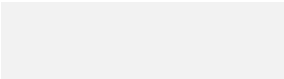




Cover crops and soil health: Setting the stage

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NRCS Soil Health Division



Why do we use cover crops?



Farmers' Top Three Reasons for Cover Crop adoption:

- Increase soil organic matter
- Reduce erosion
- Suppress weeds



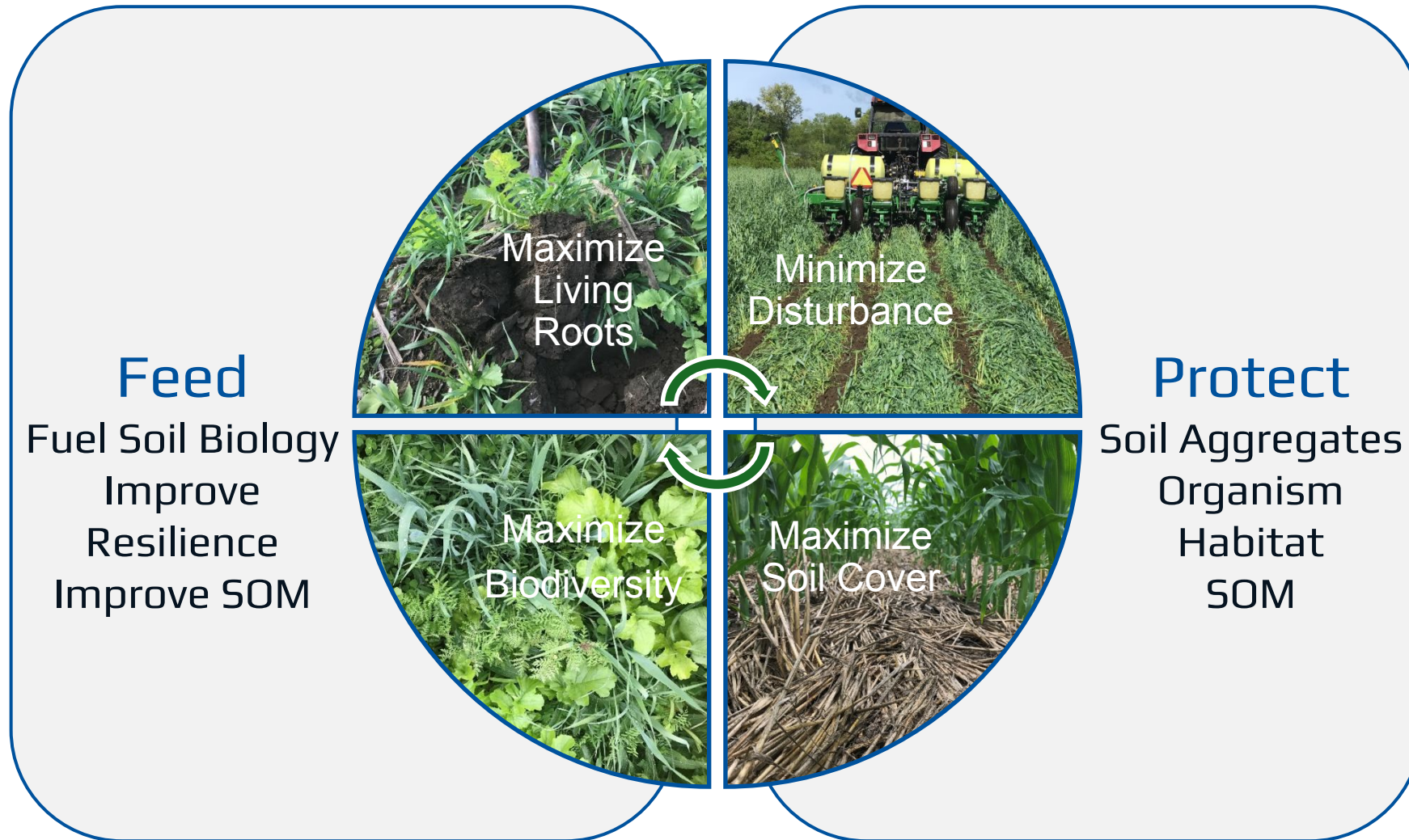
Cover crops and Soil Health

Soil health definition:

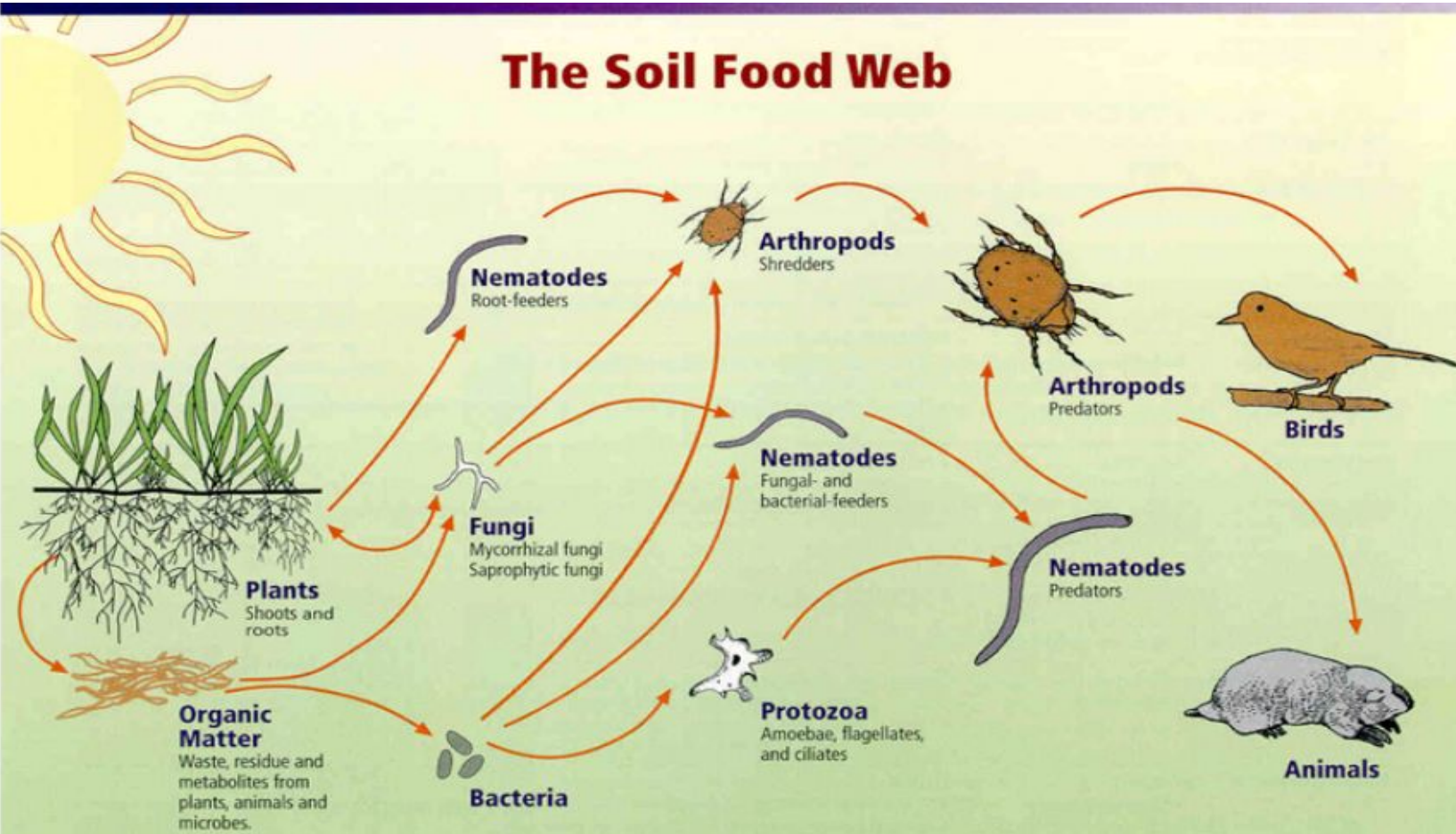
The continued capacity of the soil to function as a vital living ecosystem that sustains plants, animal and humans.



Four simple principles to foster soil health for high functioning soils:



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

Relationships between soil food web, plants, organic matter, and birds and mammals
 Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html

Organic matter: Sources, forms, functions

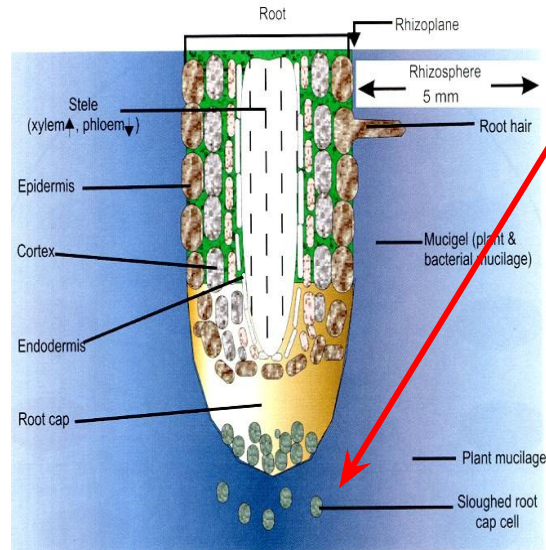
- -Classical view of soil organic matter-
 - Three main categories of soil organic matter:
 - *Living*
 - *Root exudates and recently dead*
 - *Long dead*
 - **Living**—still active plant/ animal/ microbial tissue.
 - **Root exudates and recently dead:**
 - *Fuel for the soil foodweb*
 - **Long dead:** Stable OM (“humus”)
 - Holds and exchanges water and nutrients
 - *The question: Does “humus” really exist???*

Plant roots are at the heart of developing soil structure

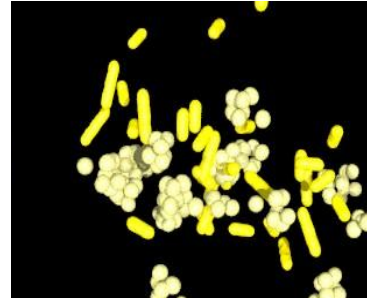
- Structure = aggregation: grouping soil particles
- Good aggregation = high porosity
- High porosity = good water and air movement, root development, and biological diversity
- **Protects soil minerals, organic matter, nutrients, and water**
 - **Protected organic matter = stable organic matter (“humus”)**



Plant Roots Attract Microbes



Exudates: carbohydrates and proteins secreted by roots; attract bacteria which nematodes & protozoa consume, which mineralize nutrients for plants.



Bacteria and fungi are like little fertilizer bags



Nematodes and protozoa consume microbes and excrete plant available nutrients

Root exudates and turnover: Bring on the roots!



Muruganandum, 2005



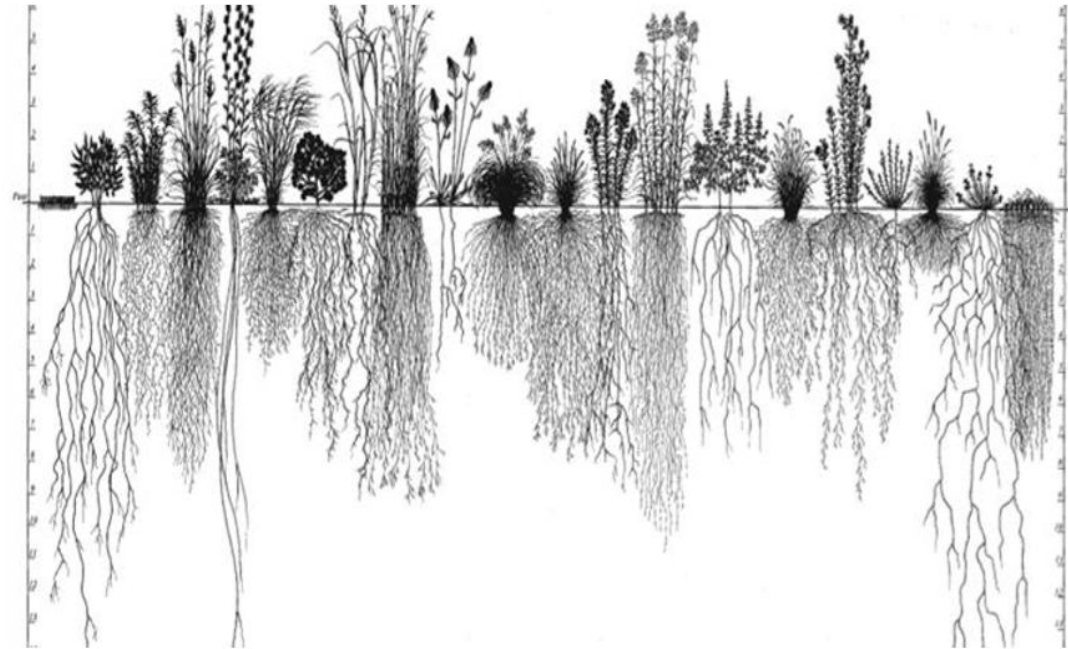
AMF on corn root with hyphae and spores.
Green dye indicates glycoprotein production

Roots are
Amazing!



Root architecture

Diversity of Plants



Provides Diversity in Roots

A Quantitative Study

the Roots and Root Hairs of a Winter Rye Plant (*Secale cereale*)

Howard J. Dittmer, 1937. Amer. J. Botany. 24 (7): 417-420

Table 1. Roots

Root Categories	Number of roots per unit*	Total number of roots by categories	Average length (inches)	Total root length by categories (feet)	Total root surface, by categories (sq. feet)
Main	1.0	143	18.0	214.50	1.53
Secondary	249.0	35,607	6.0	17,803.50	45.06
Tertiary	16,060.5	2,296,651	3.0	574,162.75	758.60
Quaternary	80,302.6	11,483,271	1.5	1,452,075.60	1,748.90
TOTALS	97,613.1	13,815,672		2,044,256.50	2,554.09

*A unit includes one main root with all secondary, tertiary, and quaternary roots. There were 143 such units on this plant.



Cover crops promote soil health in many ways!

- Crop diversity (habitat)
- Soil surface armor (erosion)
- Build stable soil aggregates
- Improve water cycle/ availability
- IPM/beneficial insects
- Build or improve soil organic matter
- Nutrient cycling/ efficiency
- Air Quality
- Adjust carbon/nitrogen ratios
- Wildlife winter food & shelter
- Livestock integration

Four simple principles to foster soil health for high functioning soils:

