Getting Down and Dirty

Regenerative "Post-modern agriculture is not anti-science...it is the most modern agriculture because it builds carefully and creatively on advances in scientific knowledge particularly in the disciplines of biology, ecology and microbiology." Prof. Norman Uphoff

(Professor of Government and International Agriculture; Cornell International Institute for Food)

What is Regenerative Agriculture??

Literature defines Regenerative Ag as:

Any system of food (or fibre) production with these *objectives:*

1. The incorporation of natural processes into ag production, ensuring *profitable*, *efficient* & *quality* food production

2. Reduce need for inputs

A reduction in external, harmful and non-renewable inputs with the more targeted use of the remaining inputs *with the aim of reducing costs*

3. Producers are the experts

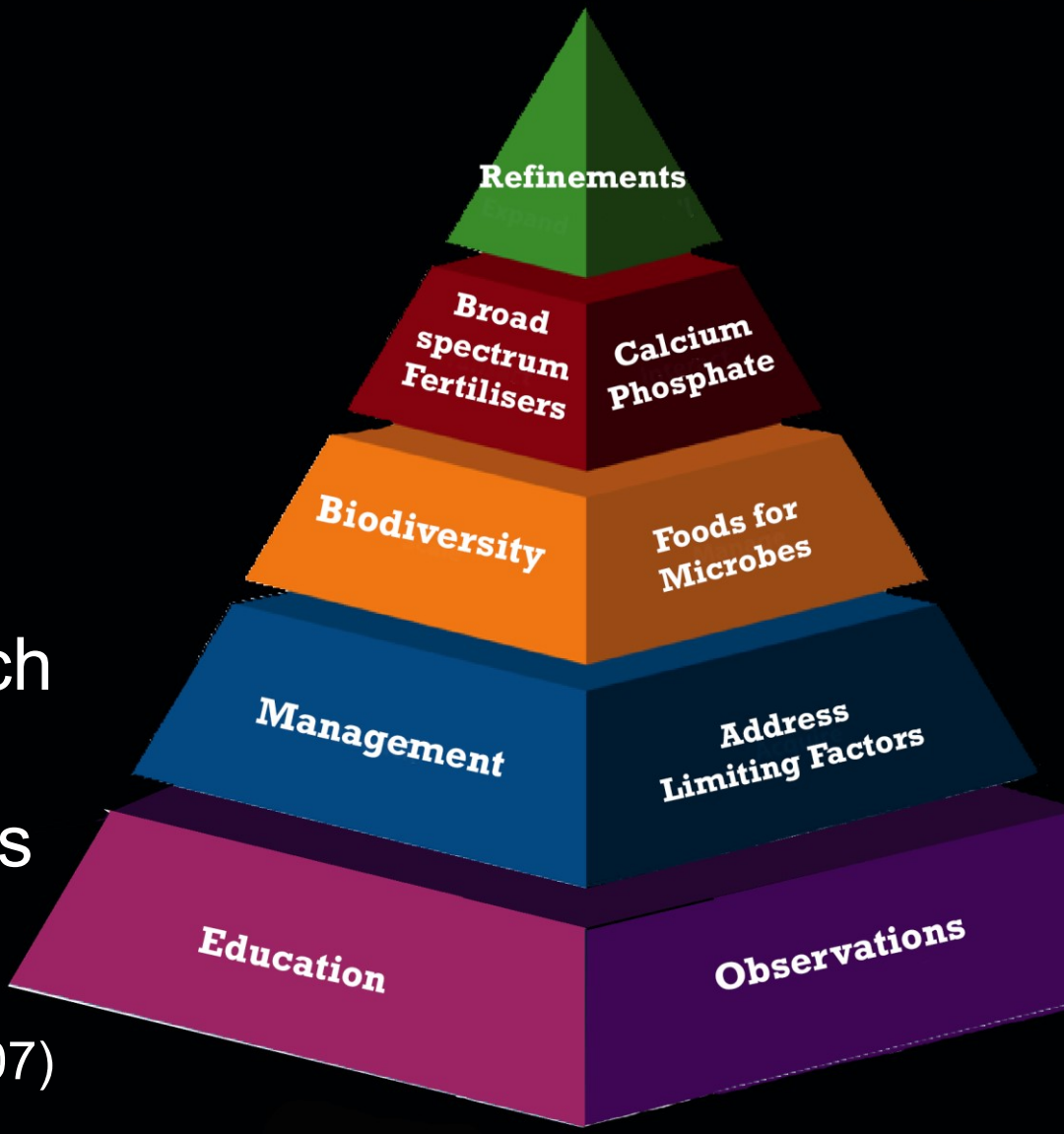
The full participation of farmers and rural people in all aspects of the problem analysis, tech development, adaptation and extension

Regenerative farming systems involve a complex learning system:

Not an ‘add on’ but a whole systems approach

Applied in local contexts

(Roling, 2007)



Mindset

Principles

1. Optimise plant brix (photosynthesis)

2. Ensure year round cover/armour

3. Reduce disturbance

4. Lift biodiversity & biomass

5. Address limiting factors (air, water, breakdown, nutrients)

6. Integrate animals

Outcomes

INCREASING BIODIVERSITY

WATER QUALITY

SOIL HEALTH MEASURES

GHG REDUCTIONS

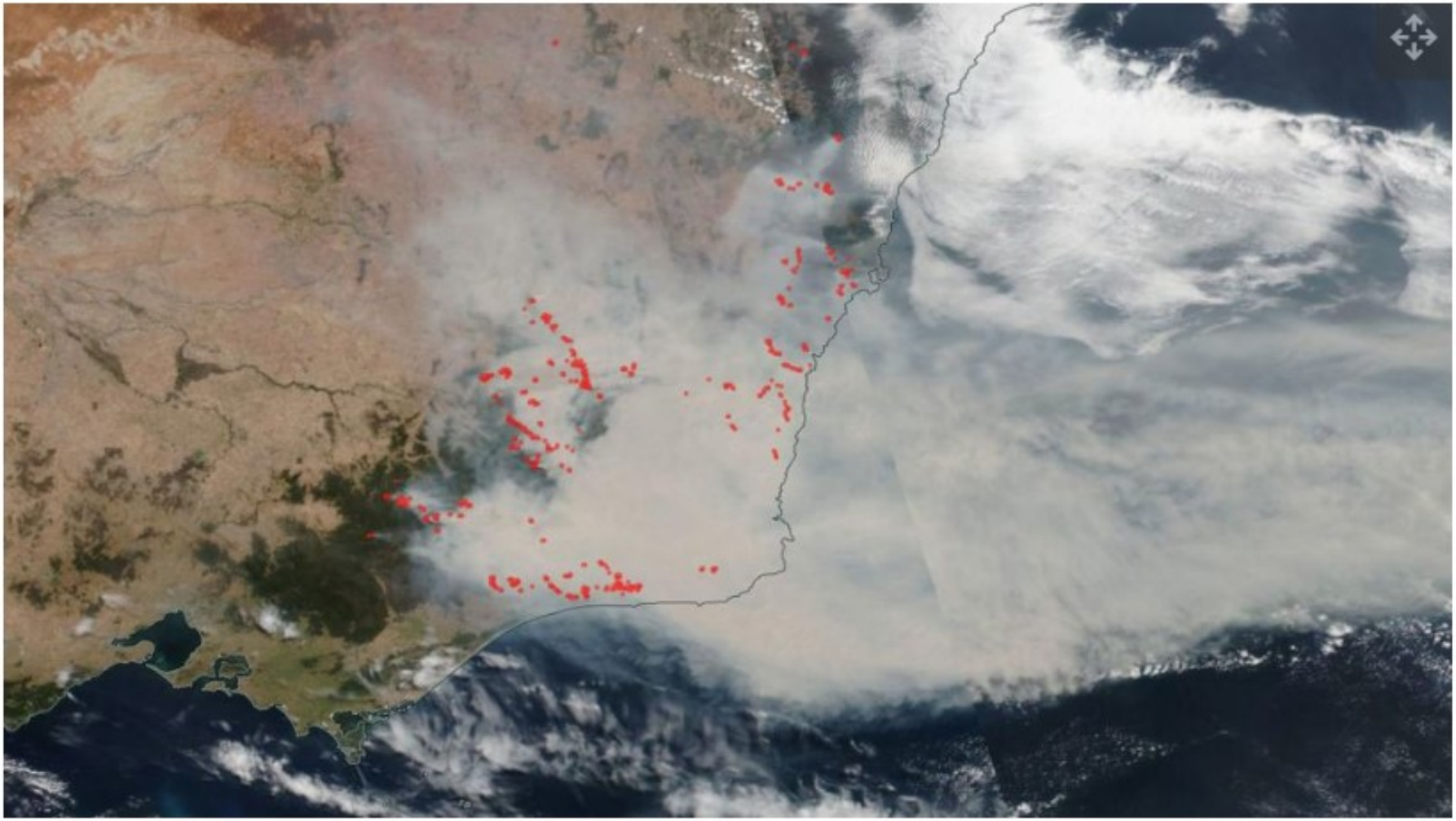
FOOD QUALITY

PROFIT/ WELLNESS

“Regenerative Agriculture is the way of the future; indeed without it there is no future for Western Australia”

Alannah Mactiernan,

WA Minister for Ag and Food



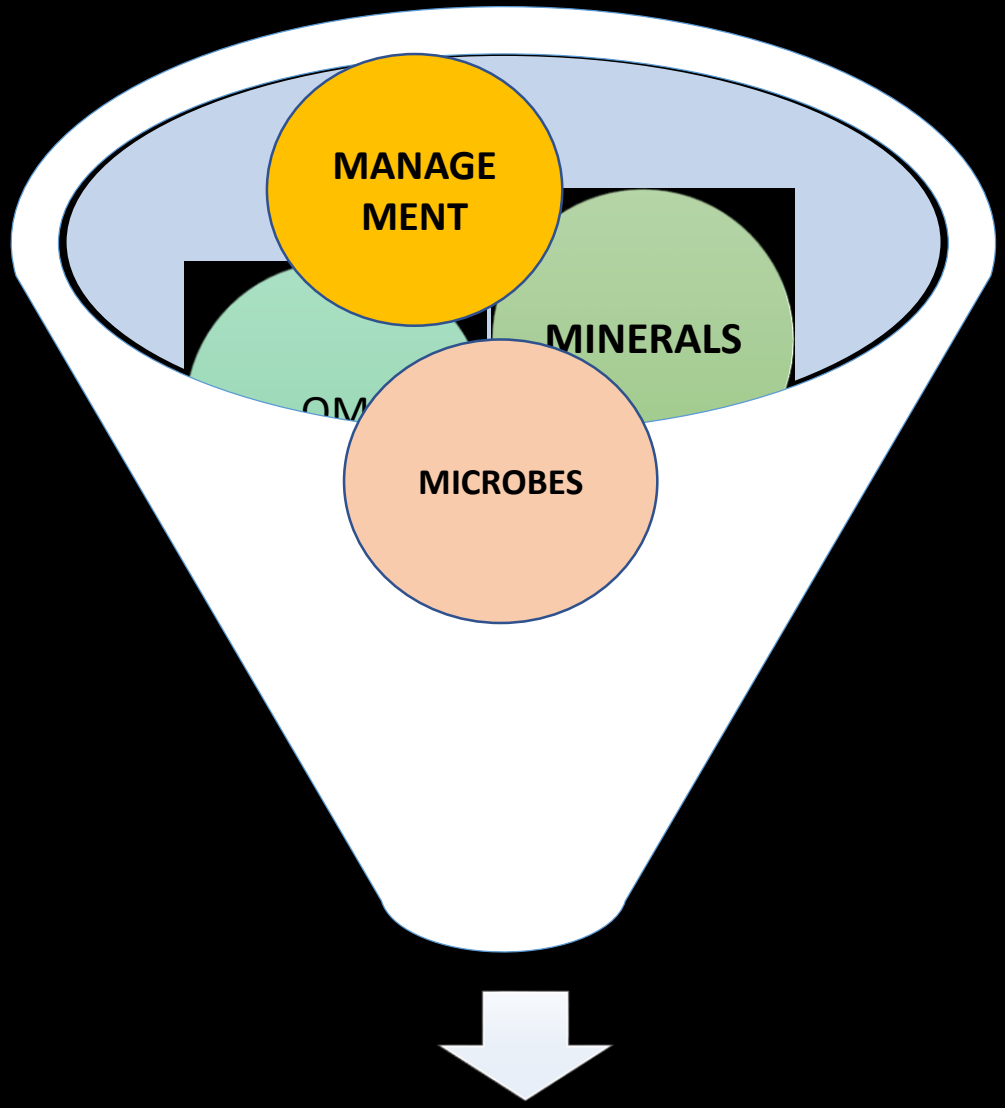
(Image credit: NASA EOSDIS)

Martin Royds, Jillamatong, Braidwood, in front of one of his weirs, with the hills that were burnt out by the recent bushfires in the background. Helicopters fighting the fires, filled up from the weirs every 40 seconds.

Cordyceps gunnii

Cordyceps variabilis. Credit Roger Heidt.


Kim Deans



SOIL HEALTH

Quorum Sensing

- Bioluminescence
- Insects; ants and honeybees
- Quorum quenching –switches biology off

- A little goes a long way…parts per trillion

- New discoveries between plants and bacteria
- exudates, aromatics -

hormones, pheromones,

enzymes, vitamins, sugars,

amino acids & proteins…

Quorum sensing

~80% of plant health and nutrition is driven by biological functions

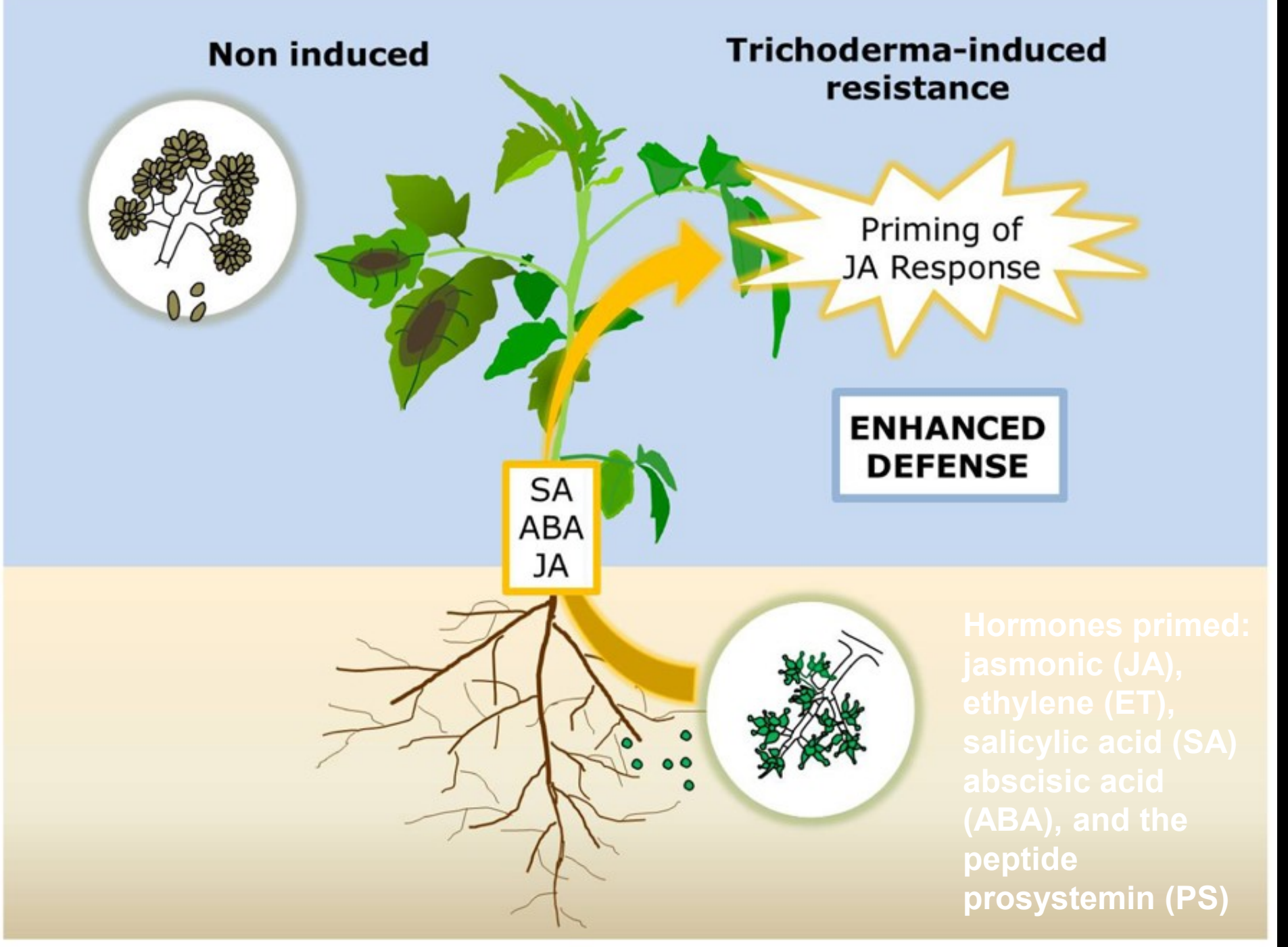
Diverse communities

= more signals

= increased resilience to stress

= crop health and quality

Optimising biological diversity and biomass is CRITICAL


Non induced
Trichoderma-induced resistance
Priming of JA Response
ENHANCED DEFENSE
SA
ABA
JA
Hormones primed: jasmonic (JA), ethylene (ET), salicylic acid (SA) abscisic acid (ABA), and the peptide prosystemin (PS)

Root exudates and the rhizosheath

Mucilage, root exudates, fats, waxes, carbon, sugars, hormones, acids, secondary metabolites…

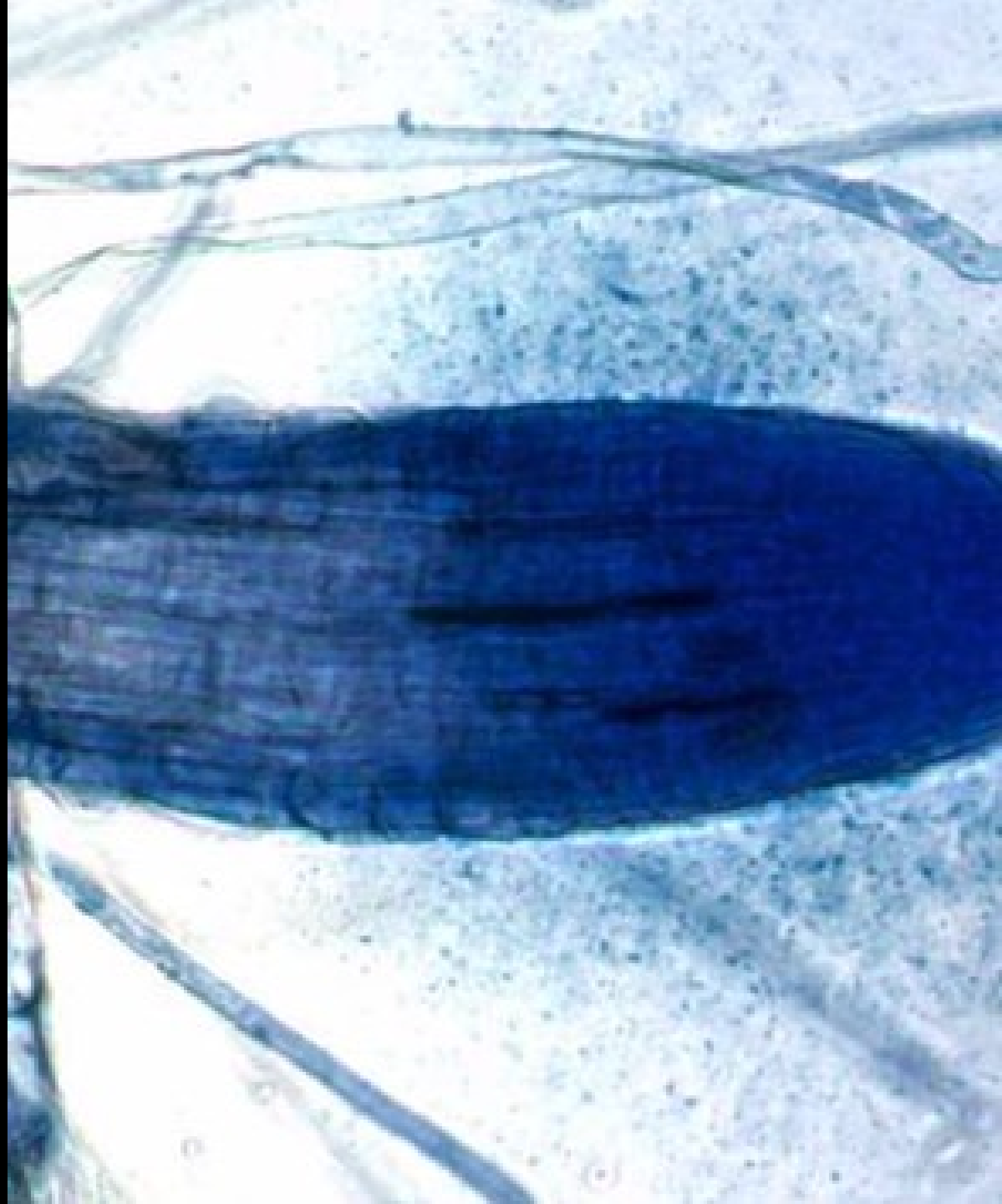
Healthy rhizosphere

- Plant protection
- Nutrient uptake
- Plant growth
- Feeds microbes
- Carbon building
- Resilience
- Buffer – temp, pH

SEED DRESSING - Encourage root development and thick rhizosheath

Rhizophagy

30% of nutrients to a seedling come from the absorption of bacteria.



Bacteria and archaea

- Oldest, simplest, most numerous organisms
- Involved in: disease suppression, nutrient retention, form soil micro-aggregates

Bacteria are essential. However,

- Bacterial dominance can lead to compaction
- High bacteria and low predators tie up nutrients
  - Increases nitrates in plants

- Germination signal for many “weeds”

What (who) makes it rain?

- 40-100% of ice crystals contain bacteria
- Pseudomonas syringae
  - ice nucleating bacteria
  - frost

Reducing the frost factors

- ***Reduce free nitrates***
- ***Higher sugar (brix)***
- ***Biological activity on leaves & in soil***
- ***Pseudomonas fluorescens***

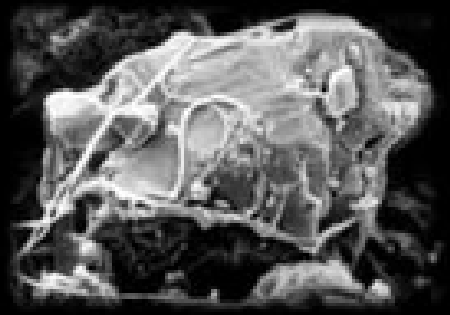
Protect from frost damage as low as 22 °F for up to two months.

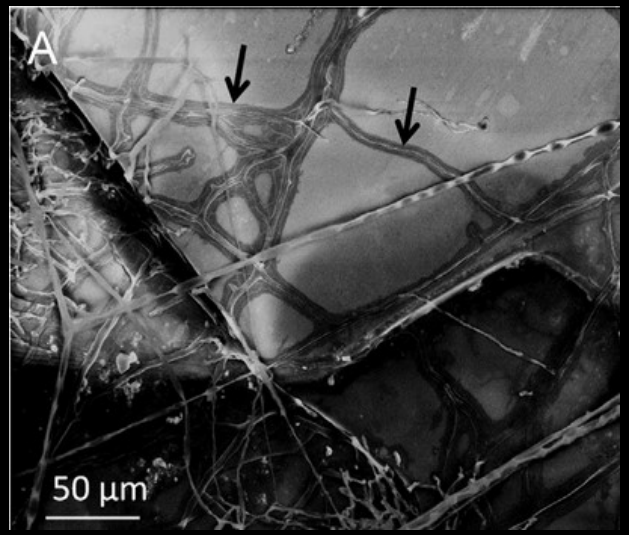
Fungi

- Disease suppression
- Retain nutrients
- Decomposers
- Form soil macroaggregates
- Hold soils together
- Yield

Geomycology

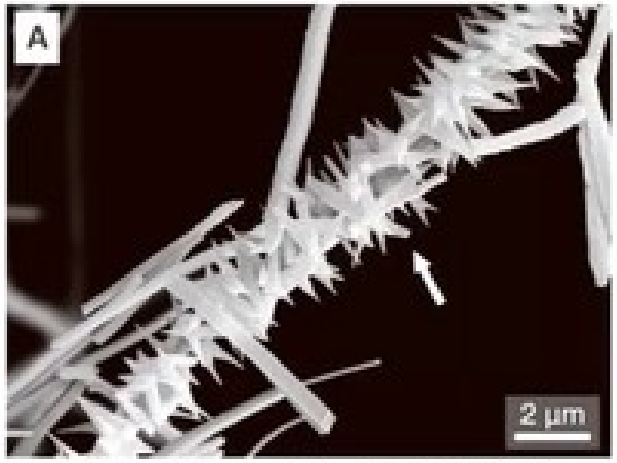
Fungi release nutrients bound on rocks





Pinzari, F et al (2016). Routes of phlogopite weathering by three fungal strains. Fungal Biology. 120.

Fungal Biomineralization



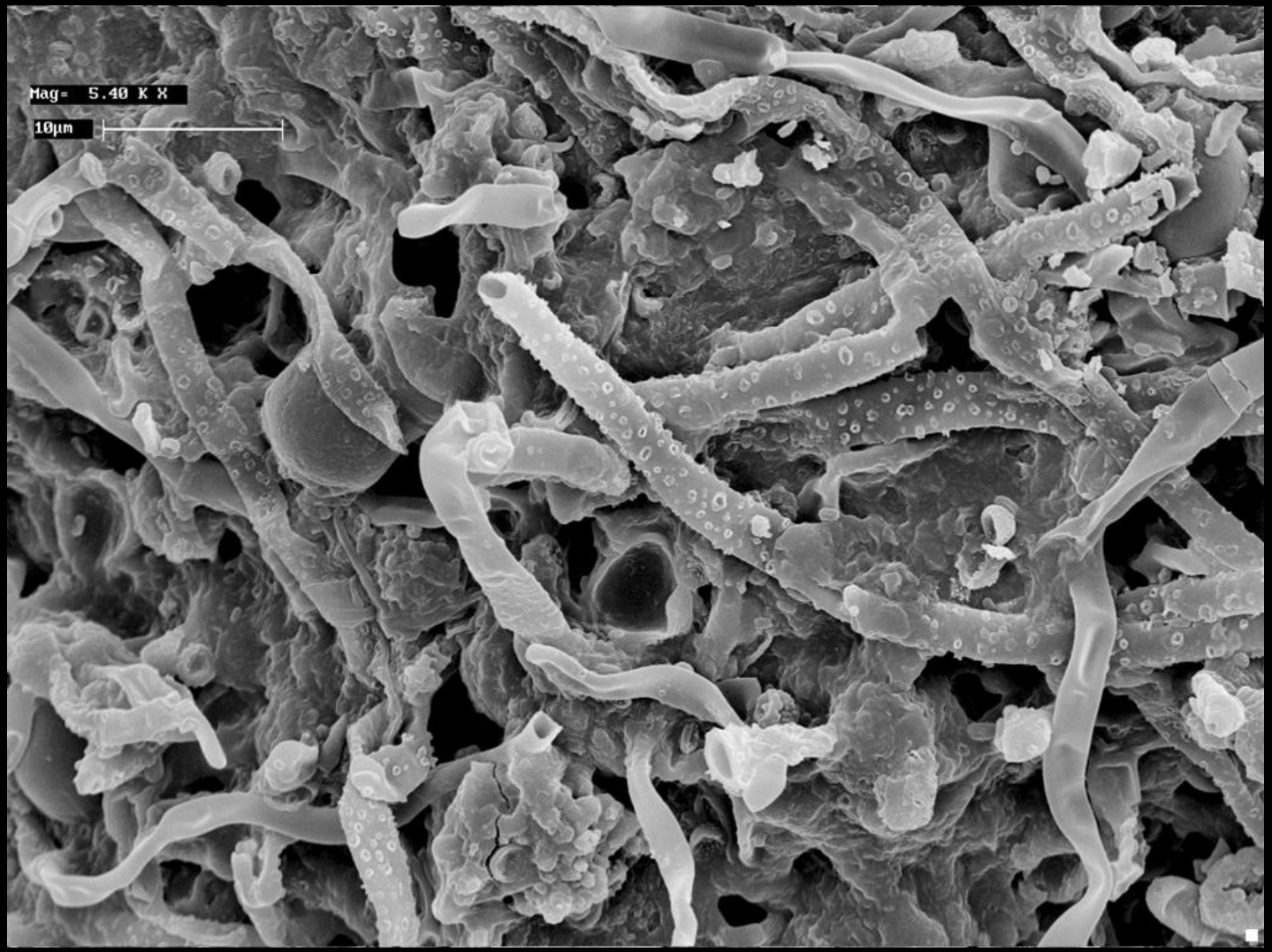
Weddelite (CaC_2O_4-$2H_2O$)

Calcite ($CaCO_3$)

Recombine minerals to create new elements

Carbon sink

Calcium oxalate

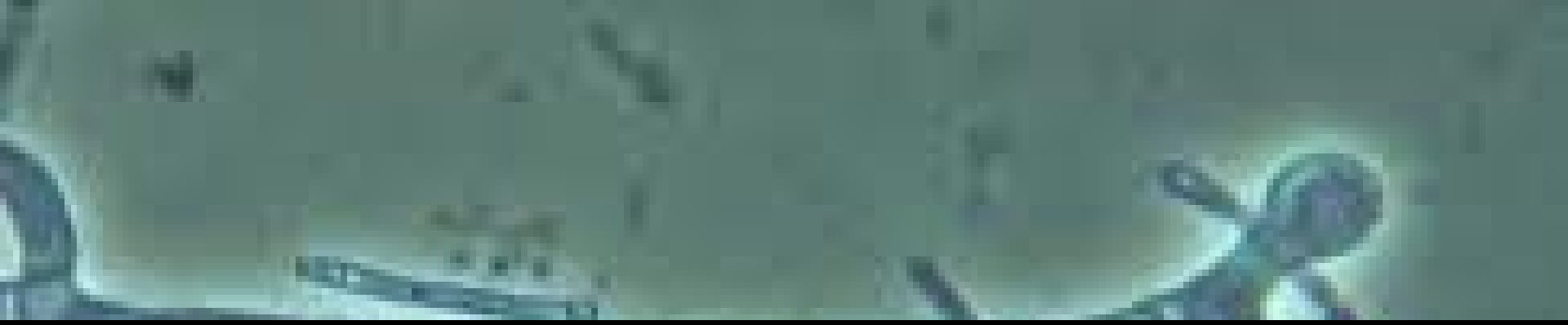


Fungi:Bacteria ratios

- As F:B ratio increase, C accumulation increase
- NMSU showing F:B ratios are more closely related to production than NPK
- Low F:B ratios increases low quality ‘weed’ species

Fungi make water. Literally

- When breaking down organic matter, 20% of what fungi produce is WATER



Fungal Foods

Fungi require more **complex carbons** “brown materials” e.g. ‘brown’ grass, cellulose, lignin, chitin, stubble, straw, fish hydrolysate, humates, biochar, wood chip…

Fungi hold soils together

Case Study

- Peggioh Station, NZ South Island
- 5000 ac mod/steep hill country
- Shorthorn cattle and Wiltshire sheep

Why change?

- High erosion
- Woody weed encroachment
- Poor air and water movement
- Low lamb scanning

2012 application

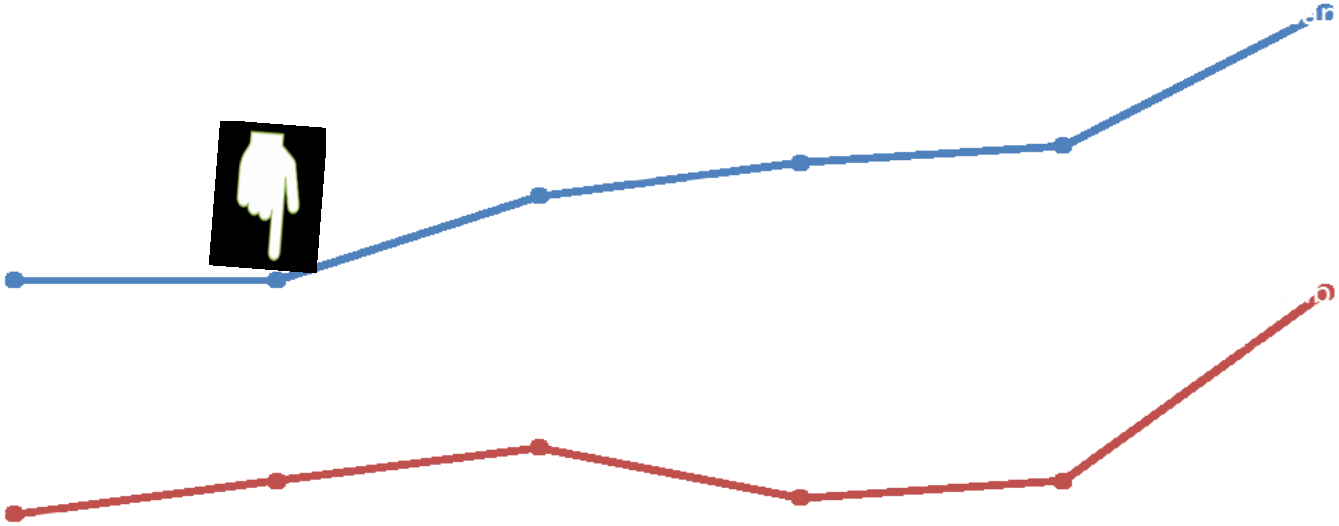
- Aerial / hectare
  - 0.1 gal fish hydrolysate
  - 7.5 gal Seawater
  - 40 # elemental sulphur
  - 1 # Boron

Results 2012-2014

150-300% increase in active and total bacteria, fungi and protozoa

Results

- Photosensitivity in lambs stopped
- Best lambing performance
- Erosion STOPPED



Two neighbouring orchards

Integrated system

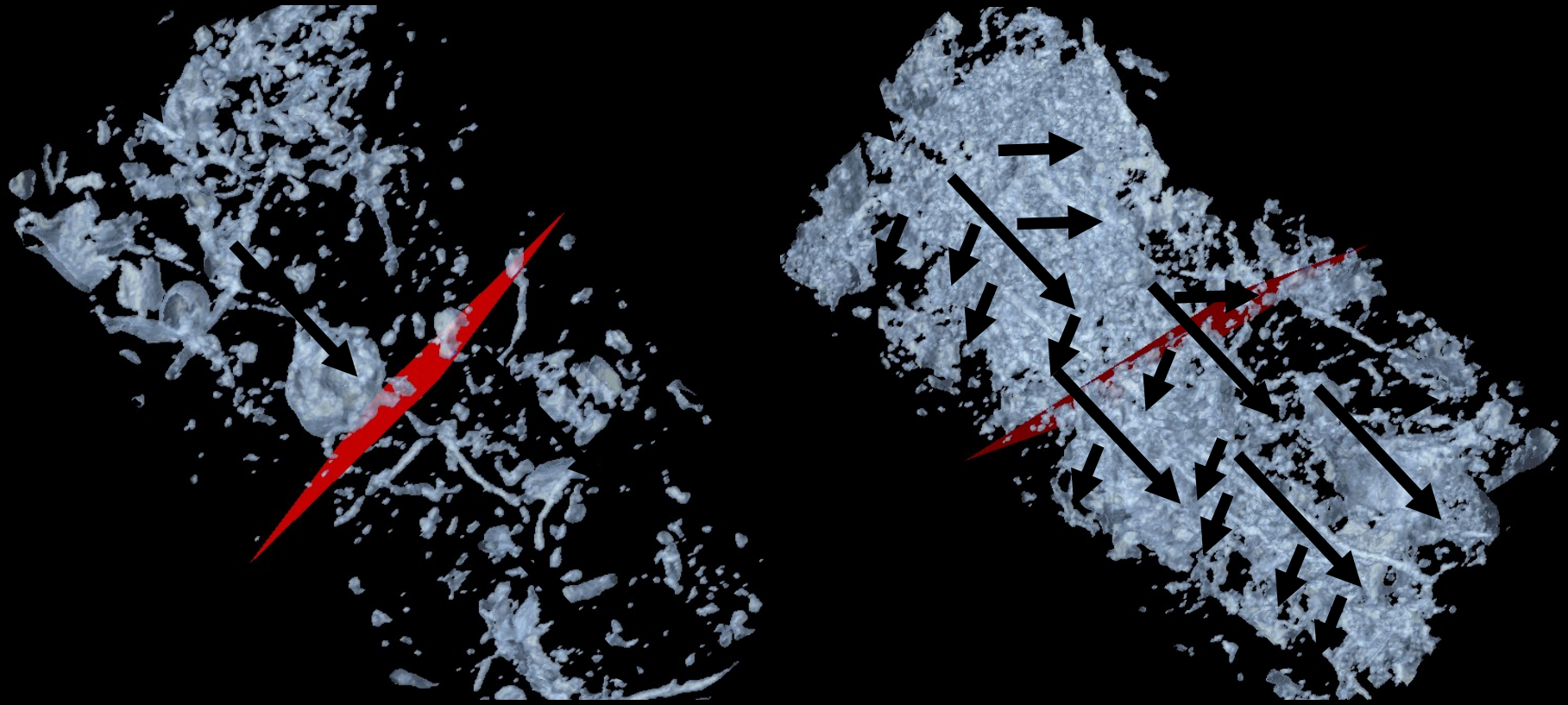
No compost application,
herbicided rows, irrigation

Biological system

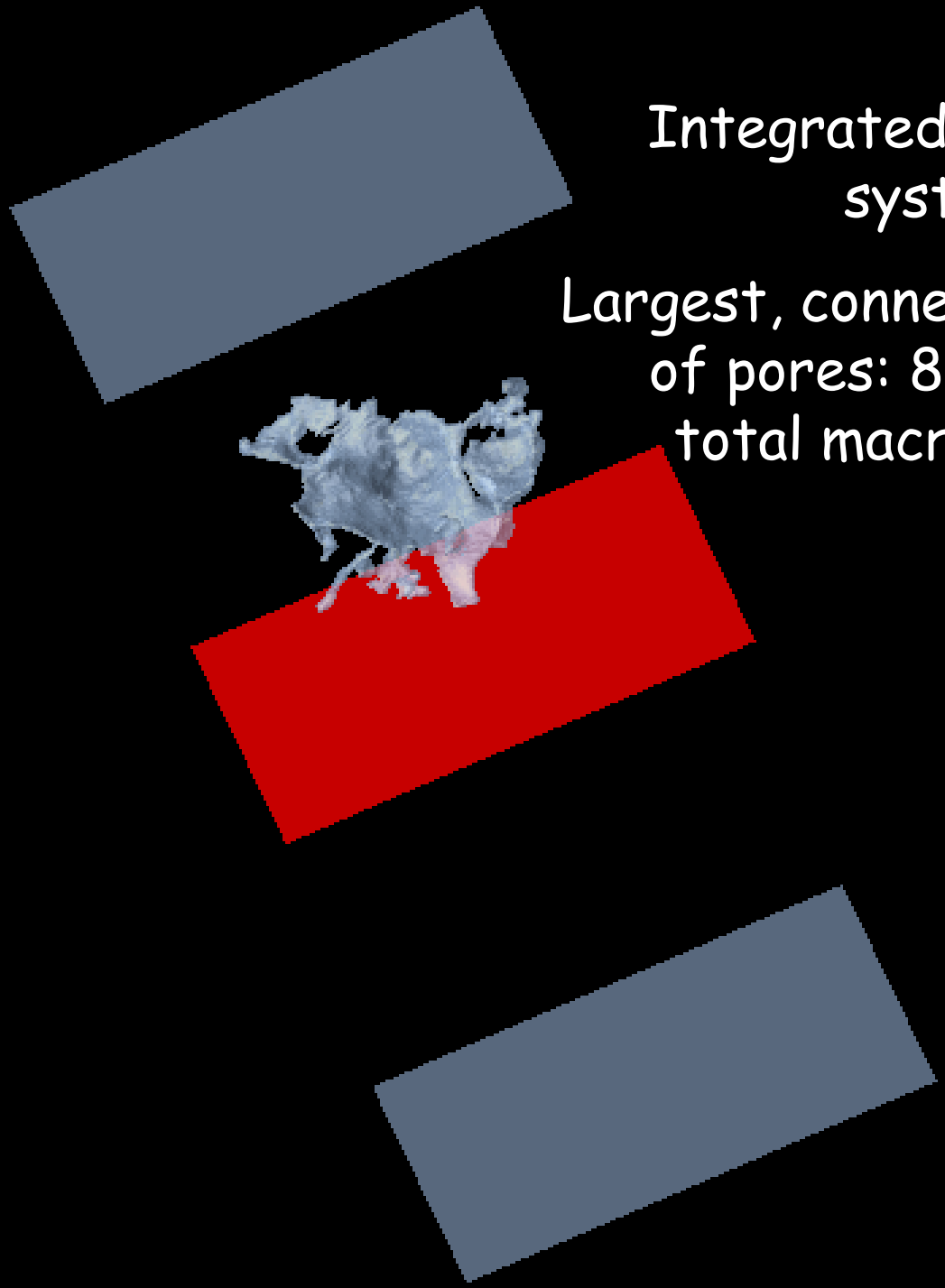
Compost application,
pasture in rows, no irrigation,

Plant & Food RESEARCH
RANGAHAU AHUMĀRA KAI

Macro-pores enhance the mixing of nutrients and contaminants

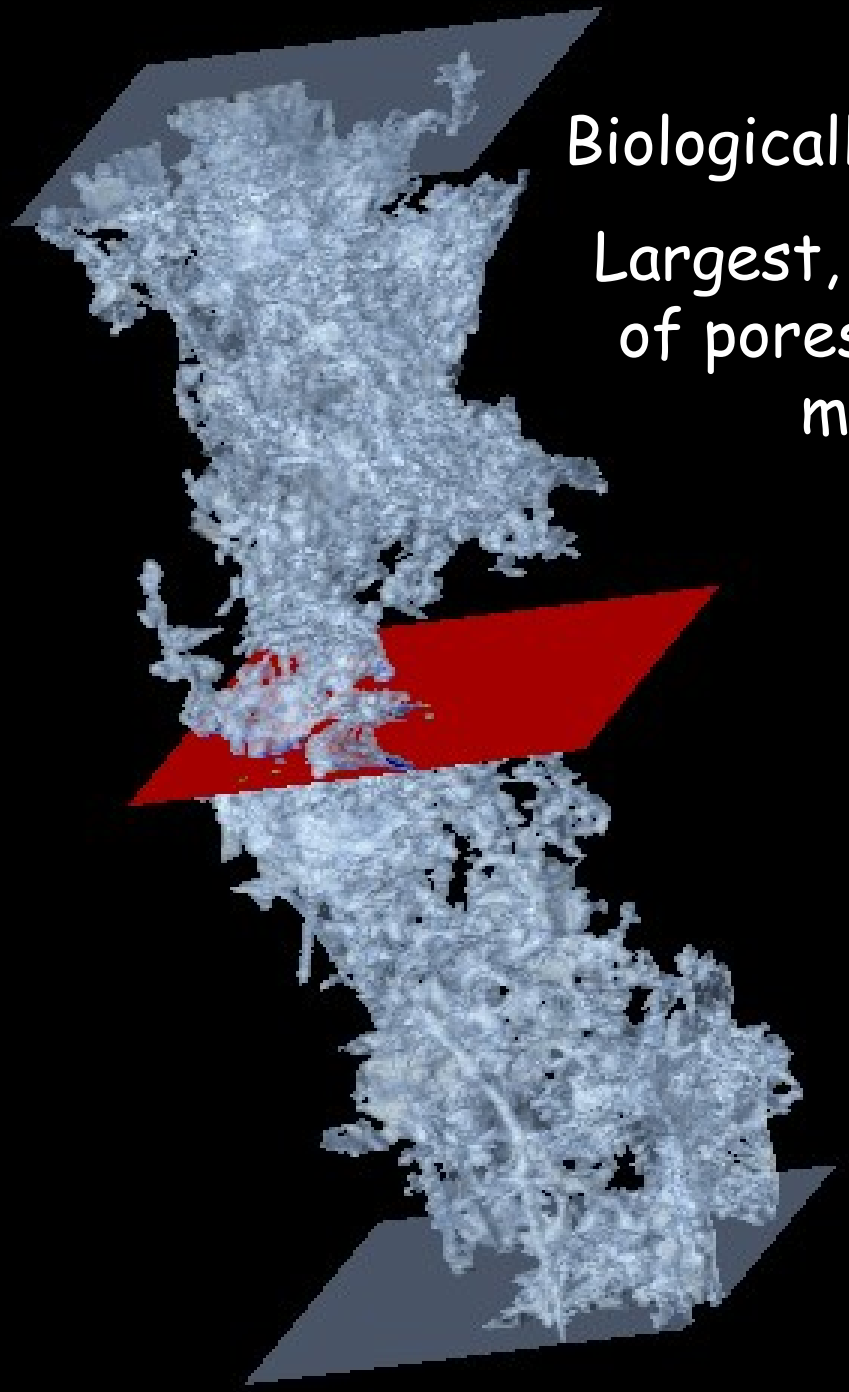


= better buffering of nutrients and filtering of contaminants



Integrated managed system

Largest, connected system of pores: 8.8% of the total macroporosity



Biologically managed orchard

Largest, connected system of pores: 79% of the total macroporosity