Practices

that capitalise on soil biology

for better health

Dr Pauline Mele

Soil Microbiologist

Biome services

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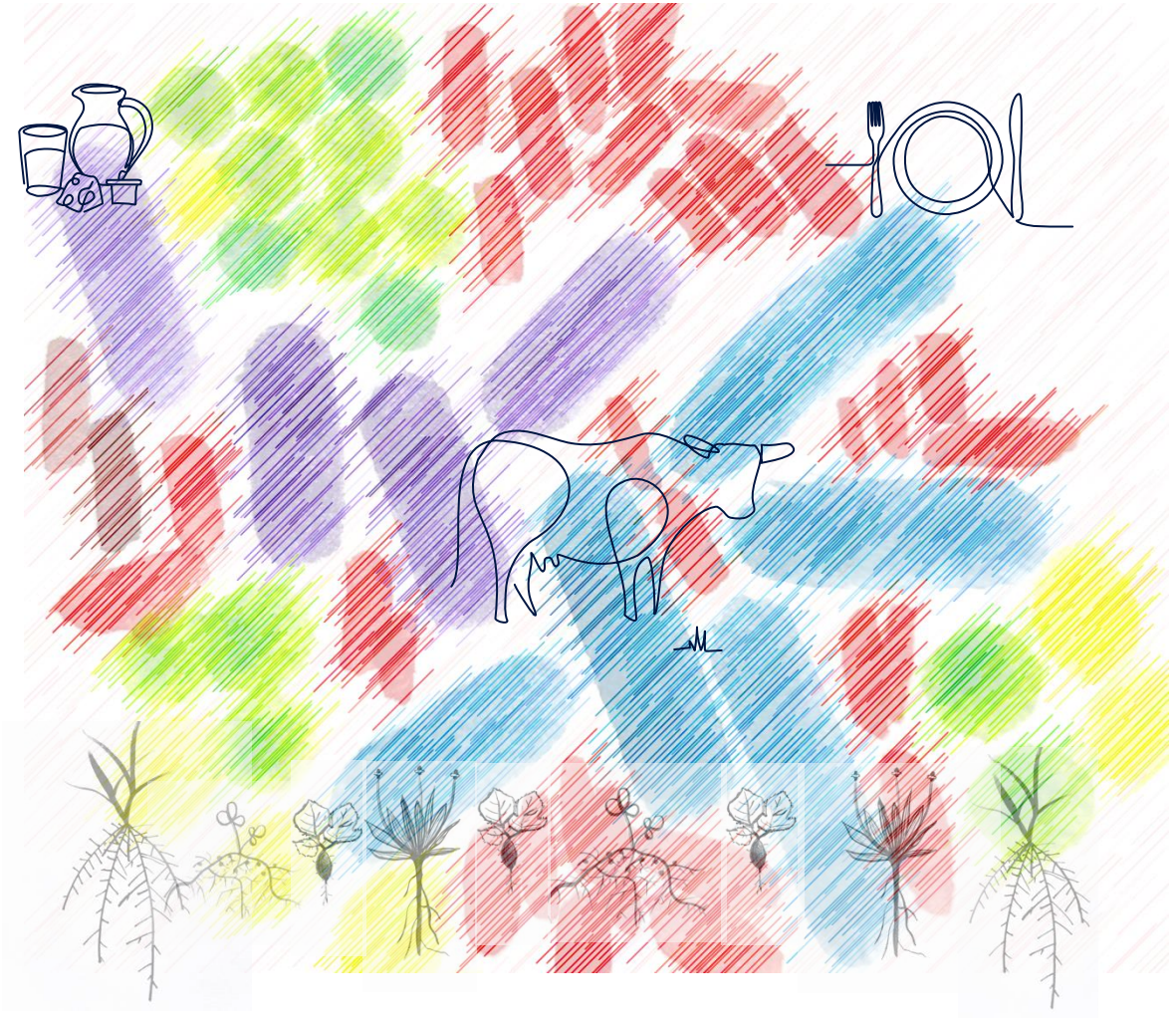
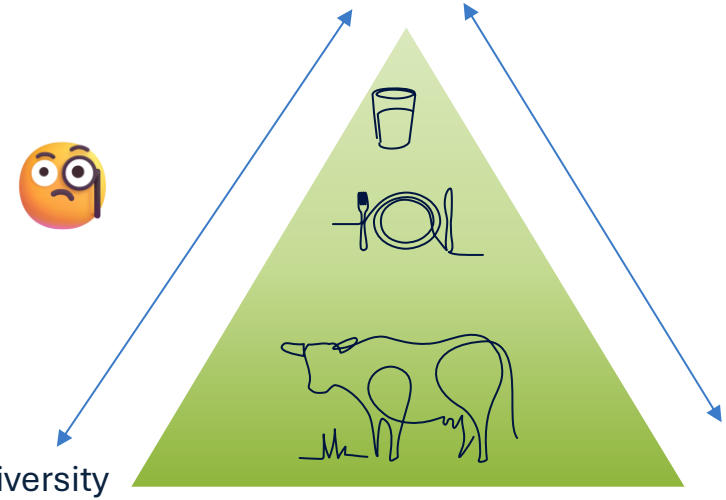
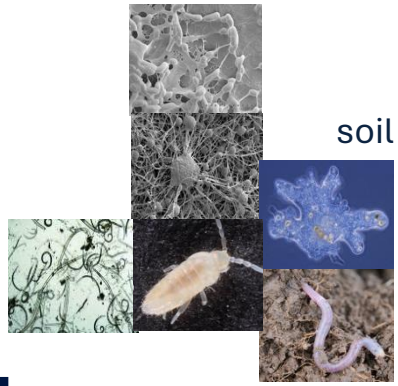


A healthy soil

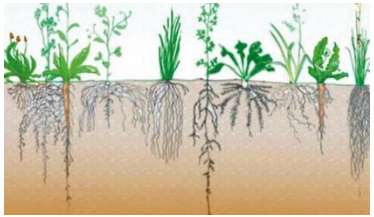
Soil structure



soil diversity



Pasture diversity (including roots)



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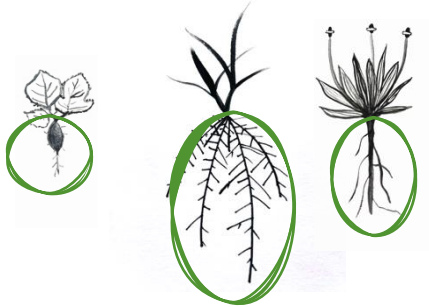
‘Champion’ microbiomes

modifiers

rumen

diet

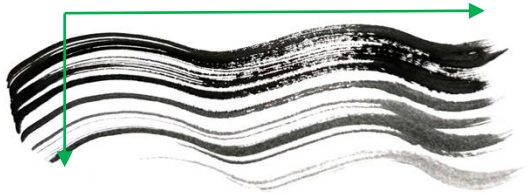
plant root zone (rhizosphere)



plant variety/genotype

seed coating

land/soil



pasture variety

fertilisers, residues, pesticides, grazing intensity, traffic

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Fermentation **2023**, *9*(2), 114; https://doi.org/10.3390/fermentation9020114

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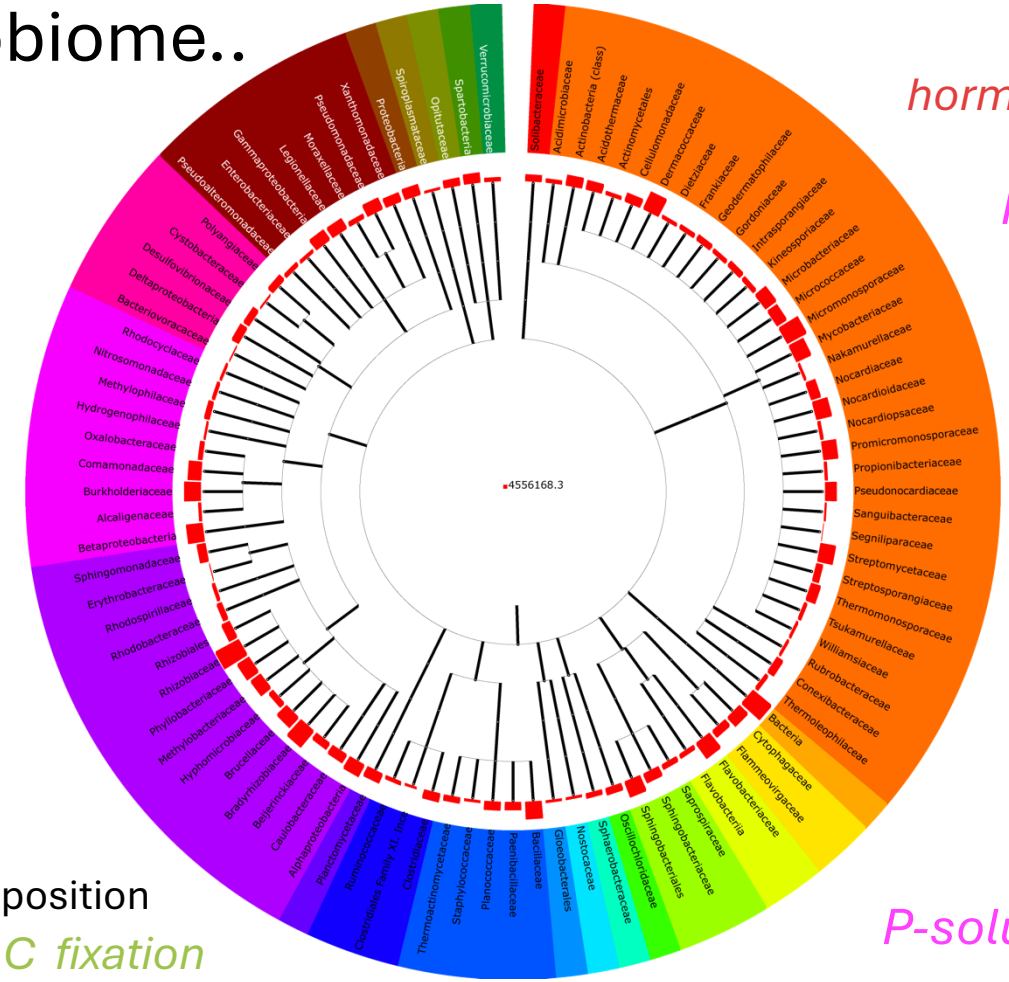
The soil microbiome..



N-mineralisation

C decomposition

N fixation

C fixation

P-solubilisation

N fixation

C decomposition

C fixation

N fixation

hormone production

N-mineralisation

C fixation

P-solubilisation

C decomposition

N fixation

C fixation

C decomposition

N-mineralisation

C fixation

P-solubilisation

N-mineralisation

hormone production

P-solubilisation

C decomposition

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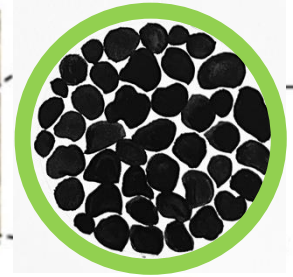
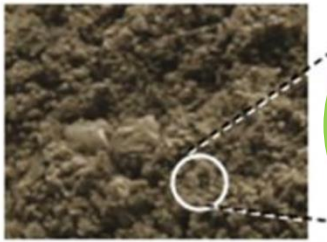
Photo | Close up | Particle size | Soil texture | Soil structure

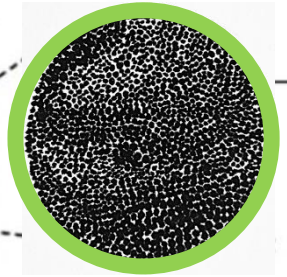
sand



0.05mm–2mm

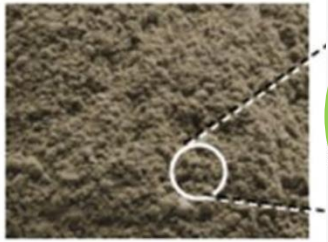
silt

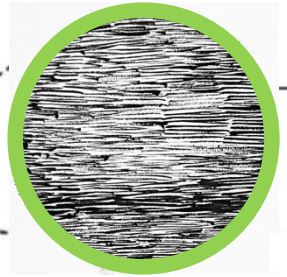




0.002mm–0.05mm

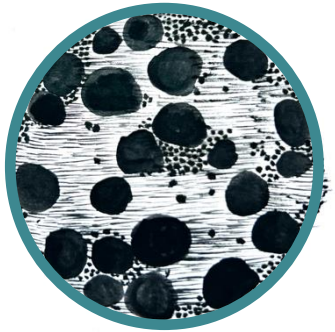
clay





<0.002mm

Clay loam
60c:30si:10sa



Sandy loam
30c:20si:70sa

Poor

Mediocre

Good

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3 steps..

for better biodiversity

1. Condition report (baseline)

- What, where & why in my soil?
- Record where & when
- Protect first

2. Farm practices (& options)

- Risks & rewards,
- Tradeoffs & consequences

3. Act

- Try something different
- Observe, Measure, & Monitor

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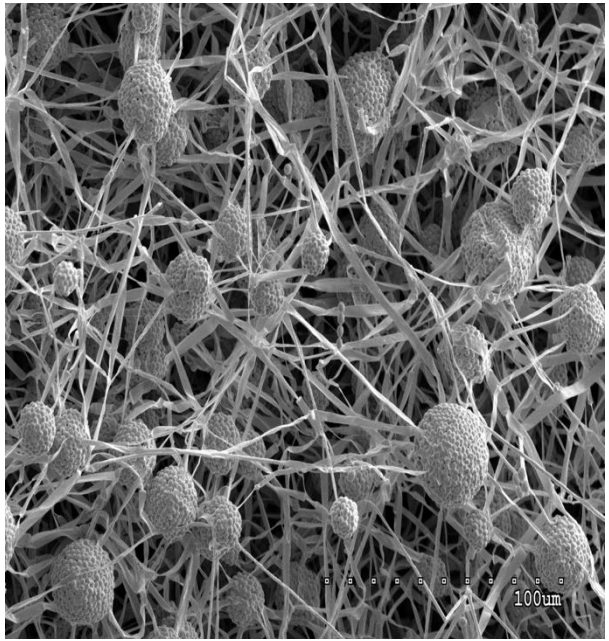
Risks to biodiversity



Topsoil disturbance & exposure

Compaction & waterlogging

Urea, super & seedcoats

Low pasture diversity

Biologicals

Soil tests

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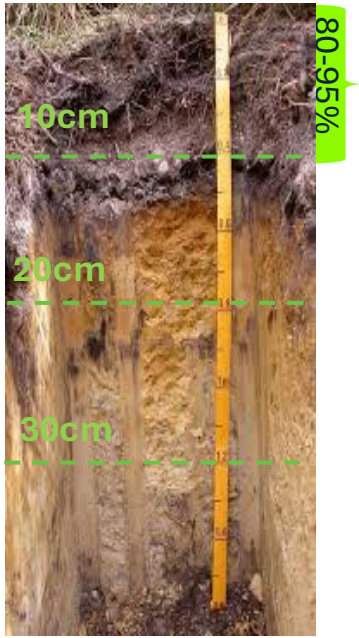
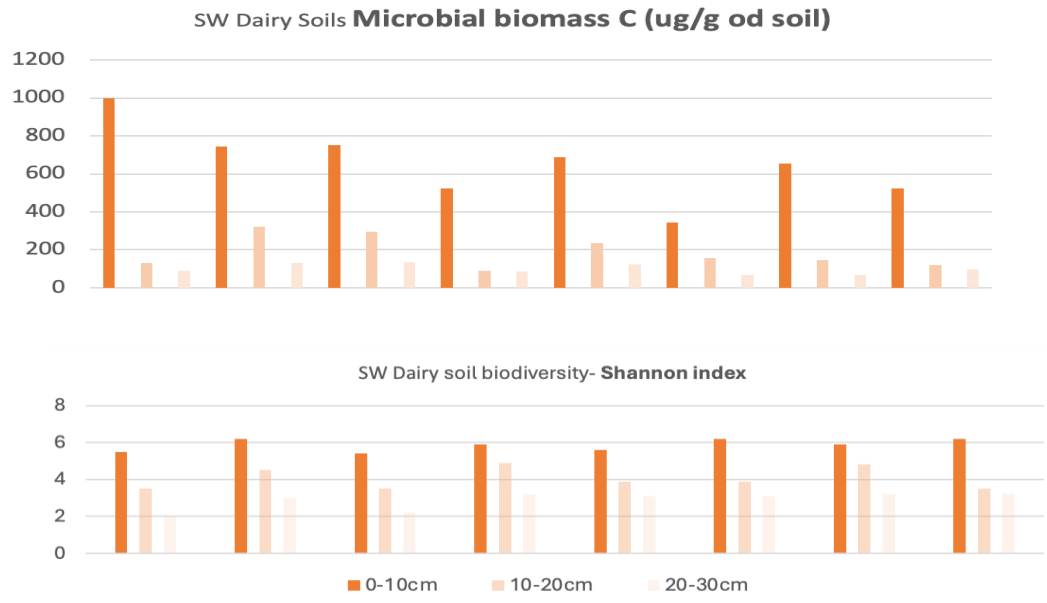
Topsoil disturbance & exposure

Pasture renovation, grazing intensity, laser levelling, vehicle movement, drought





40%

60%

80%

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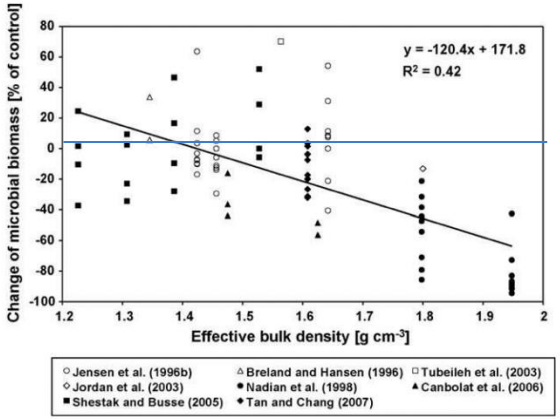
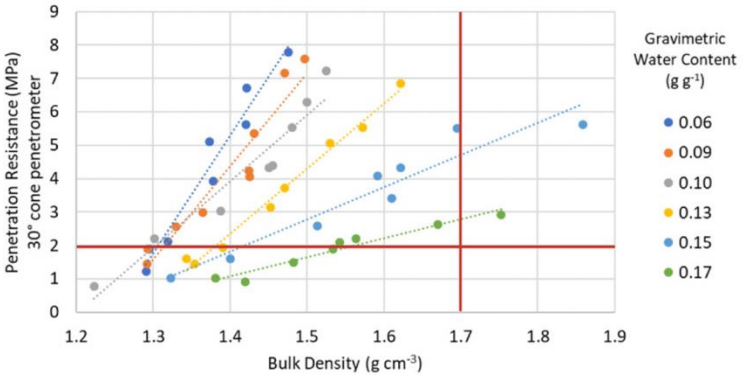
Soil Health Guide-
North Central CMA

Compaction (reduced/no pore space)

Intensive grazing, slow rotation, irrigation, high traffic, soil types





Microbial biomass starts to decline from BD 1.2 g cm^{-3}; after 1.7 g cm^{-3}, 50% reduction in biomass

Beylich & Schrader. Soil & Tillage Research 109 (2010) 133–143

Penetrometer resistance increases as BD increases

But this depends on soil water

Lardy et al 2022 https://doi.org/10.1002/ael2.20096

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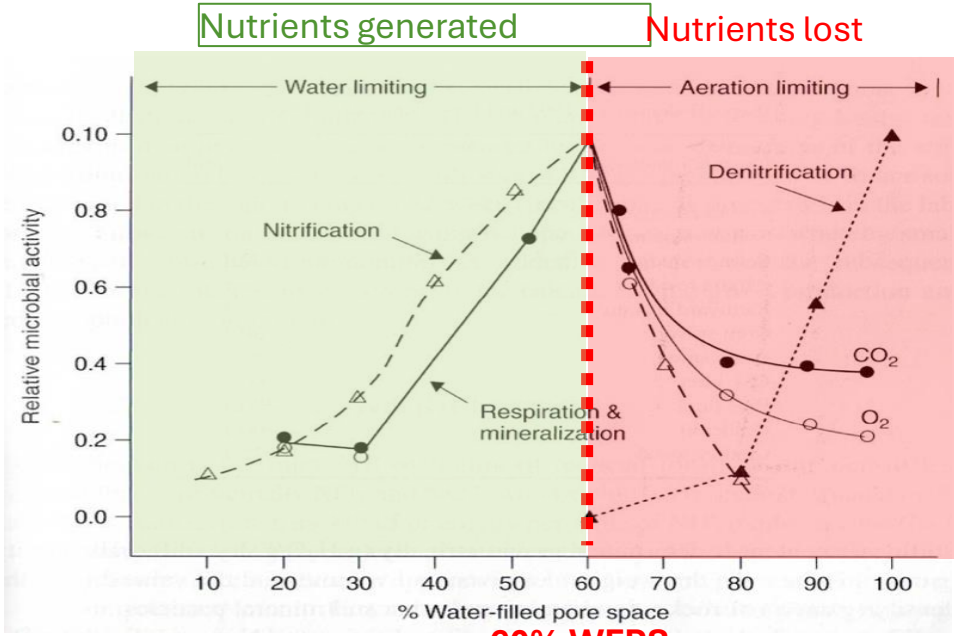
Waterlogging (water-filled pore space)

Intensive grazing, slow rotation, irrigation, high traffic, soil types



60% WFPS

Is the sweet spot!

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Urea, super & alternatives

Urea & N Fixation

N addition inhibits terrestrial N fixation overall

Zheng et al (2023) Sci Tot Env, https://doi.org/10.1016/j.scitotenv.2023.162965.

148 kg urea N ha^{-1} prevents nodulation in soybean*

Mathenge et al (2019) Soil Till Res, https://doi.org/10.1016/j.still.2019.06.007.

Urea inhibits free living N fixation

Smercina et al (2019). Appl Environ Microbiol https://doi .org/10.1128/AEM.02546-18

Urea, Super & VAM

Relative abundance of Glomerales (VAM)

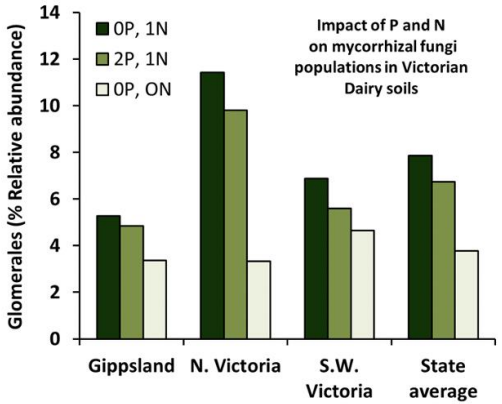

Figure 11 The relative abundance of Glomerales on each dairy farm as influenced by fertiliser treatments.

Alternatives

Slow-release alternatives; compost, effluent, some vermicast, some biologicals **

On the horizon:

- N-fixing bacteria in the presence of N-fertiliser by genetic manipulation of N fixation machinery ***
- Plant signalling remodelled to attract specific beneficial soil microbes Haskett et al (2022) *Proc. Natl. Acad. Sci. U.S.A.*, https://doi.org/10.1073/pnas.2117465119

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Seed coats

Products

> 14 products® on the market covering grasses, legumes, herbs & brassicas containing chemical coatings

Coatings

Fungicide

Insecticide

Nematicides

(Formicides

Nutrients: NPK

Lime

Biology:

VAM & many others

Potential impacts

- Decline in rhizosphere biodiversity
- Disruption of plant signalling/recruitment of microbes in the rhizosphere especially in stress conditions

Lei et al (2025) Sci of The Tot Env, https://doi.org/10.1016/j.scitotenv.2025.178413.

- Disruption
- Disruption of N fixation (free living & symbiotic)
- Disruption of VAM colonization on host roots

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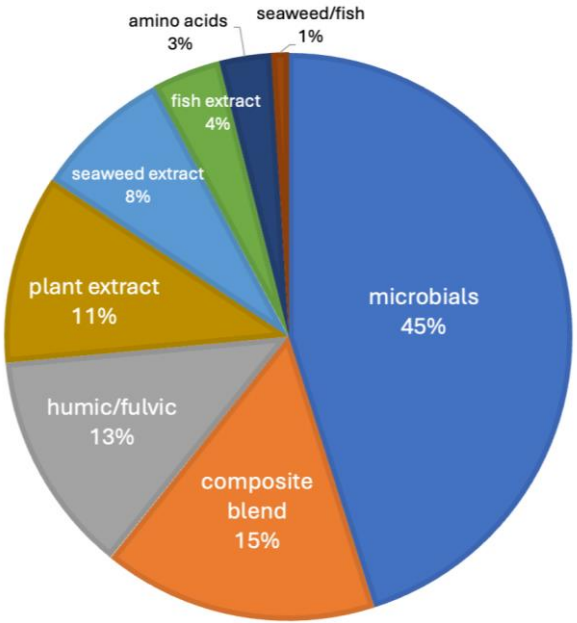
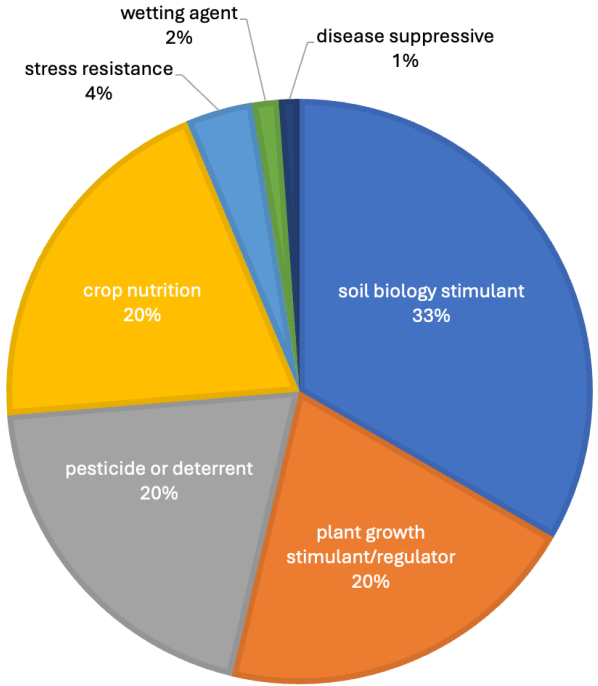
Biologicals

> 270 (2023)



Biologicals



Product types /use

Common actives

bacteria:

Streptomyces spp

Bacillus spp; *B thuringiensis* (insecticide

Pseudomonas spp

Rhizobia spp

Azotobacter spp

Acetobacter spp

fungi:

Rhizophagus spp (Glomus spp)

Trichoderma spp

Ascophylum spp

Aureobasidium spp

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https://soilwealth.com.au/wp-content/uploads/2023/07/Tradename202304final.pdf

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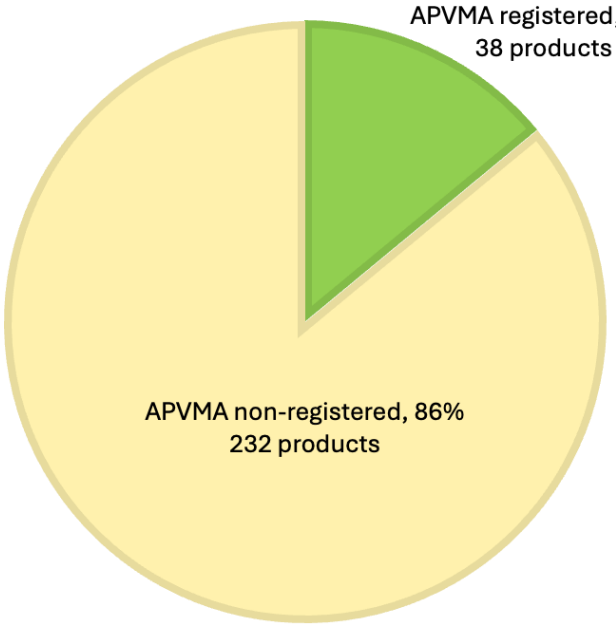
APVMA registered biological products



32 microbials
6 plant extract

24 insecticides
8 fungicides (2 pending)

All registered microbials are pesticides

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https://soilwealth.com.au/wp-content/uploads/2023/07/Tradename202304final.pdf

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Wouldn’t it be great if….

01

The pasture could feed itself

Either through stronger root-microbe cooperation Or supplementation at the right time

02

We could use Artificial Intelligence (AI) to measure & predict the needs of my pasture soil

•Integration of data over minimization

•AI has been used already to determine soil health

03

We could regulate the biological product market

Shift the ‘buyer beware’ onus off the farmer!

Create a better product by ensuring field isolation & testing

04

We could link milk & meat quality & animal health to soil biodiversity

…at a stretch, in the field measure!

How can milk & meat quality be linked*to soil parameters?

*through RDE

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Thankyou

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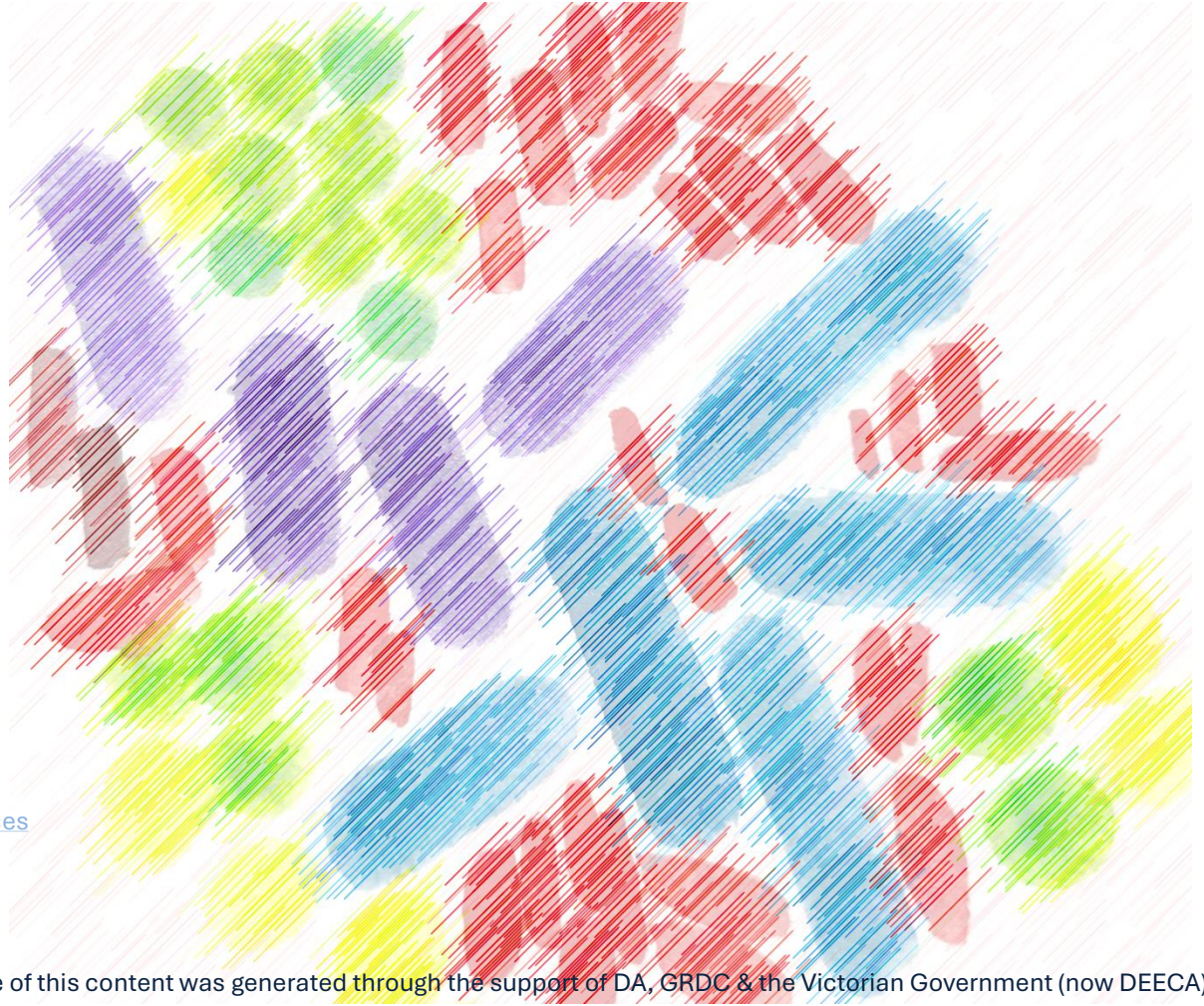

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