Grounds for Growth 2025

Soil and pasture biodiversity event

Dairy Australia

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Project Committee: Joe Jacobs, Clare Hill, Cath Lescun and Donna Gibson

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Picture being able to.....

measure, monitor, and manage the nutrients and their cycling in your soils, no matter where those nutrients come from.

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Improving soil

Exploit paddock and profile variability

Expand and extend the rhizosphere

Use “next gen” microbial nutrients

Retain and recover on-farm nutrients

- ↓ Fertilizer costs
- ↓ GHG emissions
- ↓ Nutrient loss
- ↑ Nutrient cycling
- ↑ Water use efficiency
- ↑ Pasture production
- ↑ Soil function & health

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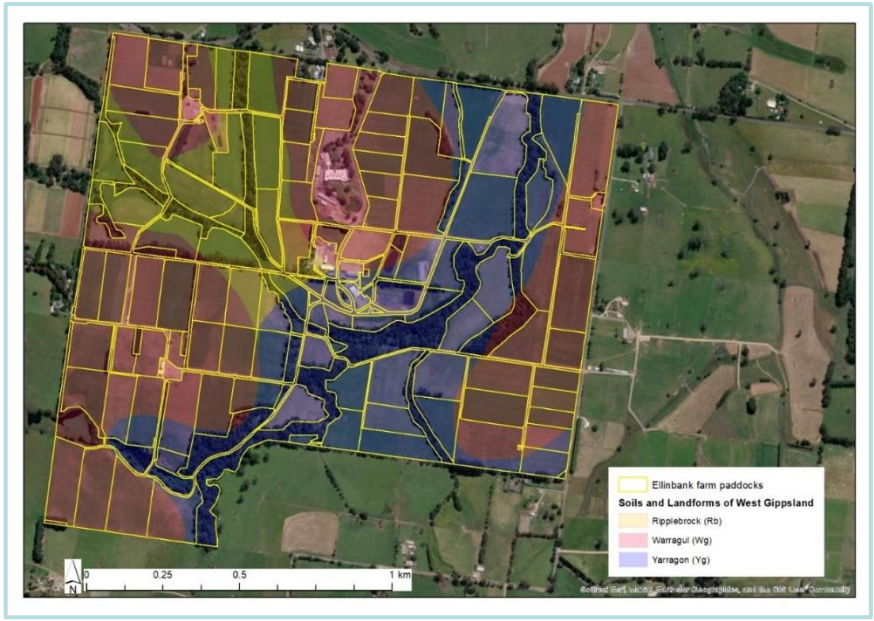
DairySoil

Dairy Soils is a part of DairyFeedbase, a partnership between Dairy Australia, the Gardiner Dairy Foundation, and Agriculture Victoria

- 5-year R&D project that commenced July 2023
- Using cutting-edge technology and bioscience to help improve profits for farmers



Study Area – Ellinbank SmartFarm

Dairy Australia GARDINER FOUNDATION AGRICULTURE VICTORIA DairyFeedbase DairySoil

01 Spatial soil variability - paddock and profile

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Spatial soil variability – paddock and profile

Measurement and monitoring

- Base soil variability paddock/farm map – once
- Targeted deeper soil profile sampling – once every decade
- Soil sampling top 0 to 40 cm – regularly in line with key decisions
- Soil moisture monitoring – real time

Management

- Variable rate and measured fertilizer, manure, and other soil ameliorant application
- Timing of nitrogen application
- Precise approach to multispecies design including root architecture
- Pasture growth forecasting to support forage budgeting

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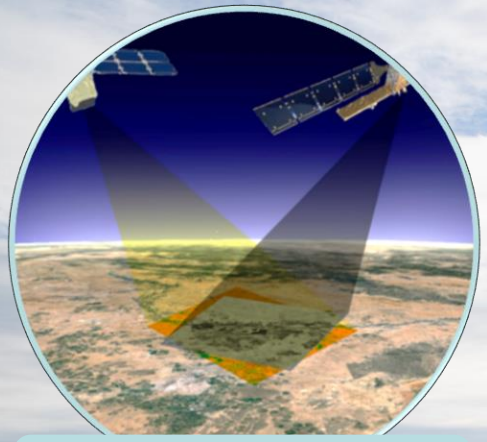
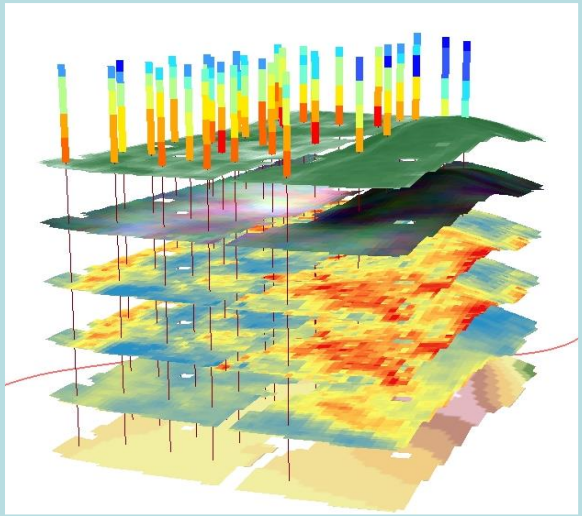


Radar and multi-spectral satellite data



Point-to-farm multi-dimensional soil attribute mapping

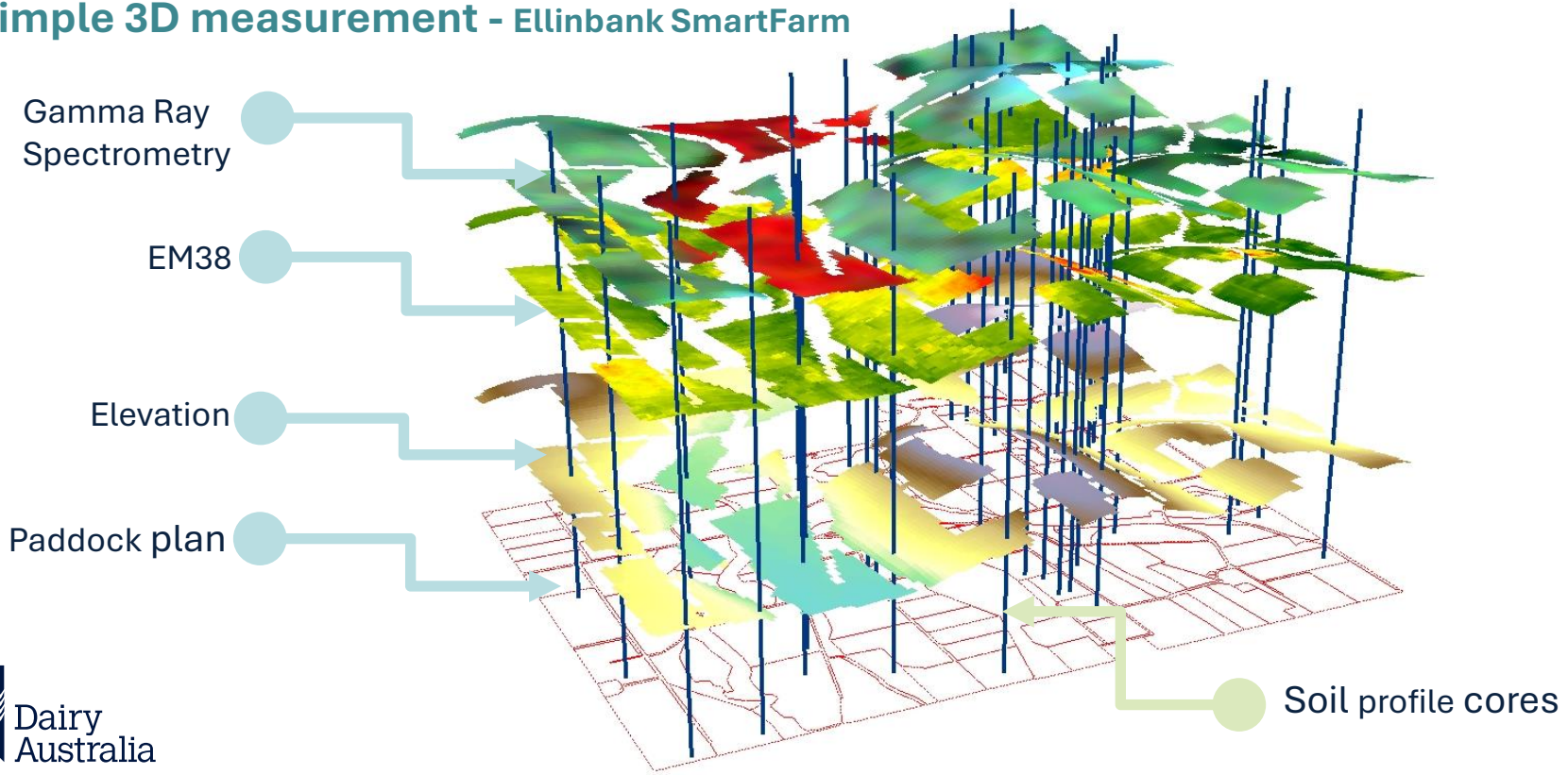
Gamma ray spectroscopy and EM 38 data

Soil core and pasture biomass measurements

Hand-held mid infrared and soil moisture sensors

Spatial soil variability – paddock and profile

Simple 3D measurement - Ellinbank SmartFarm



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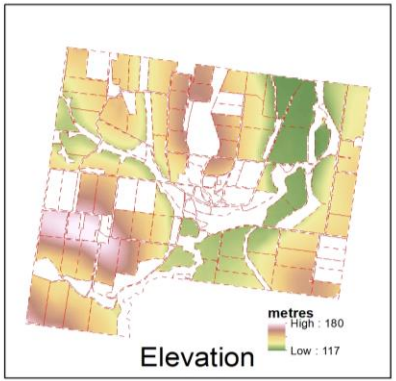
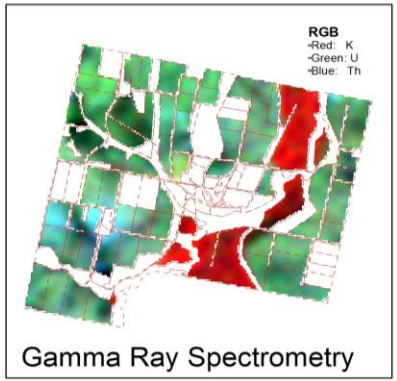
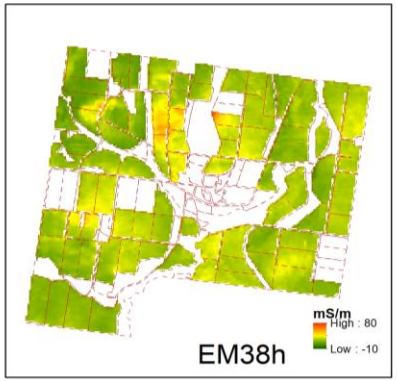
Spatial soil variability – paddock and profile

Simple 3D measurement - Ellinbank SmartFarm







0 200 400 800 1,200 Metres

Ferrosol on the slopes and crests. But, it varies with the southwest quarter subtly different to the remainder (more blue in the GRS map).
Hydrosol (red in the GRS map) on the former swamp (green on the elevation map).
Electrical conductivity in the surface (EMh) and subsurface (EMv) soil is low. EMv was higher in the former swamp, presumably it was wetter.

Summary

Geophysical Platform

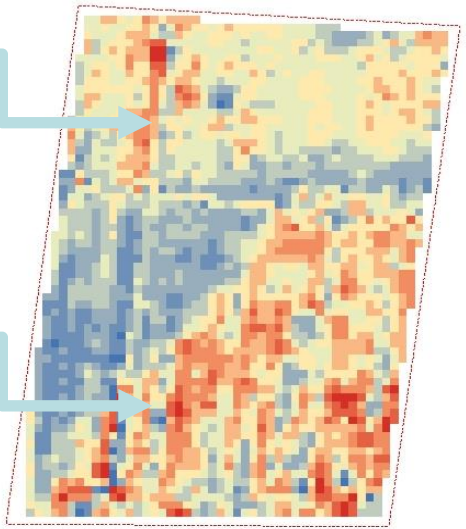
Spatial soil variability – soil moisture

Can we use EM38 to estimate water use and relate it to biomass of pastures?

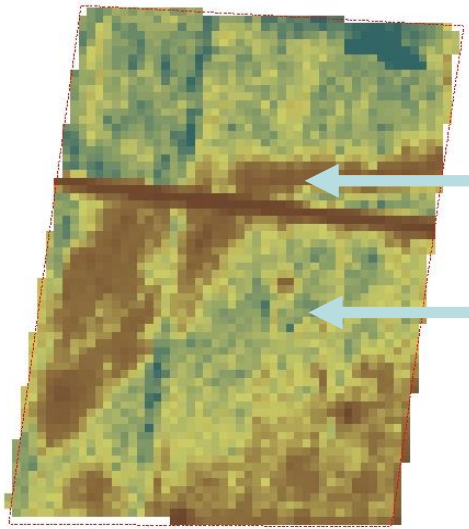
Science from grains (canola) to dairy (PRG)?

EM38 x 2

Soil moisture (x 30)



Nurrabiel (west of the Grampians)



Biomass from Sentinel 2

Biomass cuts at the same 30 points

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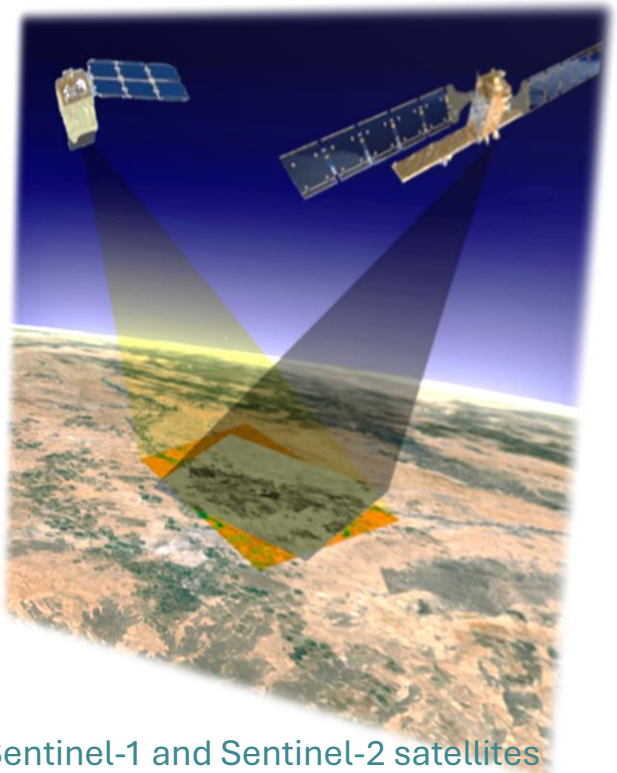
PASTURE SMARTS

Spatial soil variability – remote measurement of soil moisture

- Timely and accurate information
- Cost effective in terms of time and resources
- Contiguous measurements across the farm
- Frequent measurements



Sentinel-1 and Sentinel-2 satellites

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Spatial soil variability – remote measurement of soil moisture

Can we measure soil moisture regularly across the farm?

Satellite data

- Sentinel-1
- Sentinel-2

Geophysical data

Elevation data

EMI data

Soil moisture data

Pasture samples

1. Soil moisture probes handheld data (0-5 cm)
2. CropX soil profile moisture probes
3. Green Brain weather & soil profile moisture
4. Volumetric soil moisture samples

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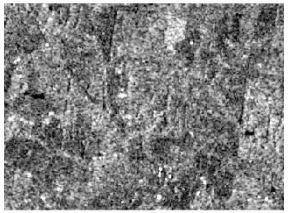
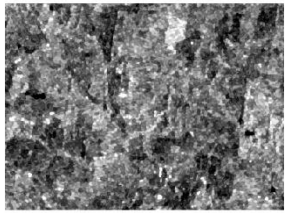
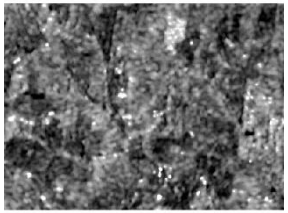
Spatial soil variability – remote measurement of soil moisture



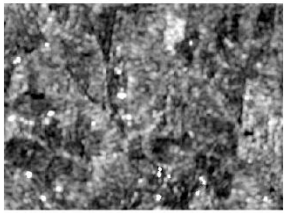
No filter



Refined lee 5x5



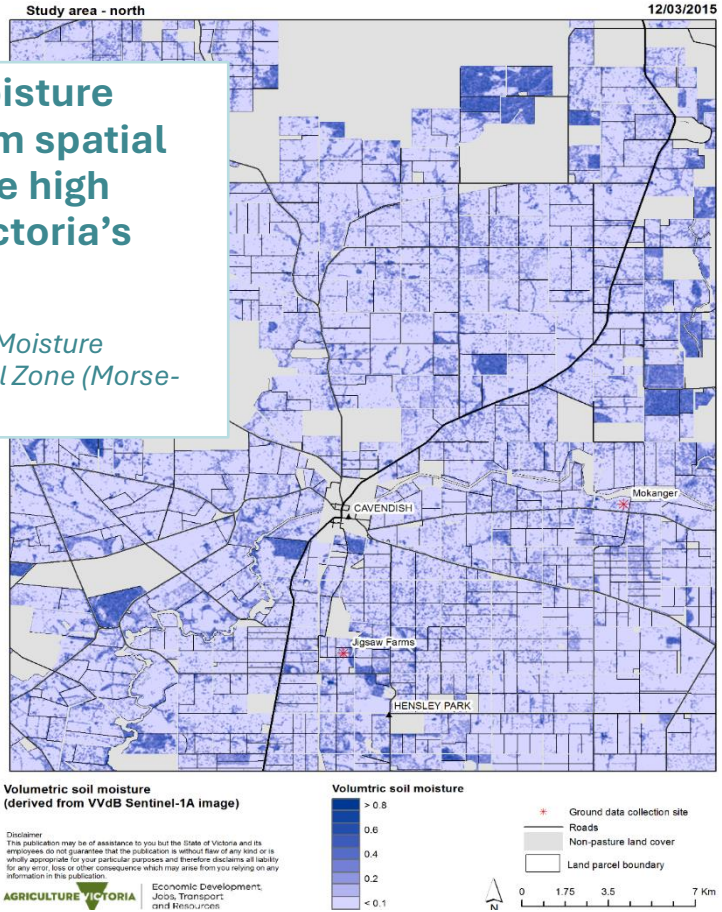
Lee Sigma 5x5



Gamma Map 5x5

Sentinel-1 soil moisture predictions at 10 m spatial resolution over the high rainfall zone of Victoria's south-east

Previous AVR project "Soil Moisture Mapping in the High Rainfall Zone (Morse-McNabb et al. 2016)"



			Detailed Analysis Results				Semivariogram Parameters			Optimization metrics				
	Band	Kernel size	Mean	Std	Min	Max	Range	Sill	Nugget	MSE	Correlation	Range	Sill	Nugget
Original images	VV	no filter	-12.16	2.67	-23.93	9.88	1.82	7.06	0.02	NA	NA	NA	NA	NA
Gamma Map filter	VV	5x5	-11.65	1.95	-19.84	5.45	3.25	3.68	0.05	9.80	0.99	3.08	3.79	0.05
	VV	7x7	-11.58	1.77	-18.84	2.81	4.31	3.04	0.05	15.21	0.96	4.24	3.04	0.06
Lee Sigma	VV	5x5	-11.67	1.99	-20.12	9.88	3.25	3.87	0.06	8.20	0.99	3.18	3.85	0.05
	VV	7x7	-11.63	1.85	-19.52	9.88	3.96	3.21	0.05	10.62	0.98	3.65	3.46	0.06
Refined Lee	VV	5x5	-11.96	2.10	-21.31	6.20	2.82	4.30	0.05	7.57	0.99	3.10	4.28	0.07
	VV	7x7	-11.96	2.10	-21.31	6.20	2.77	4.26	0.05	7.61	0.99	2.97	4.26	0.06

Spatial soil variability – rapid in-situ paddock measurement

Can we collect more samples at a faster pace and lower cost to facilitate quicker decision-making?

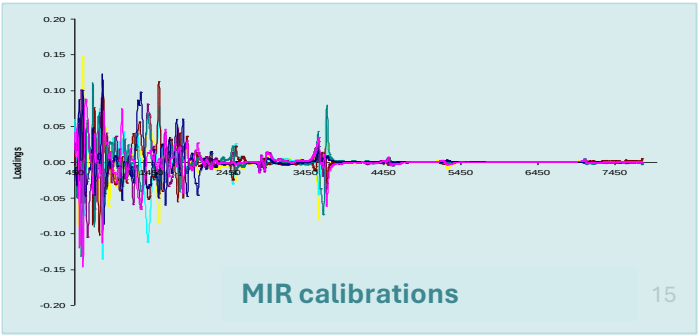
Hand-held sensors will help farmers take fast, cheap, real-time measurements on the farm. These measurements will help soil, fertiliser and manure management

We are developing accurate calibrations using spectroscopy and laboratory analysis

We are exploring new spectroscopy techniques for improved rapid real-time measurement

Hand-held MIR

Z-903 LIBS GEO



MIR calibrations

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02 Expanding and extending the rhizosphere

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DairyFeedbase

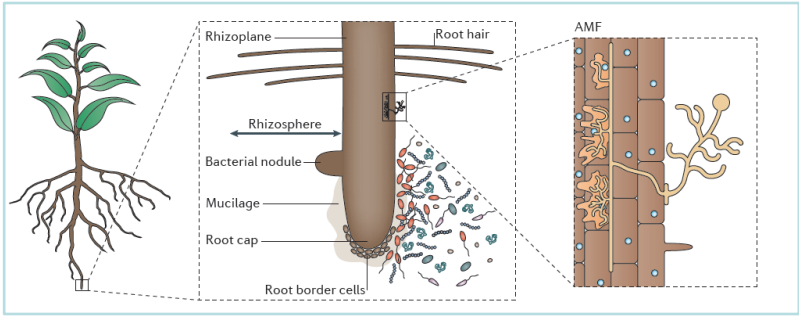
DairySoil

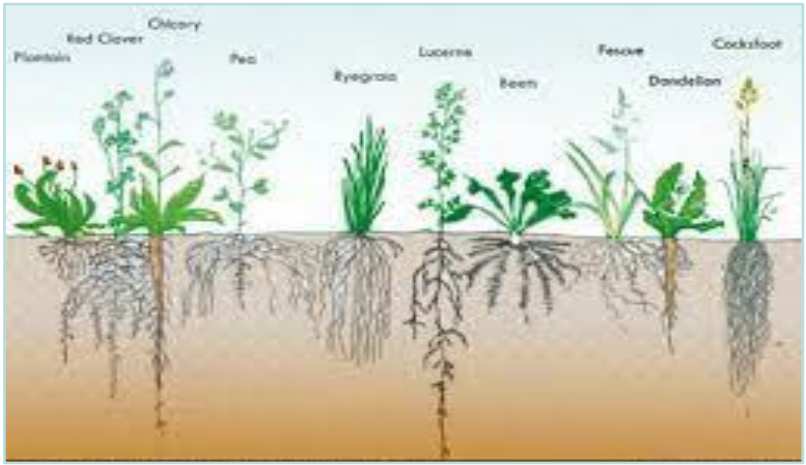
Building the rhizosphere – deep, diverse root systems

The rhizosphere is the narrow zone of soil surrounding plant roots that is characterised by root exudation and an abundance of saprophytic, pathogenic and symbiotic bacteria and fungi.

Rhizosphere chemistry and physics differ from the adjacent soil matrix and root tissues.

Important for shoulder season production, pasture persistence and drought resilience and an input in designing multispecies pasture mixes





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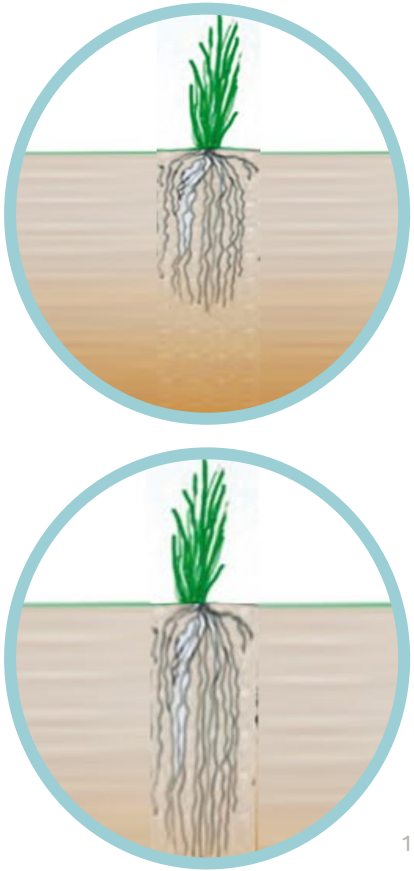
Building the rhizosphere – deep, diverse root systems



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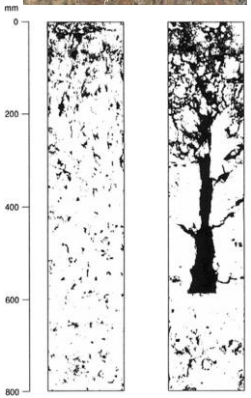
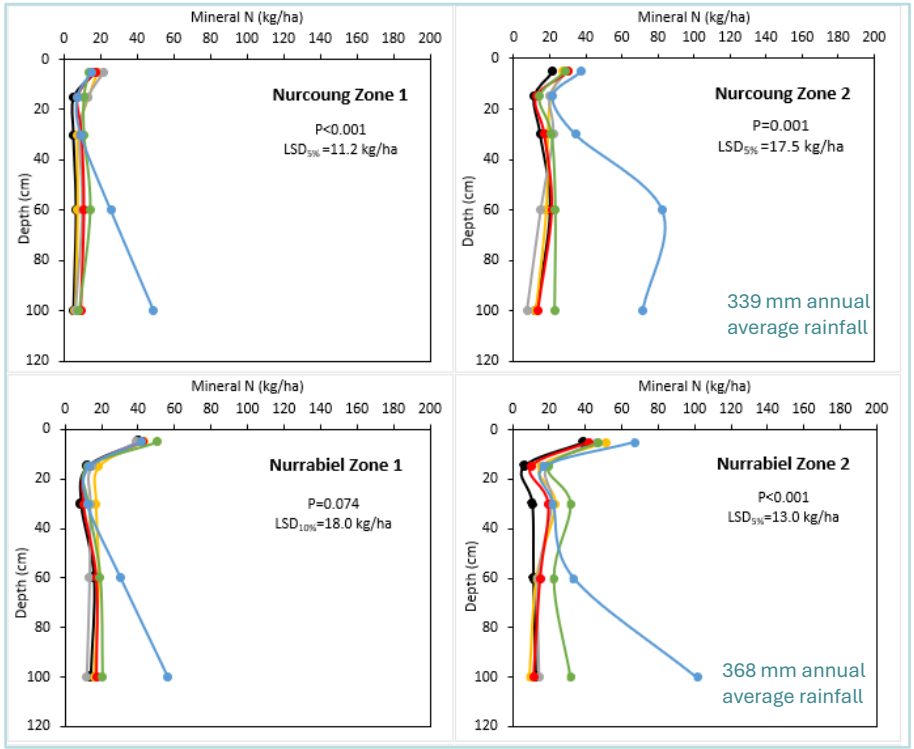
Building the rhizosphere – deep, diverse root systems

1. Perennial multispecies pastures



2. Subsoil amelioration



Soil pre-sowing mineral nitrogen (0-120 cm) in each soil zone in April 2024, three years after treatment

Roger Armstrong (GRDC DJP2209-002RTX)

03 Next generation microbial nutrients

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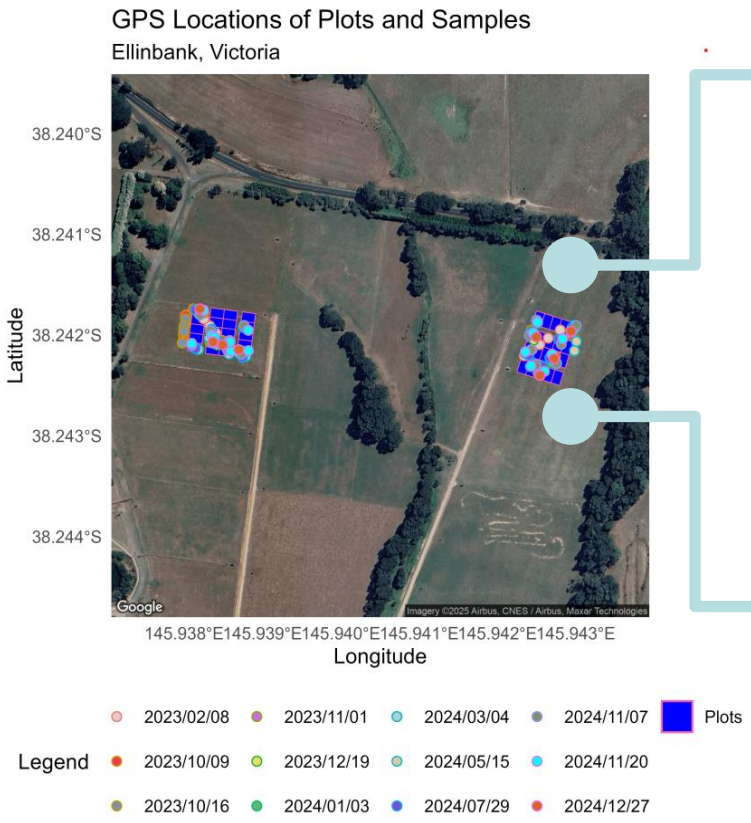
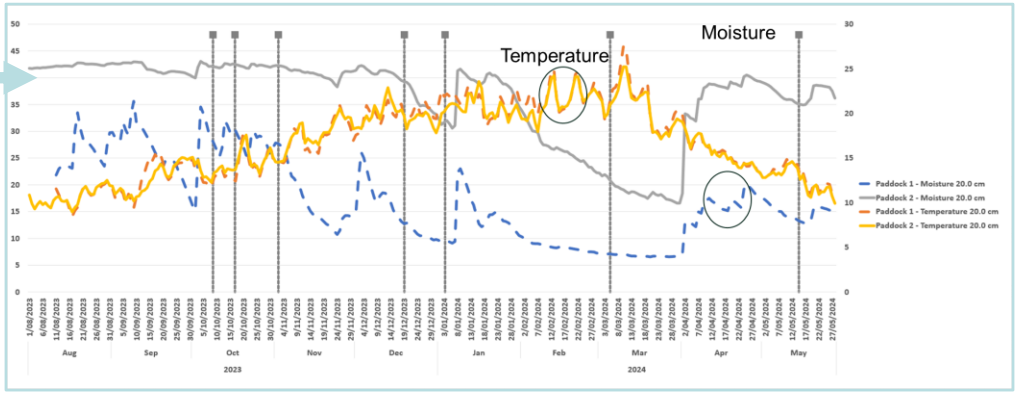
DairyFeedbase

DairySoil

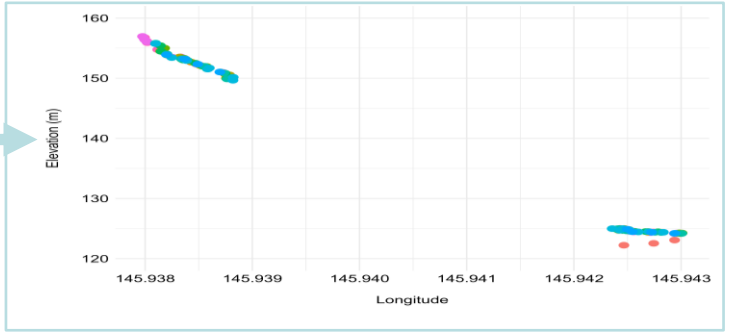
Next gen microbial nutrients – a paddock understanding

Where and when are we sampling?





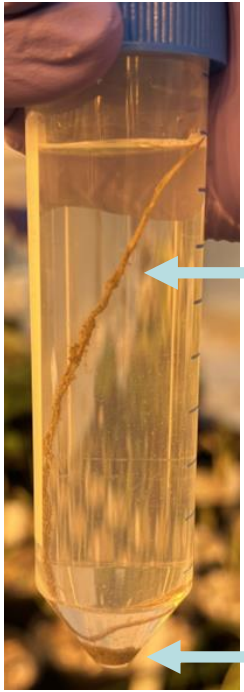
Daily soil temperature and moisture at 20 cm



Height of sample from sea level

Next gen microbial nutrients – a paddock understanding

Plant and rhizosphere samples



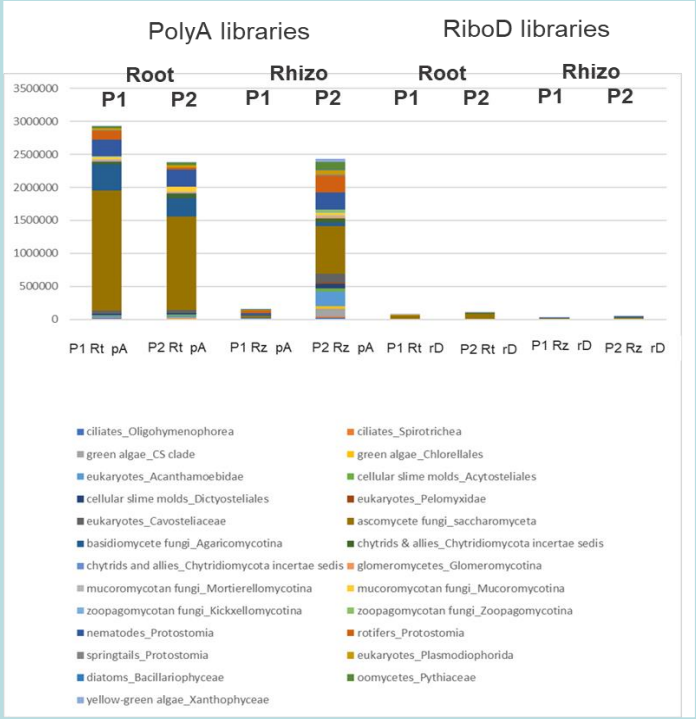
Core Set Per Timepoint

- 1 plant per perennial ryegrass plot – 4 plants per soil type
- Additional plants sampled at some timepoints:
  - Ryegrass plants across Ferrosol Paddock 1 at same height
  - Ryegrass plants from legume heavy plots
  - Red clover plants from legume heavy plots
- 144 plants sampled so far. RNA libraries capture a lot of the diversity

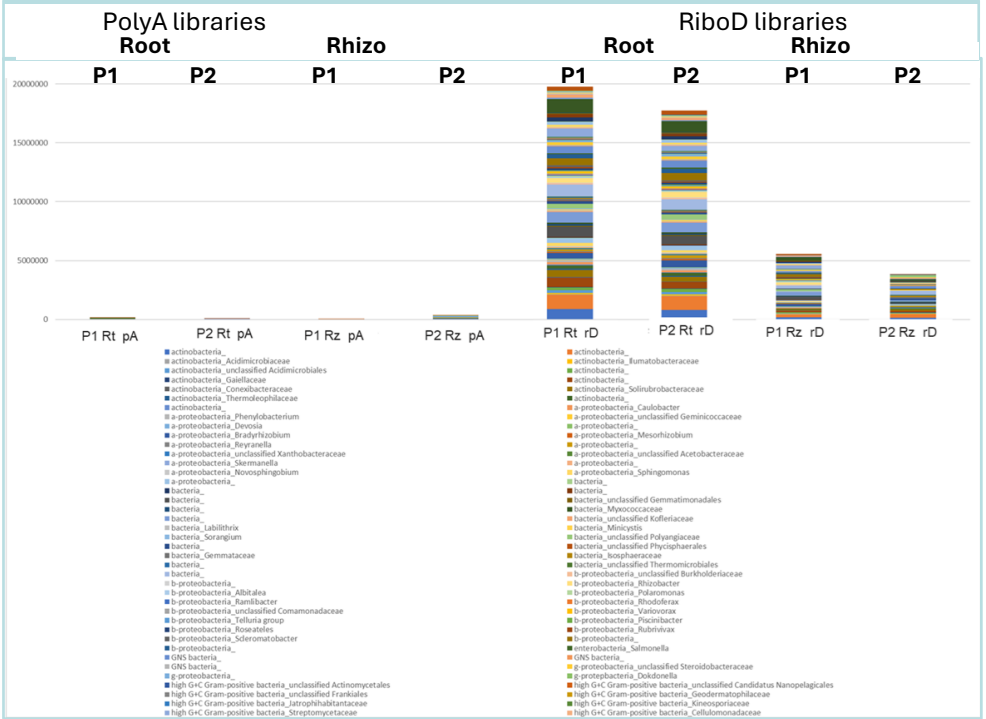
Next gen microbial nutrients – a paddock understanding

RNA sequencing is sampling diversity in the field - numbers of contigs

Eukaryote targeted libraries *(includes fungi)*



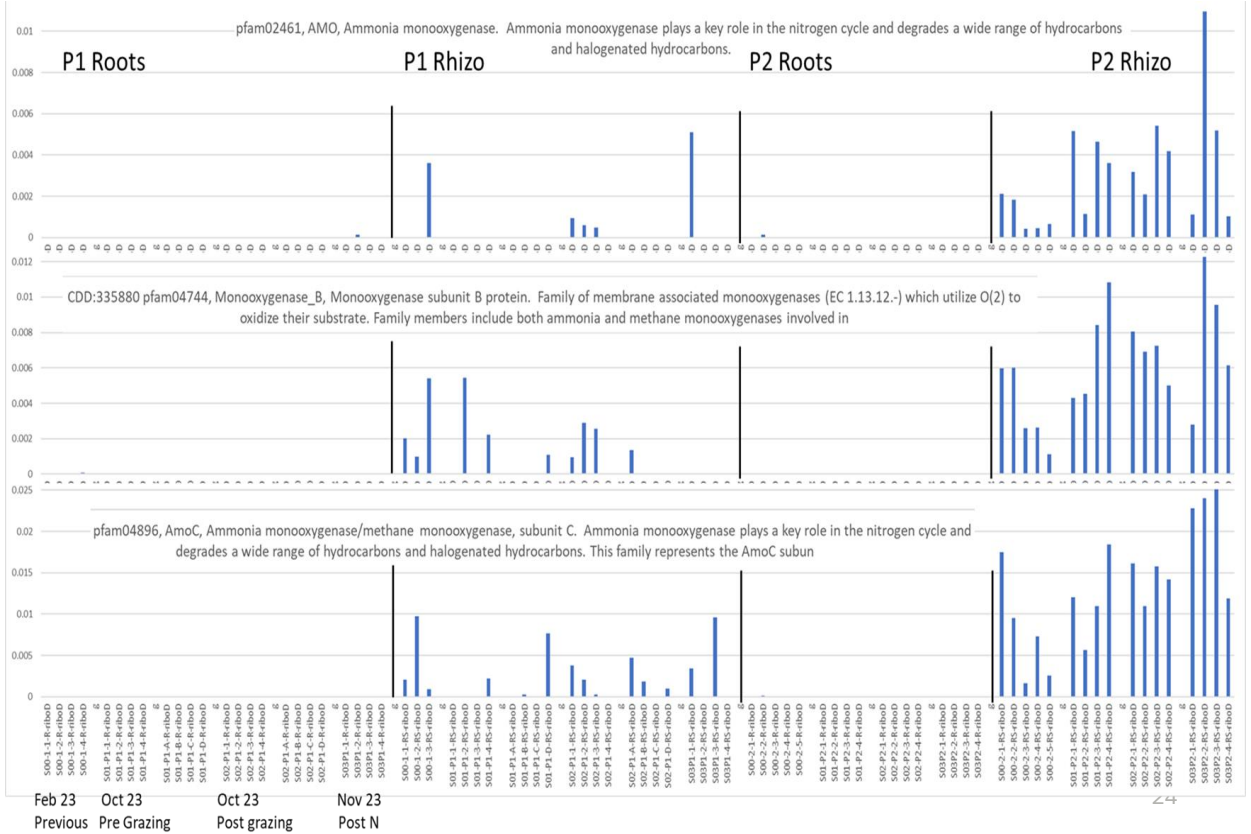
Prokaryote targeted libraries *(includes bacteria)*



Next gen microbial nutrients – a paddock understanding

Proportion of RNA contigs for AMO A Pfams among the RNA libraries

- Protein families, known as PFAMs, refer to protein motifs that are linked to specific functions.
- These RNA contigs are associated with ammonia monooxyegase
- In this case, the functions are associated with the rhizosphere RNA, not the root RNA
- This data could serve as a baseline to evaluate the effects of de-nitrification inhibitors on functions within the rhizosphere



04 Retain and recover on-farm nutrients

Brief overview

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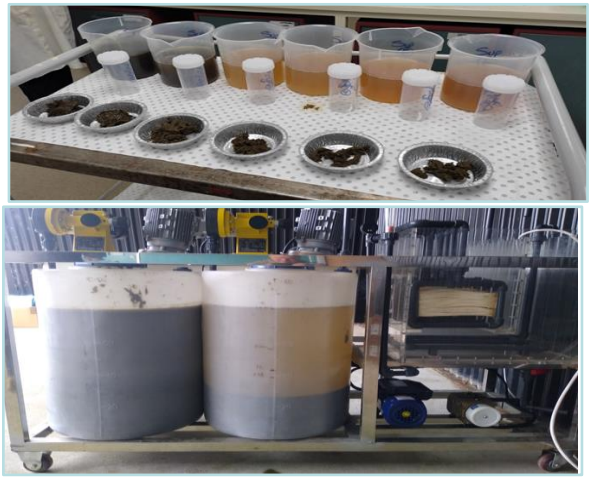
DairyFeedbase

DairySoil

Retain and recover on-farm nutrients – managing manure

Nutrient retention

- N retention/loss reduction
- Alternative GHG emission reduction technology
- Novel and commercial treatments
- Manure sources



Solid-liquid separation

- Increase water clarity/reuse
- Increase high nutrient solids
- Test scales
- Test on commercial farms

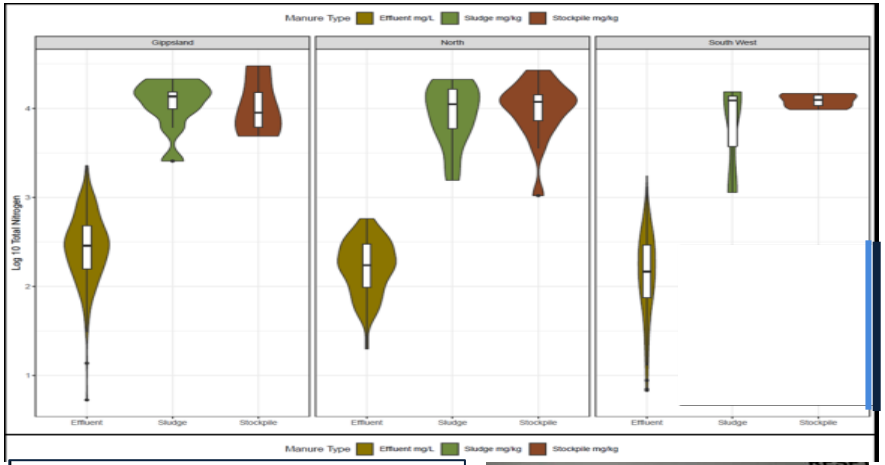
Land apply manure

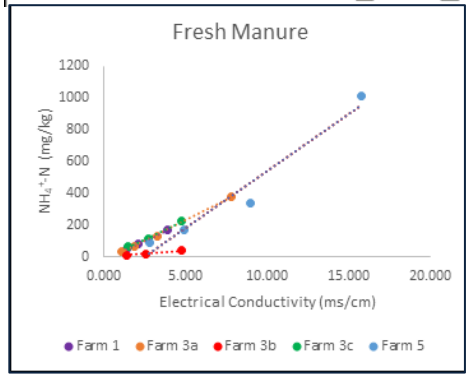
- Treated manure effects on pasture, soil, leaching potential and gas emissions
- New formulations for sub-soil manuring
- Calibrations for nutrient measurement at application

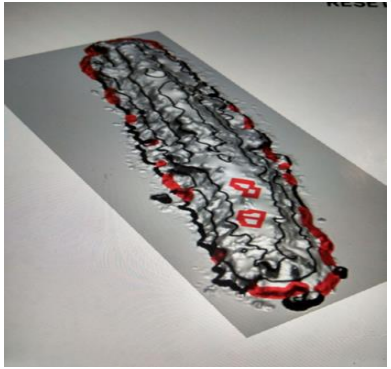
Retain and recover on-farm nutrients – managing manure

Valuing and using on-farm nutrients to replace synthetic fertilisers

- Variations in manure nutrients make it hard to determine applied amounts, and testing can be costly and time-consuming.
- DairySoil is developing new relationships using NIR, other spectral parameters, for physico-chemical nutrient analysis of manure
- These will support the improvement of sensors (in-line and hand-held).
- The measure of stockpile manures volume and nutrients is also important







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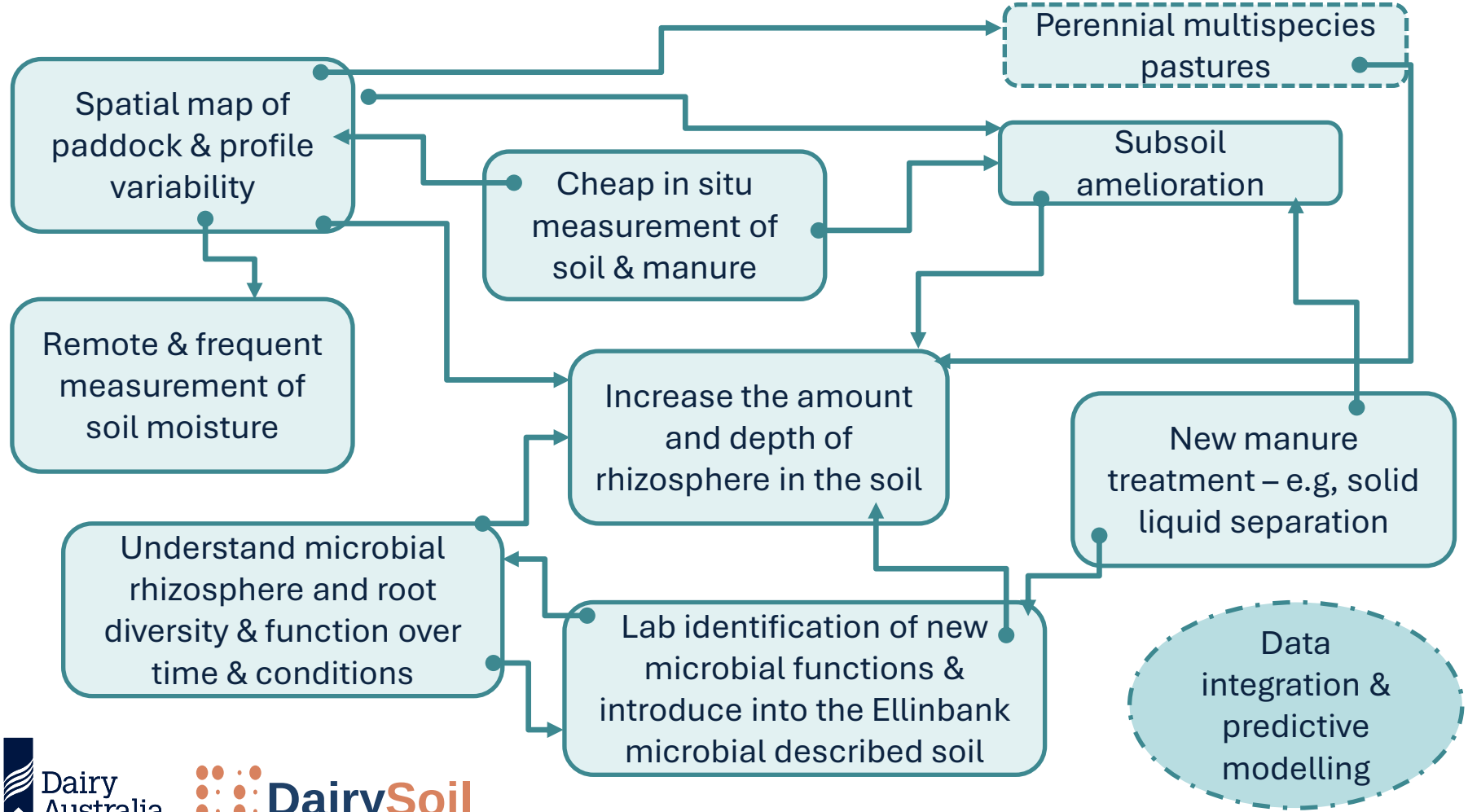
Summary and take home messages



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Take home messages

1) Precision Agriculture

- Measuring and managing soil variability is essential to unlock precision ag technologies for dairy pastures
  - Tools are available today
  - New tools and technologies will improve data collection and display
- Selecting appropriate tools, whether conventional tests or proximal sensors, for each soil property is crucial, along with considering spatial and paddock context
- Soil moisture via remote sensing will advance pasture growth prediction and feed budgeting

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Take home messages

2) Rhizosphere

- The biology of the rhizosphere is complex and influenced by soil, species, weather and climate
- Microbes have evolved in conjunction with pasture species
- Improving soil microbial biology needs to consider resident communities

3) Soil nutrients

- Need to be efficient regardless of source
- Great potential for improved management of on-farm nutrients (manure, urine, biologically fixed N)

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Stay connected and discover more about DairySoil ..... join us on this exciting journey!

Scan the QR code to explore the DairySoils website and to learn more about the latest research for resilient dairy soils!

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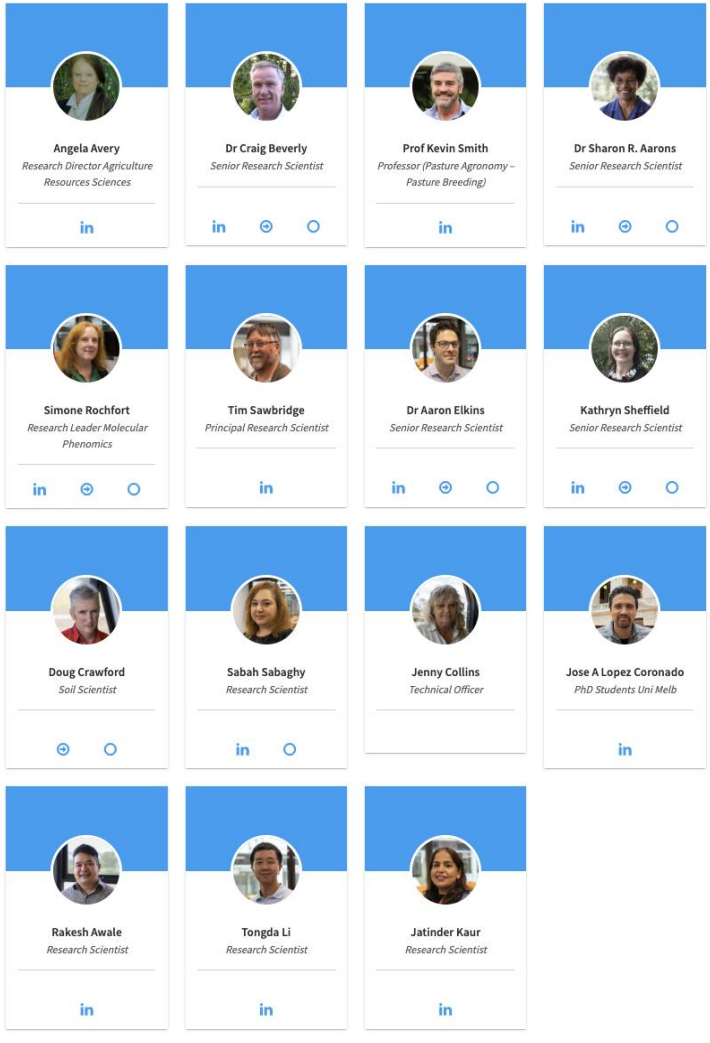
GARDINER FOUNDATION

AGRICULTURE VICTORIA




Remote measurement of soil (moisture, bulk density, PAW)
Precise application base on soil
New manure base fertiliser products – home grown fertiliser
New microbes that fix nitrogen and bacteria and mycorrhiza that unlock soil stored phosphorus.
GRDC
New soil module to improve PastureSmarts predictions
In paddock realtime measurement of soil
Diverse multi-species that deepen the rhizosphere
Soil management practices that deepen the rhizosphere and improve soil function
Better understanding and measurement of soil microbial communities