Sustainable Agriculture & Soil Management

Presented by Alpha Ag Solutions

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- Soil/plant/soil biology relationship
- Microbial technologies
- Mycorrhizal technologies
- Create sustainable soils for crop production
- Answer questions

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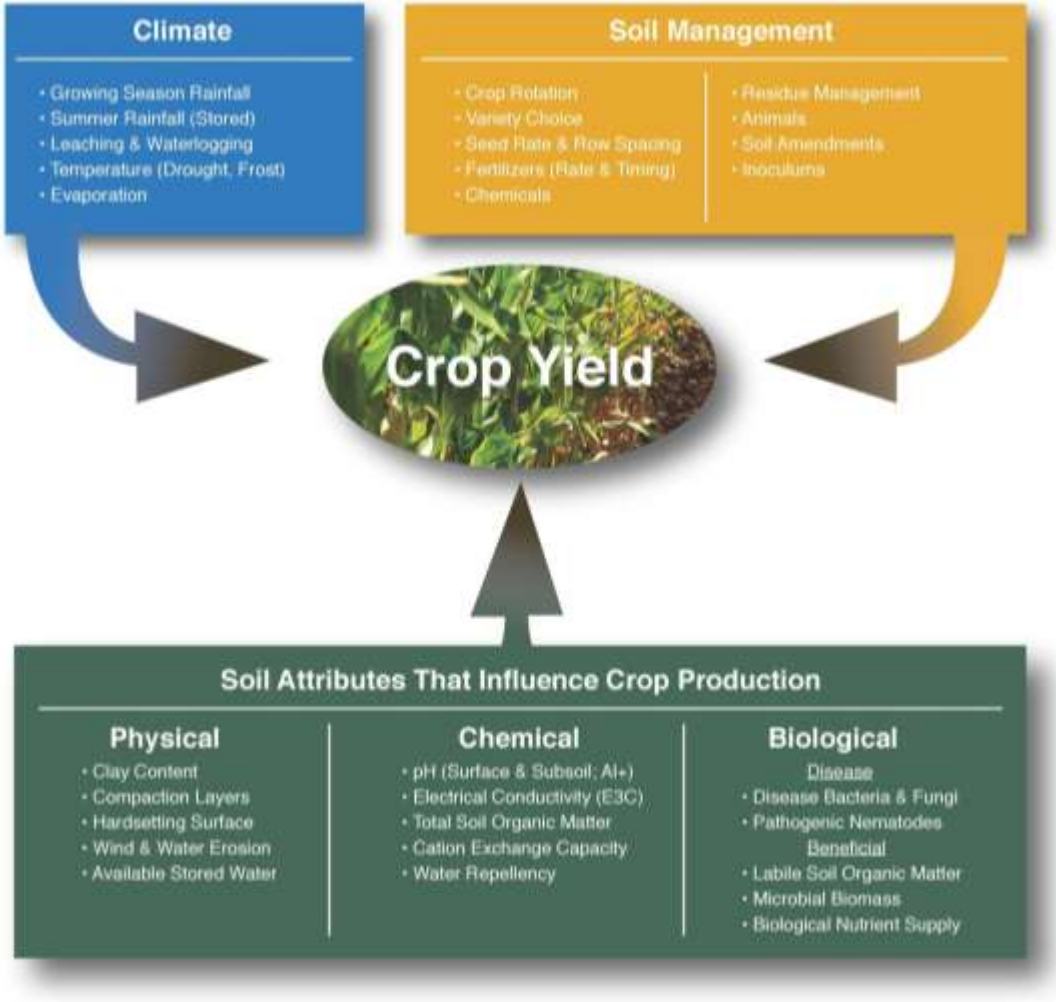
Yield inputs

Crop Production Variables



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Soil

"The foundation of all plant life"

"Management practices make difference to soil life, it helps to back up and examine the vast diversity of micro- and macro-organisms living in the soil and the critical roles they play in agriculture."

Soil Issues

- Continuous Use of Manure
- Drought
- Low Organic Matter
- Tillage Practices
- Compaction
- Crop Rotation
- Freezing
- Flooding

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Soil

SOIL IMPROVEMENT GUIDELINES

Soil Test Parameter	Compatible Microbial Range
Organic Matter	0-5%+
Phosphorus P1	5 to 30 ppm
Phosphorus P2	10 to 100 ppm
Potassium light textured soils	50 to 200 ppm
Potassium dark textured soils	125 to 300 ppm
Magnesium	50 to 300 ppm
Sodium	0 to 3%
Soil pH	5.5 to 8.4
Cation Exchange Capacity	5 to 35 meq/100g
Percent Base Saturation - potassium	2 to 10%
Percent Base Saturation - magnesium	5 to 20%
Percent Base Saturation- calcium	50 to 80%
Zinc	1 to 3 ppm
Manganese	10 to 30 ppm
Iron	10 to 30 ppm
Copper	1 to 3 ppm
Boron	1 to 2.5 ppm
Soluble Salts	0 to 2 mmhos/cm
Sulfur	2 to 15 ppm

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Factors Affecting Soil Structure

- **External Loading**
  - **Compaction**
  - **Poor drainage**
  - **Treatment of wet soil**
- **Cultivation History**
  - **Field age**
  - **Crop rotation**
  - **Liming, use of manure**

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Factors Affecting Soil Structure

- **Soil Properties**
  - Soil texture
  - Soil organic matter
  - PH
  - Cation exchange capacity
- **Natural Processes**
  - Biological activity
  - Microbes
  - Roots
  - Number of drying/wetting cycles (clay soils)

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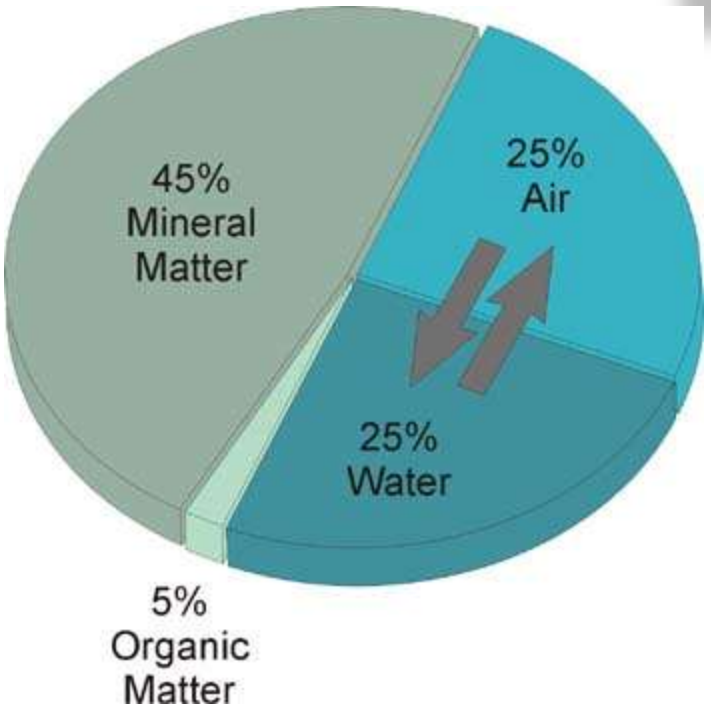
Soil Components

- Mineral
  - Primary
  - Secondary
- Water
- Organic Matter
- Gases
- Microorganisms
- Fungal Hyphae

Soil Components



Soil Components: Soils consist of four major components: (1) mineral (or inorganic), (2) organic, (3) water, and (4) air. The relative proportions of these four soil components vary with soil type and climatic conditions. Review the approximate proportions (by volume) of the four soil components in a mineral soil under optimum conditions for plant growth.

Image Source: : Leslie Dampier
Faculty of Land and Food Systems
THE UNIVERSITY OF BRITISH COLUMBIA

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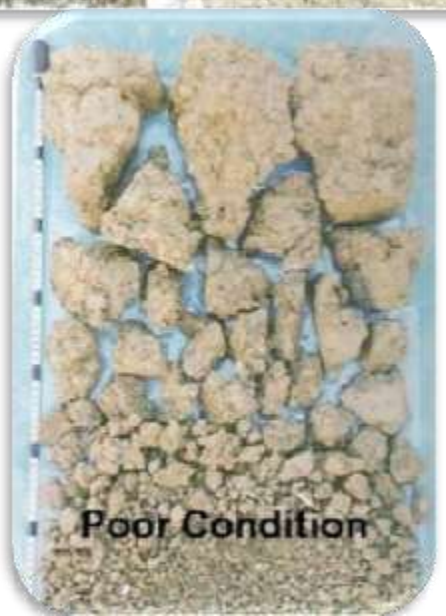
Soil Structure



Well Structured Soil Will:

- Hold large amounts of water and nutrients
- Not puddle when wet or become dusty when dry
- Have adequate drainage and aeration
- Provide a medium for roots to explore for moisture and nutrients

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Good Soil Features

- Drains well
- Resists erosion & nutrient loss
- Soaks up heavy rains
- Supports high populations of diverse soil organisms
- Produces healthy, high quality crops
- Stores moisture for drought periods
- Creates sustainable agriculture crops

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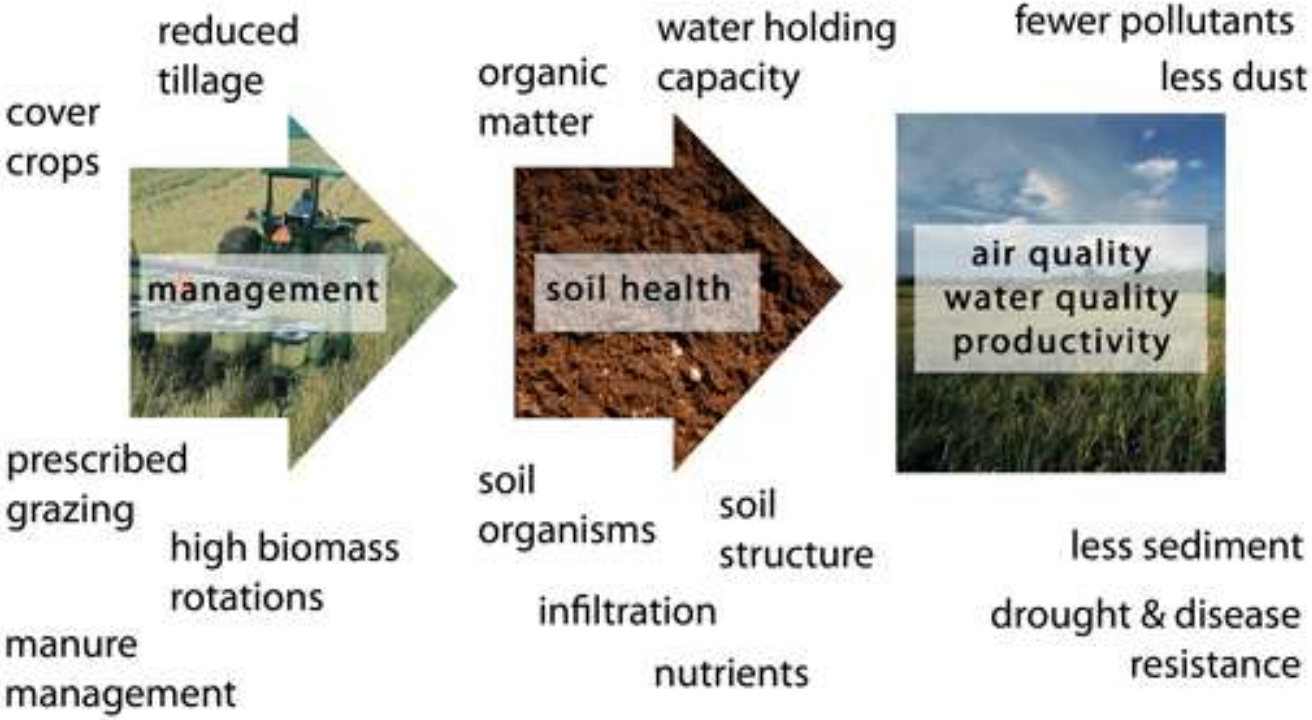
Organic Matter

Managing soil organic matter is the key to air and water quality.



Above provided by NRCS

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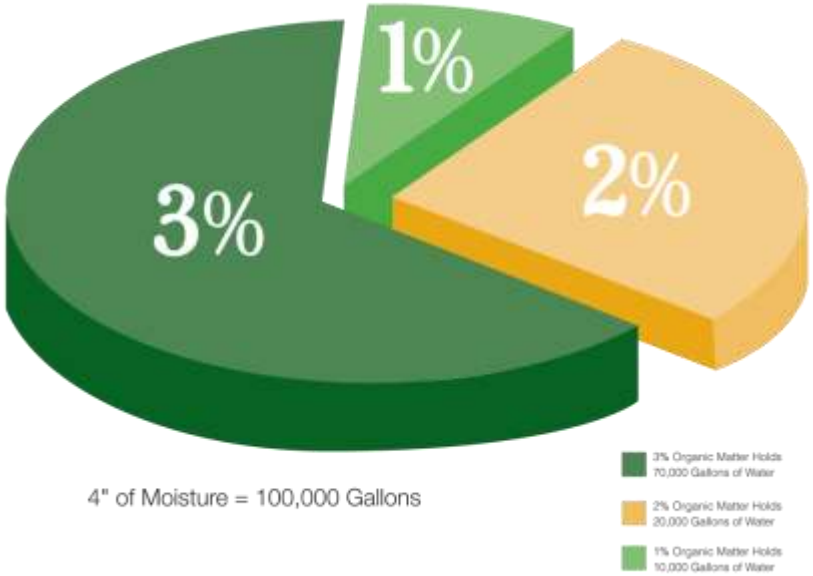
Bank Account for Plant Nutrients

Water retention

- 1% or less OM can hold less than 10,000 gallons of water
- 3% OM 1 acre can hold 2-3 inches of rain or 56,000 to 84,000 gal of water



Nutrient/Organic Matter Value

- Soil containing 4% organic matter in top 7”
- 80,000 lbs of organic matter/acre
- Will contain 5.25% N, 4,200 lbs/acre

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Bank Account for Plant Nutrients

Ways to Increase Organic Matter/H_2O

- Bioaugmentation
- Cover Crops
- Reduce Tillage
- Crop Rotation
- Forage Crops

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Soil Organic Matter

Value of Soil Organic Matter Assumptions: 2,000,000 pounds of soil in the top 6 inches/Acre	
Nutrients:	1% organic matter = 20,000# 50% Carbon, C:N ratio =10:1
Nitrogen:	1000# * $0.50/#N = $500
Phosphorus:	100# * $0.70/#P = $70
Potassium:	100# * $0.40/#K = $40
Sulfur:	100# * $0.50/#S = $50
Carbon:	10,000# or 5 ton * $4/Ton = $20
Value of 1% SOM Nutrients/Acre	Equals $680.00
Relative Ration of Nutrients:	100 Carbon/10 Nitrogen/ 1 Phosphorus/1 Potassium/1 Sulfur

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Soil Biodiversity

- Creates more stable and resilient soils
- Drives nutrient recycling
- Decomposition
- Disease control
- Provides structure for water retention
- Results in "Team Play" in soil
- Some nematode control

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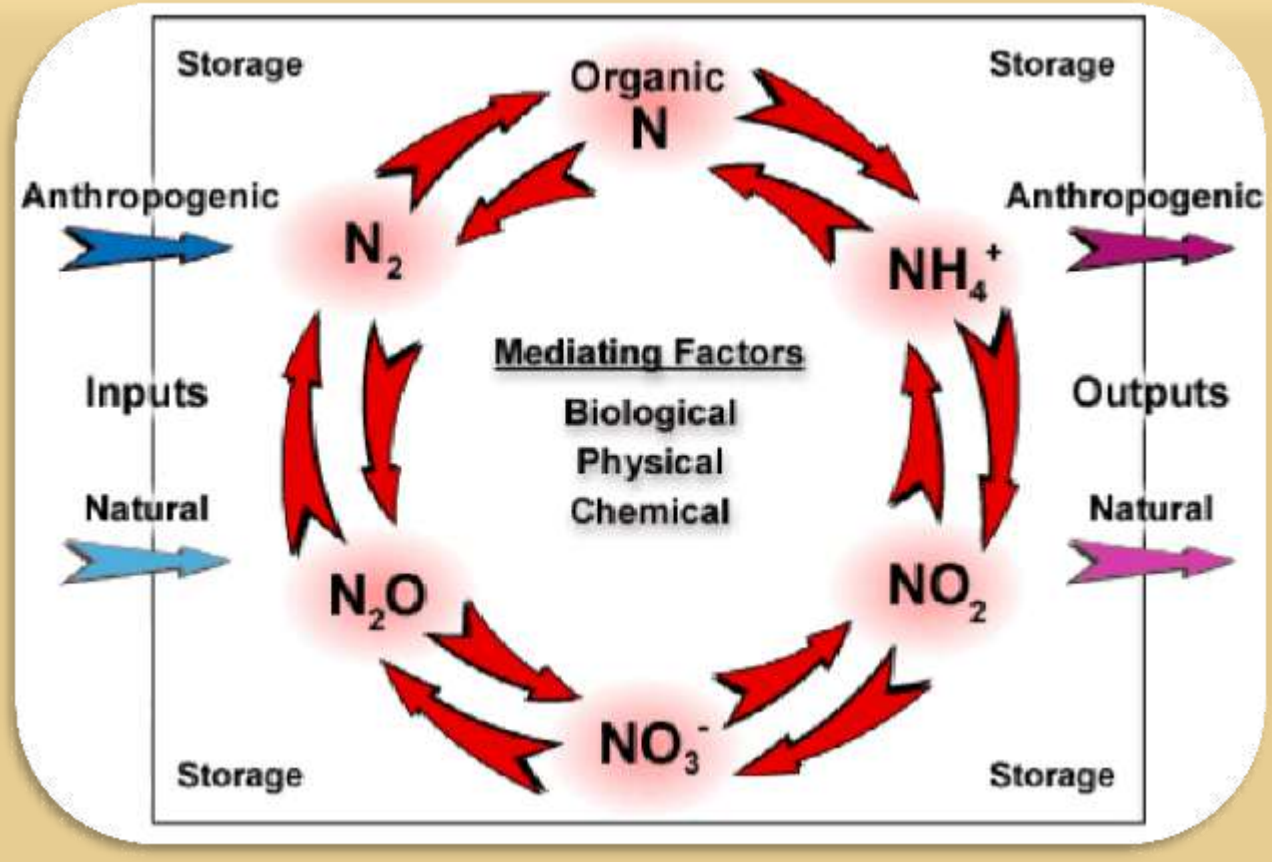
Cycling Nutrients

Soil biology manages nutrients



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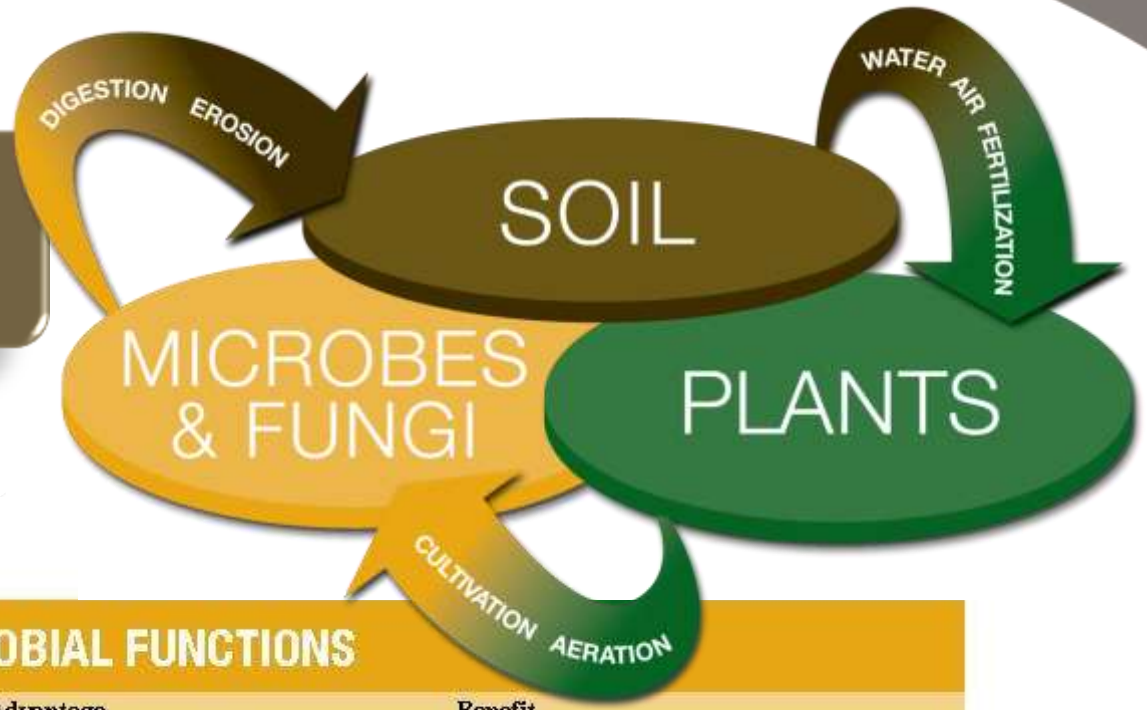
Soil is a Living Ecosystem



MICROBIAL FUNCTIONS

Feature	Advantage	Benefit
Cellulose Destroyer	Enhanced breakdown of crop waste	Returns organic matter to soil
Nitrogen fixers	Conversion of ammonia to nitrates	Allows plant to utilize nitrogen
Decomposers	Decompose organic material	Builds humus for soil
Phosphate fixer	Solubilization of phosphorus	Allows plant to utilize phosphorus
Promotes root development	Production of phytohormones	Suppresses Disease
Beneficial fungi	Production of glomulin	Builds soil tilth and promotes water retention
Sulfur oxidizer	Convert sulfides to sulfates	Makes sulfur available to plants

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Typical Numbers of Soil Organisms in Healthy Ecosystems

	Ag Land	Prairie	Forest
	Organisms per gram (teaspoon) of soil		
Bacteria	100 mil. -1 bil.	100 mil. -1 bil.	100 mil. -1 bil.
Fungi	Several yards	10s – 100's of yds	1-40 miles (in conifers)
Protozoa	1000's	1000's	100,000's
Nematodes	10-20	10's – 100's	100's
	Organisms per square foot		
Arthropods	< 100	500-2000	10,000-25,000
Earthworms	5-30	10-50	10-50 (0 in conifers)

Source: USDA Natural Resource Conservation Service

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Biological Soil Enhancements

- Builds tilth soil
- Produces a glue compound for water retention and binds soil
- Creates more air spaces
- Helps developing root structure
- Helps establish earth worm populations
- Creates conduits for nutrient travel
- Builds organic matter

Left: High humus & rich in carbon

Right: Poor humus content

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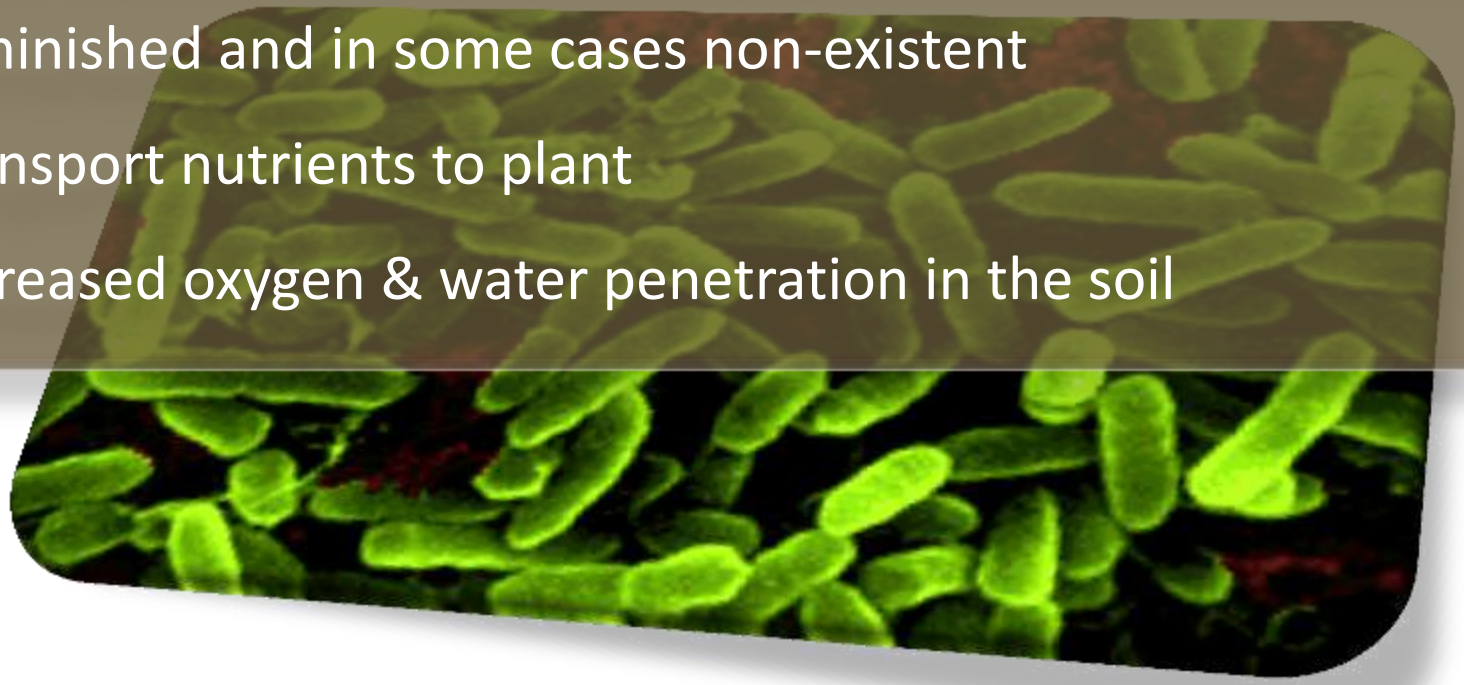
Microbial Bacteria

Naturally occurring in the environment

- Mother Natures little engines that are hard at work
- Due to over-fertilization, lack of aeration and lack of organic matter in the soil, the population of microbes has been severely diminished and in some cases non-existent
- Transport nutrients to plant
- Increased oxygen & water penetration in the soil



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Microbial Bacteria

Naturally occurring in the environment

Microbes

Microbial Facts

- Microbes are always present in soil
- Microbes in soil are proportional to organic matter content
- Microbes maintain good soil structure which promotes soil aeration, root growth & water management
- Suppression of pathogenic micro-organisms cause diseases
- Microbes transforms nutrients for plant utilization

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Microbial Bacteria

Naturally occurring in the environment

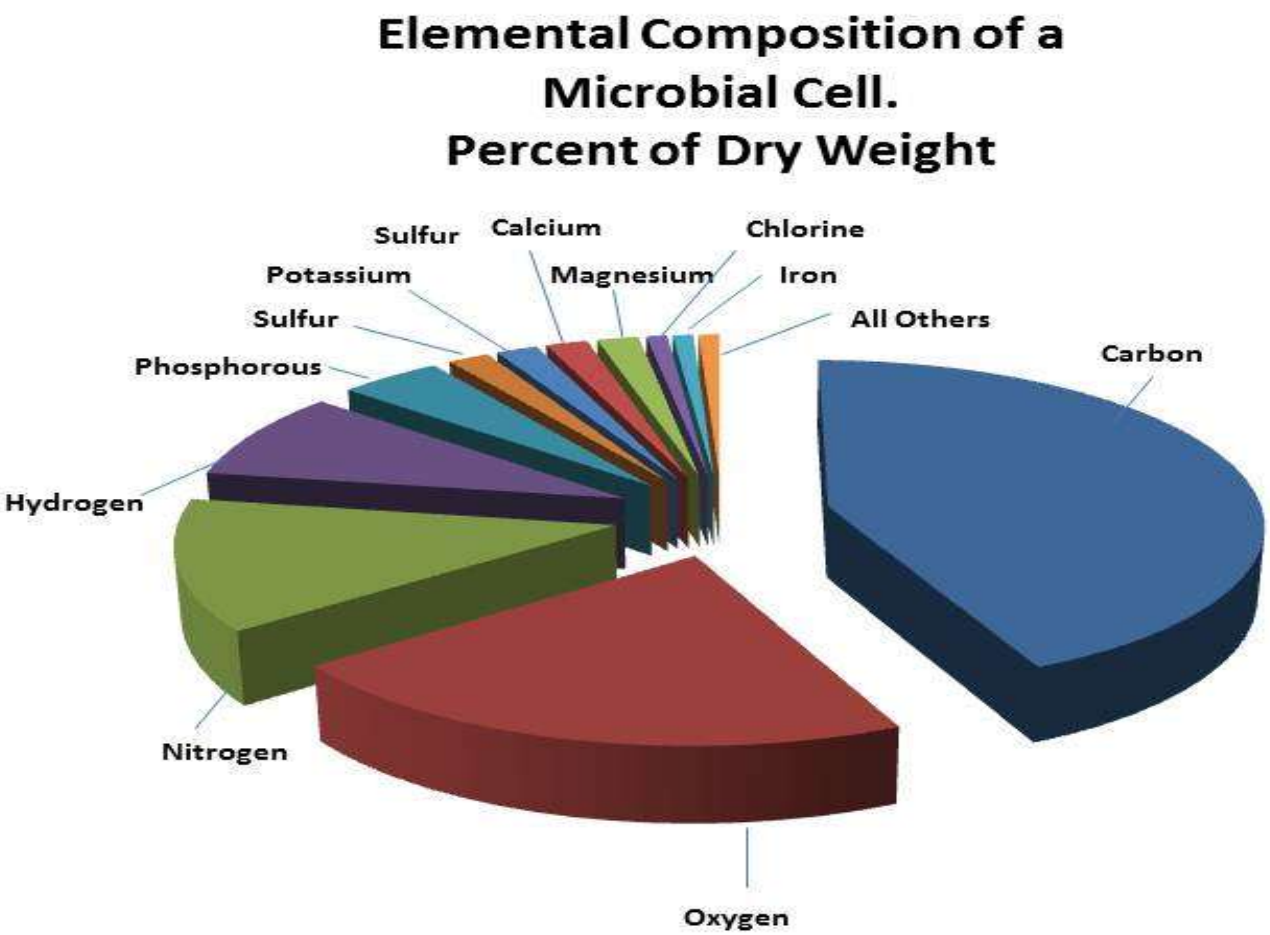

Figure adapted from WEF, 1994

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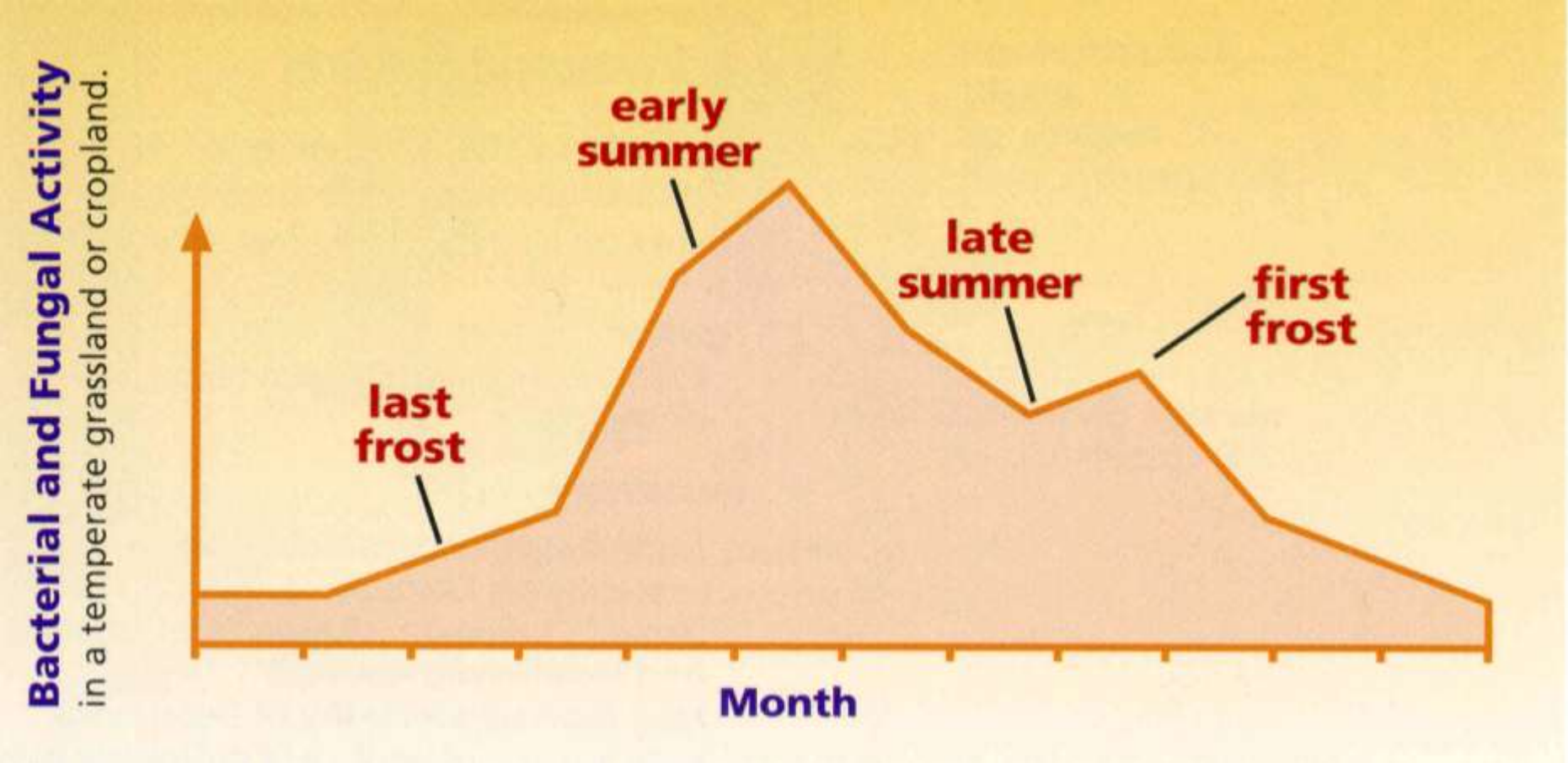
Seasonal Microbial Activity



Source: USDA Natural Resource Conservation Service

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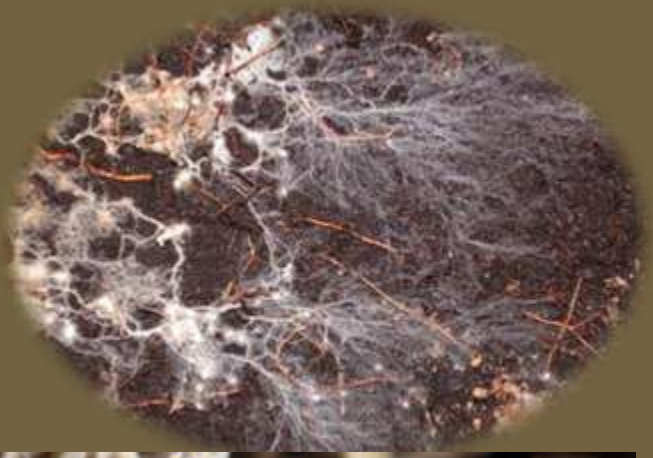
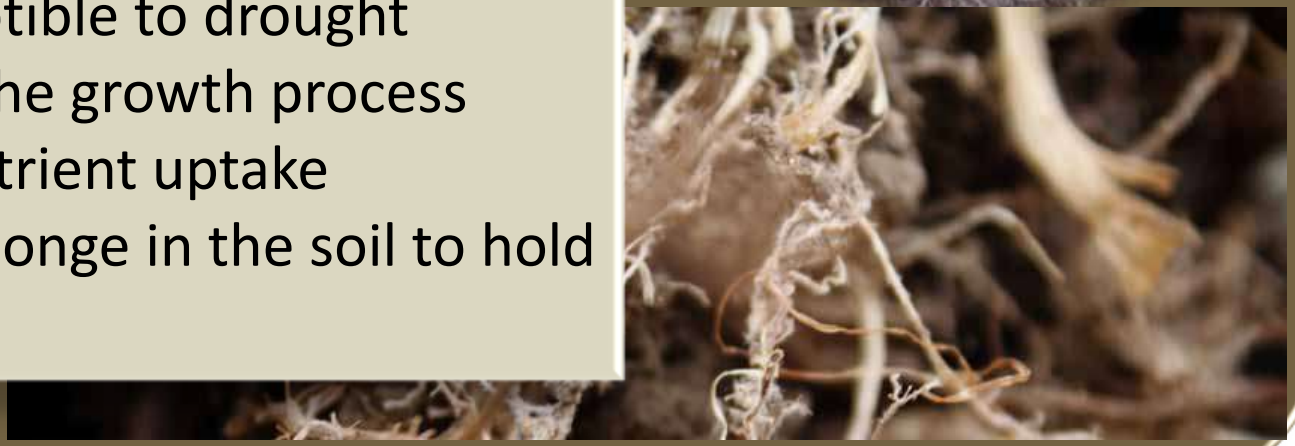
Mycorrhizal Fungi

Naturally occurring in the environment

- Mycorrhizal attaches itself inside the root system
- "Soil superglue"
  - Builds soil aggregate
  - Proceeds organic matter
- Strengthens the root system
- Making the plant less susceptible to wind damage
- Less susceptible to drought
- Expedites the growth process through nutrient uptake
- Acts as a sponge in the soil to hold moisture

Mycorrhizal Fungi





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What Results Can be Accomplished at Bioaugmentation?

- Increased crop yield
- Lowering of input costs
- Reduce fertilizer inputs
- Increased root structure development
- Better decomposition of crop residues

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What Results Can be Accomplished at Bioaugmentation?

- Increased water holding capacity
- Improved internal drainage
- Nutrient holding capacity
- Increase organic matter in soil
- Move ph toward neutral
- Better sustainable soil

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A DIVISION OF ALPHA BIOSYSTEMS

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