available uses. The collection, curation and delivery of land degradation data, information and knowledge in Queensland has been largely ad hoc over the last 50 years. With increasing demand for land degradation data, this project aims to bring together relevant information in a coordinated manner to better meet stakeholder needs.

Information on land degradation can support multiple Queensland Government business areas and other external stakeholders. Land degradation data and information is used for the prioritisation of on ground investment programs (e.g. Queensland Natural Resource Recovery program), water quality modelling (as part of Great Barrier Reef program), to support statutory regional plans and Queensland legislation (such as the Soil Conservation Act 1986, Vegetation Management Act 1999 and Environmental Protection Act 1994).

Land degradation results in costly onsite and off-site impacts, such as silting of dams, water quality decline, decreased agricultural productivity and damage to infrastructure. Secondary costs to the environment and tourism result from transported sediments and nutrients entering waterways and oceans (including the Great Barrier Reef).

This project is multifaceted and involves collecting the necessary data to represent condition and trend of Queensland's soil resource in relation to erosion (e.g. gully mapping, identifying known mass movement sites), soil acidification and salinity. It includes filling data and knowledge gaps and using legacy data to deliver products via pathways that maximise uptake and use, with minimal effort (e.g. QGlobe and QSpatial).

Increased knowledge and access to land degradation information across Queensland will allow stakeholders to make informed decisions about reducing impacts to infrastructure and agricultural productivity while optimising the use of available land resources.

POSTER ABSTRACTS

Yield gap analysis of taro in Samoa using Decision Support System for Agrotechnology Transfer model

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Taro (Colocasia esculenta) is crucial to Samoa's culture, economy, and food security, yet its yields often fall short of potential. This study aims to quantify the yield gap of taro in Samoa using the DSSAT model, with data collected from taro farms in wetland and dryland sites between 2023 and 2024. Key variables such as soil properties, climate, crop management, and yield data were used to calibrate the model, which then simulated taro growth under optimal conditions to estimate potential yields. The model was then employed to estimate potential yields under optimal conditions and compare them with actual yields to quantify the yield gap. The study reveals significant yield gaps between the actual and potential yields of taro in both sites in Samoa. In dryland sites yield gap was 86.17% whilst in wetland sites the yield gap was 78.86%. To address this yield gap, alternative management scenarios were developed that had the potential to improve taro yields. This included variations in the management of nitrogen fertilizer, planting window, planting density, the addition of irrigation, and the combination of these scenarios. The management scenarios tested show a significant improvement in yield compared to the baseline The combination of management scenarios, including shifting planting from baseline (January) to October, applying a nitrogen fertilizer rate of 500 kg/ha, using a 1 m x 1 m spacing with 4 plants per square meter, a depth of 30 cm, and providing 15 mm irrigation, has significantly narrowed the yield gap between the predicted and potential yields. In the dryland scenario, the gap was minimized from 86.17% to 1.29%, Whilst for the wetland scenario, the gap was minimized from 78.86% to 3.66%. This suggests that adopting these specific management practices can close the yield gap significantly and bring yields closer to their potential.

Integrating Indigenous Soil Management Knowledge for Cocoa (Theobromae cacao) Cultivation in the Dry Mutli-species Grasslands

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The Government of PNG has tasked the Cocoa Board of Papua New Guinea with a target of 310 000 metric tonnes of cocoa exports to be achieved by 2030. Though, the target has been set, land in suitable growing environments is limited. However, there are vast areas of grassland on the Sepik Plains on the PNG mainland that can be reclaimed for cocoa production. The only problem seen is the soil structure and fertility, which is not as good as in volcanic ash soils and may present problems, and perhaps the need for drainage.

The vegetation in the Sepik Plains consist of savannah where multi-species grasses including cogon grass (Imperata cylindrica) are predominant. This region is dominated by Tropudalfs/Tropudalts soil types with moderately drained, fine textured, low to moderate fertility (Hanson et al., 1998). In addition, the soils are associated with heavy texture and poorly structured subsoils restricting root development (Nelson et al., 2011). Generally, grasslands are unable to fulfill the ecological requirements of cocoa trees because of the heavy texture and poorly structured soils; insufficient and variable rainfall; and low soil organic matter levels.

To address these issues, an observation trial integrating local land transformation knowledge on land tillage was established in the Sepik Plains at Yakimbole, West Yangoru, East Sepik Province. The trial was specifically aimed at addressing possible soil structure and fertility problems as a prerequisite for success in the expansion of cocoa into the grasslands. This could transform the cocoa industry nationwide by allowing expansion of cocoa production without further damaging rainforest resources. The trial compared growth and establishment of cocoa on ploughed soil and soil left undisturbed. Observations and growth measurements collected indicated that cocoa planted on ploughed soil, combined with temporary and permanent shade performed better.

POSTER ABSTRACTS

Soil nitrogen and sulphur applications influence yield and key aroma compounds in Marlborough Sauvignon blanc.

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This research examined the effects of nitrogen (N) and sulphur (S) fertiliser applications on grapevine performance and wine quality across two soil vigour zones in a commercial vineyard. The primary objective was to evaluate how these nutrients influence vine yield, juice yeast assimilable nitrogen (YAN), and wine thiol composition—key aromatic compounds in Sauvignon blanc. The study spanned two growing seasons, with treatments including nitrogen only (urea), sulphur only (elemental sulphur), a combination of nitrogen and sulphur (ammonium sulphate), and a control with no fertilizer. Fertilisers were applied at flowering each season at a rate equivalent to 100 kg/ha of ammonium sulphate.

Over the two seasons, no significant yield changes were observed in the high vigour zone or in the low vigour zone during the first year. However, nitrogen application increased vine yield in the low vigour zone during the second year. Nitrogen also consistently elevated juice YAN levels over both seasons, especially in the low vigour zone during the second year. No significant effects were seen from sulphur application on yield or juice composition.

For aromatic wine thiols, no significant differences in 3-mercaptohexanol (3MH) or 3-mercaptohexyl acetate (3MHA) were observed in the first year. In the second year, nitrogen fertilisation was linked to higher concentrations of these thiols, particularly in high vigour soils. Notably, wines from the lower vigour zone without nitrogen had higher levels of 4-mercapto-4-methylpentan-2-one (4MMP), suggesting that soil driven lower vine vigour combined with nitrogen limitation may enhance this desirable thiol.

These findings highlight the importance of site-specific nitrogen management in optimizing vineyard productivity and wine quality, especially in soils of lower vigour where nitrogen can significantly impact both yield and aromatic compound expression.

POSTER ABSTRACTS

New Zealand apple orchard nitrogen balances and litter decomposition

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Plant & Food Research is undertaking an ambitious research programme to create a digital twin of an apple orchard ecosystem. We are developing a set of tools and models that can describe the soil in an orchard ecosystem to investigate the contribution of soil biogeochemical cycles to ecosystem and crop productivity. Key knowledge gaps exist around the nitrogen balances of modern apple production systems and the quantity and rate of nitrogen recycled within the orchard ecosystem. Here we present the results of two years (2022–2024) of monitoring fluxes of nitrogen within two apple production systems (tall spindle, 2D planar tree architectures) from two New Zealand apple growing regions (Hawkes Bay, Tasman). This monitoring included changes in soil profile mineral nitrogen, soil potentially mineralisable nitrogen, fertiliser inputs, and measures of plant residue returns within the orchard from groundcover mowing, fruit thinning, pruning and leaf fall. Additionally, we measured field decomposition and nitrogen loss rates of mowed groundcover and senesced apple leaf residues under these two apple production systems using the litterbag technique. These data will be used to develop a first iteration of a residue decomposition model to simulate nitrogen cycling within the orchard ecosystem.

POSTER ABSTRACTS

Soil and Yield Impacts of Summer Cover Crops in Cropping Systems of Southeast Australia

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Summer cover crops are gaining significant interest in temperate cropping systems of southeast Australia due to the ecosystem services they may be able to provide. These include prevention of soil erosion, building soil organic carbon, improving soil structure and promoting soil biological activity. However, most evidence for this is derived from winter cover crops used in temperate cropping systems of the Northern Hemisphere, with Australian evidence lacking. Two field trials examining summer cover crops compared to bare fallow in wheat-canola rotation system were established in summer 2020/21 in northern Victoria and central New South Wales. Annual cover crop biomass up until summer 2023/24 has ranged from 500-3000 kg.-1ha. In response to this, no significant cash crop yield penalties have been observed, however maximum decreases of 10-15% have occurred. Similarly, no sustained significant increases of soil carbon or most soil functional indices occurred across the sites. The exception to this being increased saturated hydraulic conductivity at the Victorian site in 2022. Soil water results have been highly varied in response to seasonal conditions, but a general trend of declining water at soil depth following cover crops has been observed. Overall, the study, so far, has highlighted the challenge of producing biomass over the summer period in south-eastern Australia where evaporative demand greatly exceeds rainfall. However, when summer conditions are favourable and early autumn rainfall is provided, these systems can be implemented in the southeast Australian cropping context, with consequences on cash crop yields dependant on in-crop rainfall.

Te Rua o Mahara | The pits of memories Weaving knowledge to understand the past

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Kaitorete is a low-lying spit/barrier complex situated south of Te Pātaka o Rākaihautū (Banks Peninsula). Kaitorete is an Ara Tawhito (ancient trail) and cultural landscape of immense importance, with hundreds of archaeological sites and evidence of pā (settlement, community) and kāinga mahinga kai (food gathering settlement).
The eviction of Mana Whenua from Kaitorete in the mid-1800s resulted in disconnection from the whenua (land), impacting the way of living, traditional knowledge, health, economic opportunities, and sovereignty. With the purchase of 1000 ha of land at Kaitorete in 2021, Mana Whenua Te Taumutu Rūnanga and Wairewa Rūnanga, and the Crown established the Tāwhaki Joint Venture, the first and only indigenous-led aerospace company in the world. The aim of Tāwhaki is to heal Kaitorete whenua, advance mātauranga, enrich connections, and bring whānau home.

Our research focused on a kāinga mahinga kai, Te Waiotemapua. This ephemeral wetland environment hosts an extensive network of rua (pits) on a lakeside ridge. Investigations centred on the network of rua, with the aim of revealing the stories of people in this landscape held by the soil.

This involved looking at the landscape through a mātauranga lens of oral histories, pūrākau (stories), manuscripts, maps, and mahinga kai practices, and using this lens to guide the use of western science tools. We applied soil science methods to look within the soil at the profile and plant microfossils, to enhance knowledge of food gathering, storage, and habitation at this kāinga mahinga kai. Our findings include identifying rua of different sizes and shapes positioned at varying heights on the ridge, signalling a range of uses, and the presence of starch grains in smaller rua, indicating kūmara storage. This transdisciplinary project weaves together mātauranga Māori and soil science, to draw on the past to provide a foundation for future opportunities and growth.

POSTER ABSTRACTS

Connecting people to soil: Learnings from the application of the Food-Landscape Networks framework

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There is a disconnect between people and soil, which is being exacerbated as our populations become increasingly urban-based. This presents a 'wicked' challenge for soil and food security that soil science alone is unable to address. A transdisciplinary research methodology was applied to develop a recently proposed framework, Food-Landscape Networks (FLN), that applies a holistic approach to understanding the reciprocal connections between soil, food, and people in contemporary local food production systems. This framework weaves mātauraka Māori and soil science to look beyond the boundaries of soil science to guide the reconnection of people and soil. The framework consists of six interrelated factors, situating soil health at its centre, that are used to assess the reciprocal connections between soil, food, and people.

Our research applies the FLN framework to three food-landscapes in the Waitaha Canterbury region: conventional, organic, and community gardens producing potatoes and/or spinach. Applying the FLN framework reveals clear disconnects between soil, food, and people in these landscapes. It also underscores the urgent need for interdisciplinary collaborations to prevent these disconnects from worsening and to facilitate the reconnection of people and soil through food production.

Key findings from applying the FLN framework include identifying that a disconnect between soil, food, and people occurs in all three food-landscapes assessed, with community gardens exhibiting the strongest connection between soil and people. For the disconnect between people and soil to be addressed, the connections between soil and food, and food and people need to be considered in the context of the reciprocal relationships encompassing factors included in the FLN framework, requiring interdisciplinary collaboration before the consumer reconnection can be achieved.

POSTER ABSTRACTS

Drained organic soil greenhouse gas emissions estimates for New Zealand

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Peatland drainage for agriculture has resulted in ongoing land subsidence (about 2 cm/yr) and GHG emissions. Preliminary estimates indicated drained Organic Soils in New Zealand contribute about 8% of annual net GHG emissions from <1% of the land area. Here, we consolidate recent work to improve activity data, existing measurements within New Zealand, and IPCC reporting guidance to refine the estimates of Organic Soil emissions at the national scale. We also examine the potential for mineral soils with peaty surface horizons to contribute to additional emissions given evidence from New Zealand and international studies suggesting these soils are likely losing carbon through time, potentially at similar rates to drained Organic Soils. The area of drained Organic soils estimated using S-map where available and the fundamental soils layer otherwise is roughly 150,000 ha, while managed peaty-mineral soils cover an added 93,000 ha. In both cases this area is largely under Grassland. Using Tier 1 default emission factors from the 2013 IPCC Wetlands Supplement (WS) along with annual carbon balance measurements available from published New Zealand studies, national emissions estimates range from 2.74 to 4.84 MtCO2e yr-1. This range is increased if peaty-mineral soils are included to 4.44 to 7.89 MtCO2e yr-1. Taken together, these estimates suggest drained Organic Soil emissions are contributing 5% to 13% of the country's net emissions (based on the 2024 National GHG Inventory Report). Using further guidance from the WS, we also explore the technical potential of rewetting to reduce these emissions. However, practical considerations associated with difficulties managing water table depth, the need to maintain productivity, alternative land-uses, and incentive mechanisms are explored in other, aligned work.

Exploring the potential of mid infrared spectroscopy for monitoring peatland condition

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Peatlands occur from the tropics to the arctic, covering 3–5% of the Earth's land surface. They store more carbon than any other terrestrial ecosystem and, when degraded, can emit large quantities of stored carbon back into the atmosphere. Given their ecological importance, effective monitoring of peatland condition is of wide global interest. Mid-infrared (MIR) spectroscopy has emerged as a viable alternative for the rapid characterization of soil, offering a high-throughput and cost-effective tool for monitoring and assessing a range of soil properties. This work aims to evaluate the application of MIR spectroscopy combined with partial least squares regression (PLSR) analysis to predict concentrations of C and N in a diverse range of peat soils from around the world.

230 peats from three distinct types of peatlands, tropical (Indonesia and Malaysia), boreal (Canada) and alpine (Australia) were analysed using MIR. Spectra were acquired over the 6000-450 cm-1 range using a Bruker HTS-XT. C and N were measured using an Elementar vario MAX cube. The PLSR model utilized 70% of the C and N data for calibration and the remaining 30% for validation.

The global and regional model's performance was evaluated by the coefficient of determination (R^2) and Lin's Concordance Correlation Coefficient. The results demonstrated significant relationships between measured soil properties and MIR spectra, with R^2 values > 0.80. These findings suggest that MIR/PLSR could serve as a reliable alternative to direct measurement for monitoring TC and TN in peat soils. The capacity of MIR spectroscopy to rapidly predict multiple properties makes this approach cost effective for applications, such as Indonesia's national-scale peatland restoration efforts, where large numbers of sites need to be monitored. Future work will explore the utility of MIR/PLSR to predict a wider range of soil properties identified as key criteria for monitoring the success of peatland restoration.

Effect of subsoil amelioration on soil structure and soil water availability

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Sodosols are renowned for having poor subsoil conditions for plant growth including low water holding capacity, low hydraulic conductivity, high bulk density, and poor root penetration. In recent years subsoil amelioration, the placement of organic amendments in the subsoil, has been promoted as a means to improve soil structure and soil water availability. This study investigated the effects of surface and subsoil organic amendments on the physical properties of a Tasmanian Sodosol. Lucerne pellets 20 kg/ha, poultry manure pellets 20 kg/ha, and gypsum 5 kg/ha were applied as both surface treatments (except gypsum) and in the subsoil at approximately 30-35 cm depth. Five years after application, soils were analysed for 13 different measures of soil structure and soil water availability. Surface application of organic amendments did not significantly improve any measure of soil structure and soil water availability in either the A2 or B2 horizons. Subsurface application of organic amendments did not significantly improve the structure or water availability of the B2 horizon. However, in the A2 horizon, subsoil application of lucerne pellets significantly improved RAW, PAWC, the proportion of pores larger than 100 um diameter, relative field capacity, air capacity, saturated hydraulic conductivity and bulk density compared to both the surface and subsurface controls. Whilst the poultry manure pellets were found to be less effective at improving soil structure, resulting in significant improvement in bulk density, and pores larger than 300 µm compared to both the surface and subsurface controls. Notably deep ripping in the absence of an organic amendments had no significant effect on any measure of soil structure or macroporosity in either the A2 or B2 horizons. This study confirmed subsoil manuring has potential to improve the structure and water holding properties of sodic subsoils above, but not below, the amendment layer.

POSTER ABSTRACTS

A interactive land suitability tool for Queensland

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An on-line statewide crop suitability tool has been developed for Queensland. The tool operates consistently across the whole state to highlight areas where the climate, soils and land are potentially suitable for specific crops.

The tool is the culmination of several attempts to make land suitability information in Queensland more transparent and accessible. It meets a known need for increased access to such information, to inform decision making, especially at the pre-feasibility stage where land development, diversification or intensification is being considered. Landowners, investors and government bodies can focus in on specific areas that show promise and where more detailed local evaluation may be pursued.

The tool operates at various scales. At a statewide scale, climate factors and slope are the attributes considered. As the user drills down, more soil and land attributes are included and the areas are assessed as being either broadly suitable or unsuitable. When zooming into the local level (<1,000 ha) results are displayed in five suitability classes for each of the available crops.

The soil and landscape attributes driving the assessments are drawn from Queensland's Soil and Land Information (SALI) database, other statewide datasets and in some cases from the Soil and Landscape Grid of Australia via the TERN portal.

The suitability results are displayed as a mosaic of cells – the size of which depends on the dimensions of the selected area. By clicking on a cell, the attributes present in that cell, along with its suitability rating for each limitation are displayed – explicitly detailing why a particular parcel of land might be considered unsuitable. The user also has the opportunity to override the automatically derived data if more accurate information is available.

The ruleset determining the suitability results is flexible and may be refined over time, while new crops are expected to be added.

Use of 15N leaf feeding technique to track nitrogen transfer in a grass-forb-legume mixture: transformation and plant uptake

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While the transfer of nitrogen (N) from legumes to neighbouring, non-legumes is widely recognised, there is still much to learn about the role of forage forbs in influencing N use efficiency (NUE) and soil health within multispecies swards. In temperate regions such as southern Australia, dairy farming relies on grazing of pastures composed of white clover (Trifolium repens L.) and perennial ryegrass (Lolium perenne L.). This is a system that is frequently favoured with clover contributing nitrogen in the form of biological nitrogen fixation (BNF). However, in high N input systems, clover often disappears, which reduces its competitive advantage, which eventually reduces the diversity of the sward.
This study aims to investigate and assess belowground N turnover rates using a 15N leaf tracing method in a legume-forb-grass system. The BNF by clover, combined with the addition of forbs and grasses, creates a more efficient N cycle process in multispecies swards, compared to legume and grass only systems.
To evaluate this hypothesis, a glasshouse pot experiment was established to estimate belowground N transfer using 15N labelled urea (98% enrichment). A 15N leaf feeding technique was used to trace N transfer from white clover to chicory, ribwort plantain, and perennial ryegrass comparing individual plants (e.g. clover-ryegrass) and plants in a mixture (i.e. clover-ryegrass-plantain-chicory). A few weeks after the establishment, a single leaf of the white clover plants was labelled with 15N urea, to trace the movement of N from clover to its non-legume companions and to the soil. The experiment will test the potential of multispecies swards to reduce the reliance on nitrogen fertiliser inputs while simultaneously enhancing herbage production and overall pasture sustainability.

Keywords: 15N, nitrogen use efficiency, pastures, multispecies swards

POSTER ABSTRACTS

Isolation of drought- and salt-tolerant plant growth-promoting bacteria from selected commercial vineyard soils in Australia

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Grape production plays a vital role in the Australian economy and is particularly susceptible to the adverse effects of drought and increasing salinity in the context of a changing climate. This study investigates drought- and salt-tolerant plant growth-promoting bacteria in the vineyard soil for potential future use as biofertilizers. Samples of bulk soil, rhizosphere soil, and grapevine roots were collected from 13 vineyards. The collected samples were tested for microbiological parameters (colony count and types), and the bulk soils were also tested for physico-chemical properties. The growth of morphologically distinct bacteria was assessed in different NaCl (for salinity) and polyethylene glycol 6000 (for drought) concentrations. Finally, the following plant growth-promoting properties were assessed: 1-aminocyclopropane-1-carboxylate deaminase, siderophore, indole-3-acetic acid, acid and base production, nitrogen fixation, and phosphorus solubilization. The common soil textures were clay, sandy loam, and clay loam. Soil water content and organic carbon were lower than the optimum range. Available potassium, calcium, magnesium, pH, and electrical conductivity were higher than the optimum range. A significant difference was observed in the total culturable bacteria population. The rhizosphere exhibited the greatest bacterial colony types. Out of 60 isolated bacteria, 70% tolerated 1.7 MPa drought, 26% tolerated 2M salinity, and 20% could withstand both conditions. A strong positive correlation was observed between the 0 and 2M NaCl-tolerant endophytes and sodium and chloride levels in the soil. Plant growth-promoting properties were observed in tested bacteria except for phosphorus solubilization. In conclusion, there is a variation in the total bacterial count and their types across the tested zones, as well as in the 2M NaCl-tolerant endophytes. Bacteria have the potential to be developed into biofertilizers as they have plant growth-promoting properties. The library of bacteria with positive properties will undergo further testing to assess their relationship with plants and, eventually, to produce biofertilizers.

Assessment of NASA's new remote sensing hyperspectral platform for mapping soil organic carbon

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Soil organic carbon (SOC) is crucial for soil health, agricultural productivity, and carbon sequestration. Accurate, traditional methods for measuring SOC are often laborious and time-consuming. Over the past decades, soil spectroscopy (using handheld hyperspectral sensors) has been shown to be a viable alternative to wet chemistry approaches. Hyperspectral sensing can identify various materials using their unique spectral signatures by dividing the spectrum into hundreds of narrow, continuous bands. Today, there is an opportunity to use the same approaches on an increasing number of spaceborne hyperspectral sensors. This study aims to evaluate the Earth Surface Mineral Dust Source Investigation (EMIT), a new hyperspectral sensor from NASA, for assessing and predicting SOC levels on diverse Australian farms.

EMIT, launched on July 14, 2022, captures soil spectral characteristics in the visible to shortwave infrared range (400-2500 nm). Mounted on the International Space Station (ISS), EMIT provides a temporal resolution varying from a few days to two weeks, depending on latitude and the ISS's orbit path, and a spatial resolution of 60 meters. The study includes several experiments:(1) Comparing Partial Least Squares Regression (PLSR), Random Forest, and XGBoost to identify the best prediction method, (2) Comparing the prediction quality of EMIT at different soil depths (0-15, 15-30, 30-60, 60-100 cm), and (3) Comparing EMIT with Sentinel-2 to test the benefit of hyperspectral over multispectral measurements.

We will explore results based on texture profile, soil type, and farming system using datasets of 75 grain-growing farms across Australia. This study will demonstrate EMIT's potential as a cost-effective, high-performance tool for SOC prediction. By integrating machine learning and hyperspectral imaging, the research will support improved soil carbon management strategies. Future work will focus on refining models and expanding the methodology to more regions across Australia.

Keywords: Hyperspectral Imaging, EMIT, Machine Learning Models, Sentinel-2, Australian agricultural landscapes

Virus-mediated Regulation of Sulfur Metabolism in Acid Sulfate Soils

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Acid sulfate soils cover extensive areas across the globe and pose profound ecological and economic challenges. While microbial activities associated with sulfur metabolisms primarily mediate the formation process of acid sulfate soils, the potential impact of viruses, known for their roles in infecting key microorganisms or encoding auxiliary metabolic genes (AMGs), remains largely unexplored. Here, we characterized the community and biogeochemical impacts of viruses in unoxidized acid sulfate soils (Hypersulfidic soils, pH 6.5-7.3) and oxidized acid sulfate soils (Sulfuric soils, pH < 3.3) using paired viromes and total metagenomes. Our results revealed higher diversity and distinct community composition of viral community in Hypersulfidic soils compared to Sulfuric soils. We identified much higher abundance and diversity of viral-encoded AMGs in Hypersulfidic soils than in Sulfuric soils. Particularly, those AMGs associated with assimilatory and dissimilatory sulfate reduction, organosulfur compound degradation, organic matter degradation, and electron transfer strongly implied the potential role of viruses in regulating sulfur cycling and shaping the formation of sulfidic materials in Hypersulfidic soils. The virus-host predictions linked viruses to a wide range of sulfate reducing and oxidizing microorganisms in both soil types, suggesting that viruses exerted a potential influence on the sulfur cycling processes via infection. Altogether, our findings highlight the roles of viruses in mediating sulfur cycling processes in acid sulfate soils and the potential of harnessing soil viruses for manipulating sulfur cycling microorganisms to control acid generation and mitigate soil acidity in practice.

International soil test kit exchange: A journey from Queensland to Central Philippines

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Abaca (Musa textilis), a banana family member, is known for its high-tensile strength fibre, significantly contributing to the Philippines economy in crafts, textiles, cordage, and specialty papers. Despite its economic importance, investment in production via improved soil health methodologies remains limited internationally. This study aimed to address this deficiency and support national research priorities through an international collaboration with Queensland Department of Agriculture and Fisheries (QDAF) and National Abaca Research Centre at Visayas State University (NARC VSU), funded by the Australian Centre for International Agricultural Research (ACIAR). The experiment evaluated the impact of five soil treatments on soil health in abaca systems using a Queensland-designed mobile soil health test kit and offered recommendations for test kit modification to improve applicability to tropical, developing environments.

Soil samples were collected from a Randomised Complete Block Design (RCBD) trial at NARC, across five treatment plots: control (T^0), lactobacillus (T^1), vermicompost (T^2), inorganic fertiliser (T^3), and cultural practice (T^4). Two 300g soil samples (0-15cm depth) were taken near the abaca pseudo stem trunk, alongside two bulk density samples, ensuring repetition in each plot. Samples were dried for 48 hours at 105°C and subjected to seven soil tests targeting biological, chemical, and physical properties to assess holistic soil health. Tests included microbial respiration (SituResp), pH, electrical conductivity (EC), phosphorous (P), nitrogen (N), moisture content, bulk density, and soil stability.

Preliminary findings indicate poor soil health across all interventions, characterised by acidic pH levels, low macronutrient levels, and low microbial respiration rates. Cultural practice (T^4) soils performed the best, while vermicompost (T^2) performed worst. The research yielded three key recommendations for improving the soil test kit's suitability for tropical, developing regions: lowering recommended P standard concentration range, adjusting the laboratory manual for developing country lab conditions, and modifying water addition protocols to compensate for dry seasons.

Decomposability of incorporated and non-incorporated leguminous mulch in Samoan Inceptisols.

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Decomposability of incorporated and non-incorporated leguminous mulch in Samoan Inceptisols

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Abstract
Carbon mineralization plays a vital role in soil health and carbon sequestration, making it a critical process in sustainable agricultural practices. This study addresses the challenge of enhancing carbon mineralization of farming soils by investigating the impact of incorporating leguminous plant residues—specifically Gliricidia (Gliricidia septum), Sesbania (Sesbania sesban), and Erythrina (Erythrina abyssinica) leaves. To achieve this, a controlled laboratory incubation method was employed over 90 days at a constant temperature of 20°C and 50% water-filled pore space. The methodology involved surface application and incorporation of 5.2 grams fresh leaves from each leguminous species in 200 g soil at the beginning of incubation. This approach was designed to achieve with the study's objective of assessing how residue incorporation influences carbon mineralization rates compared to non-incorporated treatments and the control soil. The results demonstrated statistically significant differences in CO_2 evolution among treatments, with incorporated residues exhibiting markedly higher carbon mineralization rates. Gliricidia showed the highest rate, followed by Sesbania and Erythrina. These findings highlight the critical role of leguminous residue incorporation in stimulating microbial activity and accelerating organic matter decomposition, thereby releasing the nutrients. These insights have important implications for soil fertility management and the development of sustainable carbon sequestration strategies in agricultural systems. Future research should focus on long-term field studies to evaluate the sustained impact of leguminous residue incorporation on soil health and carbon dynamics, providing valuable insights for the advancement of sustainable agricultural practices.

Sustainable biochar production for European agriculture and forest soils: the PYRAGRAF project

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Safeguarding soil health is of pivotal importance for the worldwide agriculture and forestry sector. Excessive exploitation and the challenges posed by climate change are the main drivers of soil degradation, which not only hampers the productivity of crops and related food security, but is also among the main causes of soil erosion and loss. Therefore, sustainable agriculture and forestry practices
cannot be implemented without protecting the soil and improving its health. Biochar, the main product of pyrolysis, is considered among the most promising soil amendments. In fact, it has been proven that biochar can increase the carbon retention in the soil, improve water use efficiency and enhance cation exchange capacity. Thus, several studies highlighted the positive effects of biochar not only on soil features, but also on the productivity of the crops. However, despite its great potential in both the agriculture and forestry sectors, biochar is still not widely present in the European market. The main reasons can be listed as: challenges in the feedstock logistic, since biomass has low density and is usually
scattered on large areas, thus increasing the transport costs; limited awareness of the stakeholders on biochar benefits and how it can be used to sustain their production. The PYRAGRAF project, funded by Horizon Europe Programme under the call HORIZON-CL5-2022-D3-02 aims to tackle these issues by developing efficient supply chains for biochar production from agriculture and forest residues which are largely available in Europe. By utilizing solar-assisted mobile pyrolysis units, PYRAGRAF aims to reduce the carbon footprint of biochar production and ensure cost-effective deployment, contributing to
both environmental and economic sustainability across Europe's agriculture and forestry sectors. Through the use of mobile pyrolysis units, the PYRAGRAF project empowers farmers and foresters to become prosumers, producing biochar and renewable energy directly on-site, reducing transportation costs, and promoting decentralized energy systems in rural areas. Additionally, PYRAGRAF will contribute to the establishment of regulatory frameworks and support schemes that encourage the adoption of biochar and wood vinegar, facilitating rapid market development and integration into agricultural practices.

Keywords: pyrolysis; soil amendment; carbon storage; supply chains

Key drivers of soil organic carbon storage across different carbon fractions and soil depths

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Soil carbon sequestration has been proposed as a crucial mitigation strategy not only for soil deterioration, but also for greenhouse gas emission and climate adaptation. However, little research has given efforts to quantification of compositionally different fractions of soil organic carbon (particulate organic carbon (POC), humus organic carbon (HOC), resistant organic carbon (ROC)) with the interplay of climate, soil, topography and vegetation, and the driving factors in changes of labile and recalcitrant SOC fractions are not well understood across depths and geographic regions. This research aims to identify the key drivers for different SOC-fraction storage (POC, HOC, ROC) in topsoil (0~30 cm), subsoil (30~100 cm), respectively. The relative importance of key drivers for each SOC fraction was identified by the most robust prediction model among three machine learning algorithms (RF, XGBoost, Lasso regression). Results show that the predictive performance for SOC fractions in topsoil are much better than that in subsoils, especially for ROC, which indicates that the variance of the recalcitrant carbon needs to be further identified and verified. Total nitrogen (TN), soil types and mean annual precipitation (MAP) are decisive indicators for spatial variations in POC in topsoil, while POC in subsoil is more sensitive to soil types, MAP and bulk density (BD). For HOC in topsoil, TN, C:N ratio and soil types are the top three influencing factors. In contrast, HOC variations in subsoils are predominantly affected by soil types, moisture and TN. ROC is mainly affected by TN, C:N ratio and soil types in both topsoil and subsoils. Furthermore, SOC sensitivity (POC/(HOC+ROC)) in topsoil is largely determined by MAP, C:N ratio and MAT. In subsoils, SOC sensitivity is predominantly governed by vegetation cover and soil types, suggesting that targeted land management practices for different soil types could facilitate accumulation of SOC storage in subsoils.

Application of compost to iron ore mine tailings enhances microbial activity and diversity

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Mine tailings are critical environmental contaminants that generate approximately ten billion tons annually and can elevate concentrations of heavy metals in surrounding areas. Most microbial activities and diversities are important driving forces of the ecosystem to function relationships between biological, physical and geochemical systems and are very limited in mine tailings. This glasshouse study was designed to study the impact of organic amendments on microbial activity and diversity in mine tailings, and compost was amended at the rate of 0%, 75%, and 100% w/w in iron ore mine tailings. Microbial biomass carbon was determined using the fumigation-extraction method, and results showed that, compared to non-amended tailings (0%), the MBC was 90-fold higher in 75% compost rate with a 12-fold higher microbial quotient (MBC/TOC). Microbial respiration was reported to increase with the increasing rate of compost application, and the highest rate was shown in the 75% rate of application. The microbial diversity and abundance were analysed using DAD2 with recommended settings and taxonomic sequence variants, which were classified using SILVA version 132. The compost application significantly affected microbial diversity and abundance. The most prominent phyla in mine tailings was Proteobacteria and Bacteroidetes, and with application of compost decreased abundance. Actinobacteria and Firmicutes showed an increasing trend with an increasing rate of compost application, and Actinobacteria was the second largest phylum in abundance. Further, the bacterial diversity (Shannon index) showed 5.0 at 0% rate, whereas 75% application showed 5.4, which implies that compost application increased the microbial abundance which can converts tailings into suitable medium for plant growth.

A pragmatic approach for generating pXRF datasets efficiently and effectively for large-scale soil monitoring programs

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Portable X-ray fluorescence (pXRF) is an effective tool for rapid estimation of total elemental concentrations of soil samples, offering an alternative to traditional lab methods. Optimising pXRF data collection protocols is crucial, focusing on variables like calibration mode, analysis time, and elemental detection range. The commonly used modes in soil science are Soil mode (3 beams, 90 seconds of analysis time), and Geochem mode (2 beams, 60 seconds). Moreover, it is important to consider soil sample preparation such as soil sample scanning containers (e.g., packed sample cups, plastic bags). The efficiency of pXRF data collection requires further assessment, particularly for large sample quantities under large-scale soil monitoring programs (e.g., n > 3,000).

This study assessed 182 national-scale representative soil samples from the CSIRO national soil archive to evaluate the performance of scanning soil samples in various scanning containers packed sample cups, and plastic bags) and pXRF calibration modes (Soil and Geochem), to determine the most time-efficient scanning protocol, while maintaining the accuracy of measuring total elemental concentrations for large sample amounts.
Results demonstrated strong correlations ($R^2 > 0.9$) for most elements (e.g., Ca) across different containers. However, the correlation for Mg was poor, likely due to insufficient data above the limit of detection (LOD). Among different scanning modes, elements such as K showed strong correlations (LCCC>0.7).
Consequently, scanning soil samples through a plastic bag and with Geochem mode is recommended for its shorter measurement and packing time and capability to detect light elements (e.g., Mg), which makes it feasible to use pXRF scanning for a large number of soil samples. The Soil mode is preferable when detecting elements with lower LOD is necessary (e.g., K). This study contributes to the national scale soil carbon project for analysing 3,600 soil samples, aiding in understanding soil carbon stabilisation mechanism.

POSTER ABSTRACTS

An approach to quantifying decadal changes in soil carbon stocks across key Australian agricultural regions

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There is increasing interest in monitoring and identifying drivers of soil organic carbon (SOC). Between 2022 and 2024, the Soil Organic Carbon Monitoring (SOC-M) project resampled a subset (n=300) of the 4180 sites previously sampled under the Soil Carbon Research Programme (SCaRP, 2009-2012) targeting major agricultural production areas within Australia. The subset of sites was selected using a hybrid re-sampling approach based on SOC drivers, and practical considerations such as land access and data release conditions. The resampling protocol utilised the same sampling support (25m x 25 m) as the original SCaRP study, with 10 random cores collected across the defined sampling area. For 200 sites, cores were combined at specific depth intervals (0-10, 10-20, 20-30 cm; composite sites). For the remaining 100 sites, cores were kept separate to obtain a measure of the spatial variability ('detailed' sites). Soil mass and SOC stocks were calculated for 0-10, 0-20, and 0-30 cm intervals. Stocks and soil mass of the detailed sites were derived based on the mean value of the 10 cores at each depth. Calculated stocks were standardised using equivalent soil mass, and stock change was calculated between the two sampling periods. Using climatic, edaphic, and agricultural production data proxies primarily derived from earth observational datasets, a random forest machine learning algorithm was employed to develop an empirical model of stock change. This model was used to identify and rank the key drivers of SOC change between the two sampling periods. The ultimate goal is to facilitate the development of next-generation technologies for cost-effective measurement of SOC. This will help build confidence in verifiable changes in SOC within the Australian agriculture sector, aiming to provide landholders with assurance that changes are measurable and real, potentially enabling a higher level of adoption of soil carbon farming methodologies.

SOIL MOISTURE CONTROLLED IRRIGATION SCHEDULING FOR REDUCING DEEP PERCOLATION

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Soil moisture-controlled irrigation scheduling regulates irrigation application based on user defined soil moisture limits, i.e. irrigation start and stop points are at certain percentages of PAW (Plant Available Water). This paper has identified threshold soil moisture limits to start and stop irrigation by analysing potential irrigation strategies for six soils with PAW 40, 60, 80, 100, 120 and 140mm.

The results showed that the higher the PAW based irrigation trigger points, the higher will be irrigation and deep percolation estimate. The minimum soil moisture limits to start irrigation at 55 and 60% of PAW, respectively, for the shoulder (March-April and September-October) and peak (November–February) irrigation seasons, and the maximum soil moisture limits to stop irrigation correspondingly at 80 and 90% of PAW would be optimal in terms of addressing actual crop water demand and reducing deep percolation.

The proposed optimal irrigation range has the potential to reduce average annual deep percolation to 188 mm from an existing value of 244 mm (a reduction of 56mm/year) when irrigation starts at 50 and stops at 100% of PAW, under centre-pivot irrigation. As a simple approach, the reduction in average deep percolation under centre-pivot irrigation was estimated at country levels in New Zealand by extrapolating above mentioned values. The extrapolation indicates that an average 199 million m3/year deep percolation could be reduced in New Zealand by adopting the proposed optimal irrigation strategy.

The results indicate the importance of soil moisture-controlled irrigation scheduling for reducing deep percolation from agricultural land, perhaps the biggest environmental challenge for pastoral irrigation in New Zealand, without impacting the productivity.

Keywords: Soil, Moisture, Irrigation Scheduling, Deep Percolation, Stormwater Runoff

POSTER ABSTRACTS

Everything in its right place – assessing the erosion potential of mining landforms

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Most mining in Australia will result in the development of an external landform, from tailings storage facilities through to waste rock dumps. These landforms can be incredibly large and can permanently alter the visual landscape. While each state has different regulatory requirements, there is a consistent expectation that these landforms will be rehabilitated, and the resulting landform will be erosionally stable in the long-term.

The link between landform design and erosion is meshed in complex interactions between material properties, runoff, land shape and erosion processes. Effectively, there are two levers that can be adjusted to achieve erosional stability: material type and land shape.

Material types available for use can range from fine oxide wastes, blocky granitic rock through to stripped topsoil and subsoil. The physical and chemical properties of a material from a geochemical and growth media perspective will influence its potential suitability. Erodibility testing using simulated rainfall plots and overland flow simulations can provide measured data on erodibility characteristics. This data can then be input in erosion modelling software such as the Water Erosion Prediction Program (WEPP) to determine the long-term erosion rate for a given height and gradient. In this way, the land shape can be altered to match the characteristics of the material.

The outcome of this process is the development of a 3-D rehabilitation design shape that can be input into 3-D landform evolution models such as SIBERIA. These erosion models assess the long-term rate of erosion and evolution of the landform over long time scales and can highlight weak points in a design.

The use of erosion models for mine rehabilitation is a critical component of closure. Understanding material properties from a soil scientist perspective and treating all materials as if they are soils is an essential mindset to adopt for mine site rehabilitation.

Trends in spatial sampling designs for monitoring soil organic carbon at the farm scale

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This systematic literature review examines trends in spatial sampling designs used for soil organic carbon (SOC) monitoring, with a particular focus on the unique contexts of Australian and New Zealand agricultural systems. As climate change and sustainable land management become increasingly important national and international drivers of policy and practice, reliable and accurate SOC assessment is essential. For example, the Australian Carbon Credit Unit (ACCU) scheme incentivizes farmers to improve land management practices to generate carbon credits, aiming to increase soil carbon sequestration, with benefits including enhanced soil productivity and reduced net farm-level and national-level greenhouse gas emissions. Accurate monitoring of SOC is critical in determining the carbon credit units that land managers generate.

This literature review study examines the published literature over the past 30 years, and covers advances from traditional grid-based and random sampling to contemporary methods incorporating geostatistics, remote sensing, and machine learning. It provides exemplar case studies of each method and charts the changes in popularity over time of different designs as reported in academic studies and operational guidelines. Understanding trends can provide insights into when and why certain methods have gained or lost favour over time, and which methods may be worth revisiting or identifying as emerging opportunities.

The results highlight the use of adaptive and stratified sampling strategies for capturing the variability of SOC across heterogeneous landscapes often observed in agricultural systems. A shift towards more integrative approaches is identified, leveraging high-resolution spatial data and predictive modelling to enhance SOC estimation accuracy. In Australia and New Zealand, variations in land management practices and biophysical and climatic conditions make efficient and accurate monitoring of SOC a challenging pursuit. The integration of digital soil mapping (DSM) techniques and remote sensing inputs have shown promise in addressing these challenges, offering cost-effective and scalable solutions for SOC monitoring.

Selenium and barnyard grass root extract mitigate arsenic phytotoxicity and enhance phytoaccumulation in rice soils.

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Rice (Oryza sativa L.) serves as a staple food for a major portion of the global population and is known to accumulate arsenic (As), a non-essential and toxic element, in contaminated paddy fields. This accumulation poses a serious threat to human health through rice consumption. The primary sources of As entry into paddy soils and groundwater are often attributed to natural geological sources, mining activities, rainwater leaching, as well as industrial and agricultural effluents. Once assimilated into the rice plant system, As can significantly inhibit growth, photosynthesis, and overall productivity. This study, conducted at the Rasht Rice Research Institute in Iran, was designed to ascertain the efficacy of selenium (Se) supplementation and Echinochloa crus-galli root extract in reducing the solubility and soil-to-plant transfer (mobility) of As, thus mitigating As toxicity in the rice cultivation system. Employing a factorial experimental design with three replicates, this study examined the impacts of different arsenic species (As+3, As+5), varying selenium concentrations (0, 5, and 10 mg/kg soil), and the presence or absence of a 5% Echinochloa crus-galli root extract on physiological parameters. These parameters included foliar chlorophyll content, soluble protein levels, malondialdehyde accumulation, ascorbic acid concentration, and the enzymatic activities of catalase, peroxidase, and superoxide dismutase. Additionally, the concentrations of iron (Fe) and As in Fe plaques, roots and shoot tissues, and grains were analyzed. It was hypothesized that Se treatment might alleviate the uptake capacity and toxicity of As by promoting the formation of Fe plaque on root surfaces. The root extract of Echinochloa crus-galli was proposed to decrease the mobility of As in the soil matrix through complexion and deposition. This research paves the way for further exploration into the kinetics of rice's response to As-contaminated paddy fields under the influence of Se and Echinochloa crus-galli root extracts.

SCALE UP OF PLANT MICROBIAL FUEL CELL (PMFC) IN RICE FIELDS

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Plant microbial fuel cell (PMFC) is one type of MFC that integrates plants to supply organic matter continuously through the rhizodeposits excretion. This study aimed to examine the performance of electricity production from PMFC scale-up and rice production in rice fields with reactor placement layout and exoelectrogen inoculation treatment factors. The layout consists of 3 types. First is one plot containing 9 reactors (L1), the second contains 18 reactors (L2), and the third contains 27 reactors (L3), while exoelectrogen inoculation consists of inoculation (M1) and without inoculation (M0). The results showed that the type of placement and addition of exoelectrogen microbes had a significant effect on electricity rice production, i.e., the type 3 layout with the addition of microbes (L3M1) being the best treatment. The placement with the most significant number of reactors produced the highest electricity production with voltage, current, and power around 1 V/plot, 0.5 mA/plot, and 0.32 mW/plot. The reactor placement layout and inoculation of exoelectrogen microbes significantly affected the productivity of rice plants, as seen from the dry weight. Moreover, soil parameters are summarized as follows: organic C positively correlates with PMFC electricity production, pH, Eh, bacterial density, available P, K, and CEC have no significant effect, but N, Fe, and Mn nutrients have a considerable impact. Scale-up PMFC technology with reactor multiplication in open fields is impossible because the electrodes are in the same electrolyte, and rice productivity decreases when there are too many reactors.

Assessing the risk of soil erosion using remote sensing techniques and GIS mapping

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Land degradation through soil loss is a major environmental concern because of its devastating impacts on food and water security worldwide. The Upper Tana in Kenya covers an area of about17,000 km2 and is home to over 5.3 million people. The basin, located at the eastern foot of the Mt. Kenya and the Aberdare highlands, is prone to erosion. Despite past implementation of soil and water conservation and management programs in the Upper Tana, little success has been achieved. In order to implement effective soil and water conservation strategies, a good understanding of the basin's soil erosion risk is crucial. In this paper, we discuss the application of erosion risk mapping in the planning of soil erosion control and water management. Spatially distributed evaluation of soil erosion risk mapping of this expansive basin before implementation of the soil and water conservation measures has not been undertaken in the past because of limited resources. GIS techniques and remote sensing provide a fast-processing method for complex large datasets whilst allowing efficient estimation of risks of soil erosion and its spatial distribution at a low cost and adequate accuracy. In this research, we apply a soil erosion risk prediction model along with GIS and Landsat imagery and a risk mapping to aid decision-making and soil erosion control and management in the Upper Tana Basin. We also offer a discussion on practical use of the model and erosion risk maps (ERM) in planning and implementation effective basin scale land and water management strategies and methods.

Integrating satellite remote sensing with agricultural systems models for sugarcane production optimisation in Australia

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Australia's sugarcane industry, situated within the ecologically sensitive Great Barrier Reef catchment, faces the dual challenges of maximising productivity and profitability while ensuring environmental sustainability. Precision agriculture offers a pathway to achieving these goals. This review critically examines the challenges and opportunities of integrating satellite remote sensing (RS) data with agricultural systems models (ASMs) to optimise precision sugarcane production in Australia. Satellite remote sensing provides consistent, large-area coverage with the within-field resolution necessary to meet the intensive data requirements of mechanistic ASMs. Integrating RS data with these models enables more accurate calibration, improved spatialisation of predictions, and tailored input optimisation interventions. We reviewed research development on the application of satellite RS in sugarcane growth monitoring and yield prediction, suitable soil and crop state variables and various data assimilation methods including calibration, forcing, updating and Bayesian approaches. We also highlight opportunities for deriving accurate soil state variables by integrating digital soil mapping with RS data. Such integration could optimise irrigation and nutrient management, thereby enhancing soil and ecosystem health. Furthermore, the potential of machine learning to link data-driven methods with mechanistic ASMs is explored, paving the way for the development of digital twin systems tailored to sugarcane production. However, challenges remain in ensuring data compatibility, acquisition, and harmonisation for the effective use of multi-scale, multi-sensor systems and the accurate parameterisation of ASMs. While advancements in data science can address some of these issues, significant improvements in data management literacy and stewardship are also required. By addressing these challenges and leveraging the opportunities presented by the integration of RS and agricultural systems models, this review outlines a roadmap for enhancing the sustainability and productivity of sugarcane farming in Australia.

Digitally mapping soil available phosphorus across Northern Queensland grazing regions

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Livestock productivity in grazing lands is closely tied to the amount of available phosphorus (P) in the soil. To overcome P deficiency, graziers often resort to P supplementation and fertilisation. Soil maps are commonly used to inform P management or guide further sampling. However, soil maps of P availability are not available in northern Queensland grazing regions, which contains a significant portion of the state's grazing land. The aim of this project was to fill that gap by producing a state-wide digital soil map of Colwell-P. In this project, all available Colwell-P data in Queensland was extracted from multiple sources and supplemented with additional sampling in the northern grazing regions. Spatial covariates were intersected with the available Colwell-P data and integrated into a quantile random forest (QRF) model. The QRF model performed well at predicting Colwell-P with between a 17% and 48% improvement in validation metrics compared to the previous Colwell-P map. Final prediction maps including uncertainties were generated across Queensland at a 30 m resolution and will be available through LongPaddock and QSpatial by December 2024. These maps generated will provide essential information to graziers regarding P management across all of Queensland to support a more productive red meat industry.

Global SOC Estimation: Meta-Analysis and Case Studies on Mid-infrared Proximal Sensing, Pretreatment, and Chemometrics

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With the widespread application of mid-infrared (MIR) technology in soil organic carbon (SOC) estimation studies, the issue of accuracy has become increasingly important. This study systematically analysis the key factors influencing the precision of SOC estimation, including soil sample preparation, spectral settings and preprocessing methods, statistical analysis techniques of spectral parameters, and the specificity of the study area. The research found that fine grinding and appropriate drying treatments can significantly improve model explanatory power and prediction accuracy, reducing variation caused by particle size differences and moisture interference.

Meanwhile, advanced spectral preprocessing techniques, such as Multiplicative Scatter Correction (MSC) and Savitzky-Golay Derivatives (SGD), further enhance the accuracy of SOC predictions by optimizing spectral data quality. Additionally, the study indicates that chemometric methods, such as Partial Least Squares Regression (PLSR) and Cubist, demonstrate excellent modeling capabilities when dealing with complex spectral data, significantly improving the reliability of SOC estimation.

Regional case studies (Global, China, Kenya, and Indonesia) emphasize the importance of model localization, with different preprocessing methods showing varying effectiveness across different datasets. These findings provide valuable insights for optimizing SOC estimation practices, highlighting the importance of site-specific model adjustments and advanced data processing methods in improving the accuracy of soil carbon assessment. Future research should focus on validating these strategies across different soil types and climatic conditions to enhance the robustness of SOC estimation models.

Accredited Testing Laboratories of Scientific Research Organisation of Samoa (SROS): Analytical Services and Scientific Research

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SROS, through its Technical Services Division (TSD), is mandated to provide quality-assured testing and research services to stakeholders in both the Private and Public Sectors. Quality assured through the attainment of international accreditation against the standard for testing and calibration laboratories; ISO 17025.

Shortly after SROS was established, the realization that international accreditation would add significant value to its testing services, was conceived. In March 2011, SROS's testing laboratories, namely the Chemical and Biological laboratories, attained international accreditation against the standard ISO17025. An achievement that presently contributes and assists in the monitoring and improvement of food and water quality and safety in Samoa, product development, certification of compliance of import and export products with national and international regulations, environmental assessments, development of national standards, HACCP analyses, and so much more. At present, the testing capacity of the Chemical and Biological laboratories encompass a range of physical, chemical and microbiological analyses, which include but are not limited to; nutritional analyses of foods and food products, SOIL profile analyses, animal feed analyses, pesticide residue analyses.
Soil plays a vital role in sustaining life on the planet. Nearly all of the food that humans consume, except for what is harvested from marine environments, is grown in the Earth's soils. So Our Lab can Analyse for the Availability of Nitrogen, Phosphorus and Potassium and any other Test parameter that are requested by Our customers Using South Pacific Agricultural Chemistry Laboratory Network Method Book that id recommended for Soil, Plant and Water Samples.Less obvious functions that soils serve are providing a medium to attenuate pollutants and excess water, groundwater recharge, nutrient cycling, and habitat for microorganisms.
Some Soil methods are aimed at assessing fertility by measuring plant available nutrients, while others measure soil properties that are used to characterize and classify Soil.

A Comprehensive Review of Biochar's Role in Mitigating Antibiotic Resistance Genes and Enhancing Soil Health

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Soil is essential for maintaining healthy ecosystems and ensuring the quality of agricultural products. However, in recent years, the widespread emergence of antibiotic resistance genes has severely compromised soil health, leading to a range of issues that impact both ecosystems and human well-being. Biochar has emerged as a promising solution to mitigate the spread, migration, and transformation of these harmful genes. Despite extensive research, there remain gaps in our understanding of the underlying mechanisms and methods for its effective application.

This study addresses this gap by providing a thorough review of biochar's influence on antibiotics and ARGs, based on a bibliometric analysis of 864 publications since 2011.

China has emerged as the leading contributor in this field, followed by the United States and Australia. Our co-authorship network analysis identified 434 institutions actively participating in this research. Keyword analysis revealed three primary research clusters: (1) understanding the biological and chemical interactions between biochar and microbial communities, (2) the use of advanced oxidation processes and specific chemical agents on biochar, and (3) the application and modification of biochar for environmental remediation. Thematic evolution analysis indicated a shift in research focus over the past 12 years, from early studies on biochar's impact on antibiotic bioavailability for ARG control to its environmental applications in combating antibiotic resistance. Additionally, we deeply discuss the current international research landscape across different contexts, highlighting biochar's mechanisms and modification technologies.

This study serves as a critical reference, offering new insights and guiding future research in this rapidly evolving field.

POSTER ABSTRACTS

The Chemistry of New Zealand Native Plants Growing in Low Fertility Soil Amended with Biosolids

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Biosolids are the treated and partially dried product of the solid component of wastewater. The management of biosolids is a global environmental issue. Biosolids contain a range of macronutrients and trace elements, including essential plant nutrients and potential contaminants. Biosolids have potential for beneficial reuse to improve chemical and physical properties of the soil due to high concentrations of plant nutrients and organic carbon. Previous experiments in controlled conditions have shown that the rate and type of biosolids application on low-fertility soil can sometimes improve plant growth and result in profound changes in the plant's chemical composition. Yet there is a lack of information about plant responses under field conditions. We used a field trial to assess the growth and chemical composition of native plants grown in low fertility soil amended with biosolids. Biosolids were applied at two rates using four contrasting application methods: surface application, mixed into the topsoil, application in bands, and application at depth. We present soil and plant chemistry for a range of species as a function of the rate and configuration of biosolids addition. The results will inform the most effective application methods and plant species for future restoration projects.

Soil testing with a digital tool to support Australian farmers' management of soil constraints

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Soil testing at sufficient intensity to understand soil variability is not widely practiced by Australian farmers, who instead rely on tacit knowledge with sparsely collected soil information. Soil scientists and local agronomists engaged with farmers in a series of action learning workshops (in Queensland and NSW) to support their local understanding of soil and crop performance and improve the value of soil testing. In the introductory workshop, farmers identified soil sampling locations with an online tool (ConstraintID). The online tool uses crop growth patterns over a 20-year period as a basis for targeted soil sampling. A survey at the introductory workshop captured farmer background information relevant to the project. In the follow-up workshop another survey gauged the impact of the project on farmers' knowledge and intentions following review of their soil test data. Prior experience with soil testing varied, with the largest proportion of participants identified as "regular users," soil testing every 2 to 3 years (43%). Only a small percentage (5%) had never soil tested. Farm locations (n=121) were soil sampled (up to 90 cm deep) in the three crop performance zones (high, low and inconsistent) identified per field. Explanatory workshops presented soil test results to farmers along with advice on managing soil constraints. More than half the attendees motivated to participate were "unsure" in their soils knowledge, while the rest were "confident". Agronomists were widely used to interpret soil test results with less than a quarter of participants (23%) interpreting them independently, despite nearly 60% of farmers expressing confidence they could do so. Most farmers, at the follow-up workshop agreed the soil test results identified good and poor performing areas within paddocks that fitted with their local knowledge, and would soil test more frequently, but not necessarily aided by the online tool.

Mapping soil conditions under future climate change across New South Wales

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Soil conditions are fundamental to the agricultural productivity and ecological balance of New South Wales (NSW), Australia. Anticipated climate change, characterized by increasing temperatures, shifting precipitation patterns, and more frequent extreme weather events, will likely exacerbate soil degradation, posing significant risks to soil health and threatening the sustainability of agriculture and natural ecosystems in NSW. For example, increased temperatures may accelerate organic matter decomposition, reducing soil fertility. Altered precipitation patterns are expected to intensify soil erosion and cause irregular soil moisture levels, leading to both drought and flooding challenges.

This study aims to establish a detailed baseline map (100-m resolution) of critical soil properties—soil organic carbon, cation exchange capacity, soil texture, pH, available phosphorus, and macro-nutrient content (sum-of-bases)—and project potential changes at 0–30 cm and 30–100 cm soil depth intervals under 10 future climate scenarios until ~2100. The climate change projections are sourced from the NSW and Australian Regional Climate Modelling (NARCliM 2.0) projection, with five global climate models and two regional models.

Advanced monitoring technologies will be used to track soil conditions, alongside region-specific research to understand the long-term effects of climate change. This study also aims to develop effective adaptation strategies tailored to the specific conditions of NSW, such as mitigating erosion, enhancing soil organic content, optimizing water use, maintaining soil moisture levels, and bolstering soil structure and fertility. By implementing these measures, NSW can mitigate the adverse impacts of climate change on soil conditions, ensuring sustainable agriculture and ecological health for future generations.

POSTER ABSTRACTS

S-Map information for East Coast Wairarapa

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S-Map Eastern Wairarapa was completed during 2023-2024. The new map covers around 205,000 hectares. There were 655 observations taken. The eastern Wairarapa region has a varied climate, geology and parent material which results in some complexity in the soils and their patterns. There has been no significant soil mapping completed in the eastern Wairarapa mapping area since the general survey of the soil of the North Island in 1954.

Due to there being little previous detailed mapped done for the area, a lot of the work focussed on mapping areas of LUC 1-4. The hilly country of the mapping area related heavily to the parent material of the soil. The key areas of different soils were the Q4 alluvium terraces of Wainuioru, the Q5 marine benches of Homewood and Mangaroa Limestone.

More pallic soils were descripted on the Q4 alluvium terraces in Wainuioru in the East Coast Wairarapa area that previously shown in the Fundamental Soils Layer (FSL). These areas had perched gley fragic pallic soils and mottled argillic pallic soils on Loess over Alluvium. The main differences were in texture and rainfall.

On the East Coast of the mapping area there were areas of Q5 marine benches (mainly in Homewood and Castlepoint). These marine benches were previously mapped as Pallic Orthic Brown soils. When mapped for S-map East Coast Wairarapa they were mapped as mottled immature pallic soils with some ultic argillic pallic soils mapped on middle Pliestocene marine benches.

There were more Melanic soils mapped in the area which was due to the discovery of typic orthic melanic soils and associated calcareous orthic brown on Mangaroa Limestone and the associate Kaiwhata limestone further North.

POSTER ABSTRACTS

Subsoil organic carbon stocks in long-term grazing systems of Northeast NSW

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Soil organic carbon (SOC) mapping and monitoring has been extensively carried out across Australia, with growing interest in SOC for agricultural sustainability and carbon sequestration potential. Despite subsoils (greater than 30cm depth) containing up to 60% of total SOC stocks, they have remained largely overlooked in SOC research, with research focussing on topsoils, above 30cm depth. More studies which consider subsoils, are required to identify the spatial variability, and mechanisms responsible for SOC accumulation and change. This study aims to address this gap by quantifying subsoil C stocks in long-term grazing systems of northeast New South Wales, Australia. Fifty-four paddocks were sampled across a number of grazing properties, covering 3 different soil types, and representing the major pasture management practices of the region. Samples were analysed for SOC and nitrogen, with particle size analysis conducted to determine clay content. Subsoil SOC concentrations ranged from 0.4% to 2%, compared to <1% to 8% in the topsoil. These concentrations for subsoil C stocks tend to decrease with depth, and with decreasing clay content. However, when considering C content across the entire sampled depth (0 to up to 130 cm) subsoil stocks (30 to up to 130 cm) occasionally exceeded those of topsoils (0 – 30 cm), where subsoils exceeded 30cm depth. This work indicates a need to consider subsoil SOC stocks, to accurately monitor SOC change across the entire profile. Further research will consider the correlation between subsoil C content, inherent soil properties such as iron and aluminium oxides, and environmental covariates including, climate, terrain, and vegetation indices, to elucidate the drivers of subsoil C storage.

Mechanisms generating post-fire soil water repellence in a dry Eucalyptus Forest in South East Australia

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Fire can influence the water repellence of soils. Fire results in the volatilization of waxes and resins from the leaf litter on the forest floor, which then condense on soil particles and forms a hydrophobic layer. Also, the removal of leaf litter by fire results in higher evaporation rates and drier surface soils. It is unclear which of these processes dominates in the generation and retention of post-fire water repellence. This field study was designed to isolate these processes and determine the relative significance of each process to the total level of soil water repellence after a fire.

Treatment plots were set up at burnt and unburnt sites in a dry Eucalyptus Forest in Victoria, Australia. Treatments applied were the addition of a 3cm layer of leaf litter to the soil surface (L); removal of all leaf litter and dead plant material to expose the bare soil surface (NL) and a control (C), which was the state of the surface soil without any interference. Water repellence measurements using the critical surface tension test (CST), were used to determine the water repellence of the soil at 0 cm, 2.5 cm, and 5 cm depths. CST measurements were conducted in spring 2009 (1080 measurements) and autumn 2010 (1080 measurements).

This study found the water repellence of the surface soil on the burnt sites was consistently greater than the water repellence of the unburnt sites. An exception was the control treatment in spring. There was a trend towards greater water repellence in the treatments with litter. This was most apparent in the surface soil in autumn at both burnt and unburnt sites. There was great variability in the water repellence measurements, which indicates that there are other interactions occurring between fire, water repellence and leaf litter, which encompass depth and season.

Soils of Northland

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Northland's soils are highly diverse, reflecting the complex geology and landscapes of the region, but available information about these soils has previously been largely outdated and low-resolution. An updated soil map of the Kaikohe - Waitangi catchment was uploaded to S-map online in August 2024. This soil survey was completed over 2 years by a number of soil surveyors at MWLR. The soil-landscape relationship of Northland, and particularly the Kaikohe to Waitangi catchment is very complex, and often difficult to understand. These soils were not well researched, nor well-understood, so over this time, over 1000 soil observations were collected across the survey areas to contribute to creating a soil map for the area.

S-map is increasingly using a modelling approach to predict soil pattern with the use of covariate layers including numerous terrain attributes derived from high resolution digital elevation models (DEM). A digital soil modelling approach was used for this area, which was a great test of the ability to predict soils in an unpredictable landscape. The soil survey of the Northland area has helped to provide high quality and up to date soil information for the Northland region including the in-depth characterisation of some poorly understood soils such as the Kerikeri Oxidic soils.

This presentation will discuss the soils of Northland, discussing some of the more poorly understood and rare soils of Northland, and will also discuss the approach and process used to map this area and some of the challenges and advantages of these methods used to deliver a map that covered over 50,000 hectares of the region.

Rapid Profiling of Organic Compounds in Soils: A Breakthrough Using Accelerated Solvent Extraction and GC-MS

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Soils are complex matrices, containing a diverse array of compounds derived from plant litter and microbial biomass. Accurate analysis of Soil Organic Matter (SOM) is essential for evaluating soil quality and health. This process requires a multi-biomarker strategy combined with robust analytical methods to accurately capture the complexity and dynamics of SOM. This study introduces a reliable, straightforward, and rapid method for detecting both polar and non-polar compounds in soil using accelerated solvent extraction (ASE) combined with gas chromatography-mass spectrometry (ASE/GC–MS). By optimizing extraction parameters—including solvent selection, temperature, extraction time, and number of cycles—we identified optimal conditions: isopropanol and ammonia solvent mixture at 75°C, with a 3-minute extraction time and 5 extraction cycles. This method was successfully applied to real sandy soil samples, extracting over 100 compounds. Notably, this technique offers significant advantages such as fully automated operation, minimal extraction time, and reduced solvent usage. This innovative approach provides a robust tool for evaluating the impact of organic compounds on soil health, making it a valuable asset in environmental and soil science research.

POSTER ABSTRACTS

Optimizing DNA extraction from allophanic soils using casein, and implications for apparent microbial community composition

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Allophanic soils are so named because of the presence of the clay allophane, and, in Aotearoa New Zealand, are predominantly found in the North Island. They make up 12.5% of New Zealand soils and are often found in highly productive agricultural regions. Due to their distinct physical and chemical properties, extracting microbial DNA from these clay-rich soils is extremely challenging using standard extraction kits. Casein blocks DNA adsorption by allophane particles, freeing it to be successfully extracted. However, excess casein promotes DNA adsorption by humic acids in addition to casein itself adsorbing DNA molecules. This study was conducted to optimise microbial DNA extraction from allophanic soils using a casein additive and assess impacts of the modified protocol on microbial composition and diversity. Soil with varying allophane levels, determined by percentage phosphate (P) retention, were collected from different sites across NZ, and DNA was extracted using the PowerSoil Pro kit with casein added in the first step. Illumina MiSeq sequencing of 16S and ITS rRNA was used to determine the impact of the casein additive on apparent bacterial and fungal community composition. Amending the extraction protocol with casein gave successful DNA extraction from high-clay soils, significantly increasing yield. The optimal casein rate for soils with percent P retention >85% fell between 1–2 mg per extraction to achieve the highest DNA yield. Impacts of casein addition on apparent microbial communities will also be presented.

Preliminary statistics of the evolution of organic carbon stocks in the French Soil Monitoring Network

Jose Luis Munera-Echeverri[1], Line Boulonne[1], Nicolas Saby[1], Jean-Lou Maupetit[1], Dominique Arrouays[1], Manuel Martin[1]
[1]Inrae, Orléans, France

Soil organic carbon (SOC) plays a crucial role in maintaining soil quality, regulating climate, and promoting environmental sustainability. SOC is a major sink of atmospheric carbon dioxide and it has been shown to affect ecosystem services provided by soil such as water infiltration and retention, nutrient release, biological activity, among others. As a result, various initiatives worldwide are monitoring the evolution of SOC stocks and aiming to identify soil management practices that enhance SOC stocks. The French Soil Quality Measurement Network (RMQS) is an interesting tool for monitoring and assessing changes in SOC stocks at the national scale. In this presentation, we aim to show the first estimates of the evolution of SOC stocks at 0 to 30 cm in French soils based on observations collected under the RMQS, with particular emphasis on the three main land uses: croplands, grasslands, and forests. For this purpose, we used the currently available data, i.e., those from the first campaign (2000-2009) and the first two years of the second campaign (2016-2017). The available sites for estimating the evolution of SOC stocks are distributed evenly throughout the national territory. So far, we have not detected any significant change of SOC stocks at the national scale and in the selected land use categories (estimated based on the 15% of the network's sites). Yet, we will discuss stratification strategies based on environmental factors as well as on farming practices and forest types for detection of factors leading to a change of SOC stocks.

Nitrogen increase in arable lands is not linked to soil acidification in French topsoil

Jose Luis Munera-Echeverri[1], Nicolas Saby[1], Line Boulonne[1], Dominique Arrouays[1], Manuel Martin[1]
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Nitrogen fertilization and deposition have been shown to produce soil acidification. Soil acidification is an ongoing problem in croplands worldwide leading to lower cation exchange capacity, loss of exchangeable cations and carbonates, and loss of soil fertility. Using data from the first (2000 to 2009) and second campaigns (ongoing; 2016 to 2027) of the French soil quality monitoring network (RMQS for its acronym in French), we assessed the annual rate of change of total N, soil pH, and other soil properties such as soil organic (SOC) and inorganic carbon (SIC), cation exchange capacity and cation saturation in 162 arable lands. The results show a significant increase of total N in the topsoil layer (0-30 cm; 2.9±2.0 mg N kg-1 yr-1), a significant increase of soil pH both in topsoil (0.006±0.005 pH units yr-1) and subsoil (30-50 cm; 0.008±0.04 pH units yr-1), and an increase of CEC in topsoil (0.024±0.014 cmol(+) kg-1 yr-1), while SOC, SIC and saturation of exchangeable cations did not change significantly in topsoil nor subsoil. The results show a high correlation between the rates of change of total N and SOC (R2 = 0.79), suggesting that the additional N gained between the two campaigns was part of soil organic matter. The rate of change of soil pH was negatively correlated with the initial pH and had no relation to the change of total N. The rate of change of CEC had a positive relation with the rate of change of soil pH. Our results show no soil acidification despite the increase of soil N in French croplands. The role of environmental factors and agricultural practices such as liming on the change of total N and soil pH will be discussed in this presentation.

Exploring soil resilience to pH changes in Australian agriculture through field surveys and meta analysis

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Soil health is significantly impacted by pH stress, with both low (acidic) and high (alkaline) pH levels affecting nutrient availability. These changes can lead to deficiencies or toxicities that not only impede plant growth but also alter microbial activity and diversity, essential for soil function and resilience. Despite its importance, there is limited information on how soil systems respond to pH variations and the mechanisms underlying their resilience. This study aims to address this gap through a systematic review and meta-analysis, focusing on pH buffering capacity (pHBC) as an indicator of soil function changes across agricultural, forest, and grassland ecosystems. Our meta-analysis identifies key soil functions influencing global pHBC, including pH level, buffering capacity, clay content, cation exchange capacity (CEC), organic matter, and microbial activities (microbial biomass, respiration, and enzymatic functions related to carbon and nitrogen cycling). Structural equation modeling (SEM) was employed to elucidate the direct and indirect effects of these functions on pHBC. We propose a new, easily measurable pHBC index that integrates data on soil pH, clay content, respiration, and enzymatic activities related to nitrogen cycling. Field surveys of 21 soil samples from Australian agricultural sites, spanning pH levels from 3.99 to 8.9, validated the index's accuracy for acidic soils. However, for alkaline soils, pH level and clay content emerged as the most useful factors. These findings underscore the importance of understanding soil functions in shaping pHBC, which is crucial for effective ecosystem management.

POSTER ABSTRACTS

Regenerating soil health in an intensive vegetable production system

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Maintaining soil health can be a major challenge in intensive vegetable production (IVP) systems. Land and crop management practices tend to deplete soil organic matter reserves that are the basis for many of the physicochemical and biological processes underpinning soil health and function. Resulting negative effects are well documented and include a loss in soil structure, reduced soil water retention and a loss in soil nutrient retention, release and use efficiency. Maintenance or remediation of soil C stocks is, therefore, an important objective in intensive cropping systems. A range of approaches have been suggested to this end, including direct application of carbon-rich materials (e.g. manures, composts, biochar), carbon sequestration through cover cropping and targeted land management strategies (e.g. conservation tillage). In March 2023, a set of field trials was established on the Tūranganui-a-Kiwa flats, near Gisborne, to evaluate the use of two of these approaches for regenerating soil health in an IVP system, including compost as a source of imported carbon and cover crops to capture carbon in situ. This poster provides details on the experimental design, measures taken and some preliminary results from the first 18 months of monitoring.

When soils “burp”: Predicting hot moment nitrous oxide and methane fluxes from oxygen

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Hot moments are short-lived spikes in biogeochemical activity that can produce high soil nitrous oxide (N_2O) and methane (CH_4) fluxes when oxygen (O_2) supply is low. Water-filled pore space (WFPS) is often used as a proxy for soil O_2, however, it does not account for soil pore size distribution and fails to capture the complex and dynamic nature of soil O_2 diffusion and consumption. This imprecision results in a range of WFPS values where N_2O and CH_4 hot moments might occur. Accurate prediction of hot moments is important as they can make a substantial contribution (>50%) to total annual soil emissions.

This work highlights the unknowns regarding variation in soil O_2 concentrations, and the limitations this imposes on our ability to predict hot moment N_2O and CH_4 fluxes. To characterize soil O_2 dynamics, we require the quantification of:

1. Rates of soil O_2 decline and replenishment after precipitation,
2. The frequency and duration of low bulk soil O_2, which impacts the availability of terminal electron acceptors for microbial metabolism and redox reactions, and
3. An evaluation of the extent of anaerobic microsite formation in aerobic soils.

We propose creating a soil O_2 model to capture and reflect these dynamics. We hypothesize that quantifying and modelling soil O_2 dynamics will enable us to better predict hot moment N_2O and CH_4 fluxes, improving greenhouse gas budgets and aiding in the development of soil management strategies that prevent hot moment fluxes from occurring.

Changes in carbon functional groups in soil organic carbon pools with organic fertiliser incorporation

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Knowledge on the chemistry of carbon stabilisation in soils with different mineralogies is useful in designing management strategies to stabilise soil organic matter. The objective of this study was to investigate short-term changes in carbon (C) functional groups of particulate (POM) and mineral-associated organic matter (MAOM) fractions in three contrasting soils after organic fertiliser (OF) incorporation. Bulk soils (0-10 cm depth) were collected from three paddy fields in Sri Lanka which has soils classified under Ultisol, Alfisol and Entisol soil orders. The soils were air-dried, passed through a 2 mm sieve, and used in an incubation experiment with four treatments (rice-straw, gliricidia and compost applied at 10 tons of OF/ha rate and soil-only control) in triplicates. Each soil was analysed for pH, electrical conductivity, cation exchange capacity (CEC), mineralogy with X-ray diffraction (XRD), and texture. Soil was subjected to alternate wetting and drying with distilled water. Destructive soil samples obtained at 6 and 12 months of incubation were subjected to fourier transform infrared (FTIR) analysis after separating to POM (53-2000 µm) and MAOM (<53 µm) fractions. Soil pH ranged from 4.94 to 7.44, clay percentages ranged from 3.0-20.4% and CEC ranged from 2.2 to 7.3 cmol(+)/kg. The XRD analysis revealed the presence of kaolinite in all the three soils, montmorillonite and vermiculite in Ultisols and Alfisols, gibbsite in Ultisols and Entisols and illite in Alfisols and Entisols. Carbon functional groups of POM and MAOM changed with time differently depending on the OF applied and soil type. Changes in C functional groups were more prominent in Entisol and Ultisol with the application of rice-straw.

Keywords: Carbon functional groups, fourier transform infrared, mineral-associated organic matter, organic fertilisers, particulate organic matter

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Availability of water-insoluble P in ammonium phosphate fertilizers

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Depending on fertilizer source, usually around 10-20% of P in ammonium phosphate fertilizers is water-insoluble. The availability of P in the water-insoluble residues has only been assessed in a few studies (e.g. Bartos et al. 1991, SSSAJ 55:539). These studies showed that the relative agronomic effectiveness of the water-insoluble fraction was 26-75% compared to soluble P. However, it is unknown if soil properties or physical form affect the availability. The aim of this study was to assess the effect of soil properties and physical form on the availability of P in these residues.

Wheat was grown for six weeks and an indirect labelling technique (soil labelled with P-33) was used to determine the availability of t water-insoluble P of monoammonium phosphate (MAP) fertilizer in three soils with varying pH (5.4-8.5). The residues were either in granular form (water-soluble P leached out of the granule) or in ground form mixed through soil. XRD analysis suggested the main P-bearing compounds in these residues were AlNH4F2HPO4 and FeNH4(HPO4)2. For the granular residues, the availability of the residue-P compared to that of soluble P (MAP) ranged from 10% in the alkaline soil to 33% in the acid soils. When ground residues were mixed through soil, the availability was 40-50% compared to that of MAP, indicating that the greater contact with soil enhanced the dissolution of the water-insoluble residues.

In conclusion, while the water-insoluble in fertilizers likely largely becomes available over time, the rate at which this happens depends on soil properties and physical form. A low soil pH and greater contact with soil (e.g. broadcast application and soil tillage) results in faster solubilization of the residual P.

POSTER ABSTRACTS

Optimizing Nutrient Inputs to Improve Crop Resilience and Soil Fertility of Taro Systems in Fiji.

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Root crops are vital staples in Fiji and the Pacific, but low yields hinder food security. The decrease in soil fertility within taro (Colocassia esculenta) production systems has resulted in a loss in crop productivity and farm profitability. This phenomenon is acknowledged as a significant risk to soil nutrients and overall food security. The multifunctionality of taro, along with its cultural significance and ability to withstand adverse climatic conditions, renders it a suitable primary crop for addressing the objective of enhancing soil understanding. This study will evaluate the impact of mineral and organic N fertilizers on taro and maize production on sandy loam soil in Central Fiji. Increasing N rates may significantly boost taro top yield but possibly not affect marketable corm yield. Maize marketable yield may increase with N application, while total biomass may increase substantially. While N fertilizer may increase taro top yield, the implementation of improved farm management practices will have the potential to alleviate concerns over food insecurity. These findings will provide valuable insights for optimizing N fertilizer use in root crop production in the region.

Keywords: food security, mulfunctionality, N fertilizer, nutrients, root crops

An efficient tool for assessing water quality in the Great Barrier Reef catchments

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In response to poor water quality entering the Great Barrier Reef (GBR), the Australian and Queensland Governments have set water quality and farming management practice targets. The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (P2R Program) measures and reports on progress towards these targets.

Water balance simulation models, including Howleaky, are key to exploring and quantifying impacts of management practice changes on hydrology and water quality. The GBR catchments cover a large and diverse area of landscapes, soils and climates, and an assessment tool needs to be able to deal with many combinations of conditions.

Confidence in Howleaky to characterise water quality is supported by extensive validation of the model (and its predecessor, PERFECT) in Queensland. Howleaky is available as an online platform (howleaky.com). An important development has been the presentation of open access paddock monitoring data sets, soils parameters and model assessments.

Model outputs are used to inform the P2RProjector software (p2rprojector.net.au) which is used by stakeholders to assess water quality improvements associated with investments in land management practice change at the paddock scale. P2RProjector users use an online platform to map the extent of a project and the change in management practice proposed. Until recently a “data-cube” stored millions of model-runs for use by P2RProjector. This approach was cumbersome and lacked transparency. A key development was enabling P2RProjector to connect to a HowLeaky-enabled Web API to run simulations in real time. This is facilitated by a novel approach to storing management practices and spatial data elements (including soils and slope characterisations) for large parts of the GBR catchments, allowing rapid model run builds for any unique spatial location and management practice combination requested.

Multi-element Analysis of Hevea brasiliensis under Waterlogging Stress Condition using ICP-MS

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Rubber tree (Hevea brasiliensis), the source of natural rubber, is an industrially important crop as it is one of the most versatile raw materials of nature. Owing to its long-life cycle of approximately 20-30 years, rubber trees suffer from abiotic stress regimes and its recurrences. Agusan del Sur, a rubber-growing province located in Southern Philippines, is the identified area of research interest with waterlogging and insufficient soil nutrition and management as two of its major constraints affecting rubber growth and production. Given the relevance of waterlogging stress on plant performance and the economic impact it has on small-holder rubber-growing farmers, multi-analysis of elemental concentrations taken from leaf and soil samples will contribute to an increased understanding of how this type of abiotic stress affects rubber nutrition, plant growth and productivity.

Utilising advanced analytical tools and techniques such as the Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) to quantify stress and identify correlations among the elements present provides a valuable understanding about the nature and composition of the sample after exposure to different waterlogging stress treatments (Intermittently Waterlogged; Continuously Waterlogged; Control). Waterlogging resulted in visible yellowing and senescence of leaves in the actual field site at Week 4 of the experiment. On the other hand, elemental concentration from leaf and soil samples showed considerable amounts in the contents of some nutrients. Leaf samples exhibited the presence of high K, Ca, Mg, S and P across treatments. Soil samples exhibited the presence of Na, K, Ca, Mg, Al, P and Fe. This can provide a comprehensive view of how plants are functioning and responding to their environment by integrating parameters and measurements of plant productivity, responses and modes of action. All these, directed towards providing intervention and stress mitigation strategies through agronomic management practices for the farmers in Agusan del Sur, Philippines.

POSTER ABSTRACTS

Baseline soil physics data for the Whenua Haumanu regenerative agriculture project

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Regenerative agriculture, a term with no set definition, was coined in the United States through the 1970's. It generally involves managing farms to improve soil health, plant and animal nutritive quality and reducing animal stress and dependence on agricultural chemicals. It's gaining in popularity and there is abundant anecdotal evidence of environmental, economic and social benefits. Little research has been undertaken to assess the potential advantages and disadvantages of regenerative agriculture, particularly from a New Zealand perspective.

Whenua Haumanu is a seven year project funded through MPI to assess the suitability and relevance of regenerative agriculture to New Zealand, taking our climate, soils and management systems into consideration. The project is exploring contemporary and regenerative farming practices across both standard (ryegrass and white clover) and diverse pastures (multi species of grasses, herbs and legumes) on several research sites at Massey and Lincoln universities. It's a comprehensive trial measuring and monitoring from below the ground, to above the ground and into the animals and animal products, including aspects around nutrient leaching, greenhouse gas emissions, carbon storage, animal welfare, product quality and taste.

The project established farmlets on Massey University's Dairy One (dairy) and Pasture and Crop Research Unit (sheep) in 2022. A range of measures are being collected to assess any potential changes in soil chemistry, biology and physics across the different treatments through time. To date, sampling and analysis have focused on establishing a baseline that will allow potential differences to be picked up as the trial progresses. Here we present some background information on the soils and landscapes of the dairy and sheep farmlets and share some preliminary data and learning gained through the first phase of data collection and analysis. Our focus is on soil physics data with particular emphasis on moisture release characteristics and bulk density.

long-term sugarcane cultivation can alter soil nitrogen bioavailability and associated microbial processes in tropical climate

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Land use conversion of natural ecosystems to intensive agriculture can alter soil biogeochemical processes and nutrient cycling, while increasing potential for land degradation. The disturbance of soil microbial community, due to land use conversion, may also lead to detrimental effects on soil ecosystem processes and services. Therefore, the objective of this study was to examine how sugarcane cultivation alters soil nitrogen bioavailability and associated microbial processes in tropical Australia. Two adjacent paired sites (native forest vs sugarcane cultivation for 78 years; pasture vs sugarcane cultivation for 78 years) were selected and five composite surface soils (0–10 cm) were collected from each site. Sugarcane cultivations decreased total organic carbon (OC; 45–48%), total N (51–54%), and total phosphorus (P; 26–37%) pools compared with native forest and pasture. Total mineral N (NH_4+-N + NO_3−-N), dissolved organic C and N contents and cumulative aerobic respiration were also lower in sugarcane than native forest and pasture lands. Reduction in soil microbial biomass (60%) following long-term conversion to sugarcane has resulted in higher metabolic quotient (qCO2) and lower C use efficiency, indicating higher level of environmental stresses in sugarcane sites. The results also indicated the functional redundancy of nitrification process (bacterial amoA, archarel amoA) following land use conversion in both sugarcane sites, while this was only the case for denitrification process (nosZ, nirK, nirS) in sugarcane converted from pasture. Sugarcane cultivation decreased soil health and biochemical quality, N bioavailability, and N cycling processes in tropical climate of this study.

Evaluating a proximal gamma ray spectroscopy system for high resolution mapping of New Zealand soils

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Precision Agriculture (PA) offers the possibility of increased production efficiency and improved environmental outcomes in a range of food production systems. However, PA is currently not widely utilised in New Zealand, in part, due to a lack of high-resolution data about the spatial variability of soil properties. Recently, systems based on proximal gamma ray spectrometers have been developed which aim to correlate radionuclide activities present in soils with physical and chemical soil properties and produce high-resolution maps for use by PA capable machinery. We evaluated the performance of one such system (SoilOptix®) which is widely used commercially in Europe and North America, on a range of soil types and growing systems at eight locations around New Zealand. Each site (of approximately 10 hectares) was scanned according to the system guidelines and between 4 and 8 calibration soil samples analysed for texture, organic matter, pH and 12 macro- and micro-nutrients. Calibration sample laboratory results and scanning data were processed by SoilOptix® for map production. Concurrently, approximately 20 validation soil samples were taken at each location in a semi-random grid pattern and analysed for the same soil properties and then compared to the map outputs at those sites. The results show that the system clearly differentiates the soil properties between the locations with, for example, linear regression of all data points for sand, silt and clay percentages having r^2 values of 0.94, 0.97 and 0.89 respectively. Prediction accuracy within locations presents a more complicated picture with some parameters having relatively small RMSE values (e.g. pH RMSE of 0.1 to 0.4 in pH ranges of 5.6 to 7.5) whilst others are relatively large (e.g. for organic matter content a RMSE of 3.6% for a range of values from 1.5% to 7.1%).

Nested sampling design for quantifying spatial variability of soil organic carbon in Australian agricultural systems

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Sequestering carbon in soils has emerged as a keystone action to address climate change and food security, drawing attention to the challenges of monitoring changes in soil carbon over time. Schemes to incentivise farmers to change their land management to sequester more carbon in soils are underpinned by soil monitoring protocols, such as the Soil Carbon Method within the Australian Carbon Credit Unit Scheme[1]. Accurately quantifying the amount of sequestration is essential for the integrity of such schemes, but is difficult, as changes in soil organic carbon (SOC) over time are typically small[2], whilst spatial variability in the field is often substantial.

During 2023 – 2024, an extensive sampling campaign was undertaken to measure SOC and other soil properties from nine farms representing a range of climatic zones and soil types across eastern Australia. Each farm was intensively sampled using an experimental design in which fine-resolution 20x20 m cells were sampled within coarser-resolution 100x100 m cells. Whilst this initial sampling design generated valuable insights (presented in a separate abstract), analysis of the data suggested that this experimental design did not fully capture the spatial dependency structure of several soil properties, including soil organic carbon content, especially at smaller (sub-20 m) distances.

This poster showcases the experimental design for the second round of sampling, which is currently taking place. This sampling round aims to (1) improve spatial characterisation of soil organic carbon and other soil properties and (2) fill-in remaining spatial gaps of a 1 ha cell to achieve maximum sampling coverage. We therefore employed a spatially nested sampling design[3] with additional space-filling sample points, overlaid on the round one sampling set, adding an additional 60 samples per farm. This approach may have application in national and international efforts to better understand small-scale variability of soil properties.

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Boosting bacterial growth: The role of functionalized graphene oxide in microbial engineering

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Drought is a critical environmental stressor that significantly hampers plant growth, microbial survival, and soil health, substantially reducing crop productivity. Conventional carrier materials like peat have limited moisture retention capabilities, exacerbating microbial survival challenges in drought-affected lands. As an alternative, 2D nanomaterials like graphene oxide (GO), offer unique properties that could mitigate the adverse effects of drought stress on microbial species and soil properties. However, a major challenge with GO is its cytotoxicity, particularly its ability to inactivate or kill bacterial species by piercing the bacterial cell membrane with its sharp edges, acting as nano-knives.

To address this issue, this study focused on the fabrication and functionalization of GO with biodegradable polymers to reduce its cytotoxic effects while maintaining its beneficial properties as a microbial carrier. GO was electrochemically synthesized from graphite flakes using a 3D-printed Packed Bed Electrochemical Reactor (PBER). The GO was then functionalized with a low-cost, environmentally friendly biomass material sodium alginate (SA) at various concentrations (0.75, 0.25, and 0.15 mg/mL) as a surface decorator and binding agent. Calcium chloride was used as a cross-linking agent to enhance the stability of the GO-SA conjugate.

The synthesized GO-SA conjugates were characterized using Fourier transform infrared (FT-IR) spectroscopy, X-ray diffraction (XRD), and scanning electron microscopy (SEM). The functionalized GO-SA material was then inoculated with a Bradyrhizobium strain to evaluate its effectiveness as a microbial carrier. The results demonstrated that the GO-SA conjugate significantly reduced the cytotoxicity of GO, facilitating the growth and survival of the Bradyrhizobium strain. This study presents a promising approach for enhancing microbial survival in drought-affected soils, with implications for improving crop productivity and sustainability under challenging environmental conditions.

On-Farm solutions for sustainable management: The development of the SOHMA Soil Health Kit

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Soil health, defined as the capacity of soil to function as a vital living ecosystem that sustains environmental quality, crop productivity, and human health, is critical for resilient agricultural systems. Effective evaluation and enhancement of soil health are essential to achieving these goals. In Brazil, developing on-farm approaches for comprehensive soil health assessments is vital. This study aims to create an on-farm Soil Health Kit (SOHMA) for farmers and land managers to evaluate soil health directly in the field. The development of the SOHMA Soil Health Kit is structured into three stages. The first stage involves conducting a systematic literature review to establish the parameters for creating an on-farm assessment method. In the second stage, we will test and adapt promising methods to suit Brazilian conditions, as well as develop new methods for essential indicators lacking current alternatives. The final stage includes applying the selected and newly developed methods to various conservation management systems, alongside traditional methods, to validate and monitor soil health in cultivated areas. The SOHMA Kit enables practical, accessible chemical, physical, and biological assessments, using readily available materials and a comprehensive manual that guides users through test execution and result interpretation. This method is designed for farmers, agronomists, and other professionals engaged in soil health management

Uncovering soil health in Brazil: A comprehensive assessment across biomes and agricultural systems

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Soil is instrumental in providing vital environmental benefits and plays a pivotal role in achieving the Sustainable Development Goals. For instance, healthier soils have shown to yield higher crop outputs and exhibit less sensitivity to climatic shifts. - Soil Management Assessment Framework (SMAF) which is one of the most advanced analytical models to asses soil health. Therefore, the objectives of this work were i) to assess the health of Brazilian agricultural soils using the SMAF tool. To calculate the Soil Health Index for agricultural areas in Brazil, a dataset of 23,997 sample points distributed in 15 Brazilian states and collected in 2021 and 2022 was used. These sample points were obtained from soybean agricultural areas. The SMAF was used to assess soil health on a national scale using a minimum data set of five soil health indicators (P, K, pH, Bd and SOC) and the results of the soil health indicators were converted into a score ranging from 0 to 1 (unitless) using algorithms. Finally, the scores for each indicator were integrated into an overall Soil Health Index (SHI) ranging from 0 to 1. The SHI and both indicator scores were interpolated using geostatistical techniques to create a map of spatial variation in soil health and to identify local hotspots of soil health. Exploratory analyses and box plots were performed to evaluate ISS and score indicators in different biomes and regions of Brazil. The results revealed significant variances in soil health indicators across different Brazilian biomes. In general, the 0-10 cm soil layer operates at over 80% of its peak potential, indicating scope for enhanced soil health through sustainable practices. SMAF's findings highlight the inherent influence of climate and soil characteristics on soil health. These insights accentuate Brazil's central role in fostering soil health and championing sustainable agricultural endeavors globally.

Microbial respiration and diversity in response to previous landuse

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Soil health places emphasis on the living component of the soil, and its contribution to soil processes and functions underpinning the delivery of ecosystem services. Various measures can be used to assess the soil biological community and its activity. However, few measures have targets for optimal populations or the knowledge to manage these, limiting the potential biological indicators available.

Microbial respiration and the addition of different carbon substrates can be used to indicate the activity and potential changes of a microbial community, as well as implications for soil functioning. We used MicroResp methods to investigate how microbial activity and diversity changed in response to previous management on a Lismore stony silt loam in Canterbury. The site was previously under Pinus radiata and was converted to irrigated dairy pasture in 2016. We also explored whether differences in respiration rates are predictable through time.

Initial data shows basal respiration rates were not different between sites under existing P. radiata in comparison to recently converted pastures. Although there were some differences in respiration rates with carbon substrates observed in relation to time since forestry, this did not necessarily align with patterns of bacterial and fungal diversity. The greatest differences in respiration rates were observed between samples collected in spring compared to autumn. We discuss the implications of these results and investigate factors driving changes in biological measures. Continuing to assess the microbial activity and diversity through time will improve our understanding of soil biological health.

Interaction between soil microbiome and nematode community regulates crop growth

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Nematodes communities represent the most diverse and abundant multicellular fauna in the soil ecosystem, and the multi-feeding channels of nematodes provide an important linkage within the soil food web, as well as between soil and plant interactions. However, given the complex connection in the soil microbiome and the diversity of soil nematodes, their contribution, relative to other soil fauna, on enhancing plant growth and development rather than hindering growth remains largely unknown in soil ecosystem. In the presented experiment, we initially separated soil nematode communities from the remaining microbial communities (including bacteria and fungi), and then re-introduced either or both communities to a sterilised soil. Non-sterilised soil was also included as control. The aim of the study was to investigate the role of the soil nematode community and indigenous soil microbial community on the growth of wheat and canola, using three different soil types from South Australia and Victoria. Plant growth was monitored using high-throughput imaging over 6 weeks; soil was tested at the end of the experiment, including sequencing for microbial community and qPCR for nematode community. Plant growth was more strongly influenced by sterilisation, irrespective of crop type, rather than by the addition of either nematode or microbial communities. Among all treatments with sterilised soil, the addition of either nematodes or microbial communities altered the growth rate for both canola and wheat, with the effect being stronger for canola. These findings provide a new insight into the role of different components of the soil food web on crop production.

Influence of Mucuna Pruriens on Weed, Nematode and Earthworm Population in Soils of Fiji

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Mucuna pruriens, commonly known as velvet bean, is a powerful legume with profound implications for sustainable agriculture and soil health. This comprehensive study examines the dual benefits of M. pruriens, both as a cover crop and green manure, highlighting its ability to suppress weeds, improve soil fertility, and enhance microbial dynamics. A field experiment was conducted in Nadi, Fiji to explore the influence of Mucuna on weed suppression, nematode population and earth worm count. In addition, the experiment also examined the selected soil properties under different treatments (Treatment 1- Mucuna incorporated in soil after 120DAP, Treatment 2- Mucuna grown as a cover crop, and Treatment 3- Control (traditional weeds). The growth of Mucuna was terminated at 120dap Mucuna. Data was collected from the fields before planting Mucuna and at 120 days after planting Mucuna and 150dap. The results of this experiment suggested that Mucuna cover crop gradually increases the earthworm count and decreases the parasitic nematode count in the soil. Weed suppression in tabaco grown after Mucuna was significantly greater ($P<0.05$) than that grown after the traditional grass cover crop. Plant parasitic nematode count under Mucuna treatment was significantly lower ($P<0.05$) than that under traditional grass cover crop. Earthworm count in Mucuna treatments was significantly greater ($P<0.05$) than that under traditional grass cover crop. Increase in earthworm numbers may be due increased soil moisture and greater biomass accumulated by cover crops Abundance of earthworm casts on the soil surface can affect soil physical properties. This abstract underscore the critical role of M. pruriens in sustainable agricultural practices. By incorporating M. pruriens into crop rotations and soil management strategies, farmers can achieve significant agronomic and environmental benefits.

Mucuna Pruriens as Cover Crop in Tobacco Plantations as Green Manuring and Enhances Soil Biology

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The planting of Mucuna pruriens before planting Tobacco on a land is helpful as it smothers weeds, acts as a cover crop and increases beneficial organisms in the soil. In this field study, three different treatments were tested. Treatment 1- Mucuna incorporated in soil, Treatment 2- Mucuna grown as a cover crop and Treatment 3- Control. The testing was done prior to planting Mucuna and before transplanting tobacco on the field. The experimental design that was employed was Randomized Complete Block Design also known as RCBD. The competition of weeds could not withstand the aggressive nature of Mucuna pruriens and were suppressed eventually. The results of this experiment suggested that Mucuna gradually increases the earthworm count in the soil and decreases the parasitic content of the soil to some extent. The treatment that had the best results was growing Mucuna as a cover crop (treatment 2).

BIODIVERSIFICATION WITH COVER CROPS: A PATHWAY TO HEALTHIER SOILS AND HIGHER YIELDS

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One of humanity's greatest challenges is to produce more nutritious food to alleviate global hunger while simultaneously protecting the environment and mitigating climate change. This challenge is particularly pronounced in countries like Brazil, where agriculture plays a crucial role in the national economy and social development. In this context, the aim was to evaluate the impact of biodiversification of the soybean cropping system on soil health. The integrated soil health assessment was performed using the Soil Management Assessment Framework (SMAF) (Andrews et al., 2004). The SMAF assessment is based on three steps: i) selecting a minimum dataset; ii) interpreting measured indicators; iii) integrating the indicators into an overall index. Our dataset included eight soil indicators: pH, P, K, bulk density, aggregate stability, Water-filled pore space, soil organic carbon (SOC) and β-Glycosidase. Those measurements provide site specific soil chemical, physical and biological data. No effect of cover crop treatments on physical and chemical soil health indices was observed, while the soybean/cover crop mix showed the highest biological and overall soil health index compared to soybean/maize. SHI scores were about 36% higher than those of maize and maize/ruzigrass treatments, which recorded a score of 0.55. Over a five-year period, incorporating a mix of cover crops significantly enhanced soil health indicators, particularly biological attributes, compared to traditional maize-centric practices. The improvements in soil health were evident in the increased SOC and beta-glucosidase potential activity scores, which correlated positively with soybean yield and yield stability.

Mitigating Climate Change: The Role of Cover Crops in Soil Carbon Storage and GHG Emissions

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Concerns about soil degradation and increasing atmospheric levels of greenhouse gases (GHG) (CO2, N2O and CH4) have stimulated interest in the potential of soil to mitigate climate change over the past few decades. The aim was to evaluate biomass production, soil C distribution and greenhouse gas emissions in a long-term (10 years) cover crop management system in the Brazilian Savannah (Cerrado region). GHG emissions were analyzed during the soybean cycle on the biomass of cover crops in Rio Verde. The cover crops were: i) fallow, ii) maize (Zea mays), iii) maize intercropped with ruzigrass (Urochloa ruziziensis), iv) ruzigrass as single cover crop and v) a mix of cover crop species recommended for the region (Pennisetum glaucum, Crotalaria spectabilis, and U. ruziziensis). GHG fluxes were measured using manual static chambers, with four replicates per treatment and three collection times (0, 15, and 30 minutes). To determine the total weight of biomass in the sampled area, the cover crops were cut close to the ground and the entire biomass of 1 m^2 was collected. Physical fractionation of SOM was performed (Cambardella and Elliott, 1992). The soybean/U.ruziziensis and mix of cover crops showed the highest biomass production, higher C contents (g C/kg soil) in the MOP and MOAM fractions, and a soil sink for CH4. This assessment is essential for the calculation of the carbon balance of agricultural systems and for the definition of more promising management options for the mitigation of climate change.

Australia's national soil spectral library empowering low-cost soil condition measurement

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Supported by the Department of Climate Change, Energy, the Environment and Water's (DCCEEW) National Soil Carbon Innovation Challenge (NSCIC) demonstration and development grant CSIRO Agriculture and Food are building digital infrastructure, the CSIRO Soil Spectral Selection System (C4S), to support cost-effective soil carbon measurement capability and soil stock condition and state in general. Improving low cost and accurate soil carbon measurement will support more land managers to participate in carbon farming and contribute to Australia's legislated commitment to reducing emissions by 43% by 2030 and to net zero by 2050.
Embedded in CSIRO's Soil Information System (CSIS), CSIRO holds the largest and most spatially and temporally diverse soil spectral library in Australia. C4S will provide users with the option to intelligently leverage the unrealised value of this national asset for their local situation.
Together, with university and industry testing partners, CSIRO is helping to empower the use of soil spectral inference to assess not only soil carbon, but a variety of indicators relating to soil ecosystem service provision, driving down the costs of sampling and laboratory analysis, compared to existing soil monitoring frameworks. C4S is based on a study conducted under the DCCEEW NSCIC feasibility grant and postdoctoral research on Proximal tools for Natural Capital Accounting finding that by tapping into CSIRO's national soil spectral library asset intelligently to identify the most appropriate resources for a given site, the required amount of laboratory analysis needed to establish the distribution of stocks of soil properties, and importantly, detect changes within them can be halved (https://doi.org/10.1016/j.geoderma.2023.116651).

Plant Residue Addition Enhances Soil Microbial Activities and Modulates Microbial Diversity: Impacts of C/N Ratio

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This study examined the effects of adding plant residues with different C/N ratios to soil on nitrogen availability, heterotrophic respiration, and microbial diversity over time. Soil microorganisms are critical for nutrient cycling, plant health, and soil productivity, serving as sensitive indicators of soil condition changes. Plant residue retention is a common practice to enhance soil properties and promote microbial diversity and activity.

Using microcosms, crop residues (pea straw with low C/N and wheat straw with high C/N) were added to soil collected from a broadacre cropping paddock in South Australia. A soil-only control was also included. Microcosms were sampled at 6 timepoints over a 28-day incubation period. Microbial respiration was measured using a portable soil respiration unit, while nitrate and ammonium concentrations were determined through 2 M KCl soil extraction. Microbial diversity was assessed via 16S (bacteria) and ITS (fungi) sequencing at days 0, 5, and 28.

Results showed that residue addition significantly increased respiration rates compared to the control. Soil NH4-N concentrations under pea straw treatments were significantly higher than wheat straw and control treatments at days 2 and 7, but levels generally equalized by day 28. Residue addition affected species diversity for both bacteria and fungi, with increased differences between treatments observed at 28 days.

This study highlights the importance of residue C/N ratios in shaping soil microbial communities and nutrient availability, which is crucial for maintaining healthy soil ecosystems. Understanding these dynamics can inform effective soil management practices in agricultural systems.

Location matters: Regional differences are a bigger driver of bacterial diversity differences than time.

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Agricultural practices have undergone significant changes over the past two decades, resulting in substantial increases in crop productivity. However, the long-term impacts of these changes on soil microbial communities remain largely unknown. This study presents the first comprehensive analysis of soil bacterial communities across major agricultural zones in Australia over a 20-year period, examining the intricate interplay between farming practices, environmental factors, and soil microbial communities.

We analysed 652 archived soil DNA samples collected from three key agricultural regions in southern Australia between 2001 and 2022: Esperance (Western Australia), Yorke Peninsula (South Australia), and Birchip (Victoria). Using PacBio full-length 16S rRNA gene sequencing, we captured all nine hypervariable regions to generate comprehensive bacterial community profiles.

Our findings indicate that regional differences were stronger drivers of bacterial diversity than temporal changes. The changes in the relative abundance of different phyla were region-specific. Firmicutes were more abundant and showed the greatest decline over time in the Esperance region compared to the other regions. In the Yorke Peninsula and Birchip regions, the relative abundances of Actinobacteriota and Gemmatimonadota decreased from early to late periods, while Bacteroidota increased in all regions. Unexpectedly, significant changes in Nitrospirota were observed only in the Birchip region.

These findings highlight the complex interactions between soil microbes, local environmental conditions, and agricultural practices. Our results provide valuable insights into the long-term dynamics of soil bacterial communities in agricultural systems, with implications for sustainable soil management, crop productivity, and ecosystem resilience. This study represents the first long-term, multi-regional analysis of soil bacterial communities across major agricultural zones in Australia, spanning over two decades. By examining changes in soil microbiomes across different geographical areas and over time, we provide unprecedented insights into the dynamics of soil bacterial communities in response to evolving agricultural practices and environmental changes.

Response Mechanisms of Sorghum Rhizosphere Microbiome to Drought Stress

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Drought, a primary abiotic stressor that limits agricultural productivity, has emerged as a focal issue in global climate change research. Mitigating the impact of climate stress on crops is crucial for ensuring global food security. The ability of plant roots to recruit beneficial microorganisms from the soil to enhance plant resilience in resisting environmental pressures is a promising strategy. However, the underlying mechanisms of recruiting rhizosphere microorganisms remains unclear. Here, we aimed to elucidate the impact of drought stress on the recruitment of rhizosphere soil microbial communities, with a specific focus on sorghum, a drought-tolerant crop. Field experiments were conducted under drought stress conditions (85% WHC, 60% WHC, 40% WHC, and 20% WHC) at four distinct growth stages (booting, heading, grain-filling, and maturity stages). Amplicon sequencing (16S rRNA and ITS) and metabolomic analyses were employed to investigate the rhizosphere soil microbial communities under varying levels of drought stress throughout the entire growth cycle. Our results revealed significant differences in microbial community structure and root exudates across different growth stages and under varying levels of drought stress. The rhizosphere bacterial diversity exhibited no significant difference during the early stage of drought stress. However, bacterial diversity significantly decreased during the maturity stage of sorghum under drought stress. Network correlation analysis indicated that drought stress led to a reduction in the complexity of the microbial network structure in the rhizosphere soil. Notably, under drought stress, the root enriched the core taxa, including Firmicutes, Actinobacteriota, and Chloroflexi. These core taxa were significantly correlated with crop yield and quality. In conclusion, the research findings provides insights into managing of rhizosphere microbial communities to enhance crop drought tolerance, offering new strategies and research directions for agricultural microbial management.

Cellulose-based materials produced from agricultural waste biomass for moisture retention applications in soil

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There are large amounts of lignocellulosic biomass generated globally, which can be potentially utilized to produce cellulose-based materials. The cellulose-based materials possess biodegradability, abundant availability, compatibility to the environment, flexibility, easy-processing, remarkable mechanical and physical properties and high hydrophilicity characteristic and hydroxyl groups. These properties make them attractive materials for various applications such as biomedical science, tissue engineering, wastewater treatment, coating industry, textile manufacturing, food packaging and horticulture and agriculture industry. Therefore, different biomass was selected to convert them into cellulose-based materials by using treatments such as bleaching, delignification, and acid hydrolysis. The results showed cellulose-based materials exhibited higher thermal stability, better crystalline structure, irregular and porous morphology, and extraordinary water retention characteristics. The major TGA peaks for all cellulose-based materials were found at 110°C, 110-280°C, 280-360°C and 360-700°C whereas the cellulosic peaks from XRD analysis were observed at 2Θ peaks at 22˚, 26˚ and 35˚.

Influence of leguminous mulching and sheep grazing on Samoan Inceptisols under taro-based cropping system

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Soil biochemical indicators are very important for assessing the impact of soil management as they respond rapidly to environmental or anthropogenic changes. However, these parameters are not commonly studied in the Pacific Island soil and its management. This study examines the effects of different organic mulch along with sheep grazing on the biochemical indicators and nutrient dynamics of Samoan Inceptisols under a taro-based cropping system after one years of field experimentation. The treatments were Taro intercropped with Sesbania, Gliricidia, Erythinia + mulch/spray, + hand weeding, + sheep grazing/hand weeding; and Sole Taro+ mulch/spray, hand weeding, sheep grazing/hand weeding. Initial result indicates that Sesbania, Erythrina, and Gliricidia, intercropped with taro, significantly influenced the potential N mineralization compared to the sole taro cultivation. Sesbania with taro resulted in the highest mineral N availability compared with Erythrina and Gliricidia. Sole taro plots exhibited the lowest mineral N concentrations, indicating that the soil's N supply was relatively limited. Sheep grazing further impacted these treatments by enhancing organic matter decomposition and microbial activity, which can improve overall nutrient availability. Other biochemical indicators such as labile organic carbon, enzyme activities and plant available nutrient contents are also analyzed. Initial result highlights that integrating nitrogen-fixing plants such as Sesbania, Erythrina, and Gliricidia with taro and sheep grazing can effectively boost soil mineral N levels. These findings underscore the potential for adopting integrated soil management strategies to enhance soil fertility and productivity in Samoan Inceptisols, supporting sustainable taro cultivation systems.

POSTER ABSTRACTS

Comparing Visual Soil Assessment and soil quality monitoring measurements

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Soil quality monitoring in New Zealand was developed in the 1990's and two of the approaches that emerged were the on-farm Visual Soil Assessment (VSA) and Regional council state of the environment (SoE) soil quality monitoring.

The VSA is based on the visual assessment of key measurements of soil quality. Except for soil texture, the soil and plant measurements are dynamic, changing under different management and land use pressures. Therefore, the VSA is suggested as a simple and concise way to assess soil quality at a farm scale. The VSA was revised, and a second edition published in 2009 for pasture on flat and rolling land (Shepard 2009), while earlier guides existed for cropping and hill country (Shepard 2000, Shepard & Janssen 2000). Many of the measures are common across all three guides, while some measurements are specific to one. However, some measurements require detailed local knowledge likely to be held by the farmer, while others can be made simply by observation at the time of assessment.

Soil quality monitoring is the main way councils monitor the health of soils in relation to their land use in their region, i.e. how well the soil does what we want it to. Soil quality is important for State of the Environment (SoE) reporting and accessing the effectiveness of policy and plans. Similar to the VSA, key measurements of soil quality are made.

The two approaches are designed for use at different landscape scales but how similar is the information that results. VSA scores at soil quality monitoring sites are compared against soil quality monitoring values. Some VSA measurements and soil quality values show stronger relationships than others. Understanding the strengths and weaknesses, and the relationships between the two types of assessment is useful in understanding and identifying sustainable land management.

Developing Mid-Infrared Soil Spectral Capabilities in Papua New Guinea: A case study from Markham Valley

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Soil spectroscopy is widely adopted in many advanced soil laboratories as a cost- and time-effective approach to estimate key soil attributes. As such, an operational capability in these technologies is attractive in developing economies such as Papua New Guinea (PNG) where there is pressing need to support the needs of commercial and smallholder farmers to deliver cost-effective nutrient management and land planning, land carbon stewardship assessment, and tracking soil health. This case study describes the early phase of a capacity-build set in PNG's Markham Valley. We report on early development of a spectral library through scanning of 76 topsoil (0-0.15 m) samples collected across the valley. The samples were finely ground using a mortar and pestle prior to scanning by a Bruker Alpha II spectrophotometer. The spectra were pre-processed, and chemometric models were fitted for total organic carbon and nitrogen. Due to the limited number of calibration soil samples, instead of fully independent validation, 100 bootstrapped partial least squares regression models were fitted, and out-of-bag samples were used to assess model quality. We present the initial results from the spectral model fitting and model quality assessment, along with insights from the preparation of soil samples. Additionally, we discuss key considerations in setting up an operational infrared spectral facility in the Papua New Guinea University of Technology's (PNGUOT) soil laboratory.

Te Whenua Tupu Living Lab: new facility for soil and ecosystem research for sustainable horticulture

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Te Whenua Tupu – The Living Lab, located at the New Zealand Wine Centre campus Marlborough and opened in July 2024, is a new state-of the art facility established to become world-leading in the study of above- and below-ground perennial horticulture production systems, addressing the productivity, profitability and environmental challenge priorities of plant-based industries. The Living Lab (TLL) also serves to create a hub for collaborative research and education, to attract national and international talent, enable Agri-tech innovators to test and demonstrate new technologies and products, and align research capability to central and local government priorities.

At the heart of TLL is a focus on biology, function and the below-ground interaction of soil, microbes and plants, integrated with above-ground biology and atmosphere. At an industry relevant scale and in one outdoor location (but protected by a high-roofed fully retractable Cravo plastic house), we can bring together a range of 1.7m3 cored silt/sand/clay loam soils (with intact rooted plants of varying age and from various environments) or reconstituted gravelly soils, in bespoke cylindrical ‘pots’ (1.2m wide by 1.5m deep) with integrated leachate collection, and filled weights in excess of 3.5 tonnes. Such large-scale has been deliberately incorporated to flexibly accommodate large soil volumes and a broad range of potential crops, including tree crops.

We are currently developing whole-system capability for non-destructive root observation, minimally invasive rhizosphere biopsy, the mapping of detailed (3D) soil moisture depletion profiles and accurate measurement of below-ground gas exchange and soil atmosphere composition. Above-ground we are developing whole canopy gas exchange and phenotyping capabilities to closely monitor growing system architecture, carbon uptake and allocation.

An introduction to the facility and its capabilities, including large-scale soil coring of grapevines and establishment of a networked soil sensor database and user interface pipeline, will be provided.

Properties and distribution of Acid Sulfate Soils during wetting-drying cycles on Norfolk Island

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Norfolk Island, situated 750 kilometers north of New Zealand, faces increasing pressure on its freshwater resources due to climate variability and population growth. Since 1970, rainfall has decreased, with mean annual rainfall dropping by 11% from 1334 mm/year (1915-1969) to 1184 mm/year (1970-2020). This trend aligns with global climate change patterns (IPCC, 2023). The presence of acid sulfate soils (ASS) in catchments can threaten water resource by reducing water quality, if acidification occurs (Fanning et al., 2017). Understanding the distribution of ASS hazards is crucial for protecting water resources for these vulnerable islands.

On Norfolk Island, freshwater wetlands experience various disturbances such as deforestation, groundwater extraction, and dam construction. However, the ASS characteristics of these wetlands during drying and rewetting cycles are not well understood. This paper aims to characterize ASS types in inland wetlands and their responses to climatic cycles. We present results from soil surveys conducted during three contrasting events: i) drought (2020), ii) rewetting (2021), and iii) flooding (2022).

Before the 2020 drought, wetlands experienced periodic wetting and drying, allowing organic matter to accumulate in peaty soils. The drought exposed 3,500-5,000 ha of hypersulfidic material, forming sulfuric organic soils and acidic drainage, with notable accumulations of Ammoniojarosite and schwertmannite. Rewetting in 2021 led to the reformation of Fe-monosulfides and the formation of Subaqueous Monosulfidic and Hypersulfidic organic soils. Flooding in 2022 caused sediment reworking, sulfide oxidation, and increased alkalinity of the soils. Flow during the flood event were sufficient to scour and re-deposit peat layers from some wetlands. These processes have likely reduced ASS hazards compared to pre-flood conditions but did not eliminate ASS formation processes, or potential risks to down gradient receptors. This study enhances understanding of ASS hazards on Norfolk Island, aiding in the protection of soil, water resources, and infrastructure in changing climate.

Mesa Tops and Technology Flops: The Foibles of Technology for Soil Survey

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Digital soil mapping is readily available in Australia and is a widely used source of land resource information. But, it is generally only available at a broad scale and does not provide the level of detail required in practice for mining, construction, farming, and other applications. It is therefore important to have strong traditional soil survey skills to gather on-ground, detailed soils information.

In the context of consulting, time is the biggest limitation. There is only enough time for one stage of site selection, sampling, and mapping. This requires a modified 'hybrid' approach, merging desktop and field surveys. Desktop assessments are used as a guide to the soil landscape patterns within a defined area. Then, a traditional soil survey approach is used to ground-truth and gather primary data. The soil surveyor must be open to being challenged by patterns in the soil landscapes that are not evident in an initial desktop assessment. They must combine data from the different sources to provide appropriate soils information for the desired land use in an efficient time frame.

This hybrid approach was applied to a soil survey for a greenfield mine site in central Queensland. The outcomes of the survey were to be used for site rehabilitation planning. The information gathered from the desktop assessment was too broad for the required scale, showing little variation in soil types. Through the field program, subtle yet important soil landscape and soil vegetation patterns were identified that were not reflected within the desktop assessment.

This example demonstrates the pitfalls of technology for soil surveys. If reliance on the technology and broad scale mapping is too great, then the outcomes or quality of the end use of the area would be vastly different.

Queensland Land Resource Assessment Guidelines

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Accurate assessment of soil and land resources is necessary to enhance Queensland's capacity to protect the environment, manage natural resources and support government programs.

Core tasks of Queensland Government soil scientists are to map, model, research and monitor land resources, identification of landscape hazards and evaluation of potential land uses. Soil scientists in the private sector, universities and other non-government organisations also collect a considerable amount of soil and land resource information. It is desirable that all soil and land resource information is collected and managed accurately, consistently and efficiently. However, the need for Queensland-specific guidelines was identified.

The purpose of the Queensland Land Resource Assessment Guidelines (the 'Qld Guidelines') is to specify standards and procedures to ensure land resource activities are undertaken consistently throughout Queensland. This will facilitate accurate and consistent data collection, interpretation and storage, ensuring products are fit for purpose and compatible with systems such as the Australian National Soil Information System.

Key aspects of current guidelines such as the Australian Soil and Land Survey Handbook Series are summarised, with guidance to address existing gaps. Some key practices which were not well documented, such as development of Soil Profile Classes, have been captured. Some items have been included in the latest version of the "Australian Soil and Land Survey Field Handbook, Fourth Edition" (NCST 2024).

The Qld Guidelines are divided into volumes which are being written progressively. Two volumes have been completed. "Volume 1 – Soil and land resource assessment" focuses on soil description, classification, survey, mapping, landscape hazard identification and communication of soil information. "Volume 2 – Field tests" outlines standard field procedures (e.g. pH/EC, dispersion and slaking). Future volumes will include: managing land resource data; an update of "Interpreting soil analysis for agricultural land use in Queensland" (Baker and Eldershaw 1993); and digital soil assessment.

S-map update for the Upper Manawatu catchment, Tararua District

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S-map coverage in the Horizons Region is being extended in the Upper Manawatu catchment, Tararua District, with support and funding from the Ministry of Primary Industries and Horizons Regional Council. The new mapping covers 150,000 hectares to be publicly released through S-map Online in Spring 2025.

The Upper Manawatu catchment has largely gone without any extensive soil mapping, with the exception of Woodville soil survey for the Land Resource Inventory (1971), and an unpublished provisional soil survey for Tahoraiti. Despite this, there are many similarities shared with other terrace landscapes in the Manawatu, Horowhenua, and Rangitikei districts. The soils across the Upper Manawatu terraces largely conform to the soil-landscape models previously published by Cowie (1978) and Rijkse (1977).

While soil-landscape models are essential for mapping at the regional scale, observations have shown that soils patterns can be complicated by a diversity of landforms, parent materials, and rainfall across the catchment. In some landscapes, young soils have been superimposed on older non-accumulating terraces. These observations have led to discoveries of old floodplains and aggrading fans that have long been masked by modification and agricultural land use in the last 100 years.

Where possible, the original soil series have been incorporated to retain soil names that are specific to the area. The Dannevirke soil series is well known in the area for its distinctive allophanic properties. At the national scale, these soils have been mapped on the highest terraces covered in loess and some volcanic ash. Field observations and sampling has revealed that Allophanic and Allophanic Brown soils are more extensive than previously thought, as are the Q3-Q6 terraces they occur on. These observations have also shown that while the Dannevirke silt loam is common, it is only one soil within a suite of soils that occur on the high terraces.

Living Labs and Lighthouses of the EU Soil Mission - a venture towards healthier soils.

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Soil health is threatened globally because of a range of human activities, such as competition for land, intensive land use, production, consumption patterns, urbanisation, and anthropogenic climate change. The process of soil degradation can lead to a collapse of landscapes and ecosystems, making societies more vulnerable to extreme weather events, food insecurity and contamination, and political instability. It
is estimated that between 60 and 70% of EU soils are unhealthy, and the costs of soil degradation in the EU exceed 50 billion € per year. In recognition of the importance of soils, and the pressure soil functions are under, the EU made soils one out of her 5 Missions.
The Soil Mission 'A Soil Deal for Europe' is at the heart of the EU Green Deal, which is a package of policy initiatives to overcome the threats of climate change and environmental
degradation.
The 8 Mission objectives are:
1. Reduce desertification
2. Conserve soil organic carbon stocks
3. Stop soil sealing and increase re-use of
urban soils
4. Reduce soil pollution and enhance
restoration
5. Prevent erosion
6. Improve soil structure to enhance soil
biodiversity
7. Reduce the EU global footprint on soils
8. Improve soil literacy in society
A most important pillar in terms of its effective implementation of the Soil Mission remains the framework of soil Living Labs and Lighthouses, which is intended to contribute to soil health by meeting specific soil health mission objectives.
Living labs are collaborative initiatives to co-create knowledge and innovations while lighthouses are places for demonstration of solutions and of exemplary
achievements.
We are describing our perspective as both coordinators of a EU-independent Living Lab as well as partner in a Horizon Europe project NATI00NS aimed at fostering the participation of Horizon Europe Soil Mission calls for proposals.

Nature Based Solutuion for soil health. NBSOIL Project

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Nature Based Solutions (NbS) is an umbrella concept that covers a range of different approaches that have emerged from a variety of fields, such as ecosystem-based adaptation, green infrastructure and ecological restauration. Some of these approaches have emerged from the scientific research domain, while others from practice or policy contexts. However, they all share the objective of enhancing the beneficial features and processes of ecosystems to address societal challenges, such as food security, natural disasters, or climate change.

There are several approaches that fall under the NbS concept and contribute to improving soil health. These approaches include: 1) ecosystem restoration approaches such as ecological restoration, 2) issue-specific ecosystem-related approaches such as ecosystem-based adaptation, ecosystem-based mitigation, and ecosystem-based disaster risk reduction; 3) infrastructure-related approaches such as natural infrastructure and green infrastructure approaches, 4) ecosystem-based management approaches such as integrated coastal zone management; and 5) ecosystem protection approaches such as area-based conservation approaches.

One of the significant contributions of the soil-health is the incorporation of the biological perspective into soil management. Soil functions not only depend on physical and chemical properties but also on biological properties. Soil health recognizes that soils are dynamic, living systems and soil biota and their interactions are crucial to soil functions and services.

NbS offers a significant opportunity for innovation, providing long-term, tangible and positive impacts across society, and offering additional co-benefits in comparison with conventional or classical grey solutions.

NBSoil project investigated several real-life cases of NbS utilized in agricultural, forestry, urban and industrial lands. Within the urban areas we've listed three documented cases of communal urban gardening. Within industrial lands 3 cases of afforestation of urban brownfields, phytoremediation and bioremediation. Further cases are being analyzed and will be added to the deliverable consequently in upcoming month.

Evaluating the role of microbial diversity in supporting soil ecosystem functions under drought stress

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Ecosystem functions and services are increasingly threatened by drought stress on a global scale. Microbes, as the primary drivers of nearly all ecosystem functions, play a crucial role in ecosystem-wide responses to environmental stress. However, the specific characteristics of microbial communities that contribute to ecosystem stability under drought conditions remain largely unknown. To address this, we investigated the microbial factors that influence ecosystem stability by creating broad experimental gradients of microbial diversity in soils, subjecting them to drought stress, and measuring the responses of various microbial-mediated ecosystem processes, including carbon (C) and nitrogen (N) cycling rates and soil enzyme activities. Our findings revealed that some processes were positively correlated with microbial diversity, with reductions in diversity leading to decreased stability in nearly all processes. Notably, soils with moderately low microbial diversity maintained positive effects on soil functions under drought stress, but this beneficial effect was lost when microbial diversity reached very low levels. Our results highlight a threshold at which very low microbial diversity triggers an abrupt shift in soil microbial state under drought stress, potentially leading to harmful consequences for soil health.

A metagenomics-based workflow for surveillance of bacterial pathogens in soils

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Bacterial pathogens are responsible for millions of human deaths and significant losses in food production annually. Soil acts as a natural reservoir for many critical pathogens, which significantly impact agricultural production and food safety. However, the lack of accurate, high-throughput methods to identify the distribution of bacterial pathogens in soil greatly limits our ability to develop effective soil health management strategies. Here, we present MetaPatho, an easy-to-use, robust, and reproducible workflow for identifying human and plant bacterial pathogens in soil metagenomes. We first constructed high-quality pathogenic databases for human (HBPDB) and plant (PBPDB) bacterial pathogens. In silico tests (based on approximately 140,000 sequences) and soil experiments, including both pathogen DNA spike-in and cell spike-in tests, were employed to provide evidence supporting the robustness of our workflow. The in silico tests suggested that our workflow could accurately recognize pathogenic sequences, achieving an overall accuracy of 98.9%, with a specificity of 95.5% and a sensitivity of 99.7%. Further analyses from pathogen DNA and cell spike-in experiments showed that our workflow can accurately detect pathogen DNA at different concentrations from two soil types, achieving an average accuracy of 95.8%. Additionally, our workflow proved capable of accurately detecting pathogenic agents in clinical metagenomes. We then used this workflow to identify dominant pathogens in global soils across diverse ecosystems such as forests, grasslands, shrublands, and agricultural fields, providing crucial data for soil health management and the One Health policies. These results demonstrate that MetaPatho can be employed for the high-throughput and accurate surveillance of bacterial pathogens in metagenomic data and could play an important role in risk management linked to human and plant diseases.

Adsorption Behaviour of Dissolved Organic Matter from Common Land Uses onto Different Soil Minerals

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Association of organic matter (OM) with soil minerals has been recognised as the primary mechanism for its preservation in soils. However, the adsorption processes in the organo-mineral associations are still not well understood. We extracted dissolved organic matter (DOM) from decomposed plant residues of four common land use systems in Australia, i.e., pine, eucalyptus, pasture, and wheat. Six soil minerals, i.e., poorly crystalline minerals (ferrihydrite and allophane), metal oxides (goethite and birnessite), and phyllosilicates (montmorillonite and kaolinite), were selected to undertake adsorption experiments with the four DOM at pH 4.0 and 10 mM NaCl as the background electrolyte. Carbon near-edge X-ray absorption fine structure (NEXAFS) spectroscopy and attenuated total reflectance-Fourier transform infrared (ATR-FTIR) spectroscopy with a ZnSe crystal flow-through system were employed to characterise the adsorption mechanisms with minerals.

The poorly crystalline minerals showed the highest adsorption capacity for DOM, followed by metal oxides, and the least by phyllosilicates. There was no difference in the adsorption capacity for the four DOM onto the same mineral. Both NEXAFS and FTIR results showed that all clay minerals preferentially adsorbed OC with an abundance of C=C groups. The adsorption strength of OC functional groups (including C=C, C=O, C-H, and -OH) varied based on the mineral surface characteristics. The adsorption of different OC groups occurred simultaneously, but the time they took to saturate on the mineral surface varied. The findings of this study highlight the important role of minerals and functional groups of OC in the organo-mineral interactions. The stability of OM (against microbial mineralisation) in association with different minerals will be evaluated in further experiments.

Molecular composition of organic carbon does not change with land use change in a Ferrosol

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Land use change from native vegetation to cropping can significantly affect the quantity and quality of soil organic carbon (SOC). However, it remains unclear how the chemical composition of Fe and/or Al mineral associated OC is affected by the land use change. We employed a sequential chemical extraction procedure to extract four distinct Fe and/or Al oxide-OC associations: water-soluble fraction (W), sodium pyrophosphate (PP) to extract organo-metal complexes, hydroxylamine hydrochloride (HH) to extract OC associated with short-range ordered (SRO) oxides, and dithionite (DH) to extract OC associated with well-crystalline oxides. Soil OC content was measured after each extraction and extracted OC was characterised by Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR-MS). Greater amounts of OC were observed in the PP and HH fractions compared to other fractions, highlighting the importance of organo-metal complexes and SRO in SOC stabilisation. The composition of OC fractions varied in different extracts, with oxy-aromatic compounds being prevalent in the PP and HH fractions, while lipids-like compounds dominated in the DH fraction. Despite changes in the concentration of each OM fraction from native vegetation to cropping, there was a little influence of the land use change on the molecular composition of SOC associated with different mineral phases. Our results showed no selective loss or preservation of OC compounds associated with Fe/Al minerals with land use change.

Unravelling the Diversity and Abundance of Potential Plant-Beneficial Bacteria across Australia's Tomato Fields

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Plant beneficial bacteria (PBB) are bacteria that can positively impact plant health and crop yields, through enhancing plant resistance, stimulating plant growth, and bio-controlling invasion by pathogens. However, the diversity and abundance of PBB across various agricultural fields and the environmental factors driving the distribution of PBB remain largely unknown. This study examined the distribution of PBB in 180 phyllosphere, bulk soil, and rhizosphere soil samples collected from 12 commercial processing tomato fields located in VIC and NSW, Australia. The results based on amplicon sequencing of bacterial 16 rRNA gene identified 27 bacterial taxa that can be beneficial or harmful to plants, and 165 beneficial bacterial taxa at the genus level. There were no significant differences in the diversity and composition of PBB between bulk soil and rhizosphere soil samples. We aim to identify the key soil physical and chemical properties that shape the distribution patterns of PBB. The outcomes of this study are expected to enhance the fundamental understanding of the diversity of PBB and their distribution patterns. These findings may increase the potential of PBB to sustainably increase tomato yields and reduce dependence on chemical treatments in agriculture.

NOTES

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