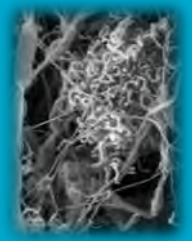
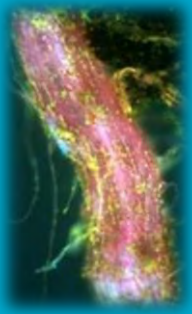
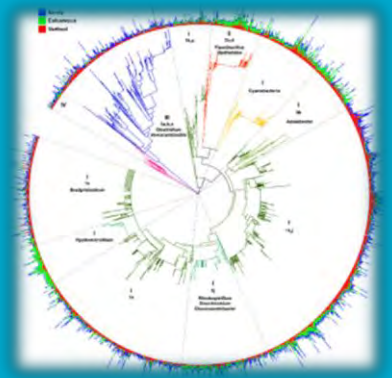
Special thanks to Mark Farrell
for presenting the talk







Microbial management and regenerative agriculture in soil

Gupta V.V.S.R.
Alison Frischke, Eliza Rieger, Jamie Wilson

Bhanu Nidumolu

CSIRO AGRICULTURE & FOOD
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Future Drought Fund
Government of South Australia
Murraylands and Riverland Landscape Board
LANDSCAPE SOUTH AUSTRALIA MURRAYLANDS AND RIVERLAND
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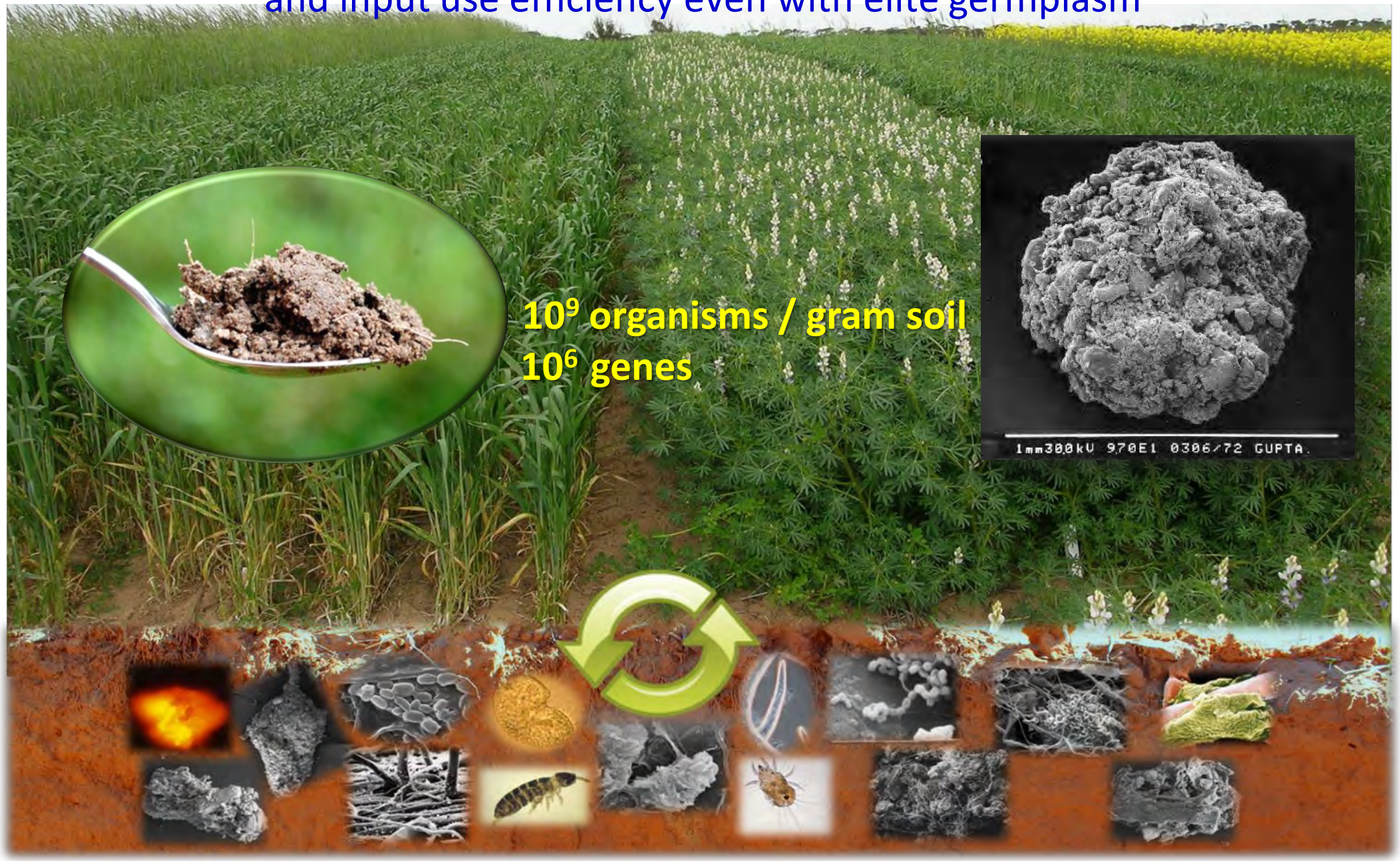
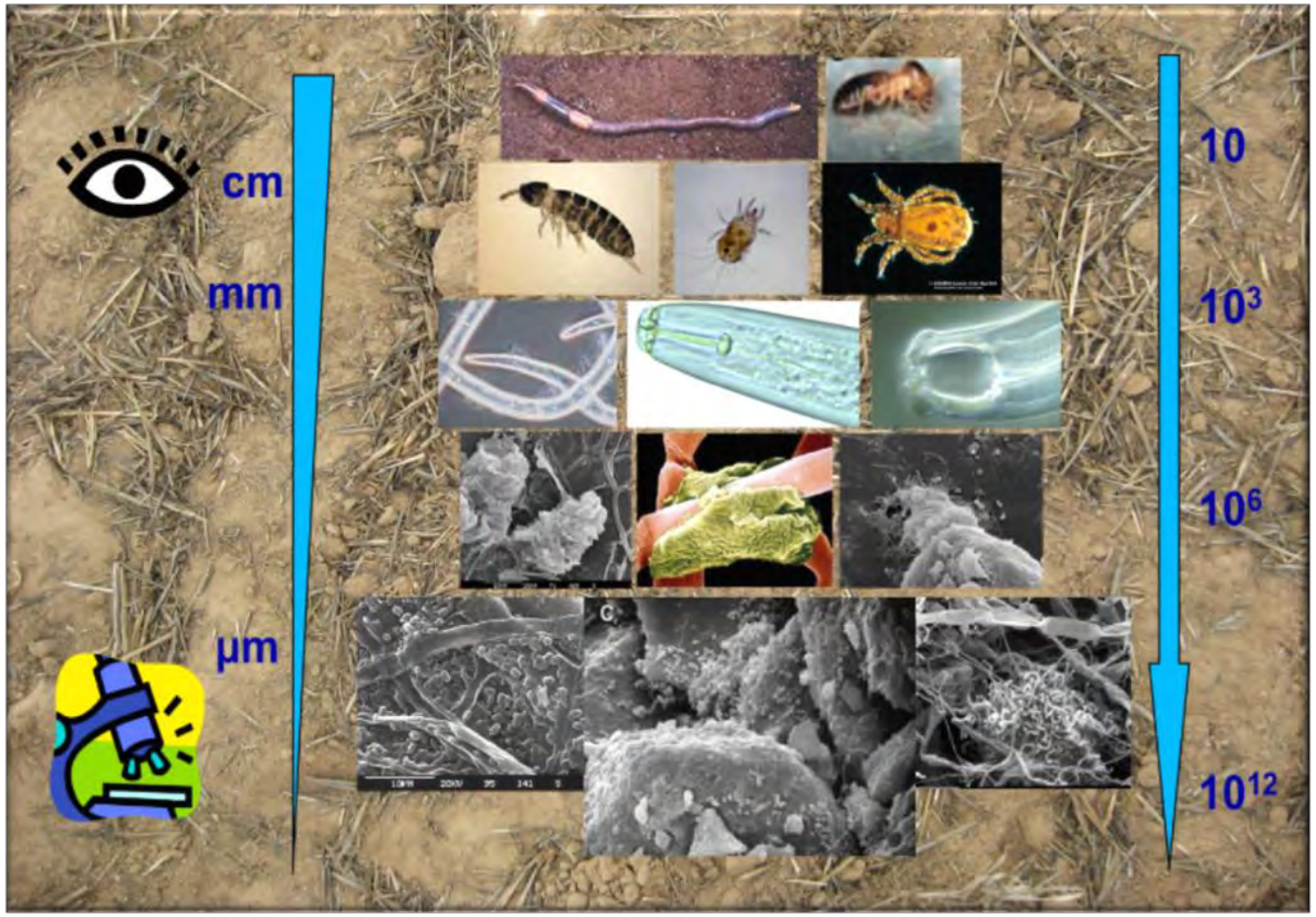
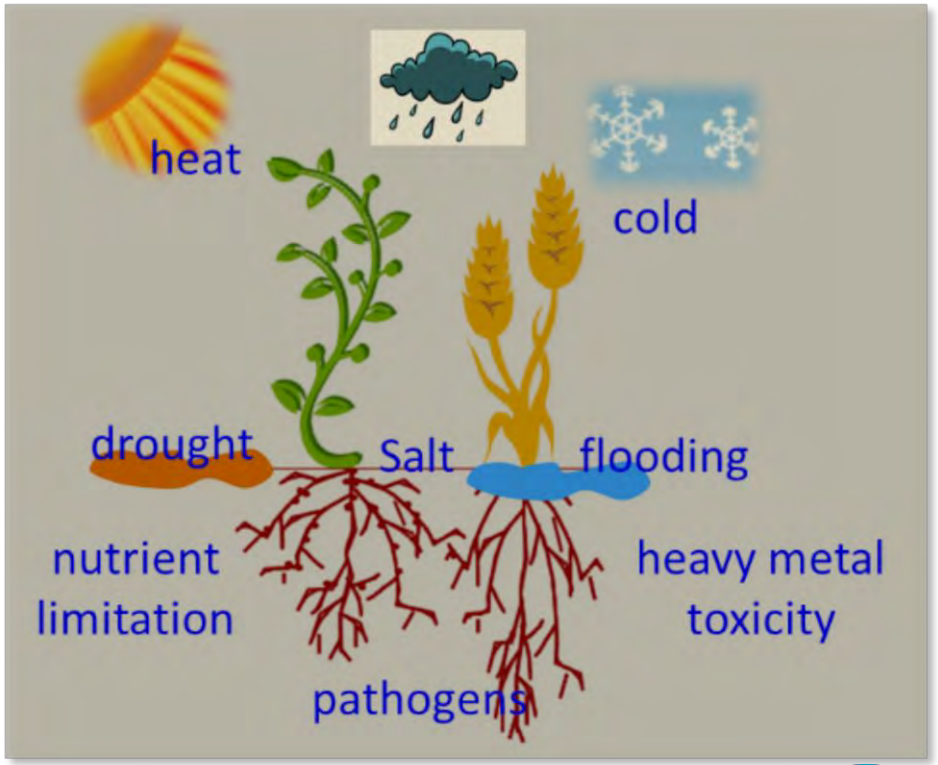
Soil biology plays a critical role in plant growth, health, nutrition and input use efficiency even with elite germplasm



Biota in Soil are Diverse

- Biota in soil are diverse in terms of size and abundance.
- Microorganisms are a key members of soil biota food-web, especially in the low rainfall regions of southern Australia
- Microorganisms in Soil are Diverse, Multifunctional & Resilient



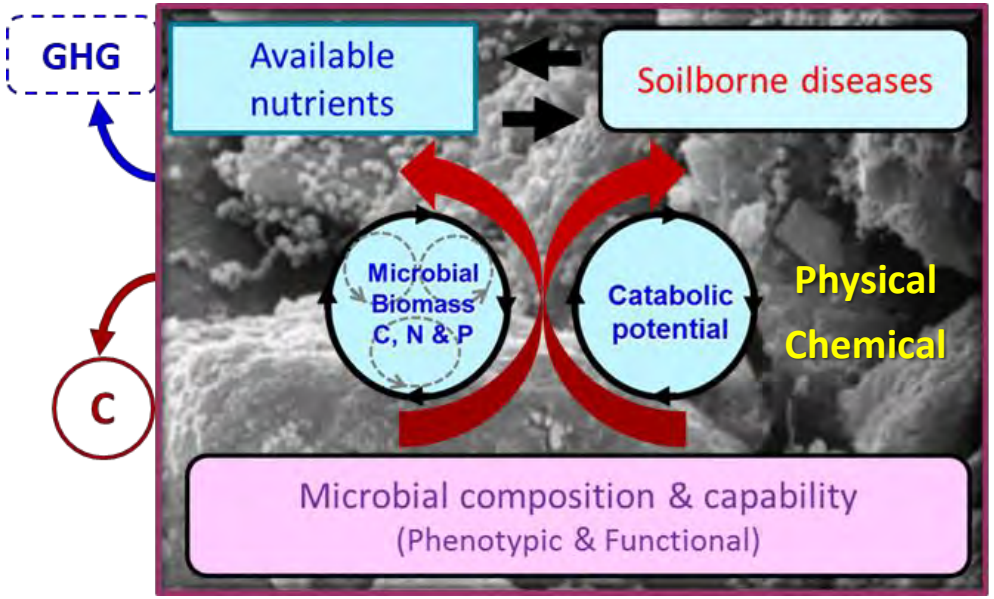


Gupta et al. 2019

Regenerative Agriculture Project: Soil biological fertility as one of the key drivers of soil health

- **Soil health** - the continued capacity of soil to function as a living system, within ecosystem and land-use boundaries, to sustain biological productivity, promote environmental quality and maintain plant, animal and human health

Functional Microbial ecology approach



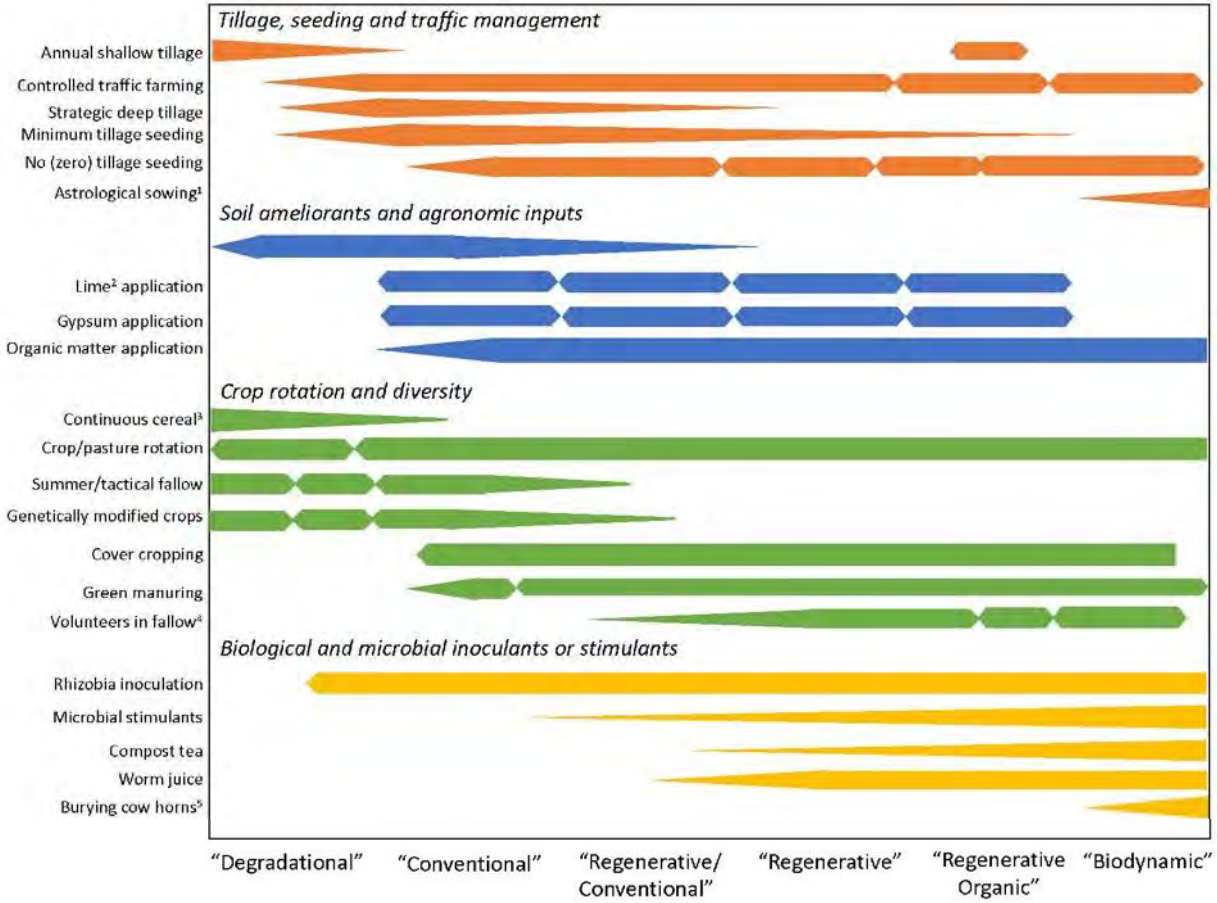
Soil health indicator tests

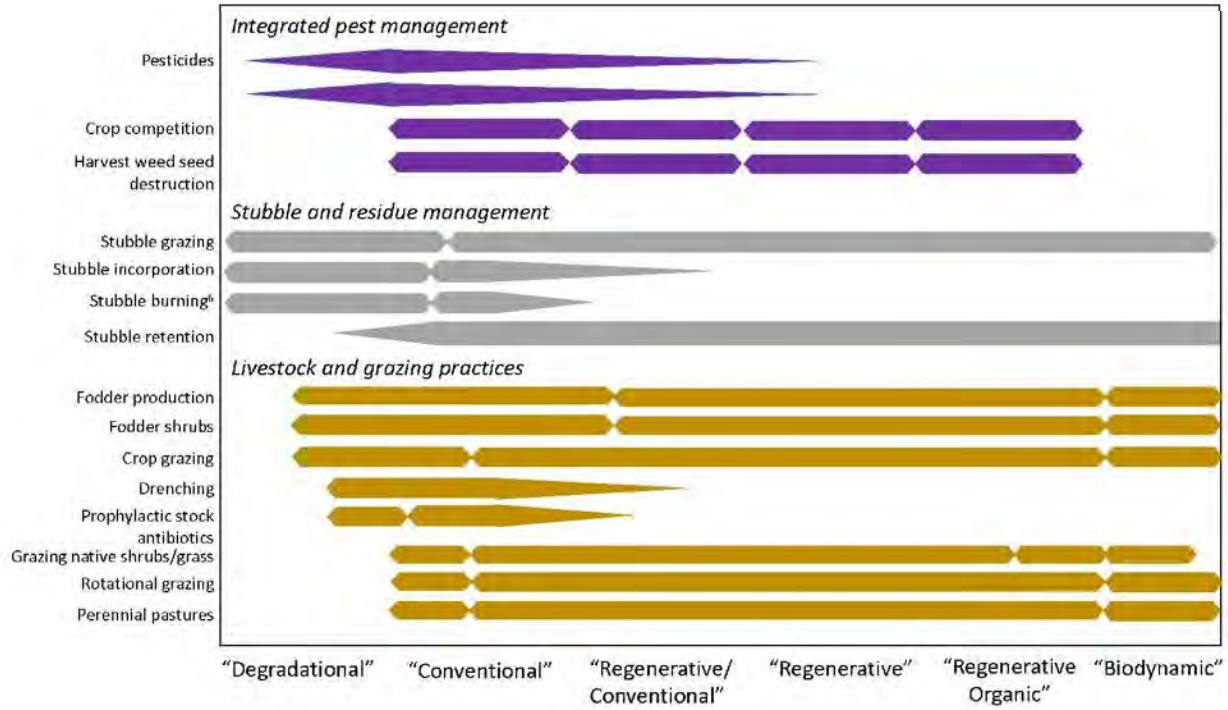
Chemical	Total organic C Active and particulate organic C Mineral N and Total N pH
Biological	Microbial biomass C and N Microbial quotient Microbial activity Microbial catabolic diversity Enzyme activities – C & nutrient cycling N mineralization potential Populations of bacteria, fungi Populations nutrient cycling microbes
Physical	Soil biological resilience Soil texture

- Soil biological functions are a product of the microbial diversity, population level and activity of organisms involved in specific biological processes.
- Key factors – availability of C (OM inputs and SOC), moisture, temperature, pH, physical structure, chemical constraints

RegenAg practices: Interpretation of Management categories

Dempster et al. (2021)





RegenAg practices: Management categories relevant for low-rainfall regions

Tillage
0 = zero till (no workings other than sowing with points or disc)
1 = 1 working and sow with points or disc, or just sow with shares
2 = old school (2 or more workings)

Cover crops / extensive green ground cover
0 = Permanent pasture >5 months of green cover, cover crops (not cut for hay)
1 = Managed pasture or self sown but with good coverage for 3 - 5 months of green cover
2 = self sown, no management; poor cover or sparse plant density
3 = long bare fallow (>8 months)

Pesticides
0 = no herbicides or other pesticides including fungicides and insecticides
1 = occasional use of herbicides, strategic use of <2 sprays or chemicals per annum
2 = multiple chemistry and applications

Biomass/stubble management
0 = All the residues retained on surface and not grazed
1 = residue retained but grazed
2 = residue retained but worked in
3 = residue removed (burnt, baled), windrow burning

Plant/Crop diversity
0 = Rotational crops including mixed pastures/cover crops
1 = Continuous cropping with rotational crops
2 = Single species - self sown pasture
3 = single species cropping

Fertiliser & manures (name and rate, kg/ha)
0 = no synthetic chemical fertilizers but organic manures or gypsum or lime added
1 = low levels of chemical fertilizers (<20 kg MAP/ha/y
2 = high inputs (starter fertilizer and in-crop applicatio

Grazing - green winter pasture phase
0 = strategic grazing (cell grazing)
1 = rotational grazing
2 = set stocking
3 = no grazing

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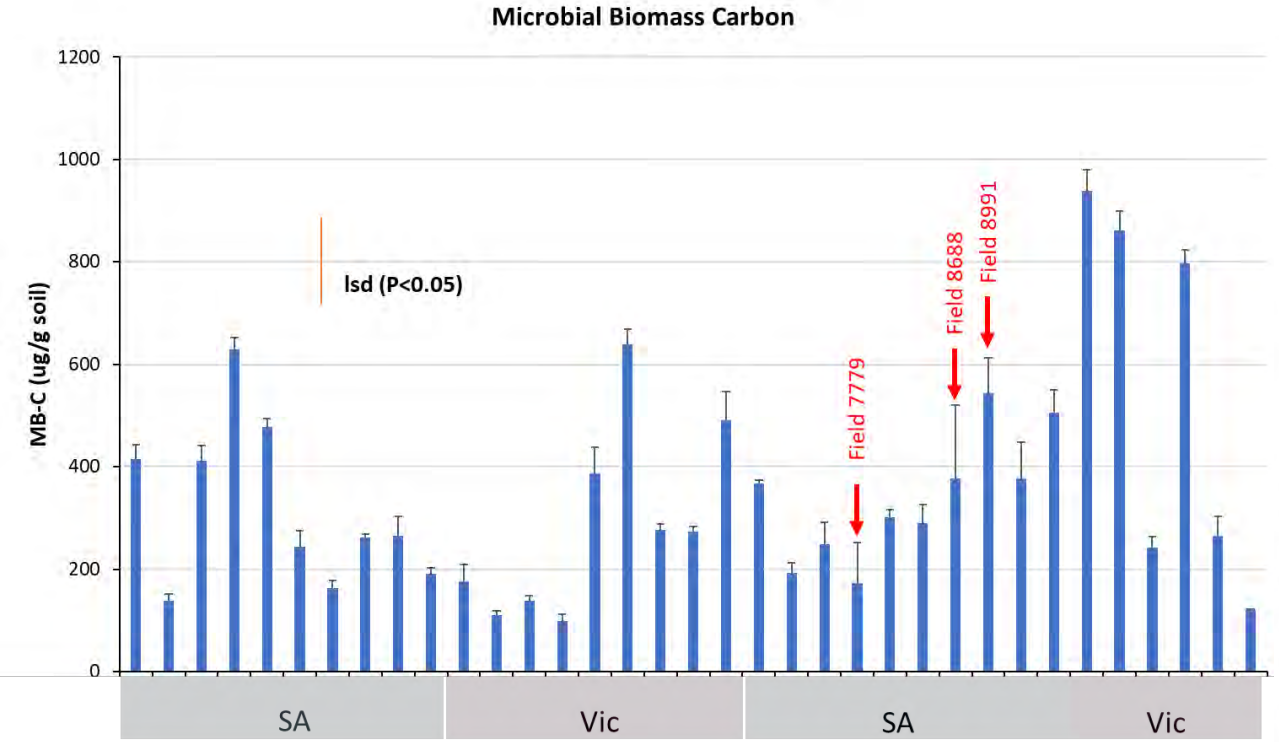
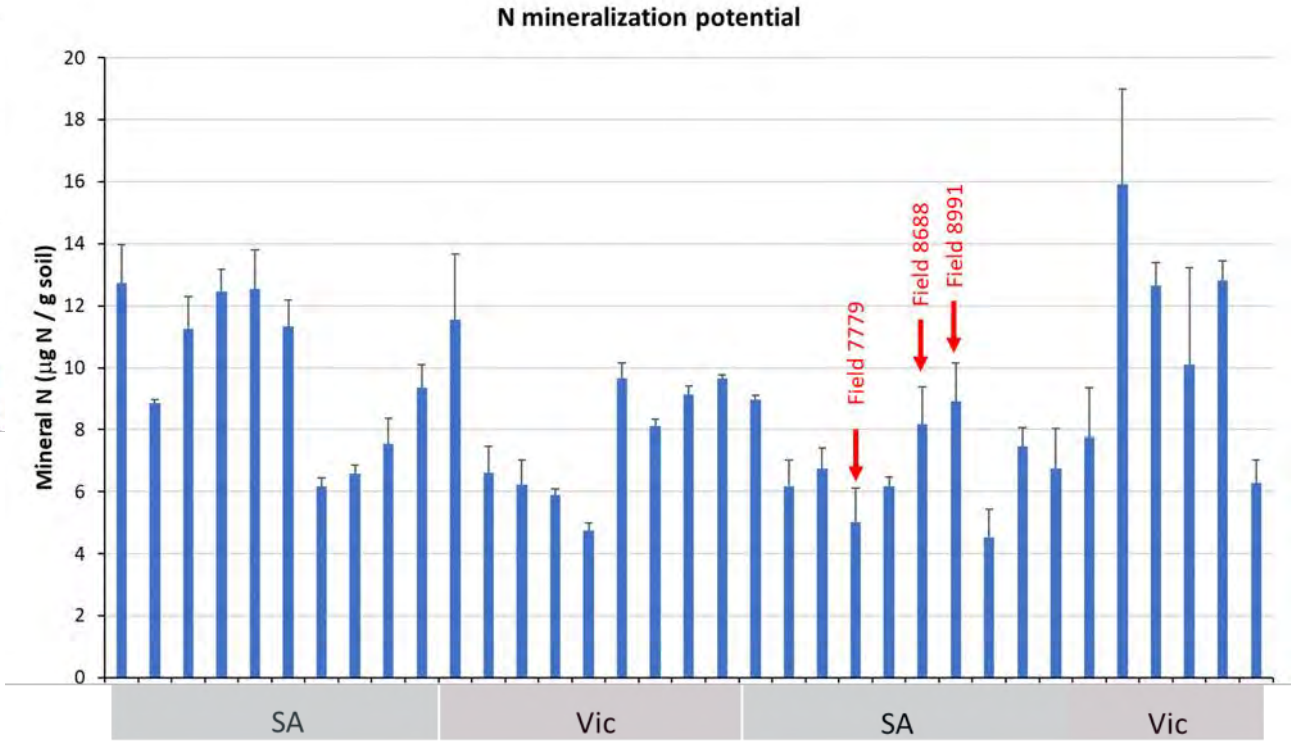
Management practices: potential / known effects on biota and biological processes

Tillage	Tillage causes significant changes in microbial community composition Alters N mineralization-immobilization processes
Stubble management	A critical source of C for soil microbes; microbial biomass and biological processes significant changes in microbial community composition; beneficial and deleterious
Grazing	Removal of C inputs can affect microbial biomass and biological processes Effects on microbial community composition is not known
Extensive ground cover (e.g. Cover crops, fallows)	Source of C for soil microbes; microbial biomass and biological processes Significant changes in microbial community composition; beneficial and deleterious
Crop diversity	Plant type based in microbial community composition; beneficial and deleterious Quantity and quality of C inputs affecting biological processes
Pesticides	Effects depend upon the chemistry, frequency of application, mixtures
Fertilizers	Essential for crop growth and C inputs Some effects on microbial community composition but at very high rates

Regenerative Agriculture Project: Soil biological fertility as one of the key drivers of soil health





Regenerative Agriculture Project: Soil biological fertility as one of the key drivers of soil health

Fields	Microbial biomass C	C mineralization potential	N mineralization potential	Catabolic properties		Active Microbes	Enzyme activitties						Active C
				Potential	Diversity		C cycling			N mineralization	P release	S mineralization	
Field - 7779													
Field - 8688													
Field - 8991													

Field – 7779: No-till, rotational grazing, retained but grazed, pasture-crop, hay crops, fertilizers, multiple chemistry pesticides as required

Field – 8688: No-till, rotational grazing, retained but grazed, pasture-crop, fertilizers, multiple chemistry pesticides as required

Field – 8991: No-till, no grazing, full stubble retention, Continuous cropping-crop rotation, fertilizers, multiple chemistry pesticides as required

- Currently analysing for biological resilience in terms of functional groups and functions
- Similar analysis using soils from non-crop period (summer) sampling

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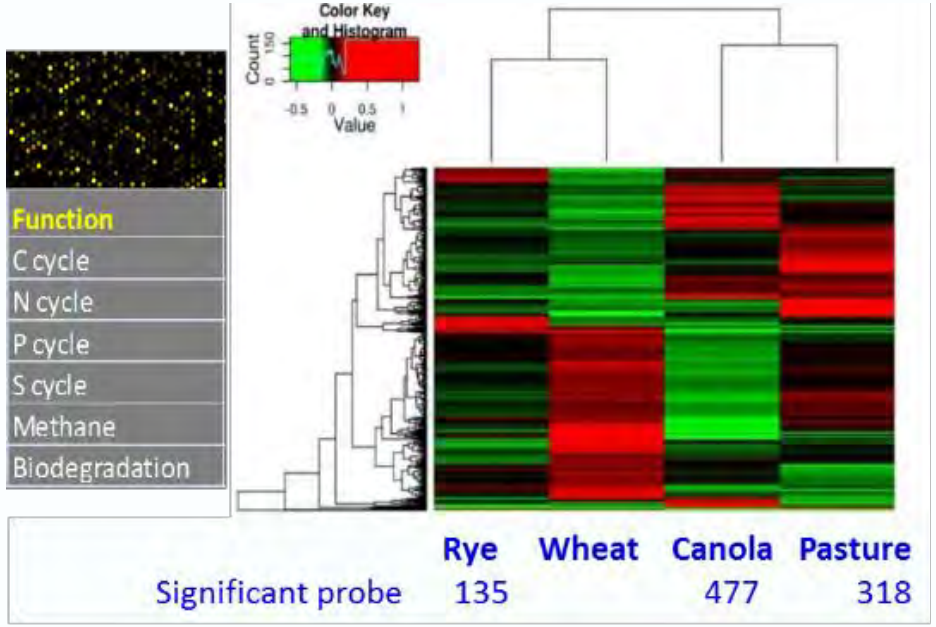
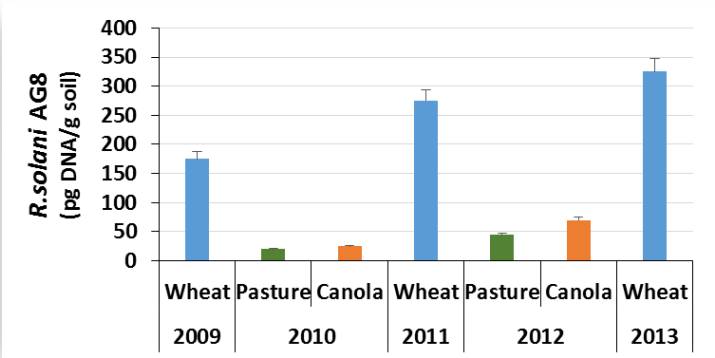
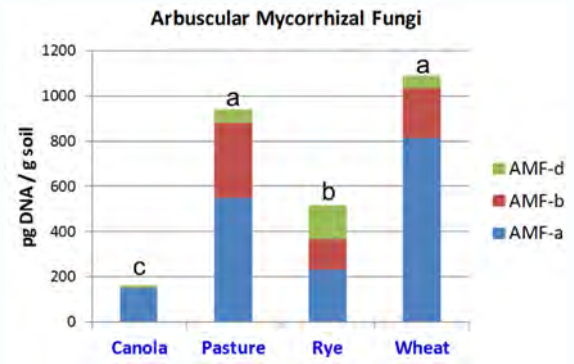
Crop rotation effects on composition and abundance of microbial communities

- Host specificity
- Crop residue – quality & quantity
- Management – inputs & disturbance

Soil type and environment modulate the magnitude of effect







Gupta et al. 2011 & 2012

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