Soil biology: creating a carbon sink

Emerita Professor Lynette Abbott
UWA School of Agriculture and Environment
& UWA Institute of Agriculture
The University of Western Australia

Email: Lynette.Abbott@uwa.edu.au

Soil Health

soilhealth APP

Transition Town Vincent's My Healthy Soils Project

16 March 2025

Overview

- Communities of soil organisms provide the backbone of healthy soils
- The abundance, diversity and functional attributes of soil organisms are tied to underlying soil characteristics
- Structural complexity of organic resources in soil creates habitat heterogeneity
- **Healthy soil supports resilience of soil function**

Characteristics of healthy soil

THE UNIVERSITY OF WESTERN AUSTRALIA

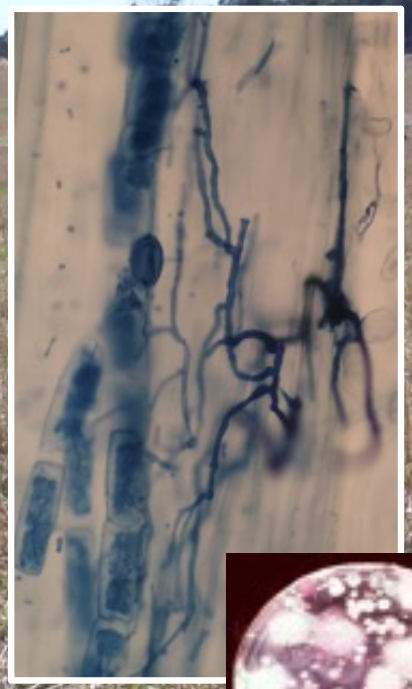
Significance of **soil biodiversity**

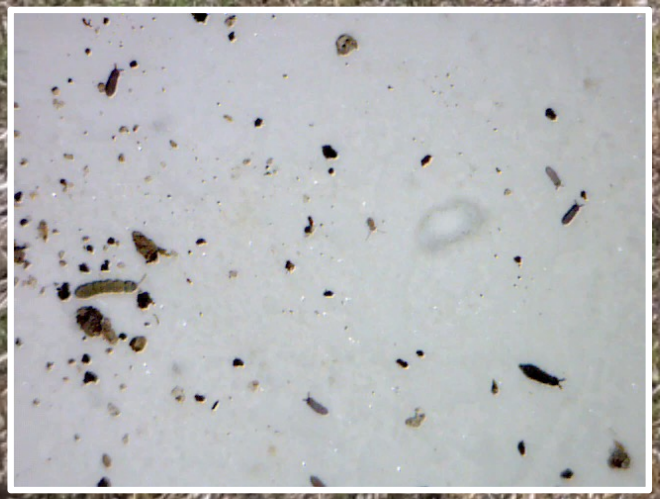
Significance of **plant diversity**

Significance of **local soil type**

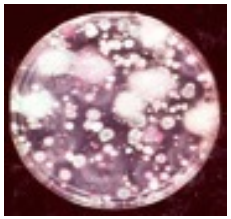
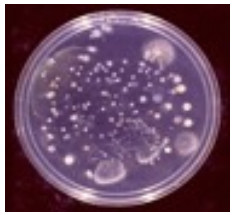
Significance of land management (= disturbance)

Significance of **soil biodiversity**

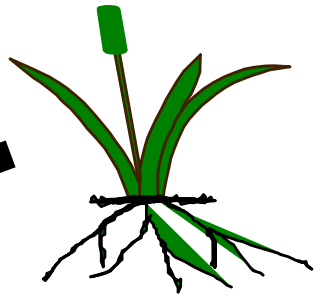




Significance of **soil biodiversity**



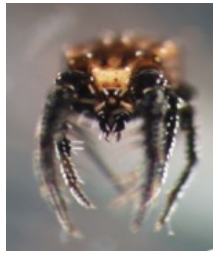


Plant residues / Organic matter

Bacteria

Fungi

Plant symbionts and pathogens



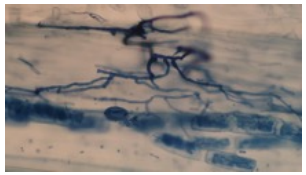
Bacterial feeding Protozoa

Fungal feeding Protozoa

Bacterivorous Nematodes

Fungivorous Nematodes

Plant parasitic Nematodes



Predatory Nematodes

Microarthropods (Collembola, Mites)

Earthworms etc

After Poster by van Vliet and Gupta

Significance of **soil biodiversity**

THE UNIVERSITY OF WESTERN AUSTRALIA

nutrient transformations

nutrient cycling

symbiotic / non-symbiotic nitrogen fixation

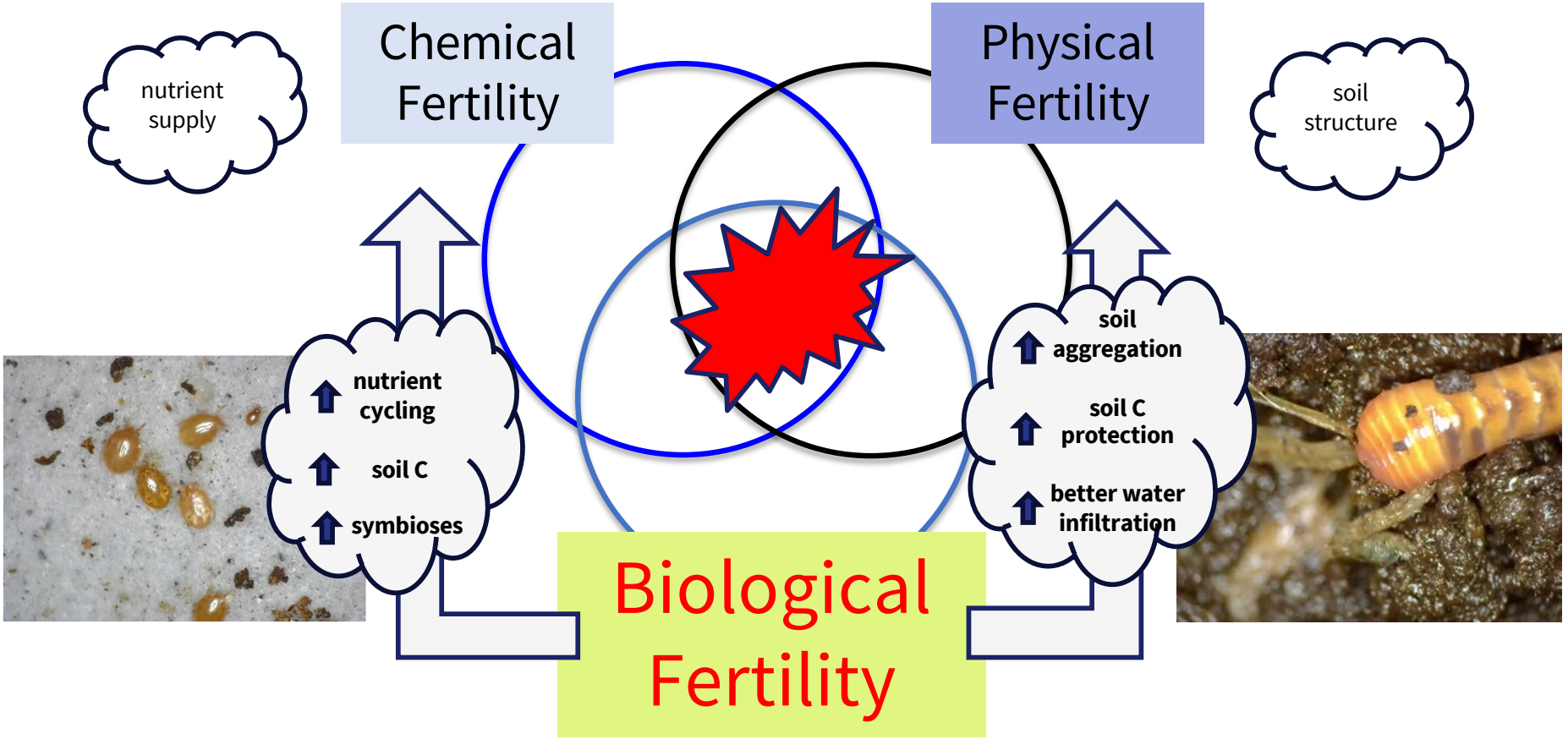
plant disease / plant disease suppression

arbuscular mycorrhizal function

soil structure (soil aggregation)

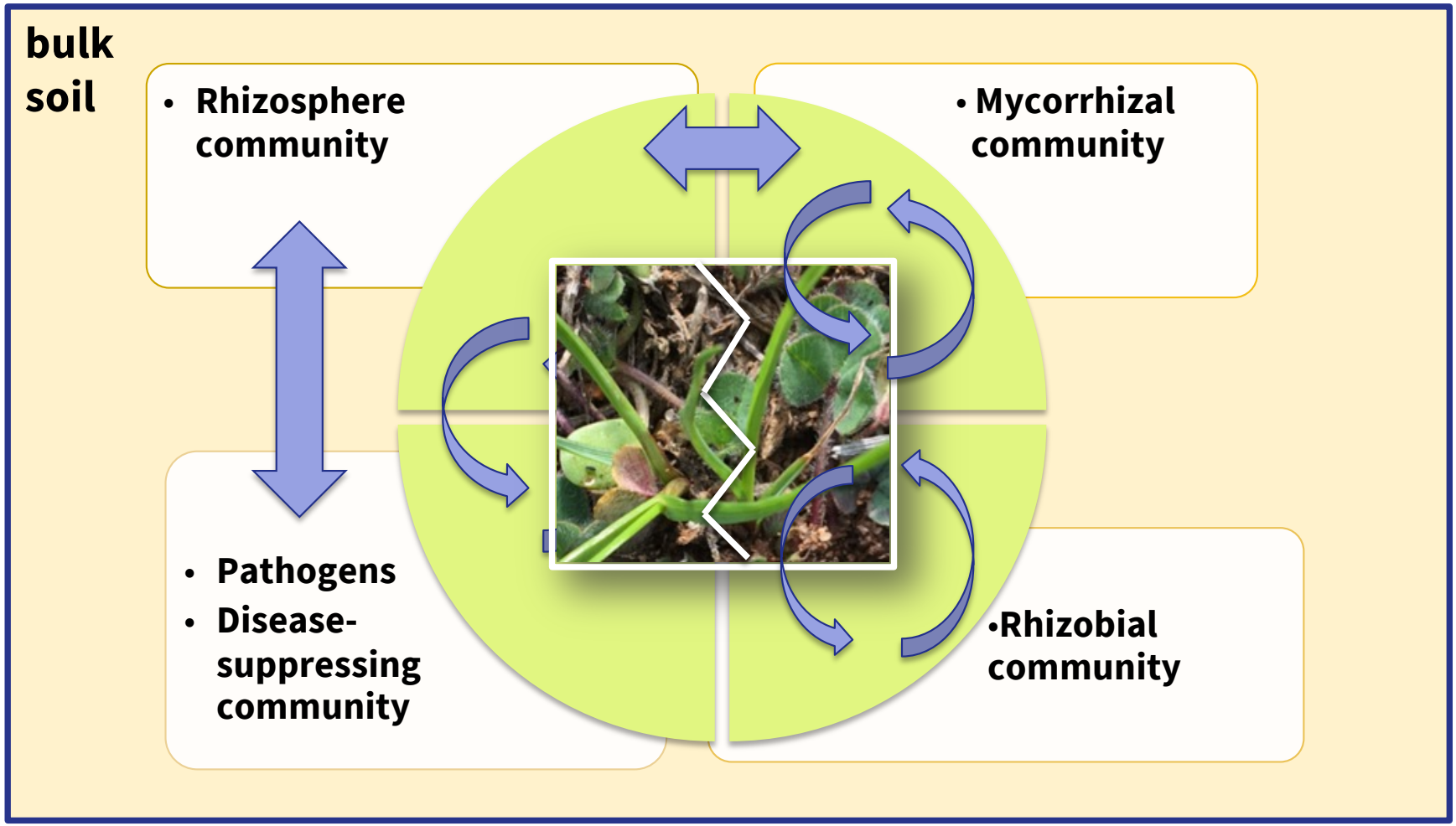
water repellence / infiltration

Significance of **soil biodiversity**

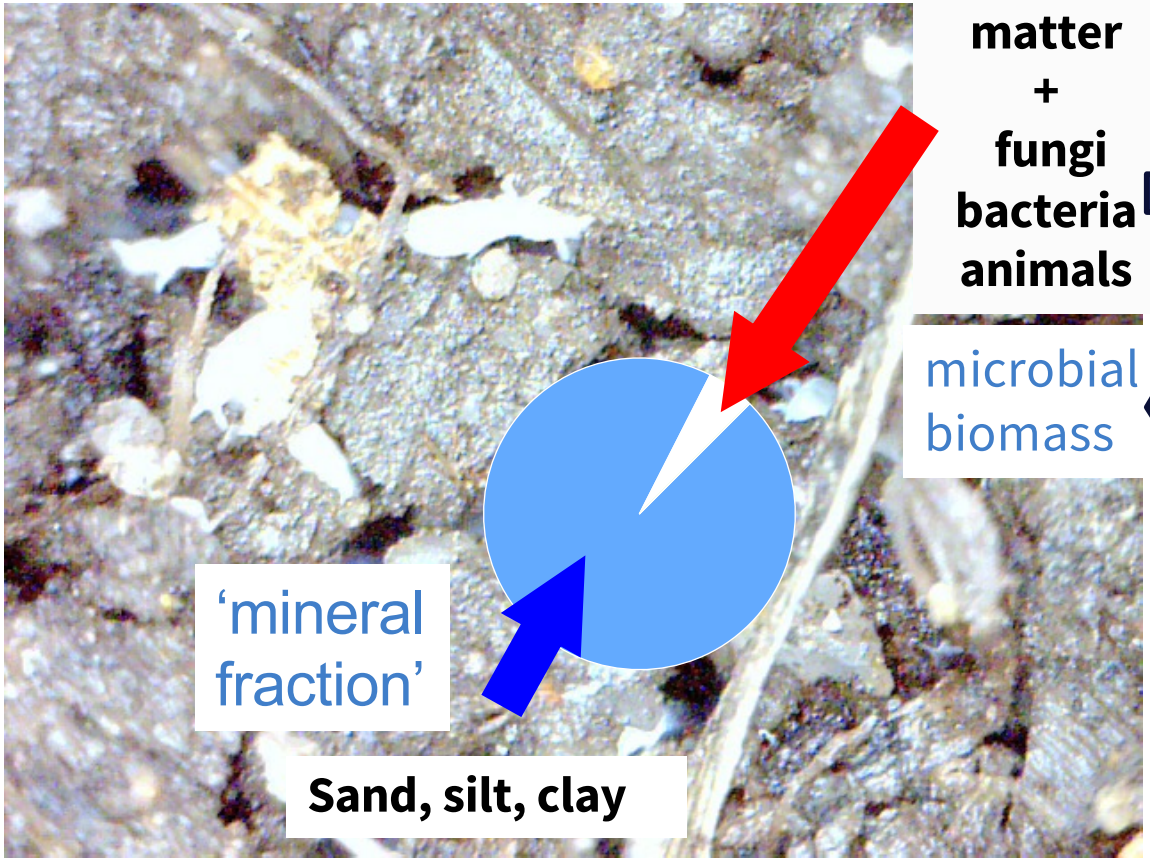


Significance of **plant biodiversity**

Significance of **plant biodiversity**



Significance of **plant biodiversity**



Diverse C inputs

- soil residues
- biological amendments

C retention

- soil type
- protection of C
- soil disturbance (land management practices)

Significance of **local soil type**

Significance of **local soil type**

= disturbance

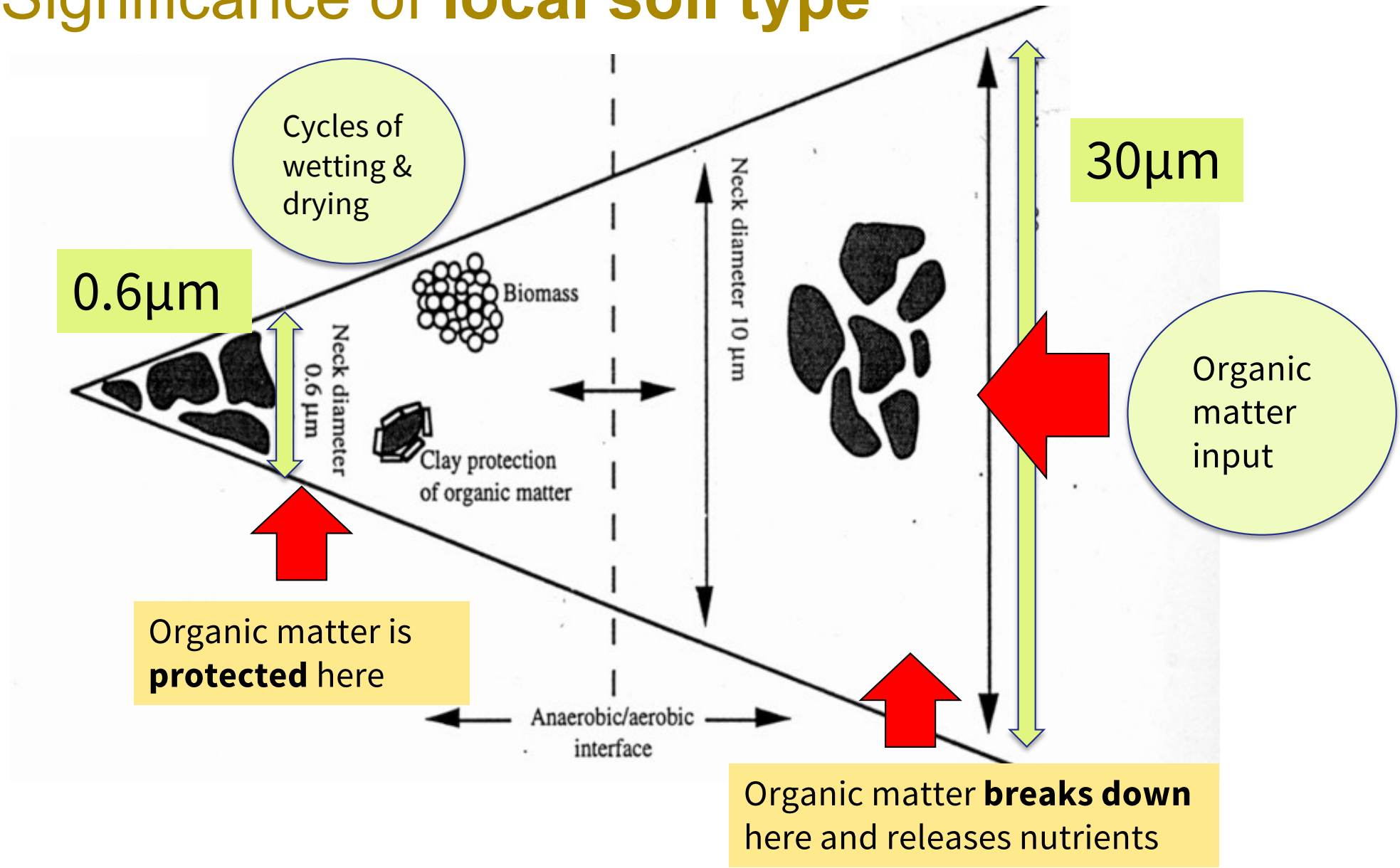
–Effects of disturbance related to **soil management**
e.g. tillage, deep ripping

–Effects of disturbance related to **plant diversity**

– e.g. mixed plant species, rotations

– Effects of disturbance related to **soil amendments**
e.g. fertilisers and organic inputs

Significance of **local soil type**



Strong et al. (1989) Aust J Soil Research 36: 855-72

Significance of **land management**

soil amendments

Fertilisers

Lime

Humates / biochar etc

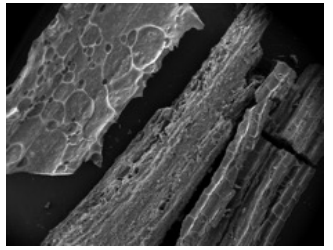
Manures / composts

Compost teas / biological extracts

Microbial inoculants

Impacts on soil constraints

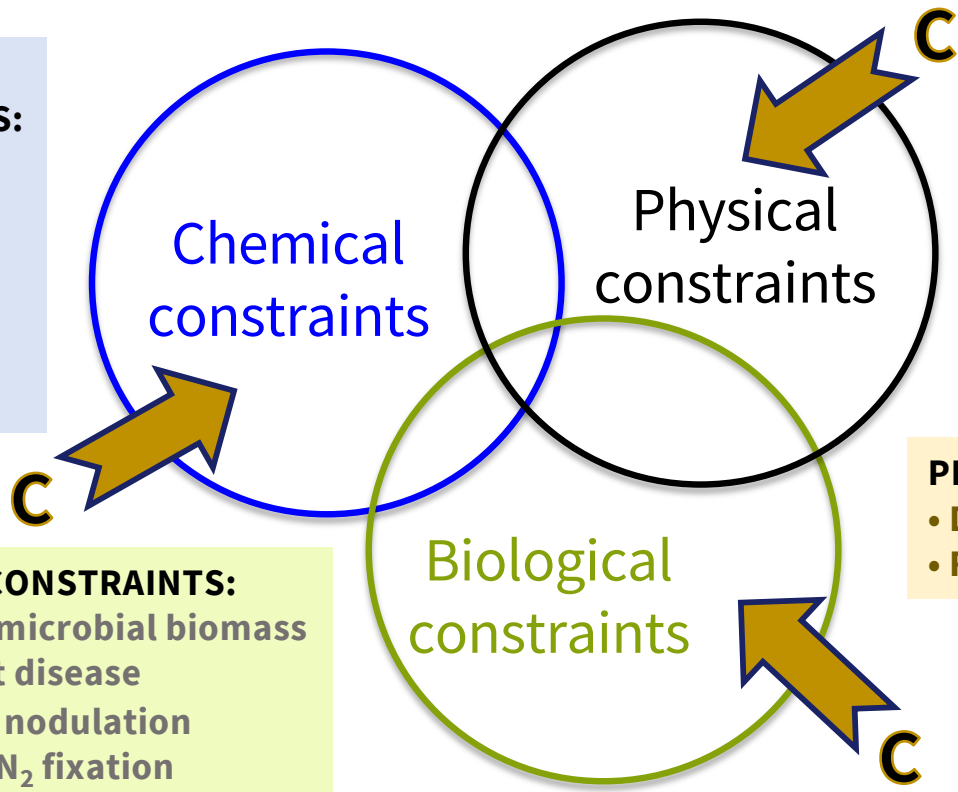
Impacts on soil biological processes



Significance of **land management**

Impacts of biological amendments on soil constraints



CHEMICAL CONSTRAINTS:
- Salinity
- Low C
- Low N
- Low pH
- High pH
- Low CEC

PHYSICAL CONSTRAINTS:
- Erosion
- Water retention
- Water infiltration
- Soil aggregation
- Compaction

PLANT CONSTRAINTS:
- Drought (seasonal)
- Frost

SOIL CONSTRAINTS:
- Low microbial biomass
- Plant disease
- Poor nodulation
- Low N_2 fixation
- Low levels of AM fungi

*** Multiple impacts also likely**

Review:
Abbott et al. (2018)

UWA Farm Ridgefield
Building ecosystems and biodiversity

Introduction of mixed tree plantations improves soil conditions and supports soil biological processes

UWA Farm Ridgefield
Building ecosystems and biodiversity

Kids to the Country Program

Strategic tree planting by school students and student volunteers (since 2012)

Farm demonstration to fast-track restoration of soil condition using permeable biomass barriers

Australian Government | National Landcare Program

Demonstration site funded by the National Landcare Program: Smart Farms - an Australian Government initiative

Intensive regenerative practices **establishing permeable biomass walls and trenches**

Trees previously planted by Greening Australia as part of Australian Government 20 Million Tree programme

Farm demonstration to fast-track restoration of soil condition using permeable biomass barriers

Examples of biological amendments used –

Straw
Compost
Biochar
Worm juice
Wood Vinegar

Diverse soil biological community established

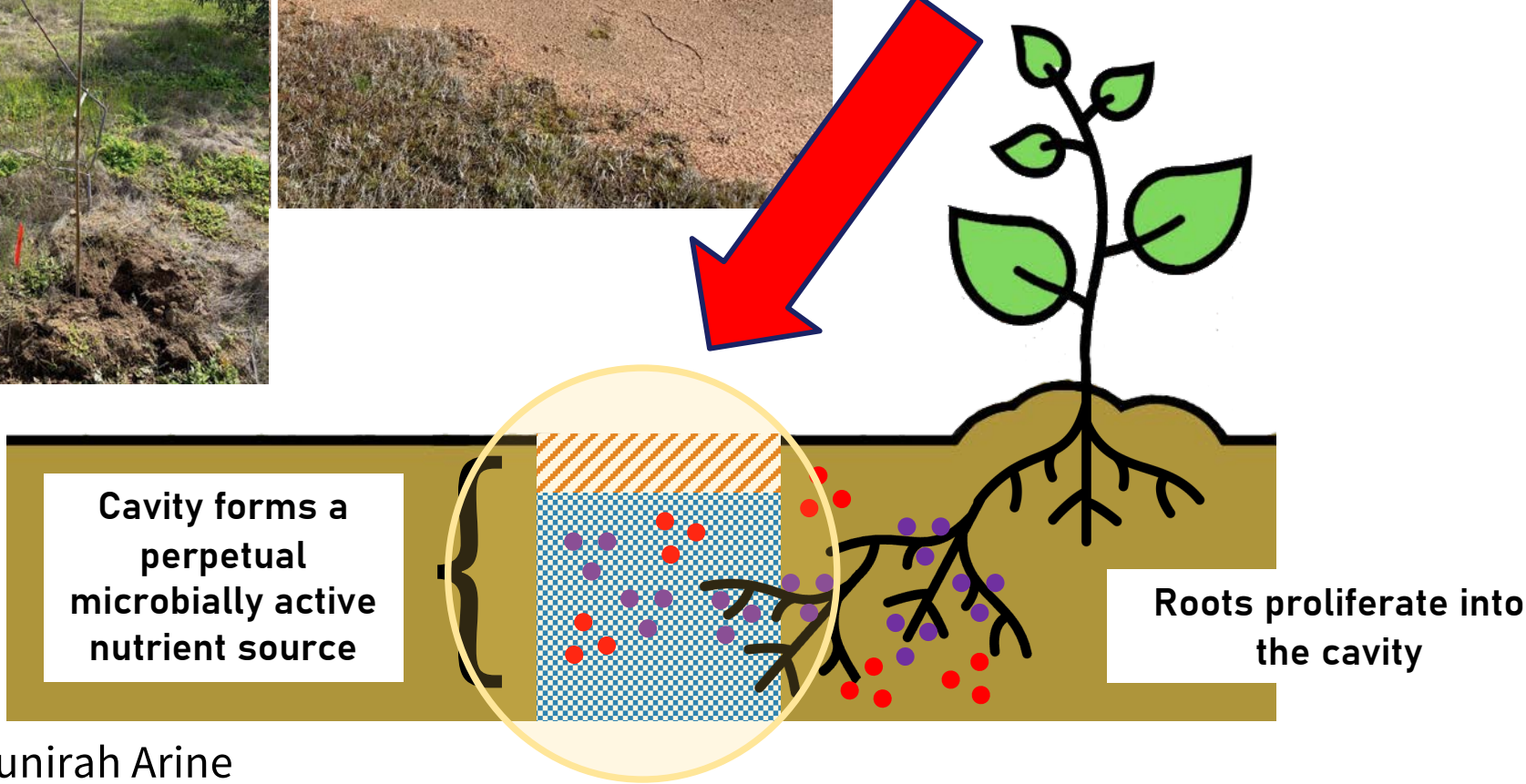


Diagram: Munirah Arine