Soil Not Just A Dirty Word:

Exploring the Mysteries of Managing Soil Biology

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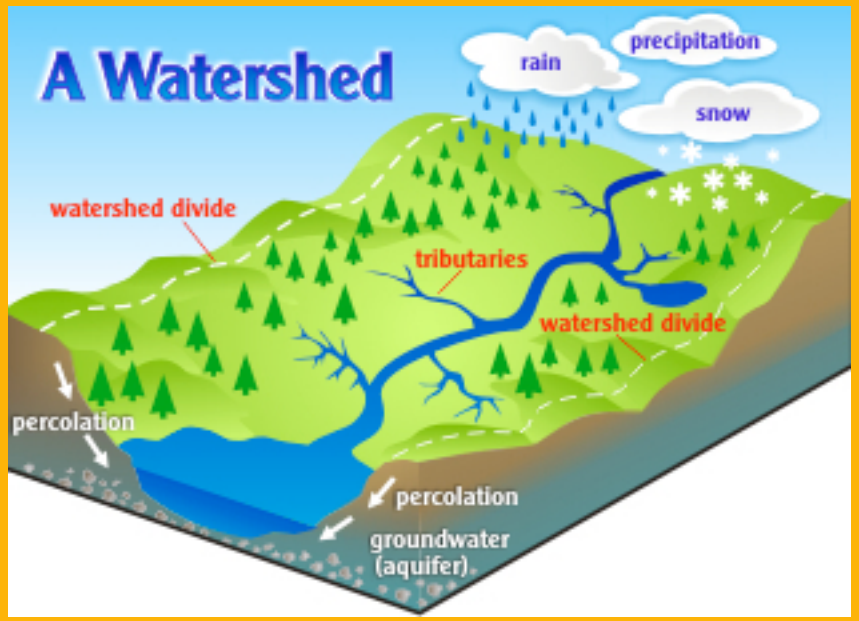
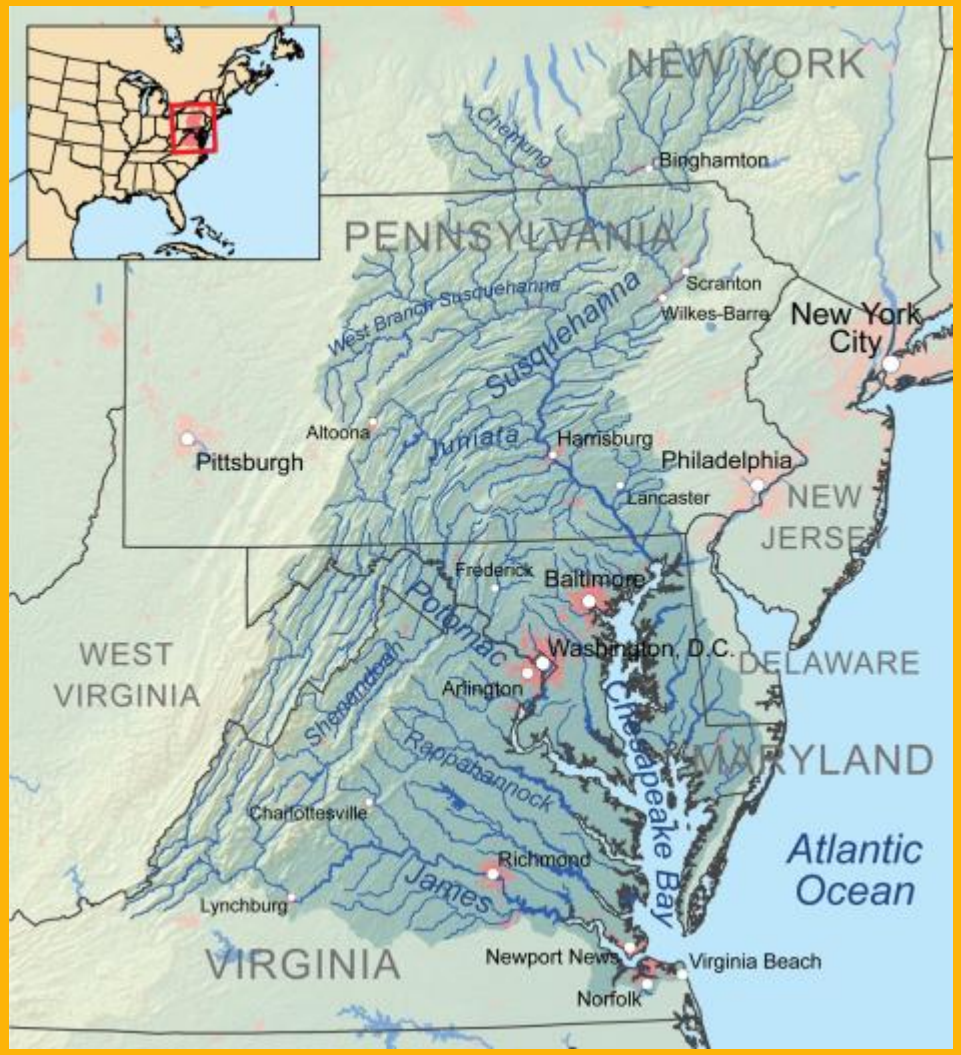
Bay-Friendly Landscaping

- We work in watershed
- From ridge top

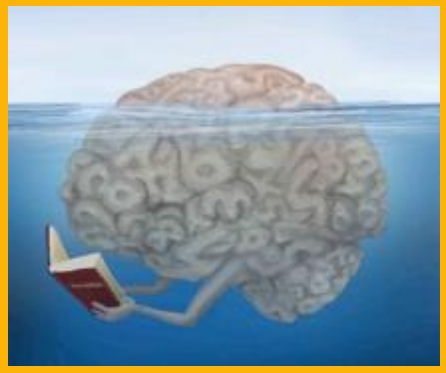
  to the bay's bottom





Bay-Friendly Landscaping

- Watershed approach
- Brock Dolman
  - Starts with headwaters in our heads
  - Infiltrate information into the Ego-system
  - Pro-life & pro-biotic not anti-biotic
- Luna Leopold
  - “The health of our water is the principle measure of how we live on the land”
- Would you drink the water out of your local creek, river, or stream?



Estuary Health Issue

- Chesapeake Bay watershed
- Turfgrass is Maryland's biggest crop
  - Estimate 80 million pounds of N annually
- Excess nitrogen & phosphorus contamination
  - Bacteria endangers human health
  - Algae blooms, kills fish
  - Habitat degradation
- Source: Urban landscapes
  - 10-17 percent nitrogen
  - 30 percent phosphorus

Fertilizer Pollution Facts

- Caused by misunderstanding of soil function
- Challenge: Meet plants nutrition needs while eliminating nutrient runoff and leaching
- We must learn & comprehend soil food web
- Proper soil management will
  - Create healthy, pest resistant plants
  - Reduce - eliminate fertilizer runoff/leaching
  - Reduce pesticide use/pollution
  - Yield a cleaner Chesapeake Bay

A Healthy Soil

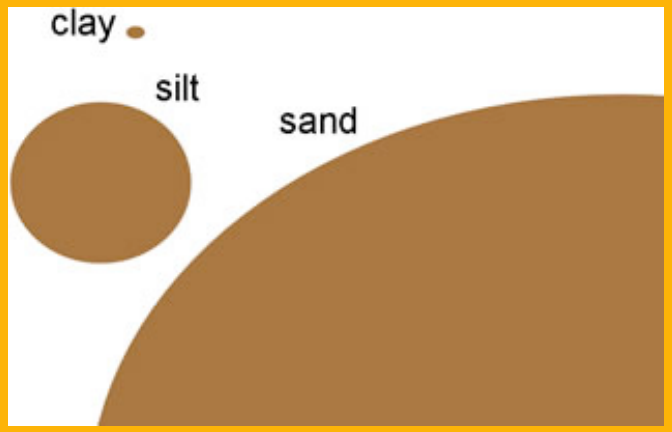
- Diverse Ecological System
  - Soil food web
- Nutrients
  - Available and in balance
  - Proper form and proper location
- Organic matter & humus
- Favorable pH
- Good soil structure
- Yields healthy pest & drought resistant plants
- Unhealthy soil = pest & pollution problems

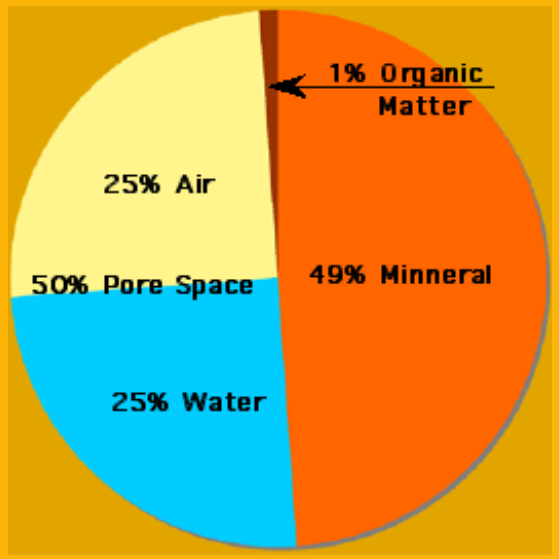
Sassafras Maryland state soil

Know Your Soil

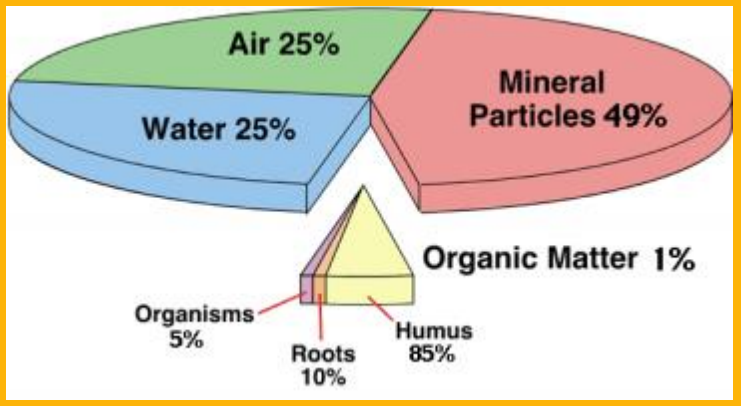
Soil is:

- 45-49% Mineral Matter
  - Sand, Slit & Clay
  - Texture = percentage
    - Do not alter soil texture
- 50 % Pore Space
  - 25% Water
  - 25% Air
  - *Roots grow in pore space*
- 1-5% Organic Matter…..
  - (*5-10% is desirable*)



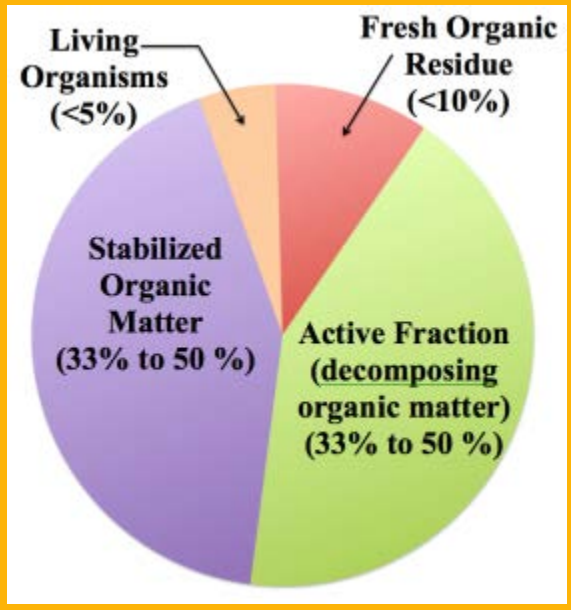


Know Your Soil



1-5% Organic Matter…..

- 85% Compost/humus
- 10% Roots/fresh residue
- 5% Living Organisms - The Key!
  - They make everything work
  - 40% Bacteria & Actinobacteria
  - 40% Fungi & Algae
  - 12% Earthworms
  - 8% Other

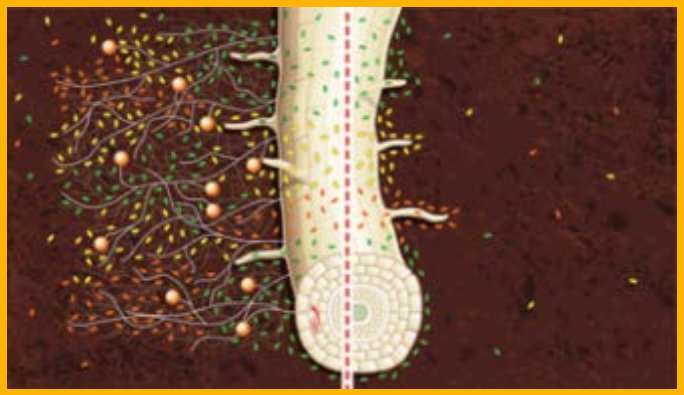


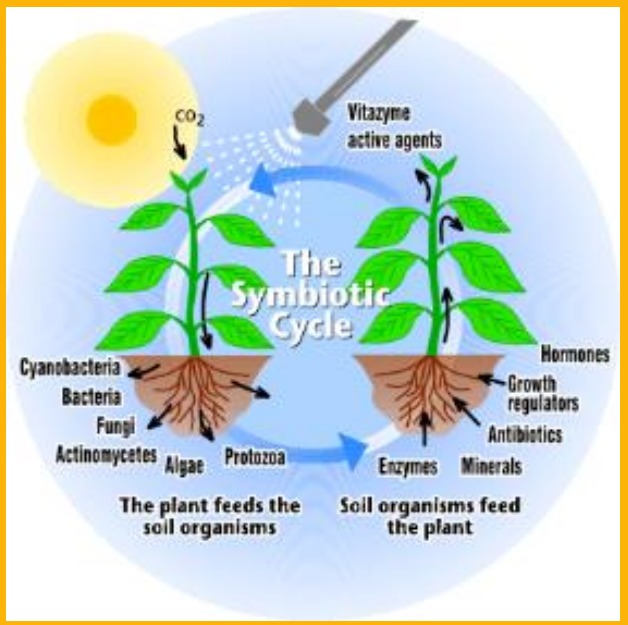
Know Your Soil: Rhizosphere

Area of soil surrounding plant roots alive with beneficial soil organisms

Soil microorganisms provide plants

- Water & nutrients
- Hormones
- Plant growth regulators
- Pest management
- Help plants communicate

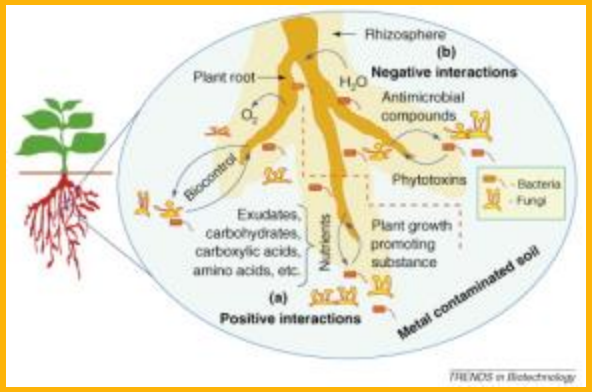




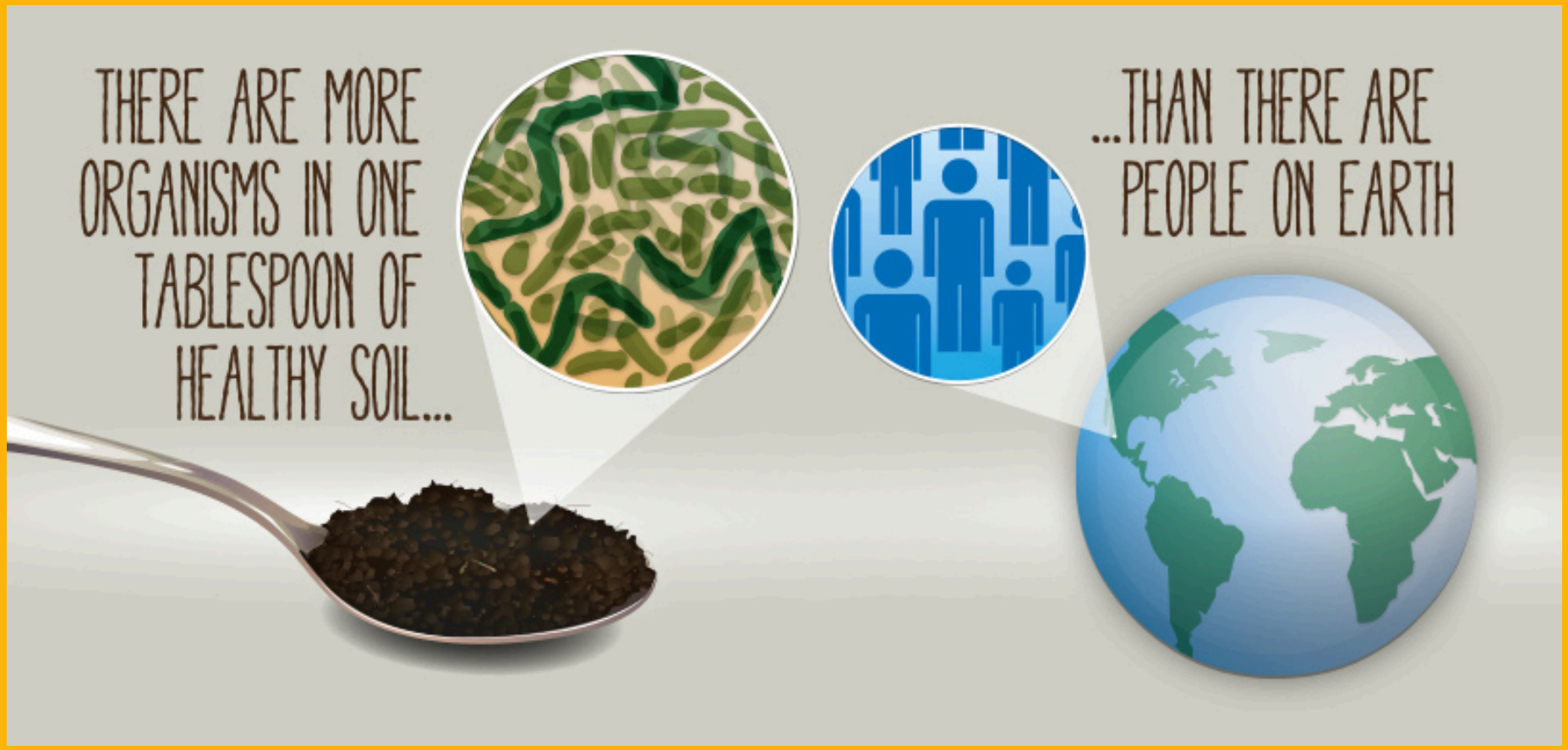
Know Your Soil: Rhizosphere

Root stimulate soil biology with exudates:

- 10-40% plant energy feeds soil biology
- Proteins, sugars, carbohydrates
  - Cakes & cookies: eggs, sugar, flour
- Stimulate beneficial microbes
- Discourage pest microbes
- Organic acids
- Allelopathic chemicals
- Whatever they need at the time
- Varies through seasons



The “Real” Landscapers: Members of the Soil Food Wed



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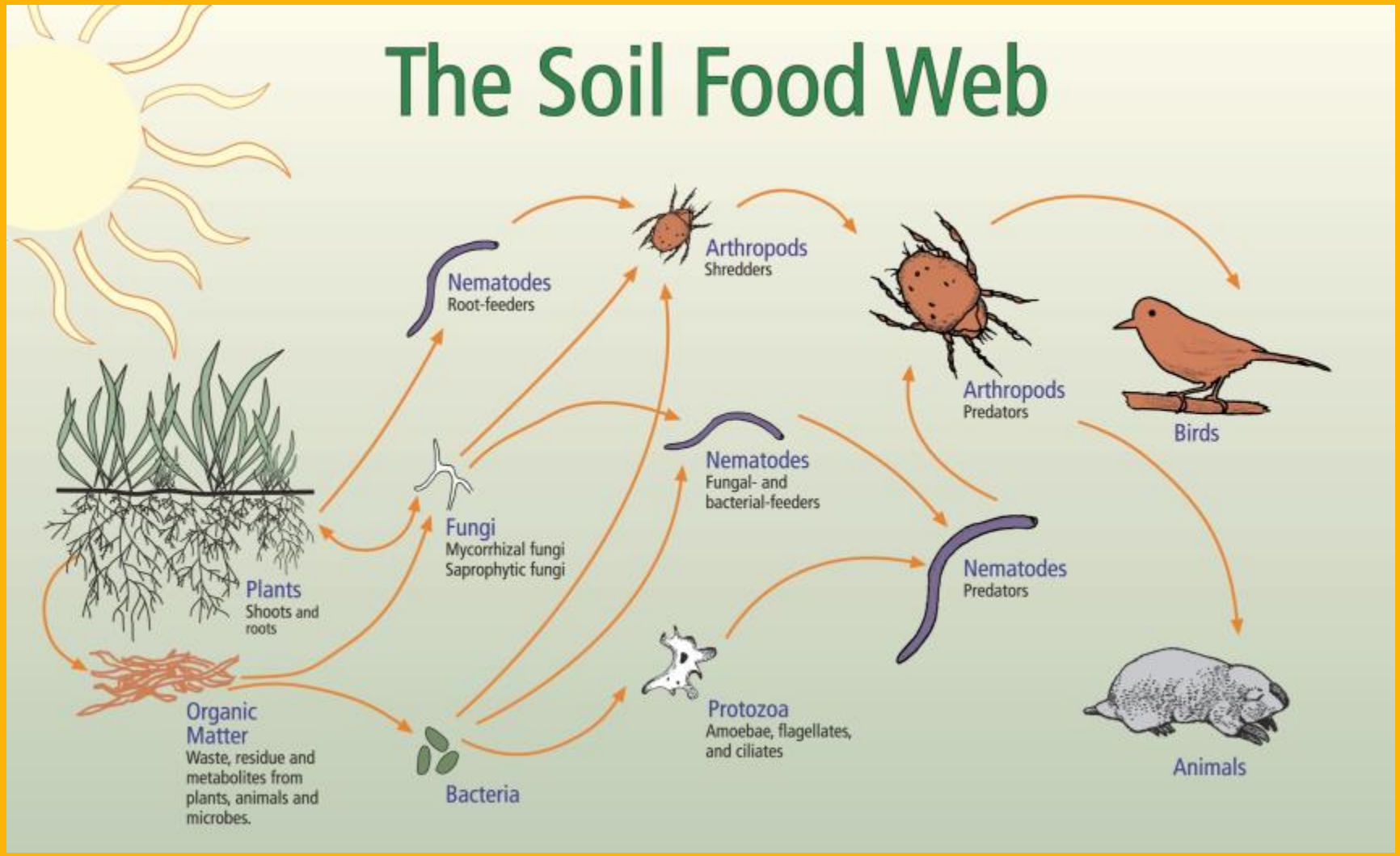
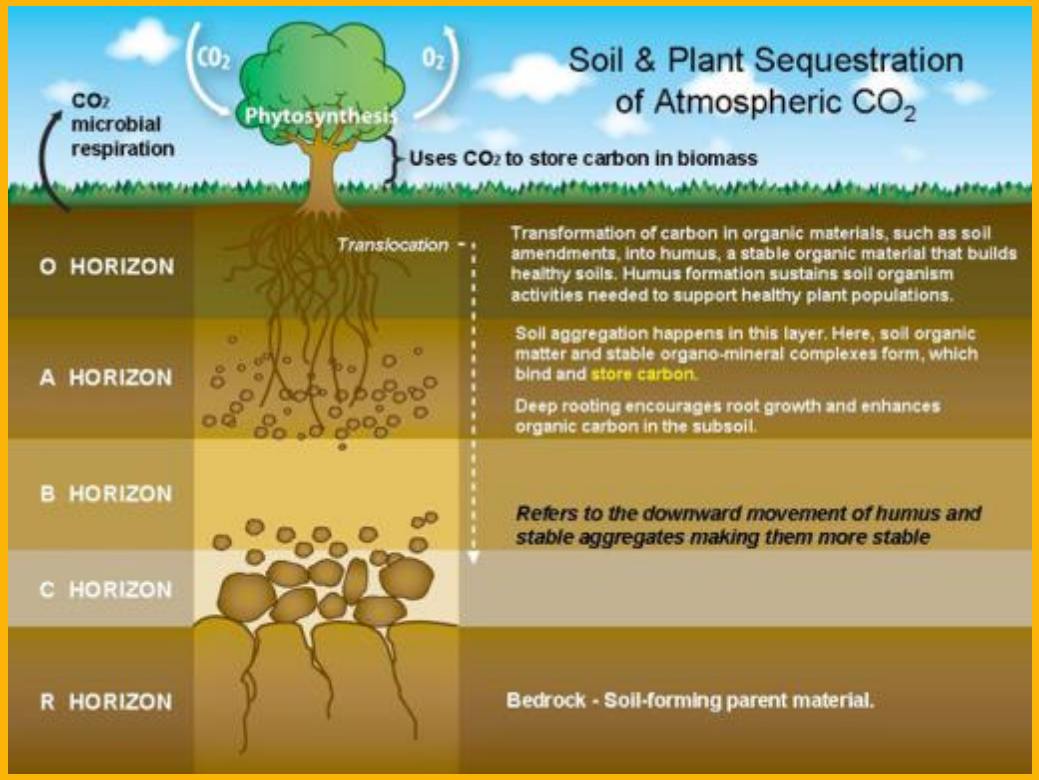


Slide courtesy of USDA NRCS

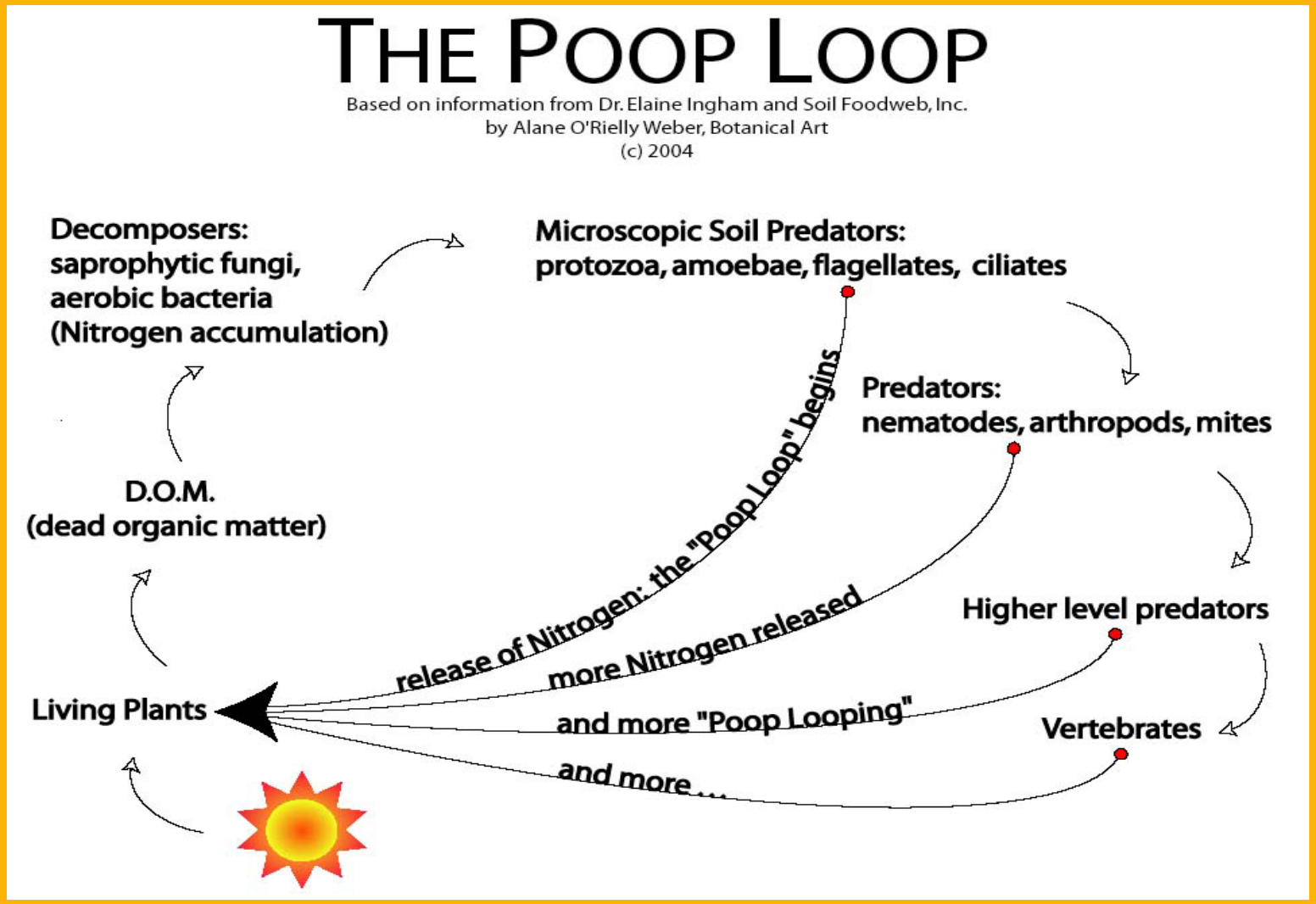
Soil Biology & Climate Change

Increase in organic matter

- 1% increases available water by 3.7 percent
- 2% sequesters carbon - reverses global warming



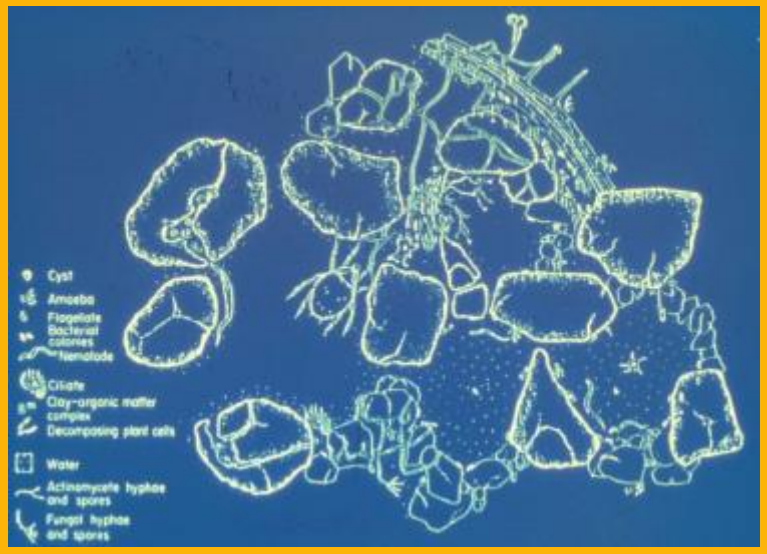
Soil Food Web Nutrient Cycling



Soil Food Web Benefits

Improve soil structure

- Particles bound together – peds
- Different size pores
  - Large – air storage
  - Medium – water storage
  - Small – biological shelter
- Improved soil aeration
- Transplant survival

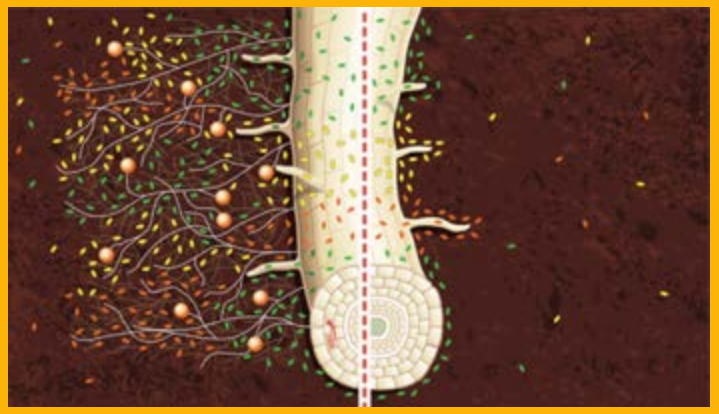


Slide courtesy of Dr. Elaine Ingham

- Improved water, root, nutrient, organism mobility
- Reduce runoff, erosion, sedimentation, leaching
- Reduce water related diseases

Soil Food Web Benefits

- Make nutrients available for plants
  - Decompose organic matter
  - Manufacture nitrogen
  - Nutrient reservoir
  - Produce plant growth hormones
  - Right place at right forms at right time
  - Improving plant fertility
- Improved water storage, utilization, quality
- Buffer imbalances, toxicities, deficiencies
- Prevent/eradicate pests
- Decompose toxins



Rhizosphere

Your Soil Food Web

Algae

- Teaspoon of soil
  - 10,000 to 100,000 cells of blue green algae
- Soil Pioneers
  - Break down rocks into soil
- Nutrient accumulator
  - Fix nitrogen
  - Liberate growth-promoting substances
    - Phosphates
- Improve soil structure
- Contain chlorophyll
  - Photosynthesize their own food
  - Contribute vast amounts of organic matter

Your Soil Food Web

Bacteria

- Nitrogen factories
  - Nitrogen fixers
  - Decomposers
- Nutrient accumulator
- Dissolve minerals (P)
- Teaspoon of soil contains up to 1 billion
  - Weight in one acre of soil = a cow or two

Your Soil Food Web

Bacteria

- Produce plant growth hormones
- Improve soil structure
  - Glues sand, silt, clay & organic matter together
  - Improve air/water/root movement
  - Improve water holding capacity

- Suppress disease & decompose toxins
- *Mycobacterium vaccae* makes you happy

Your Soil Food Web

Actinobacteria

- (Actinomycetes)
- Billions in teaspoon of soil
- Make soil - decompose OM
- Nutrient accumulator
  - Liberate nitrogen from OM
- Antibiotics
  - Spinosad
- Cause soil odor

Your Soil Food Web

Frankia

- Strange growth on roots of:
  - Alder, birch, bayberry, myrtles
  - California natives
- Live in root nodules
- Nutrient accumulator
  - Nitrogen fixer (non-legumes)
- Responsible for 15% of all biologically fixed nitrogen
- Supply most of plants N needs

on alder

Your Soil Food Web

Frankia

- Feed & protect plants & soil food web
  - Pathogen & nematode control
  - Water retention
  - Root hormones, nutrient mining
- Without frankia
  - Plants short-lived
    - Due to pathogen

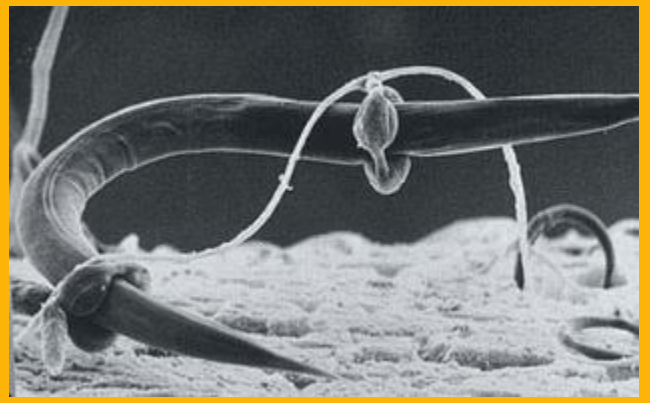
on ceanothus

Nodule on Buffaloberry

Your Soil Food Web

Fungi

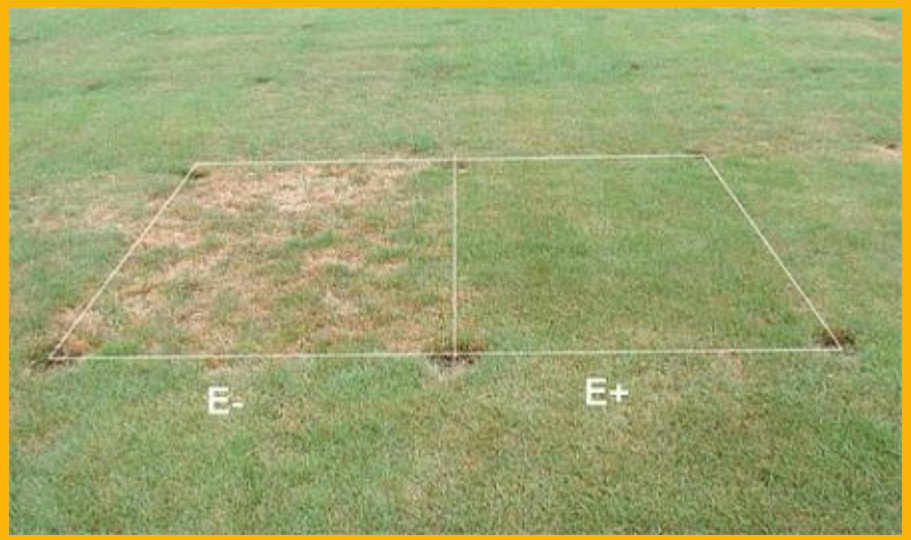
- Teaspoon of soil: several yards of hyphae
- Most beneficial
- Improve soil structure
  - Stands tie soil particles together
  - Improve air/water/root movement
  - Improve water holding capacity
- Decompose OM
- Nutrient accumulator
- Disease/Pest suppression



Your Soil Food Web

Fungi

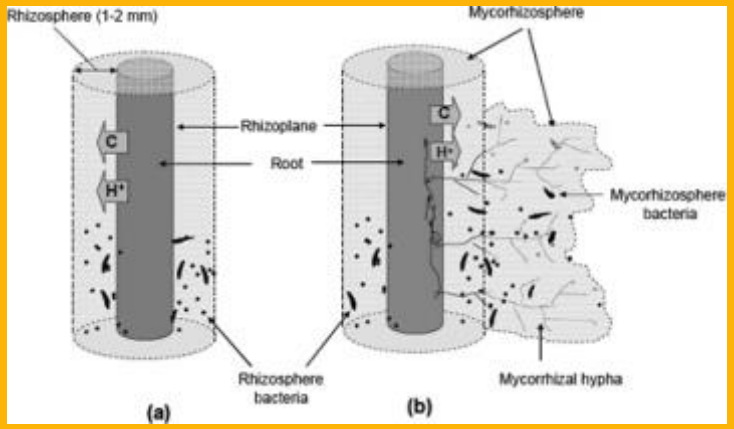
- Endophytes
  - Resistance to:
    - Drought
    - Insects
    - Stress



Your Soil Food Web

Mycorrhizal fungi

- Nutrient accumulator
- Miles of threads in a thimble of soil
- Extend area of water & nutrient absorption
- Release enzymes that make N, P, iron available
- Help plants out compete weeds




Scots Pine before adding mycorrhizal component and after.

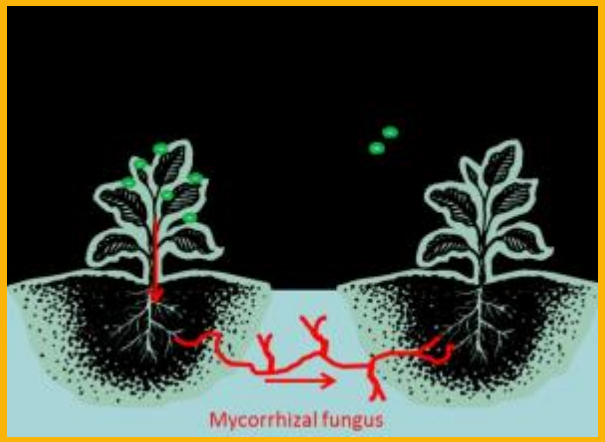
Your Soil Food Web

Mycorrhizal fungi

- Symbiotic relationship with plants
- Exude glues that form structure
- Helps plants communicate with each other
- Can add mycorrhizal fungi

Golf green without mycorrhizae

Golf green with mycorrhizae

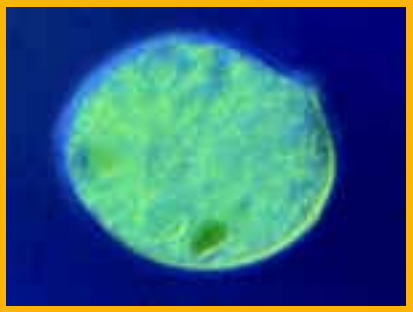


Your Soil Food Web

Protozoa

- Teaspoon of soil - several thousand
- 60,000 different varieties
- Flagellates, Amoebae, Ciliates
- Aerate soil: make large soil pores
  - Push soil around
- Nutrient disperser
- Food source for other microbes
  - Nutrient cycling

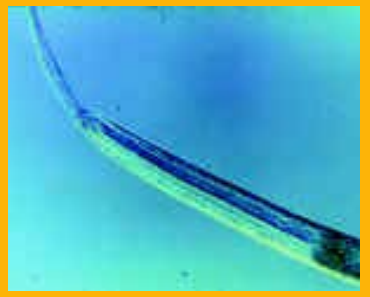
Flagellates



Ciliates

Your Soil Food Web

Nematodes



- 20,000 species
- Teaspoon of good garden soil
  - 20 eat bacteria
  - 20 eat fungi
  - 3 predatory
  - 3 plant eating

- Create large pore spaces

Your Soil Food Web

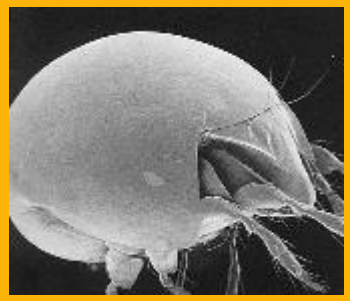
Nematodes

- Pest protection
- Nutrient disperser
- Disperse soil biology
- Food source for other organisms
- Disease suppression & development

Your Soil Food Web

Arthropods & Microarthropods

- Shredders, predators, herbivores, fungal feeders
- Breakdown organic matter
- Stimulate microbial activity
- Nutrient disperser
- Aerate soil by burrowing
- Control pests



Your Soil Food Web

Earthworms

- Manufacture fertilizer
- Mix & aggregate soil
- Incorporate organic matter --->
- Increase infiltration
- Improve water-holding capacity
- Provide channels for root growth

- Stimulate microbial activity
- Disperse soil biology
- Create favorable environment for other organism

Your Soil Food Web

Earthworms romance

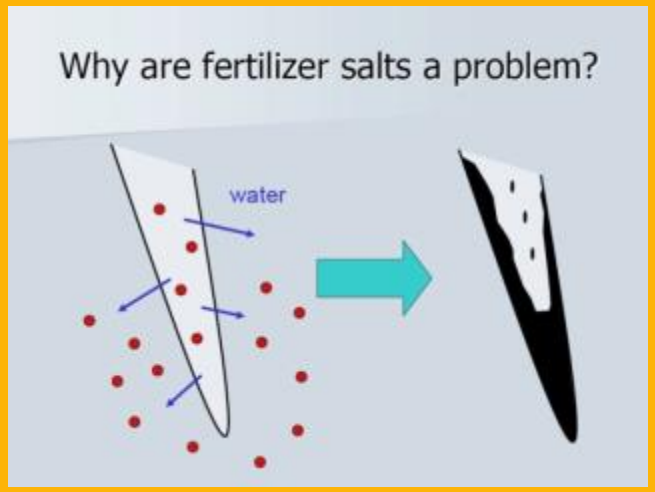
Fertilizer Choices

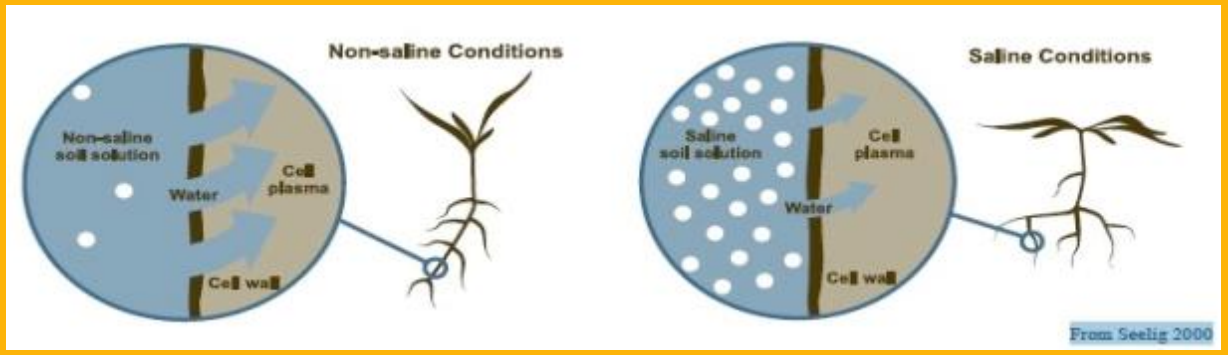
- Synthetic or
  Natural Organic
- Does the plant know the difference?
- Does the soil food web know the difference?

"So, Jack, did you use compost or chemical fertilizers?"

Fertilizer Issues: Salt

- High salt fertilizers
  - Raw manures
  - Most synthetic fertilizers
  - Affinity for water
    - Dehydrates plant roots & soil biology
    - Causing wilt & death
    - Creates deficient soil food web
- Low salt fertilizers
  - Natural organic fertilizers
  - Safe for roots and soil food web
  - Feeds soil life

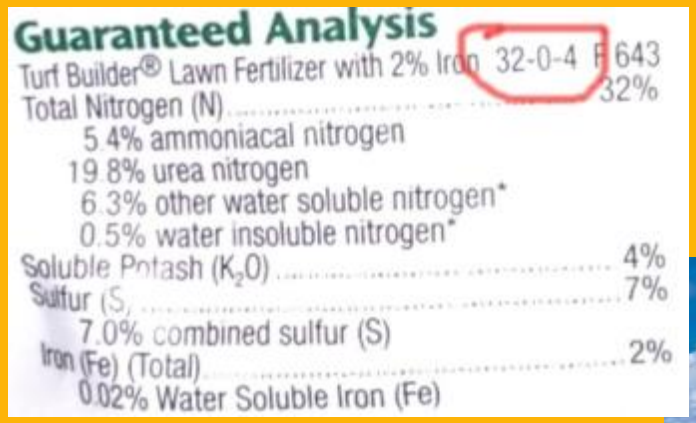


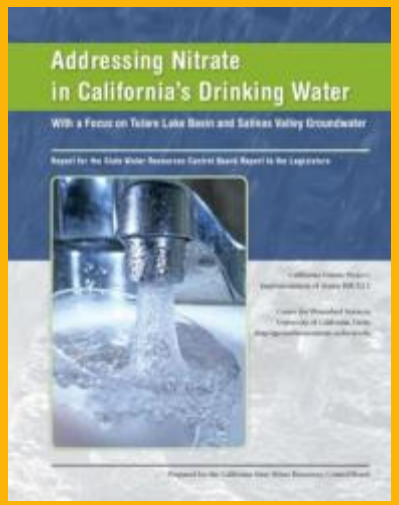


Fertilizer Issues: Solubility

Water soluble nitrogen

- Synthetic fertilizers
- Raw manures
- Runs off soil surface
  - Infiltration problem
- Not held in soil
  - Leaches below root zone
  - Short duration of action
  - Requires frequent applications
- Contaminates waterways
- Only 2-3% may reach plant
- Encourages excessive week plant growth
  - Pest susceptible
- Stimulates weed seed germination

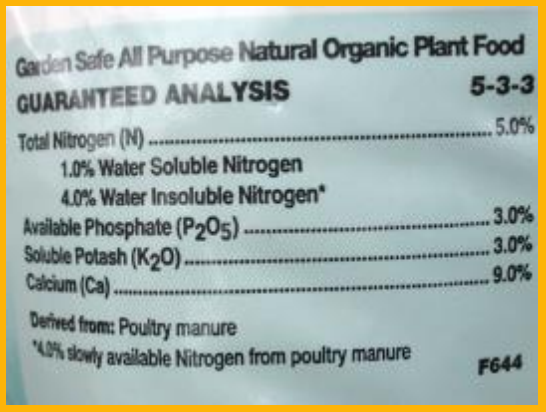


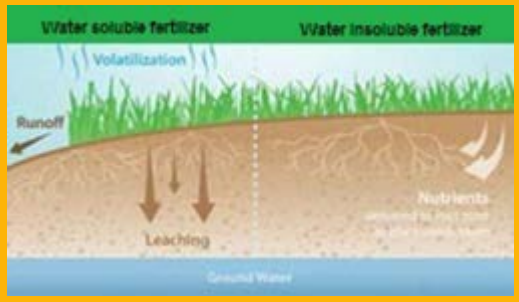


Fertilizer Issues: Solubility

Water insoluble nitrogen (WIN)

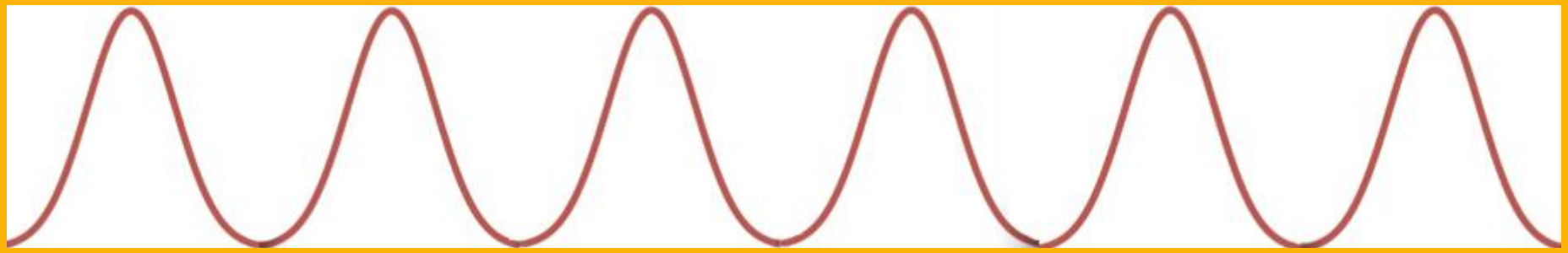
- Organic sources
- Minimal runoff
- Feeds beneficial soil organisms
  - Improves soil structure
  - Nutrients held for future use by plants
    - Less pollution
    - Long duration of availability
    - Apply less frequently
- Encourages normal plant growth
  - Pest resistant





Fertilizer Issues: Solubility

Water soluble nutrient availability applied monthly



March April May June July August Sept.

Water insoluble fertilizer availability applied in March

Fertilizer Issues

Characteristics of Nitrogen (N) Fertilizers							
Fertilizer Name	**Analysis**	**Source of N**	**Moisture Dependence**	**Low Temperature Response**	**Residual N Activity**	**Salt index (per N unit)**	**Leaching Potential**
Quickly Available							
Ammonium-nitrate	33-0-0	ammonium nitrate	minimal	rapid	4-6 weeks	3.2	high
Ammonium-sulfate	21-0-0	ammonium sulfate	minimal	rapid	4-6 weeks	3.3	high
Ammonium-phosphate	18-46-0	diammonium phosphate	minimal	rapid	4-6 weeks	1.6	high
Urea	46-0-0	urea	minimal	rapid	4/6 weeks	1.6	moderate
Natural Organic fertilizers							
Ringer	6-1-3	blood, bone, feather & seed meals	high	medium	10-12 weeks	0.7	low
Suståne	5-2-4	Aerobically composted turkey litter	high	medium	10-12 weeks	0.7	low
Milorganite	6-2-0	activated sewage sludge	high	slow	10-12 weeks	0.7	low

Source: Colorado State University

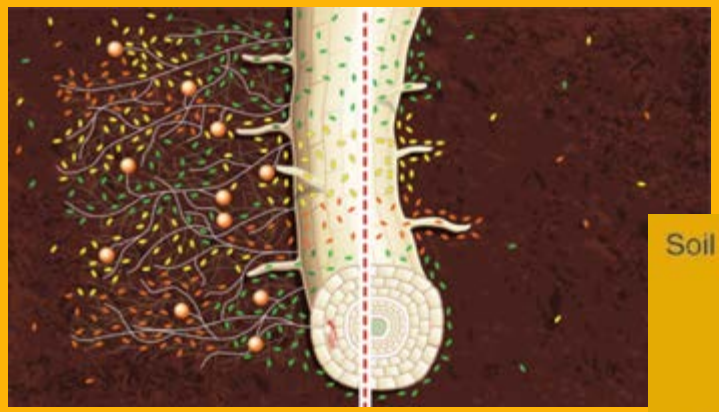
Fertilizer Issues

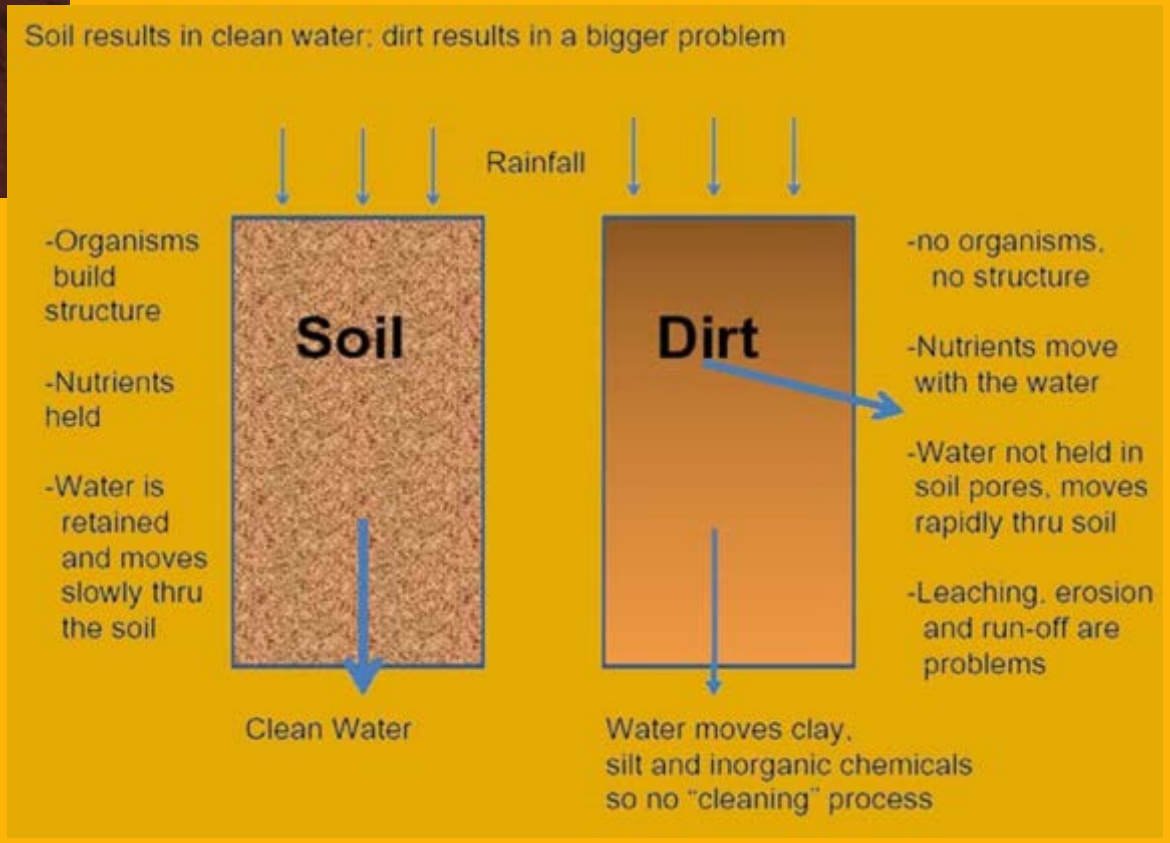
Table 1. Percentages of water-soluble and available phosphate in several common fertilizer sources.

		P_2O_5		
P_2O_5 Source	N (%)	Total (%)	Available (%)	Water soluble* (%)
Superphosphate (OSP)	0	21	20	85
Concentrated Superphosphate (CSP)	0	45	45	85
Monoammonium Phosphate (MAP)	11	49	48	82
Diammonium Phosphate (DAP)	18	47	46	90
Ammonium Polyphosphate (APP)	10	34	34	100
Rock Phosphate	0	34	38	0

*Water-soluble data are a percent of the total P2O5
Source: *Ohio Agronomy Guide*. Ohio Cooperative Extension Service Bull.472.

Living Soil vs. Dead Dirt





Slide courtesy of Dr. Elaine Ingham: Soil Foodweb Inc.

Why Do You Fertilize?

- When you apply fertilizer…
- If you are trying to feed the plants
  - Raise your hands:
- If that is you….

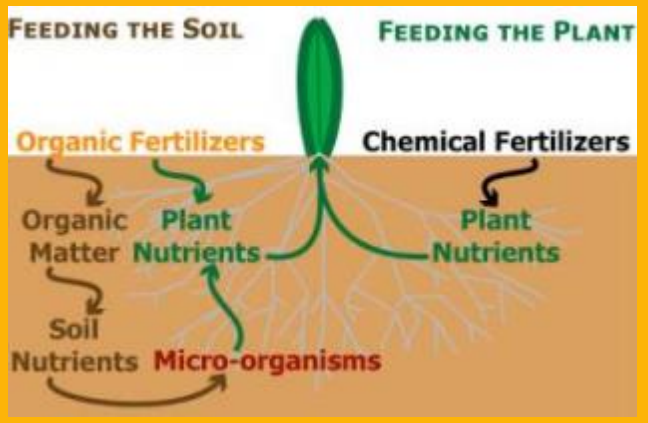
Why Do You Fertilize?

- When you apply fertilizer…
- If you are trying to feed the plants
  - Raise your hands:
- If that is you….

- **Feed the soil !**

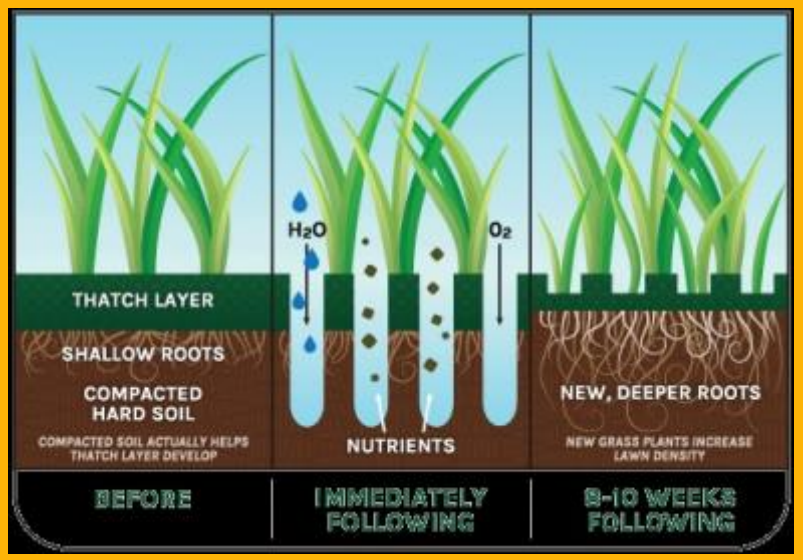
Soil Food Web Management

- Feed the soil not the plant
- Apply only organic fertilizers
  - As per soil test
  - Eliminate deficiencies, toxicities, imbalances
- Add quality organic matter
- Add beneficial soil organisms
- Proper irrigation
- Avoid synthetic fertilizers & pesticides



Soil Food Web Management

- Good drainage
  - Aerate
  - Add beneficial biology
- Minimize compaction
  - Keep off wet soil
- Minimize tillage
  - Destroys fungi
  - Destroys structure => compaction



Create A Healthy Soil Food Web

- Soil probe
- Soil test
  - Kits
  - Labs
- Choosing a lab
  - Test for:
    - N,P,K, pH, OM, CEC, excess lime ,
    - Soluble salts, calcium, magnesium, sulfur, copper
    - Sodium, manganese, boron, zinc, iron, texture
  - Recommendations
    - Organic
    - Landscape/garden
    - Usefulness

Typical Soil Report

XYZ Lavoratory
Soil Analysis

Somewhere, California
(888) 555-5555

GROWER: You	DATE OF REPORT: Today	REPORT# 491919164

SAMPLE NUMBER	LAB NUMBER	ORGANIC MATTER	PHOSPHORUS P	POTASSIUM K	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	SOLUBLE SALTS
000	55555	1.5	25	98	498	1200	110	2.3

NITRATE NO_3-N	pH	C.E.C.	SULFUR SO_4-S	ZINC Zn	MANGANESE MN	IRON FE	COPPER Cu	BORON B	EXCESS LIME	SOIL TEXTURE
8	7.5	H	7	7.5	4	62	1.6	0.3	L	Sandy Lame

RECOMMENDATIONS BY Someone Not Knowledgable

Your soil ain't so good. Add some synthetic fertilizer.

Living Resources Company

Organic Horticultural Professionals

P.O. Box 76
Citrus Heights, California 95611
(916) 726-5377
E-Mail: bugs@organiclandscape.com
www.organiclandscape.com/services

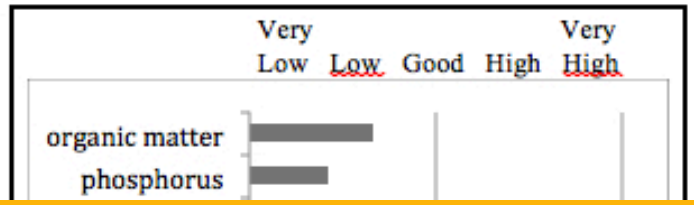
GROWER: Your Name Here	DATE OF REPORT: 4/20/14	REPORT NUMBER: 14-078-045

SAMPLE NUMBER	LAB NUMBER	ORGANIC MATTER	PHOSPHORUS P	POTASSIUM K	MAGNESIUM Mg	CALCIUM Ca	SODIUM Na	SOLUBLE SALTS
1401	50456	Low	Low	Low	Very High	Low	Good	Good

NITRATE NO3-N	pH	C.E.C	SULFUR SO4-S	ZINC Zn	MANGANESE Mn	IRON Fe	COPPER Cu	BORON B	EXCESS LIME	SOIL TEXTURE
Very Low	6.4	Low	Low	Good	Low	Good	Fair	Low	Good	Sandy loam

Soil Classification:

The figures above indicate the soil sustaining your landscape (San Joaquin sandy loam) has some serious problems. It is important to note that your soil can be amended to create a healthier more pest resistant growing environment for your landscape using slow release organic fertilizers. The application of appropriate organic fertilizers and amendments will yield a more balanced and fertile soil that will not have the nutrient availability problems you are currently experiencing. The appropriate use of organic fertilizers stimulates beneficial soil microorganisms to improve the soils condition, help your plants grow healthier, and improve their ability to resist pests naturally. As a result, pest damage and the need for costly (and potentially toxic) pest control will decline.



Soil samples collected for this analysis were only 6-8 inches deep. However it is helpful to know what is going on below these levels when creating a soil management

Low Salt WIN Fertilizers

Encourage soil life

- Diversity of foods => diversity of soil critters
- Add beneficial soil microbes
  - Aerobic compost & compost tea
  - Worm castings & worm tea
  - Organic fertilizer products
    - Dr. Earth
    - E.B. Stone Organics
    - Espoma
    - Jobe's Organic
    - Sustane

Supplement Biology

- Mycorrhizae

- Bacteria

Apply Natural Soil Amendments

- Top-dress, Mulch (~~Incorporate~~)
  - Earthworm Castings
    - Nature's fertilizer factories
  - Compost
    - Quality (no standards)
      - Ask for analysis
      - C:N ratio 10:1
  - Humates

- Provides: OM, nutrients, soil microbes
- Always keep soil covered
- Hunk's O' Bark not soil amendment

MULCH MADNESS

Soil Biology & Root Zone

- Healthy soil food web
- Roots can move down
- Access to more nutrients
- Drought resistance

What Is Organic

- USDA National Organic Program
  - National Organic Standards
  - *www.ams.usda.gov/nop/indexNet/htm*

- OMRI: Organic Materials Review Institute

OMRI LISTED
For Organic Use

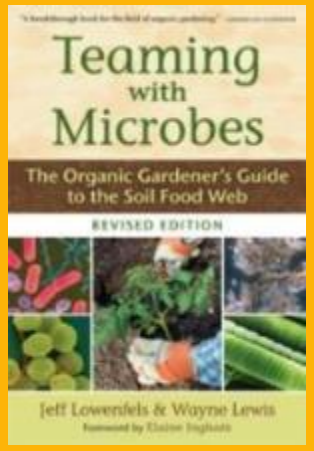
- US EPA

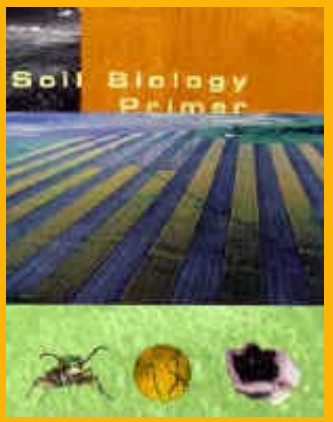
For Organic Production

Resources

- Teaming With Microbes

  By Jeff Lowenfels & Wayne Lewis





- Soil Biology Primer

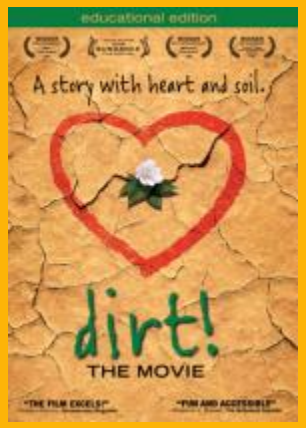
  www.soils.usda.gov/SQI/concepts/soil_biology/biology.html

- Dr. Elaine Ingham's Soil Food Web

  soilfoodweb.com

- Dirt The Movie

  dirtthemovie.org



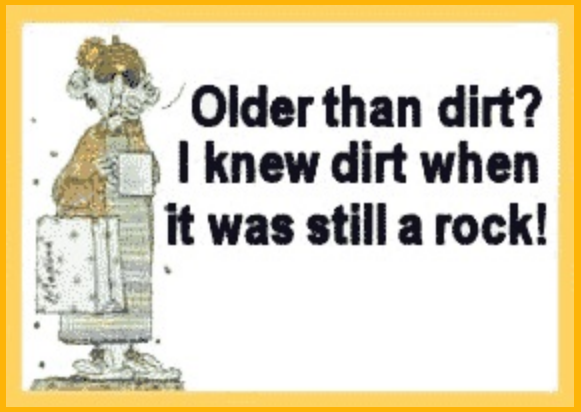
Resources

Regular appearances

- KFBK Garden Show with Farmer Fred:
  - 11:00 a.m. to 1 p.m. EST
  - 1/800/834-1530
- Get Growing with Farmer Fred:
  - 1 p.m. to 3 p.m. EST
  - 1/866-331-TALK
- Next appearance:
  - December 6
- Available streaming & podcasts through farmerfred.com

Soil Gets No Respect

- You get your face rubbed in it
- Your name dragged through it
- You can be older than it
- It's sold as commodity

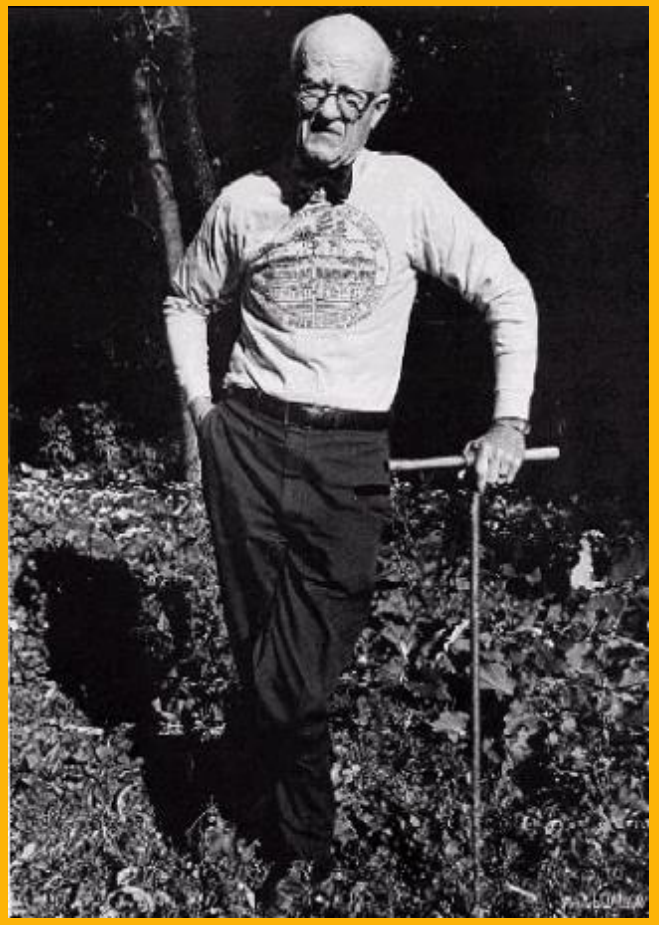


A Healthy Soil Has Value

- Improves
  - Nutrient availability
  - Soil structure
  - Plant health
  - Pest resistance
  - Transplant survival
  - Drought tolerance
  - Environmental quality
- Reduces inputs
  - Water
  - Fertilizer
  - Pest management

A Passion For Soil

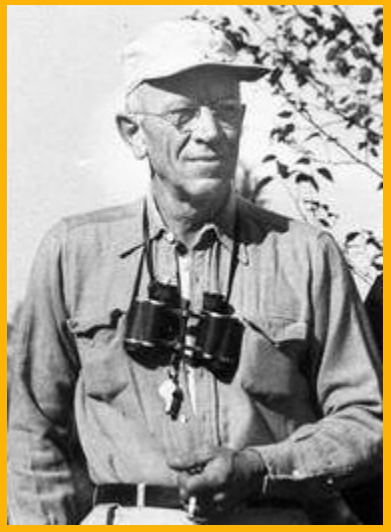
"Just walk quietly through the grasses and contemplate the complex and beautiful, yet unseen, world beneath your feet."



Francis Hole *SOA*

Soils Professor Univ. of Wisconsin
American pedologist
Undisputed poet-laureate-of-soils

Cherish Our Soil



- We owe our lives to soil
- Diverse complex ecosystem
- Demands respect & care
- Aldo Leopold *A Sand County Almanac* 1949
  - “Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals.”
  - “We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.”

Questions?

Steven M. Zien *TNS*

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