



Unlocking the Secrets In Soil:

How soil works and the management
principles of high functioning soil

**SOIL SCHOOL
2017**

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**What do you want your
soil to do for you?**



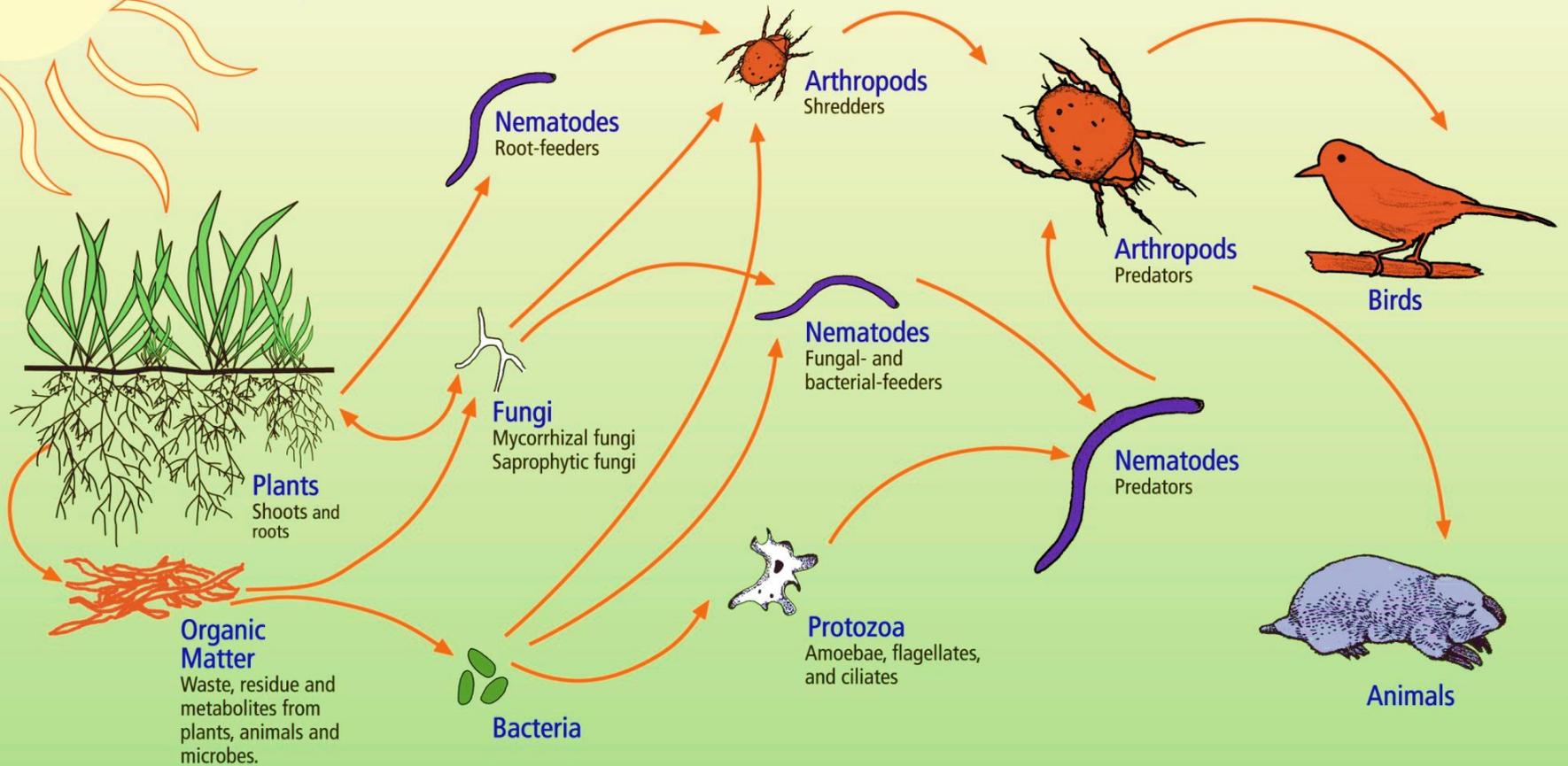
What do you want your soil to do for you?



Important Soil Functions

- Support productive plants and livestock
- Be stable and resist erosion
- Efficient at cycling nutrients internally
- Allow H₂O to enter quickly
- Drain well to avoid drowning plant roots
- Store H₂O for future plant use
- Resist pests, pathogens, and disease
- Help plants grow during 'stressful' events

The Soil Food Web



First trophic level:
Photosynthesizers

Second trophic level:
Decomposers
Mutualists
Pathogens, Parasites
Root-feeders

Third trophic level:
Shredders
Predators
Grazers

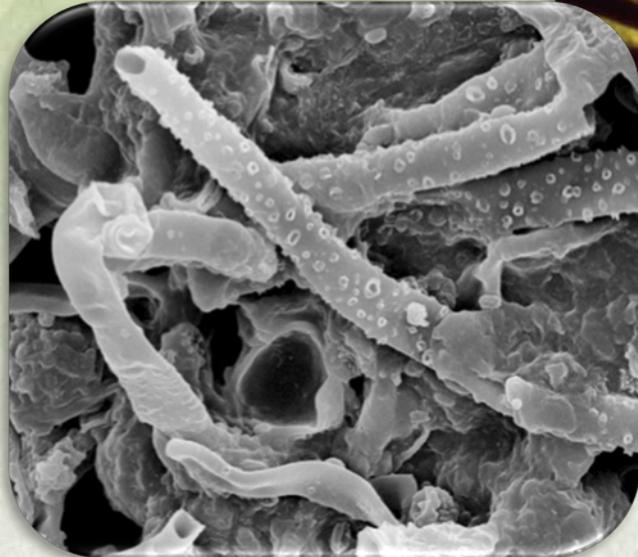
Fourth trophic level:
Higher level predators

Fifth and higher trophic levels:
Higher level predators



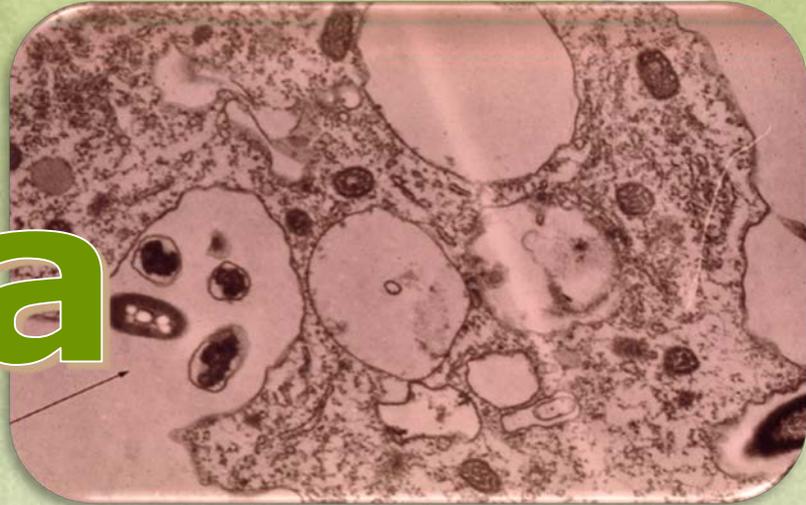
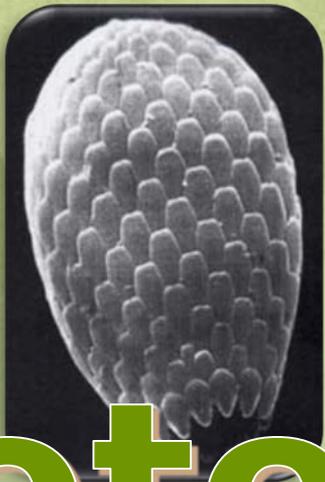
One cup of soil holds as many bacteria as there are people on Earth.

Bacteria



Fungi

A teaspoon of Ag soil = 10 yards
A teaspoon of Forest soil = 10 miles

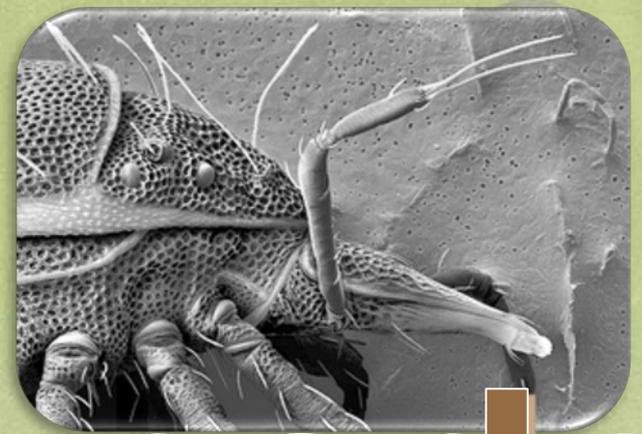


We know more about the movement of celestial bodies than about the soil underfoot – Da Vinci



Protozoa

Nematodes



Arthropods

Every time you take a step in a mature Oregon forest, your foot is being supported on the backs of 16,000 invertebrates held up by an average of 120,000 legs. – Dr. Moldenke OSU



Earthworms can turn over the top 6 inches of soil in 10-20 years.

Earthworms

The Soil Food Web

The whole is greater than the sum of its parts!

Plants
Plants provide the primary energy source for the soil food web through photosynthesis and the release of root exudates.

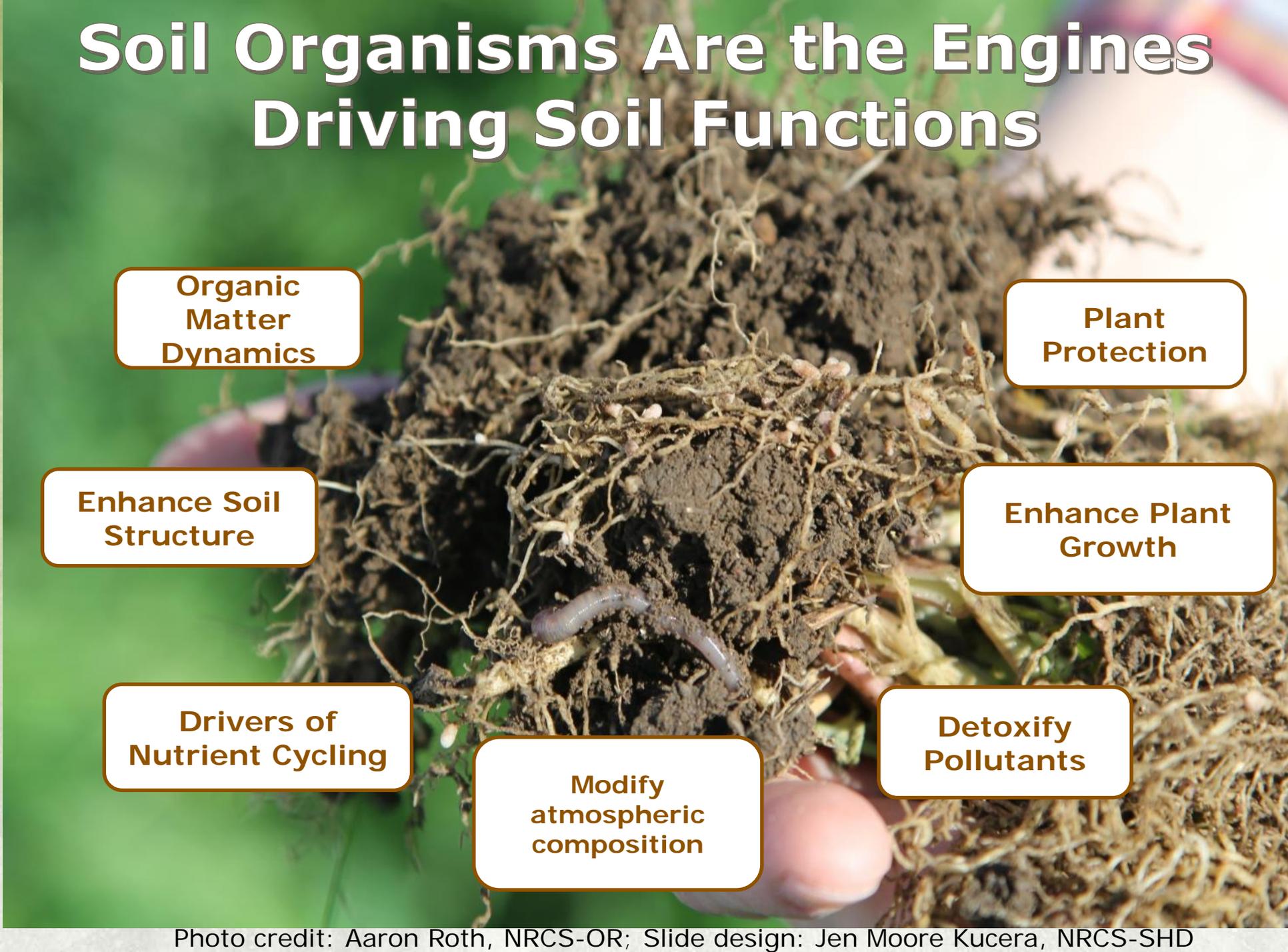
Microbes
Microbes, including bacteria and fungi, decompose organic matter and release nutrients back into the soil.

Soil Invertebrates
Soil invertebrates, such as earthworms and nematodes, play a crucial role in soil structure and nutrient cycling.

Arthropods
Arthropods, including insects and mites, contribute to soil aeration and the breakdown of organic matter.

Soil Animals
Soil animals, such as earthworms and nematodes, are essential for soil health and nutrient cycling.

Soil Organisms Are the Engines Driving Soil Functions



**Organic
Matter
Dynamics**

**Plant
Protection**

**Enhance Soil
Structure**

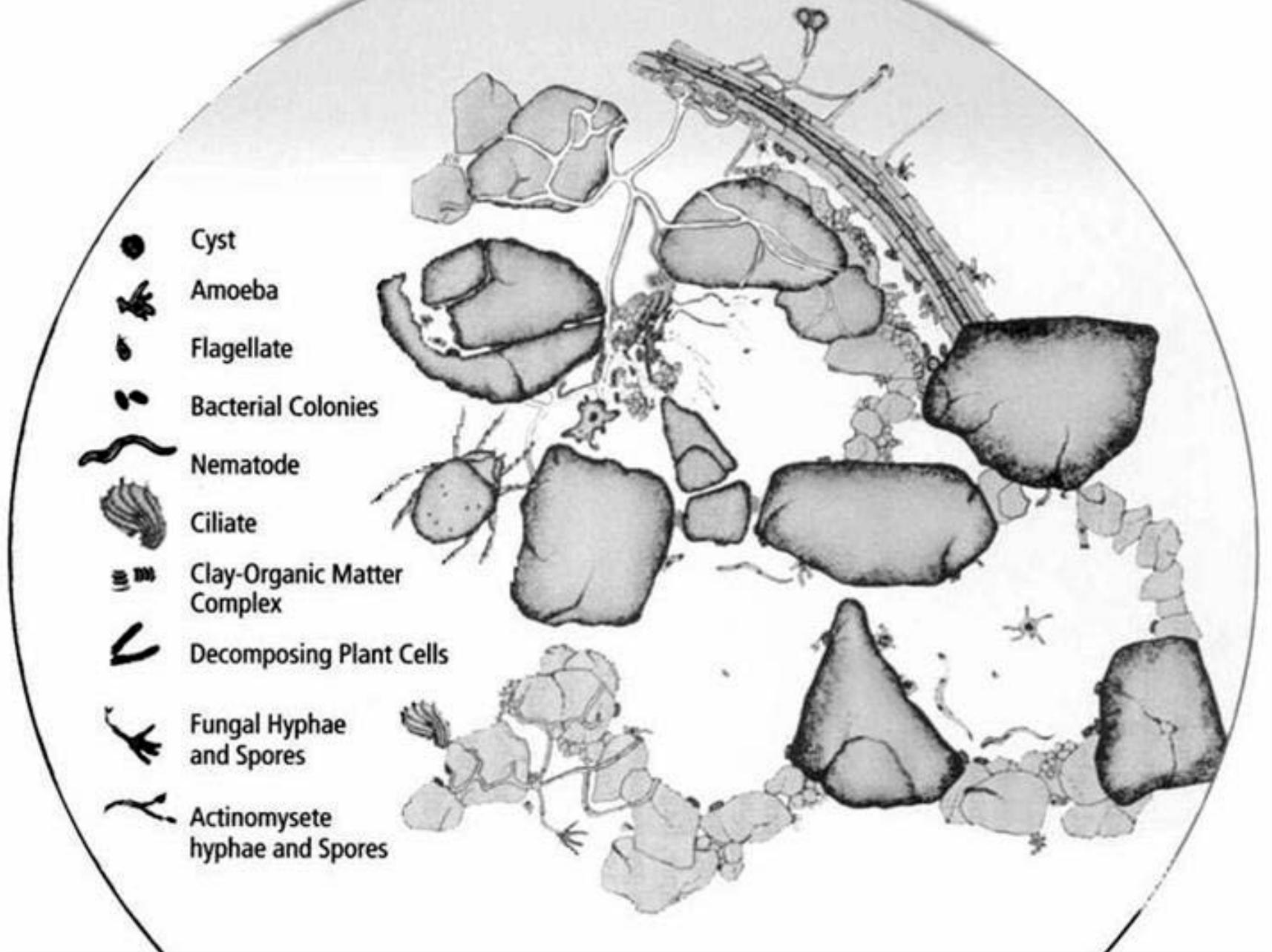
**Enhance Plant
Growth**

**Drivers of
Nutrient Cycling**

**Detoxify
Pollutants**

**Modify
atmospheric
composition**

AGGREGATES ARE HABITAT!



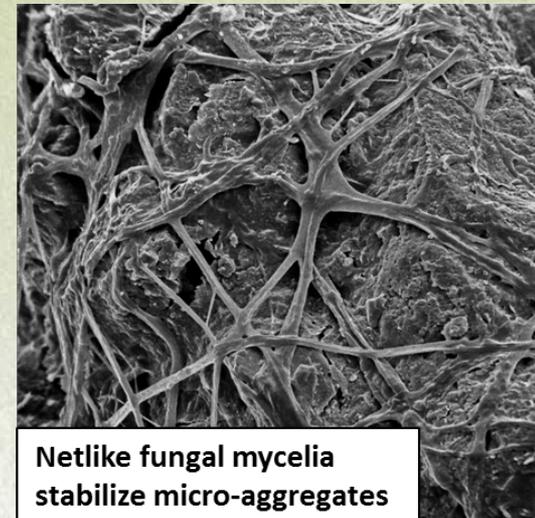
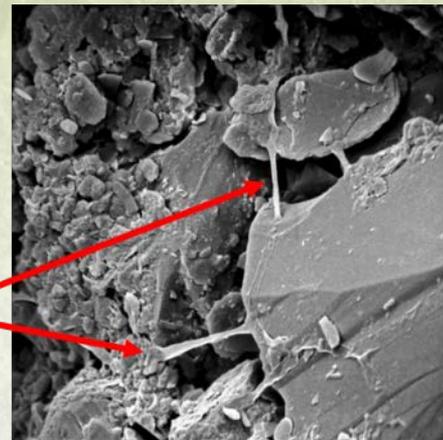
Soil Food Web Benefits: Formation & Stabilization of Aggregates



- Physical interactions
 - Plant roots enmesh soil particles
 - Earthworms (casts) and termites (mounds)
 - Soil fungi and some Actinobacteria produce filaments that physically enmesh soil particles together

How do soil
aggregates form?

**Stabilization of soil
structure by actinomycete
(bacterial) filaments**



**Netlike fungal mycelia
stabilize micro-aggregates**

Slide courtesy: Dr. Jen Moore Kucera,
NRCS-SHD
Soil image with worm: Aaron Roth,
NRCS-OR

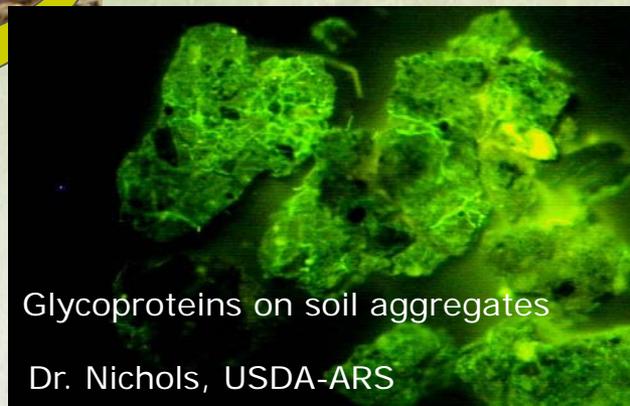
SEM photo source (accessed on 6/2/2016): Eickhorst, Thilo & Tippkoetter, Rolf. Micropedology –
The hidden world of soils. University of Bremen, Germany. <http://www.microped.uni-bremen.de>

Soil Food Web Benefits: Formation & Stabilization of Aggregates



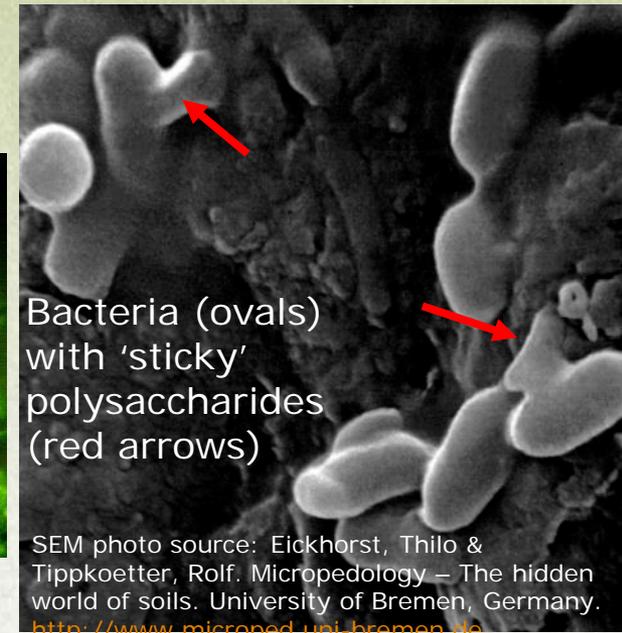
How do soil
aggregates form?

- Chemical interactions
 - Polysaccharides (sugars) and glycoproteins released by soil microbes act like glues to bind particles.



Glycoproteins on soil aggregates

Dr. Nichols, USDA-ARS



Bacteria (ovals)
with 'sticky'
polysaccharides
(red arrows)

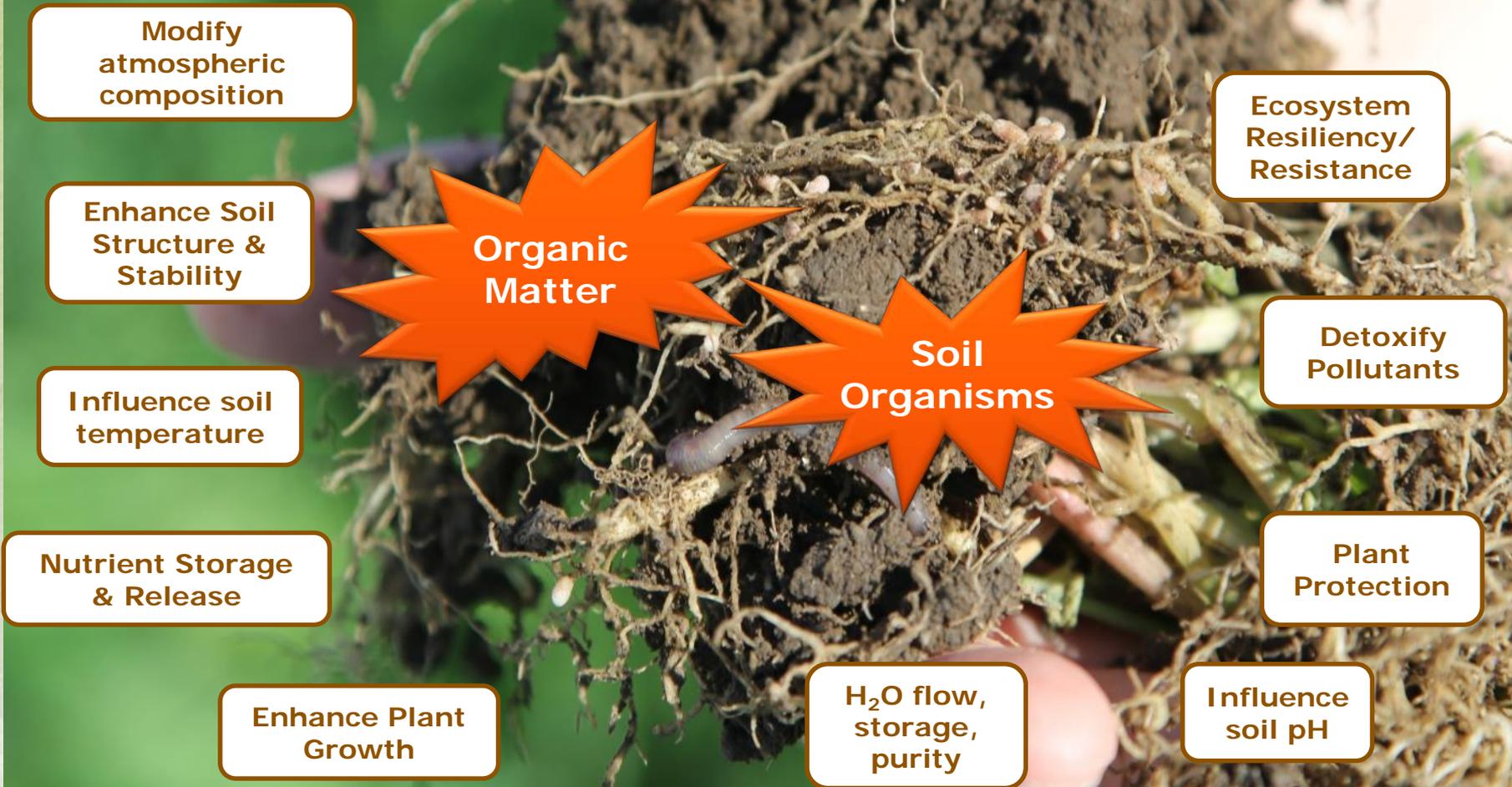
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Soil image with worm: Aaron Roth, NRCS-OR

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Inputs and land-use decisions that help provide habitat and food for soil organisms → healthy soils





“The formation and maintenance of a high degree of aggregation is one of the most difficult tasks of soil management, yet it is also one of the most important, since it is a potent means of influencing ecosystem function.”

Brady & Weil

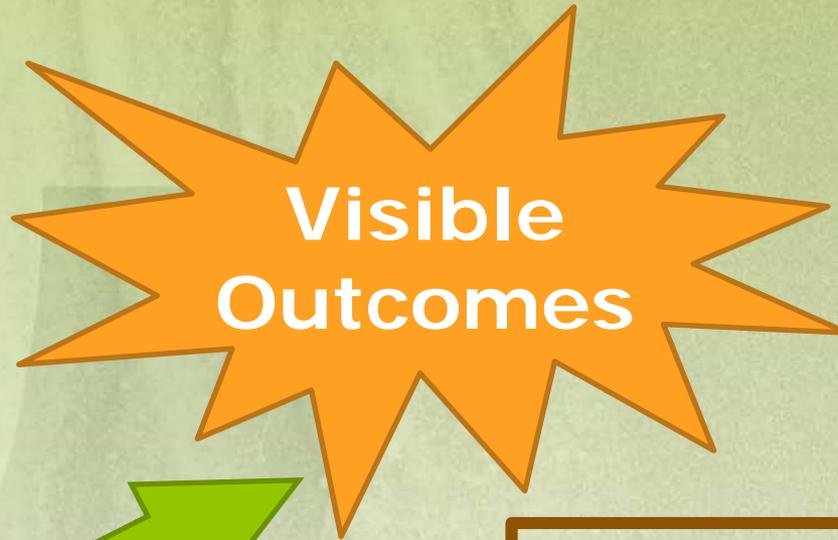
AGGREGATE STABILITY DEMO

In case you weren't convinced how awesome aggregates are.

Soil Aggradation Climb



- Jerry Hatfield
USDA-ARS 2004
– Build soil by
biological
activity not
chemical or
physical
manipulations

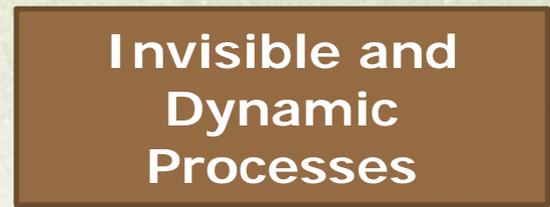


Improved AWC

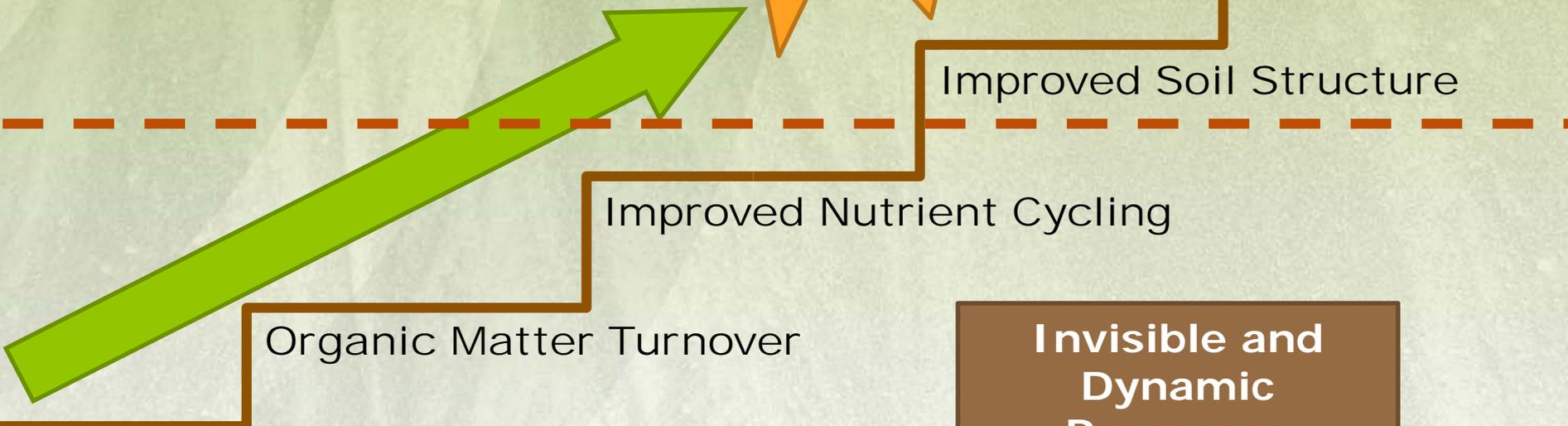
Improved Soil Structure

Improved Nutrient Cycling

Organic Matter Turnover



Biological Activity





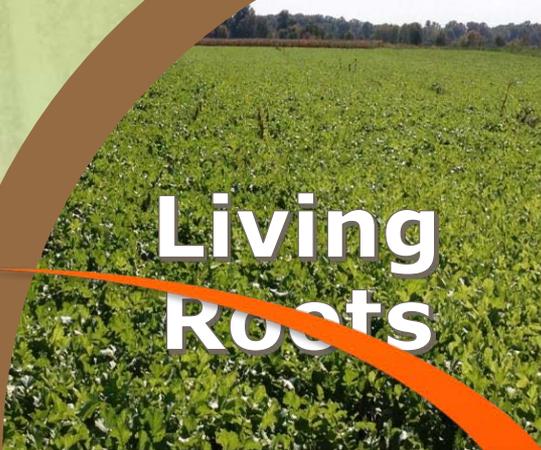
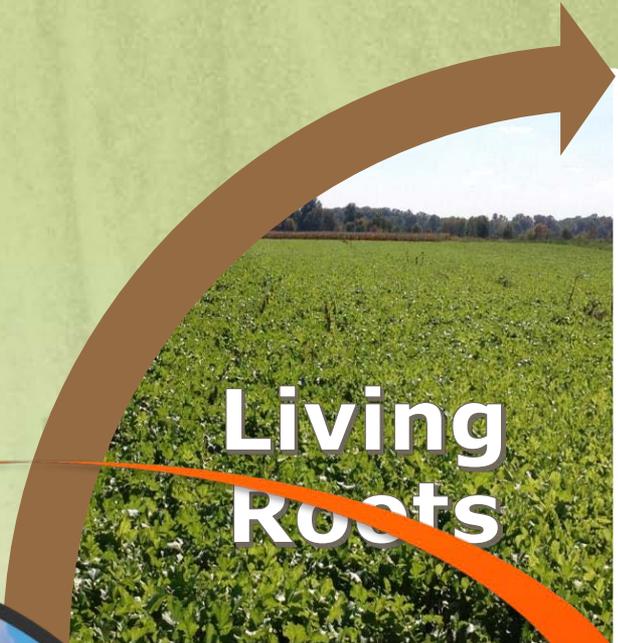
MANAGEMENT PRINCIPLES FOR HIGH FUNCTIONING SOIL

How we make it happen!

Principles of High Functioning Soils



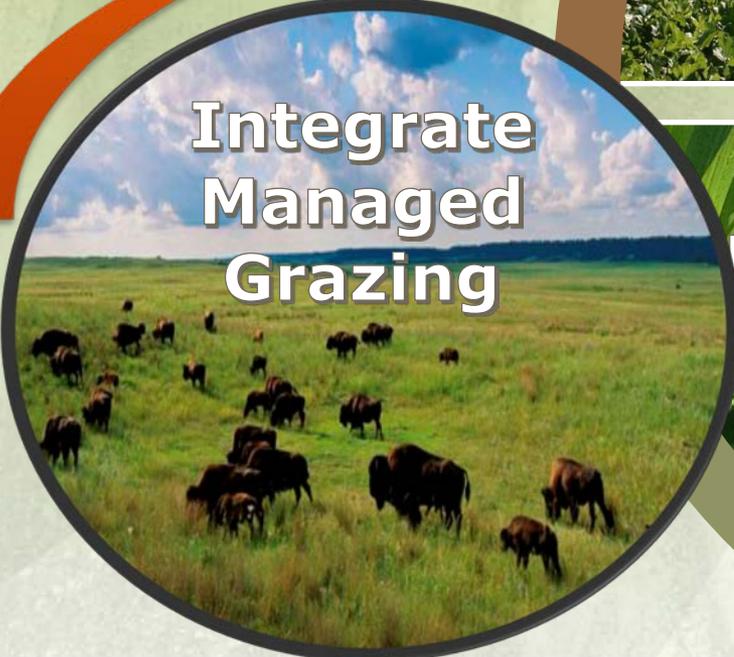
Principles of High Functioning Soils



**Living
Roots**



**Minimize
Disturbance**



**Integrate
Managed
Grazing**

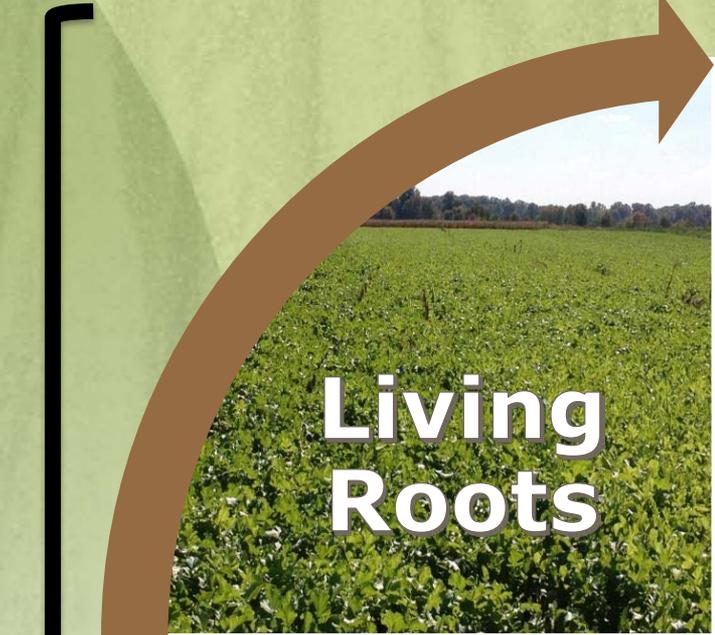


**Maximize
Diversity**



**Maximize
Soil
Cover**

FEED



**Living
Roots**



**Maximize
Diversity**



**Minimize
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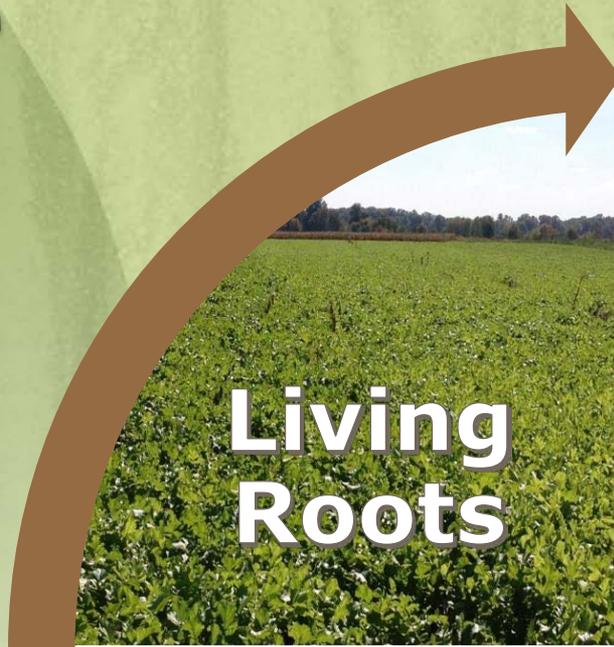


**Maximize
Soil
Cover**



PROTECT

FEED



KEEP THE CARBON FLOW

- Forage-Biomass Planting
- Crop Rotation
- Cover Crops
- Perennial Crops



ABOVE FOR BELOW

- Cover Crops
- Crop Rotation
- Rotational Grazing
- Integrated Pest Management

MINDFUL DISTURBANCE

- Timing and Depth
- Equipment Choice

- Control Travel
- Buffer Strips

- Reduced Tillage
- No-Till



JUST SAY NO TO NAKED

- Cover Crops
- Mulching
- Residue Management

- Forage and Biomass



PROTECT

Integrate Managed Grazing



- Turning cattle out to graze in harvested fields was once a common practice.
- Now grazing covers
- Now using short, intense grazing events
- These have the potential to improve the soil health and utilize any remaining nutrients

Integrate Managed Grazing



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- Now grazing covers
- Now using short, intense grazing events
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**Cattle as catalysts
for carbon!**

Integrate Managed Grazing



Soil Health Principle

Orchard Management Practices

MAXIMIZE COVER

- Cover crop between rows
- Mulch in tree row

MAXIMIZE DIVERSITY

- Think between the rows

MINIMIZE DISTURBANCE

- No-till
- Conservation tillage

LIVING ROOTS

- Cover crop
 - Think diversity



Soil Health Principle

Pasture Management Practices

MAXIMIZE COVER

- Proper Utilization – keep the good cover you have
- Prevent erosion on slopes

MAXIMIZE DIVERSITY

- Will depend on the animal
- A multispecies pasture mix

MINIMIZE DISTURBANCE

- Livestock distribution – Mind the concentration areas
- Create concentration areas
- Seasonal/Rotational grazing
- Minimize hoof shear

LIVING ROOTS

- Proper Utilization – Let the plant maintain its root system

MANAGING FOR THE PRINCIPLES

Diversity



Covered



PROGRESS!



Living Roots



Disturbance

Diversity



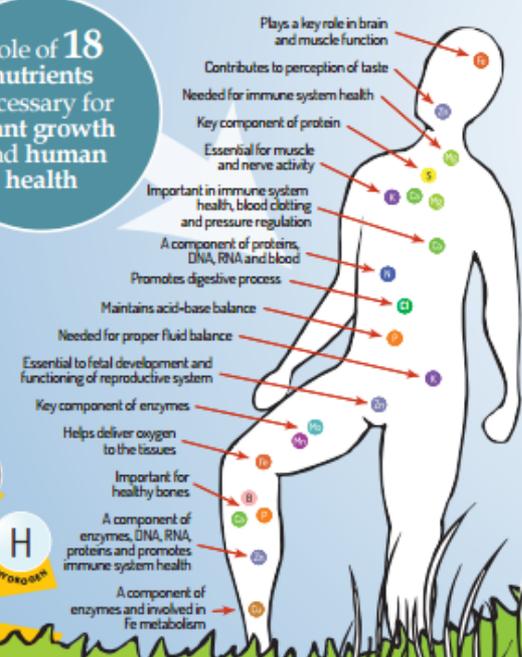
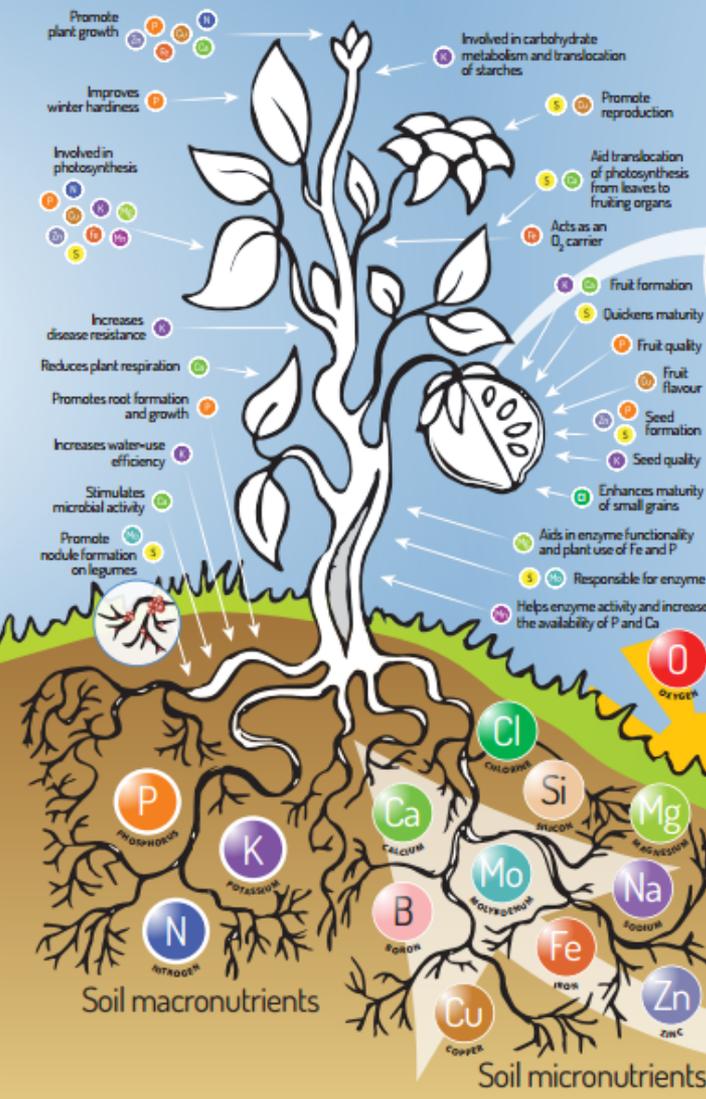
**Scale and
Management
Opportunities!**



Disturbance

Soil the foundation of nutrition

Role of 18 nutrients necessary for plant growth and human health



Soil degradation leads to the loss of soil micro and macronutrients

Nutrient-poor soils are unable to produce healthy food with all the necessary nutrients for a healthy person

Over 2 billion people suffer from micronutrient deficiencies

Increase soil organic matter content

Minimize tillage

Keep soil surface covered

Reduce erosion

Sustainable soil management for healthy soils, healthy food and healthy people

Ensure crop rotation

THANKS!



unlock the
SECRETS
IN THE SOIL

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