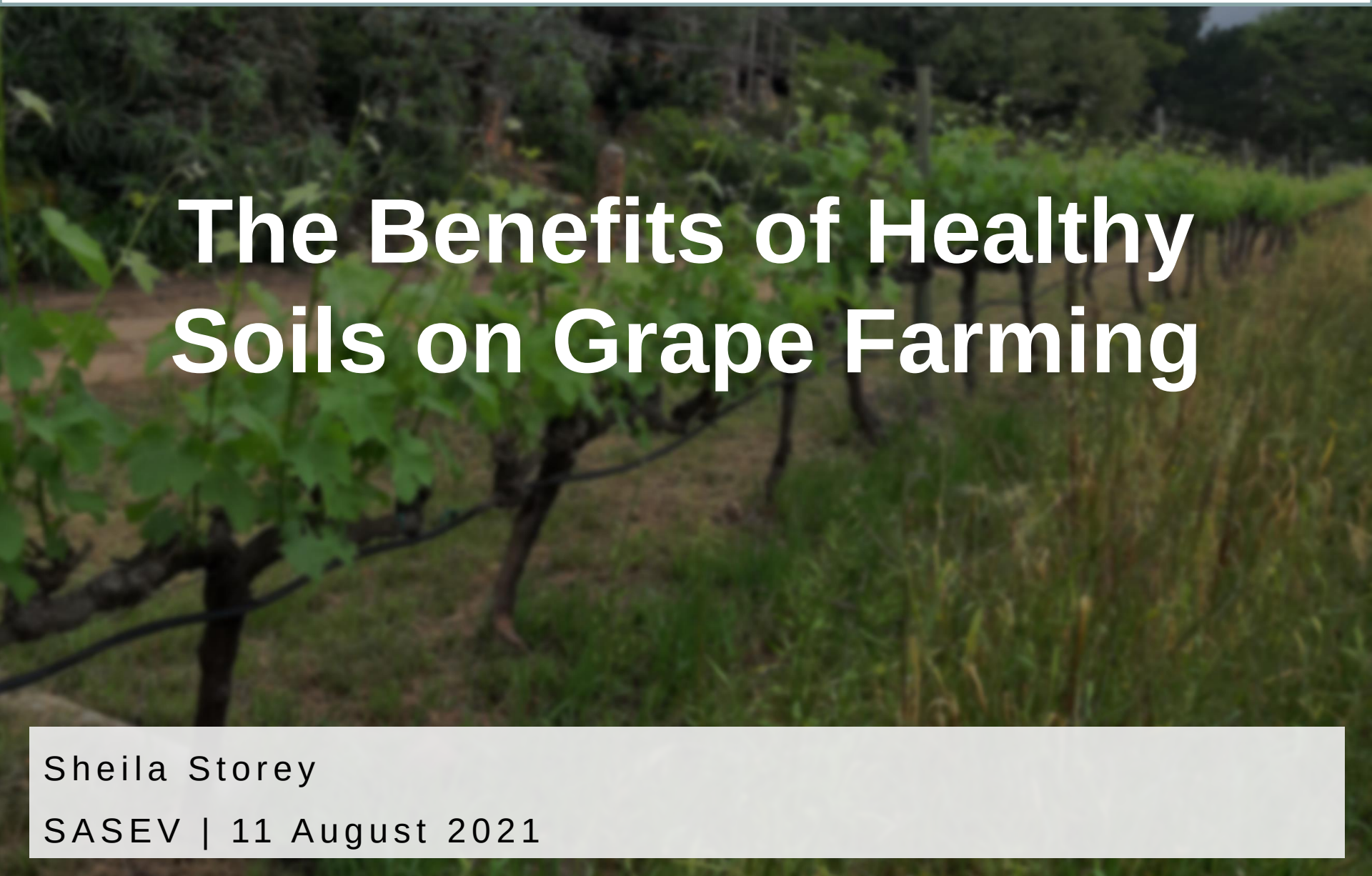
soil health SUPPORT CENTRE
measuring the heartbeat of soil life

nemlab



The Benefits of Healthy Soils on Grape Farming

Sheila Storey

SASEV | 11 August 2021

CONTENTS

- What is soil health?
- How do we achieve it?
- How to get the soil biology to work for us?
- How do we measure soil health?

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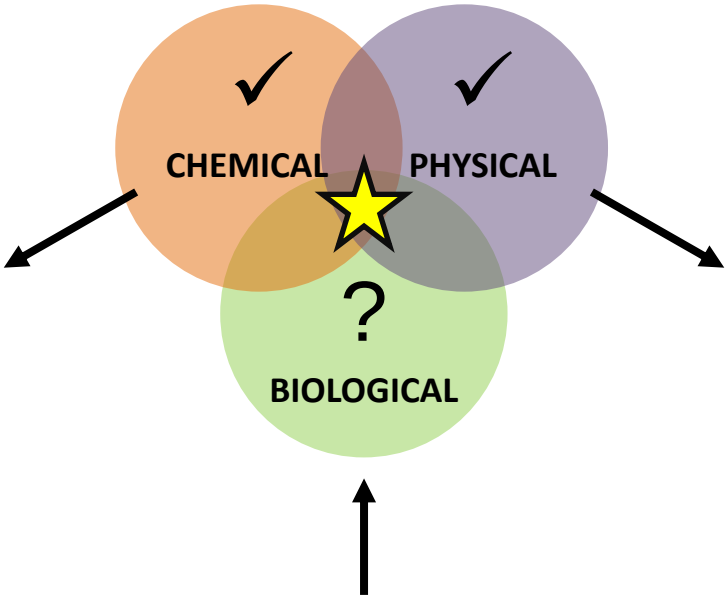
WHAT IS SOIL HEALTH?

- Nutrients
- % Organic Material
- Active C & N in OM
- Cation exchange capacity
- N, P, K
- Micronutrients
- Toxins, pollution
- Glomalin



- Soil texture
- Pore size
- Bulk density
- Compaction
- Aggregate stability
- Water infiltration
- Water holding capacity
- Good drainage

- Soil biodiversity
- Organic carbon
- Microbial biomass
- Pests and diseases
- Decomposition

- Beneficial and parasitic nematodes
- N-mineralisation
- Respiration
- Earthworm counts
- Genetic diversity

BENEFITS OF SOIL HEALTH

1. Soil is a non-renewable resource
2. Increased organic material content > humus = sponge
3. Increased water holding capacity
4. Habitat for a rich microbe diversity
5. Improved aggregate stability/ soil structure

Together the hyphae and glomalin form a sticky net that traps particles of sand, silt, clay and organic material. These nets bind everything together to form soil aggregates

BENEFITS OF SOIL HEALTH

6. No crust forming – improved water infiltration

7. Reduced run-off and evaporation

8. Improved nutrient cycling

9. Carbon sequestration

10. Low weed and pathogen pressure

11. *System resilience = ability to recover*

12. Healthy soil is the foundation for everything

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WHY SOIL HEALTH?

Example: Apples

Method

- **Apply compost annually** after harvest on the *bankie*/berm to give the soil a boost
- **Cover** immediately with straw or wood chips
- **Not** apply compost **directly on the tree**
  Compost = food for soil biology
  Cover = shelter for soil biology
- **Work row** now has **cover crops** to replace straw
  Shaded areas are a problem (maybe grass and legumes)

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WHY SOIL HEALTH?

RESULTS			
1.	C	2001	0,4%
		2006	2,5%
		2015	3,5 – 4.0%
2.	N		Was 160 – 240 kg/ha
			Currently at 40 kg/ha
3.	Crop average	2009	60 t/ha
		2017	120 t/ha
4.	Improved shelf-life		
5.	Pests		Fewer woolly apple aphid
			Fewer red spider mite
			Fewer root lesion nematode

WHY SOIL HEALTH?

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SOIL HEALTH:
How do I achieve it?

4 PRINCIPLES OF SOIL HEALTH?

COVER

Cover your soil with compost, mulch or cover crops to prevent soil from drying out (baking)

LESS DISTURBANCE

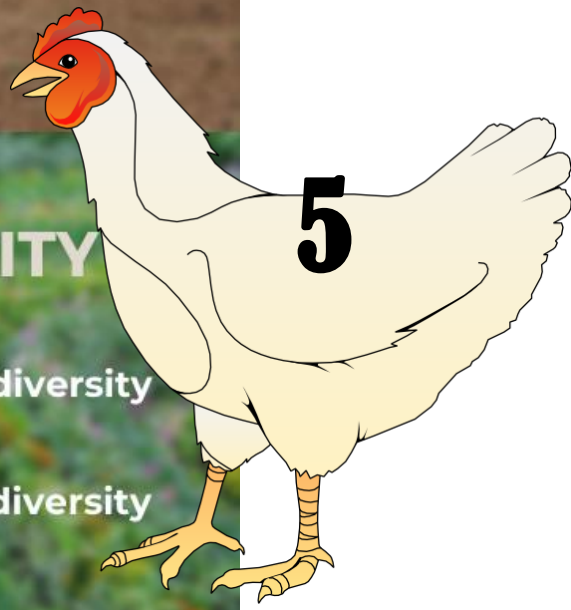
The less soil is disturbed, the more stable the habitat for the soil microbes will be

LIVING ROOTS

Root exudates feed the microbes in the soil and are important for C sequestration

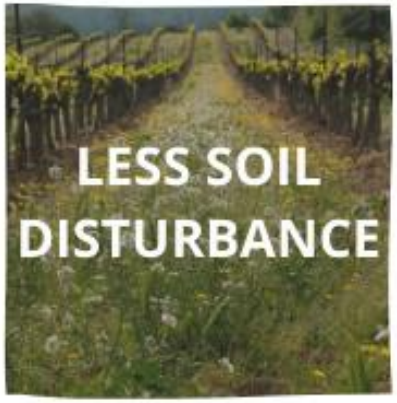
DIVERSITY

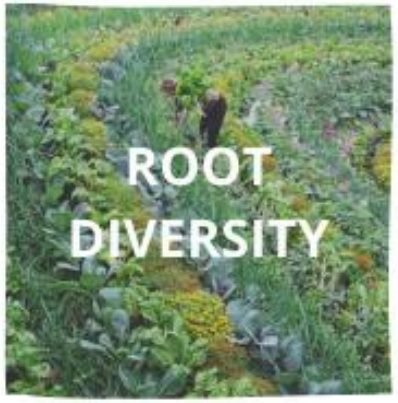
Above-ground diversity
=
Below-ground diversity



COVER CROPS

- Planting cover crops covers 4 of the soil health principles:





- A diverse selection of cover crops provides the soil with cover, living root diversity and offers biological tillage.

Photosynthesis drives the biology!

COVER CROPS

- Include a grass/grain, a brassica, a legume, a broadleaf (and a radish)

- Consider the different services offered by different plants:
  - improvement of soil structure
  - providing organic material (biomass)
  - stimulating soil biology
  - reducing erosion
  - fixation and addition of nitrogen
  - luring beneficial insects and predators
  - disrupting pest life cycles

POSSIBLE DISADVANTAGES

- Seed costs
- Frost susceptibility
- Fire risk
- Luring of pests
- Competition with primary crop

BUT

- Immeasurable benefits in rand value

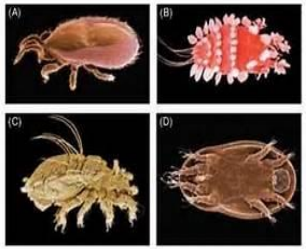
HOW TO ACHIEVE SOIL HEALTH?

Other covers

- Compost – serves as inoculum
- Covering with straw, wood chips, cuttings, etc.
- Weeds
- Compost tea
- Vermicast
- Manure (chicken/cow)

Photo: Jarred Murphy

SOIL HEALTH:
How does soil biology work for you?



ECOSYSTEM SERVICES

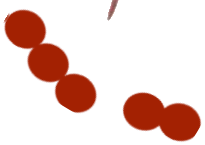
Plant Pollinators

Biological Control

Shredders and Decomposers

Soil Aerators

Nutrient cyclers



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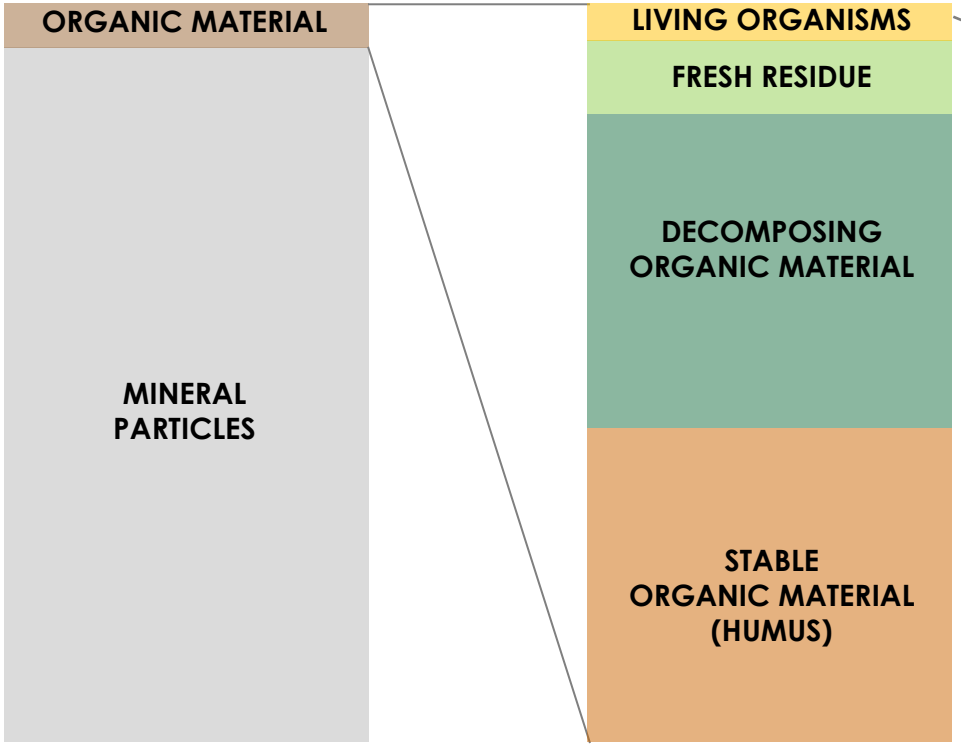
WHY SOIL BIOLOGY?

SOIL **ORGANIC MATERIAL**



Earthworms
Fungi
Bacteria
Arthropods
Nematodes
Protozoa

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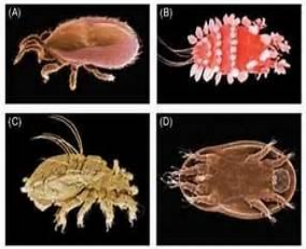
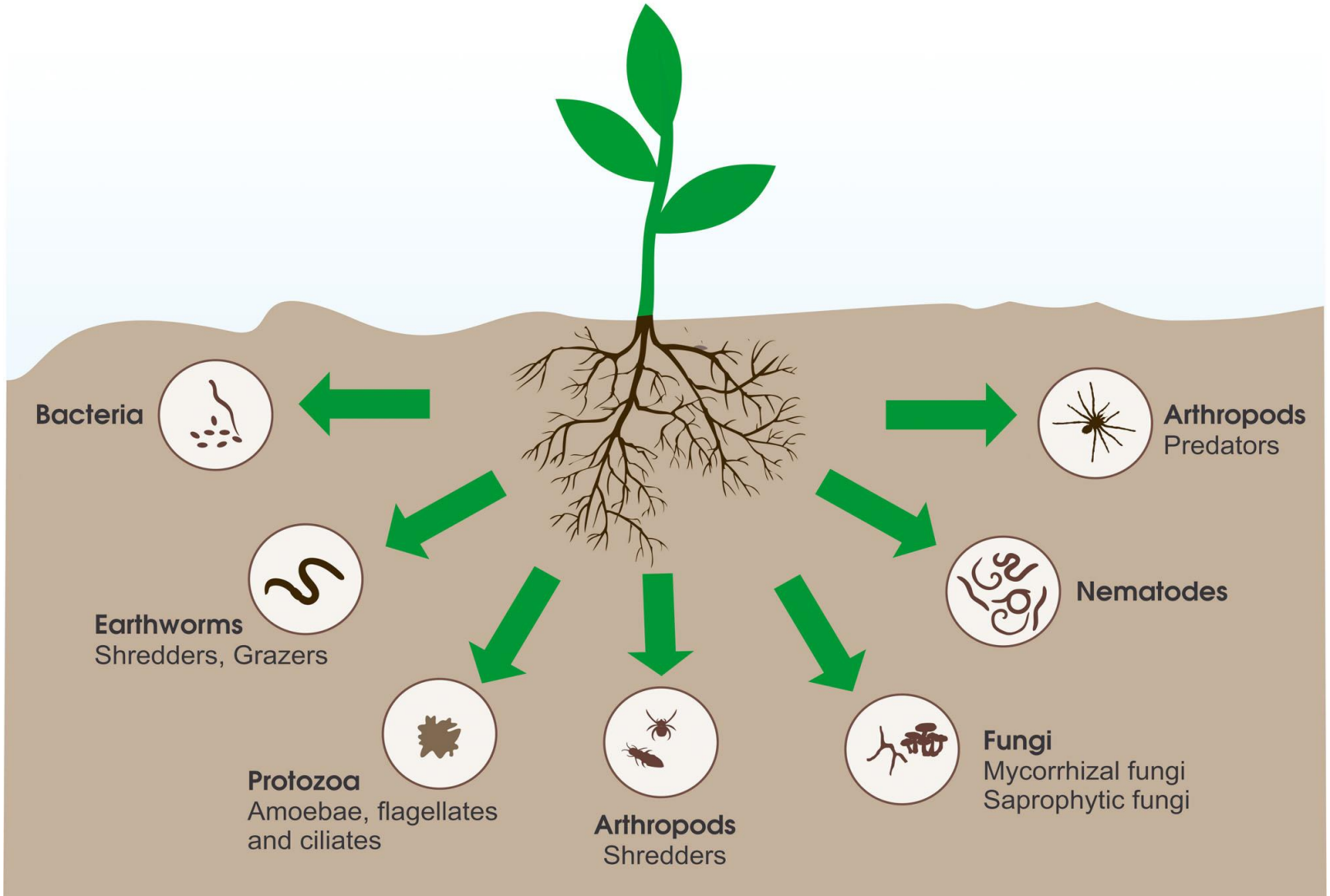
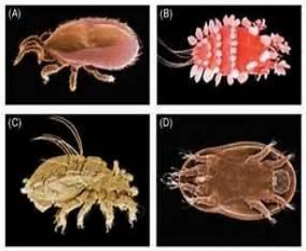


SOIL BIOLOGY

South Africa has a high level of soil biota diversity, as well as many species that are only present here (endemic).





SOIL BIOLOGY

The Soil Food Web

FIRST TROPHIC LEVEL
Photosynthesizers

SECOND TROPHIC LEVEL:
Decomposers
Mutalists
Pathogens
Parasites
Root - feeders

THIRD TROPHIC LEVEL:
Shredders
Predators
Grazers

FOURTH TROPHIC LEVEL:
Higher level predators

FIFTH TROPHIC LEVEL:
Higher level predators

Nematodes
Root-feeders

Plants
Shoots & Roots

Arthropods
Shredders

Arthropods
Predators

Birds

Earthworms
Shredders, Grazers

Fungi
Mycorrhizal fungi
Saprophytic fungi

Organic matter
Waste, residue and metabolites from plants, animals and microbes

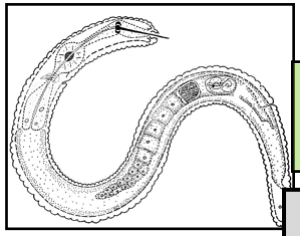
Bacteria

Nematodes
Fungal- and bacterial - feeders

Protozoa
Amoebae, flagellates and ciliates

Nematodes
Predators

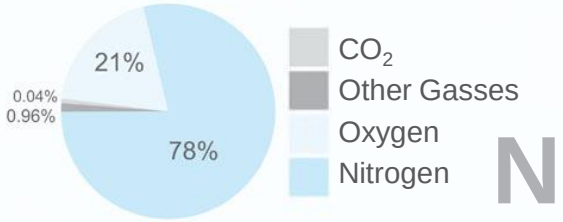
Animals



NEMATODE FEEDING GROUPS

Unicellular feeders	Unicellular eucaryote feeding: yeast, algae, lichen	
Bacterivores	Feed on bacteria: use hollow tube	
Fungivores	Feed on fungi: stylet punctures hyphae	
Herbivores	Feed on/in plant roots: use stylets	
Omnivores	Feed on more than one type of food source: org. material, etc.	
Predators	Feed on other nematodes: puncture with tooth	
EPNs	Feed on insects (and bacteria): no stylet	

NUTRIENT CYCLING



N

Photosynthesis

CO_2

Sun energy

Bacteria

Protozoa

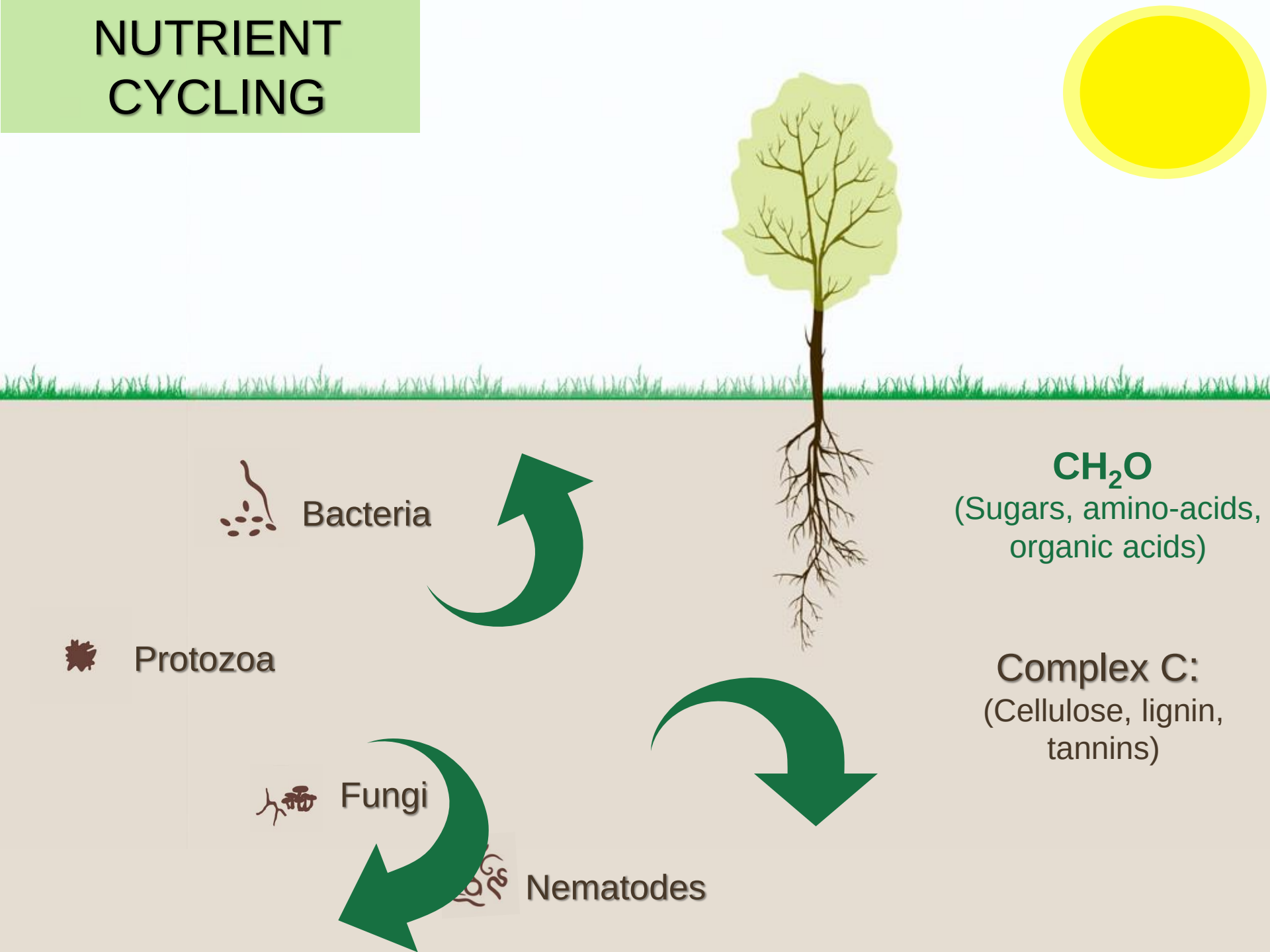
Fungi

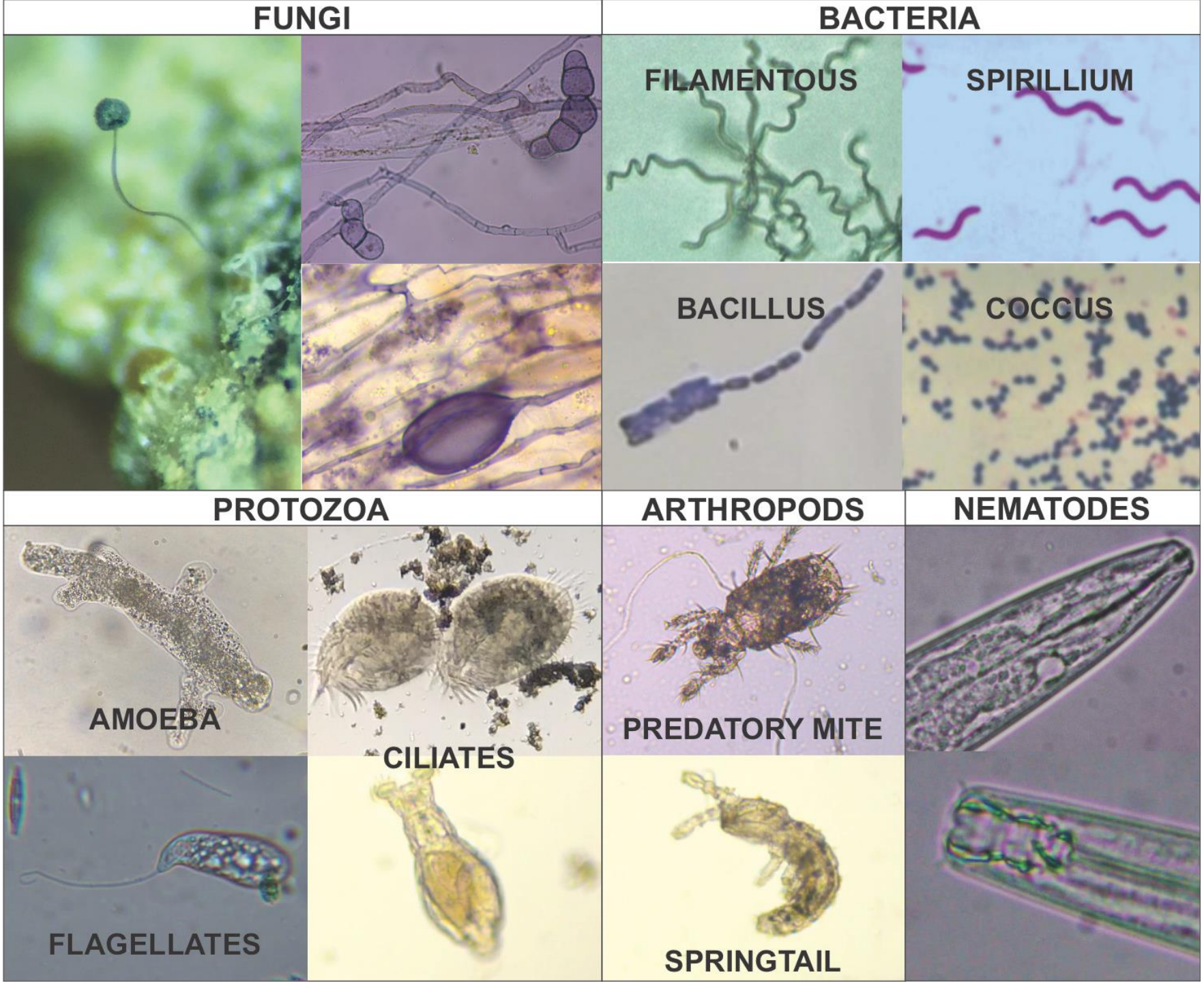
Nematodes (Excretions 9-30% N)

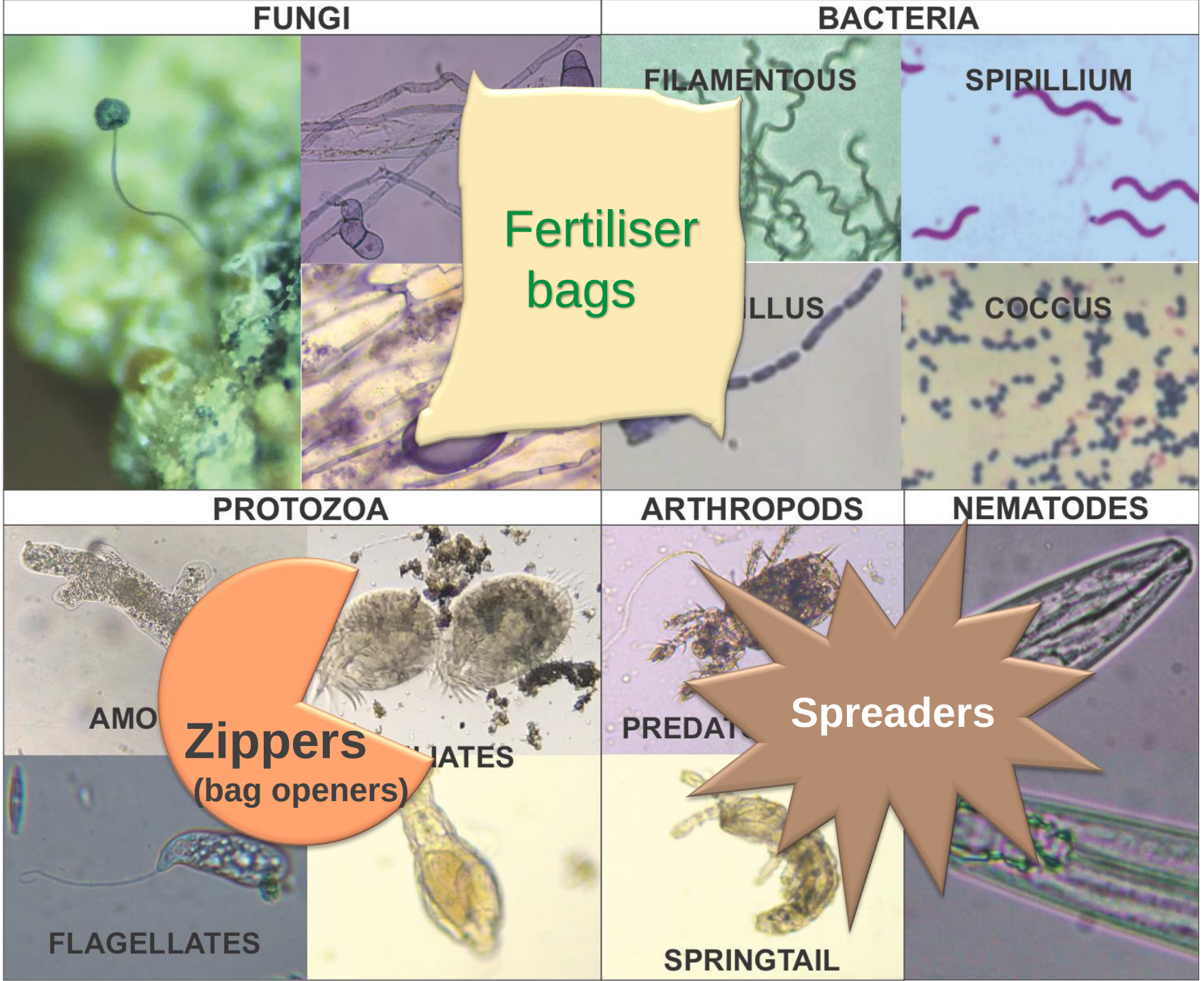
CH_2O
(Sugars, amino-acids, organic acids)

Complex C:
(Cellulose, lignin, tannins)

NUTRIENT CYCLING




FUNGI
BACTERIA
FILAMENTOUS
SPIRILLIUM
BACILLUS
COCCUS
PROTOZOA
ARTHROPODS
NEMATODES
AMOEBA
CILIATES
PREDATORY MITE
FLAGELLATES
SPRINGTAIL


FUNGI
BACTERIA
FILAMENTOUS
SPIRILLIUM
Fertiliser bags
COCCUS
PROTOZOA
ARTHROPODS
NEMATODES
Zippers
(bag openers)
Spreaders
FLAGELLATES
SPRINGTAIL

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TESTS	
Volumetric Aggregate Stability (VAS) %	
Microbial Respiration (CO_2 'burst test')	
Haney Analysis	USA
PLFA Analysis	
Mycorrhizae Colonization	
Nematode Community Profile	

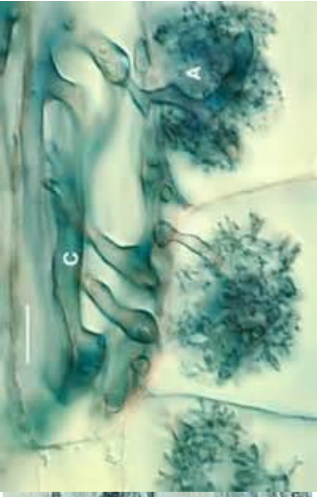
Keep our soils alive!

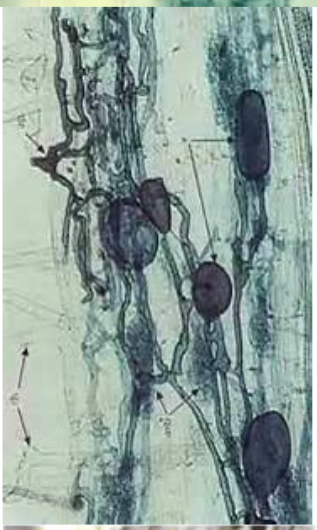
“Rhizosheath”

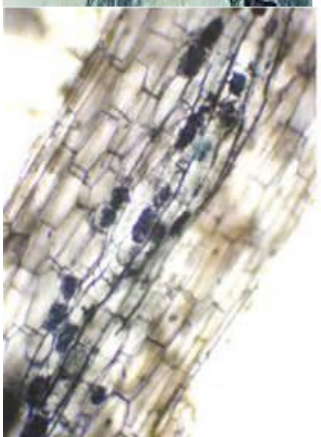
Rye planted in very sandy soils in a new citrus orchard in the Sandveld.

Volunteer rye plants from the previous season.

Photo: J Murphy







Acknowledgements

SASEV
Photographers

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