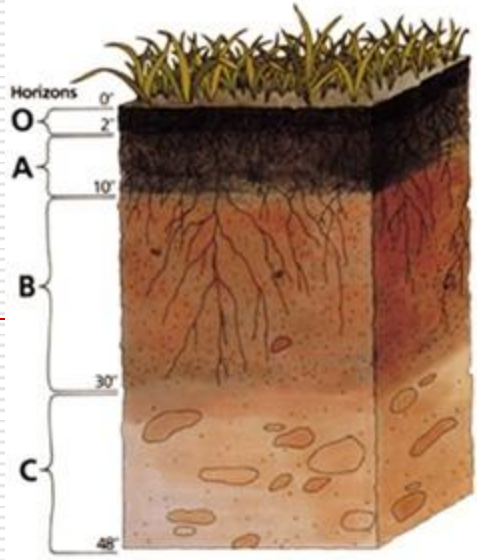
Title: Soil Organic Matter, Soil Fertility Calculations Calculations

Speaker: Bill Pan

Unit 1, Lesson 5



General principles of soil organic matter, soil fertility calculations.

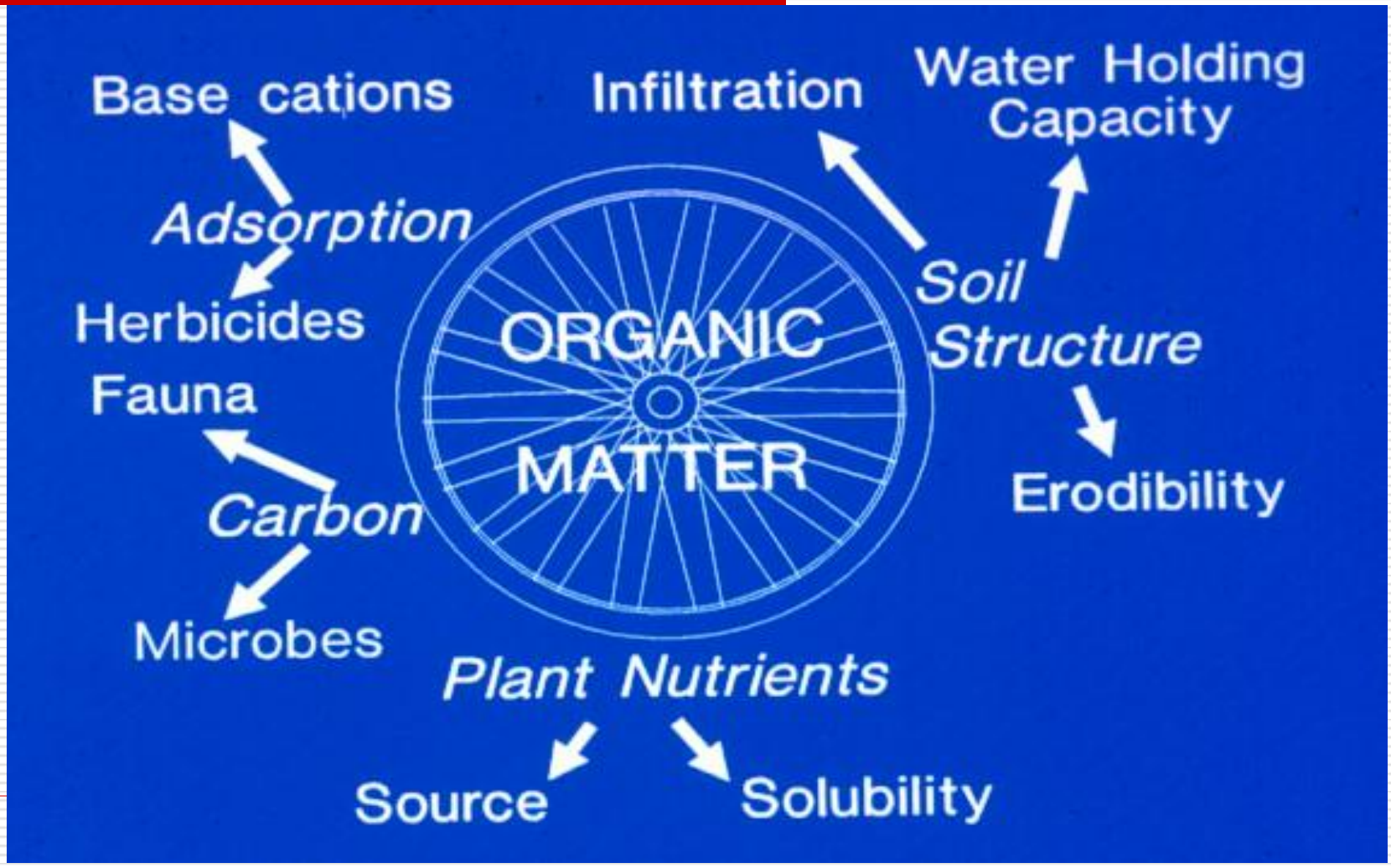
http://soils.usda.gov/education/resources/k_12/lessons/profile/

Learning Objectives

- **Organic matter functions**
- **Soil biology**
- **Organic matter constituents**
- **Building soil organic matter**
- **Soil fertility units and calculations**

http://soils.usda.gov/technical/classification/orders/mollisols.html

Soil Organic Matter-Interface between the living and the inorganic realm



Soil is a biological system

- **1 gram of soil contains > 1 million organisms**
- **they influence soil characteristics and plant health**

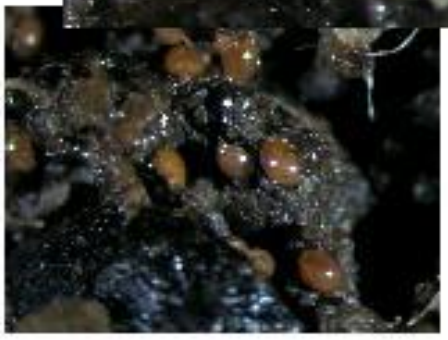
Reganold, J.P., R.I. Papendick and J.F. Parr. 1990. Sustainable agriculture. *Scientific American.* 262(6):112-120.

Soil Organisms

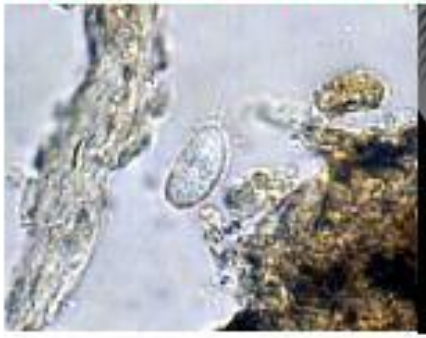
fungi, **bacteria** and **actinomycetes** are microfauna

enchytraeids are small worms, also known as **potworms**. They are bigger than nematodes and smaller than earthworms.

collembola and **mites** are mesofauna



protozoa, **nematodes**, **rotifers** are types of microfauna



Organic Constituents

Type of Material	Range (% of weight)
Nonhumic substances	
Lipids	1-6%
Carbohydrates	5-25%
Proteins	9-16%
Humic substances	Up to 80%

Humic substances (humic and fulvic acids)

- Most active fraction of organic matter
- Formed by secondary synthesis reactions; different from polymers existing in live organisms.
- Highly acidic, yellow to black polyelectrolytes

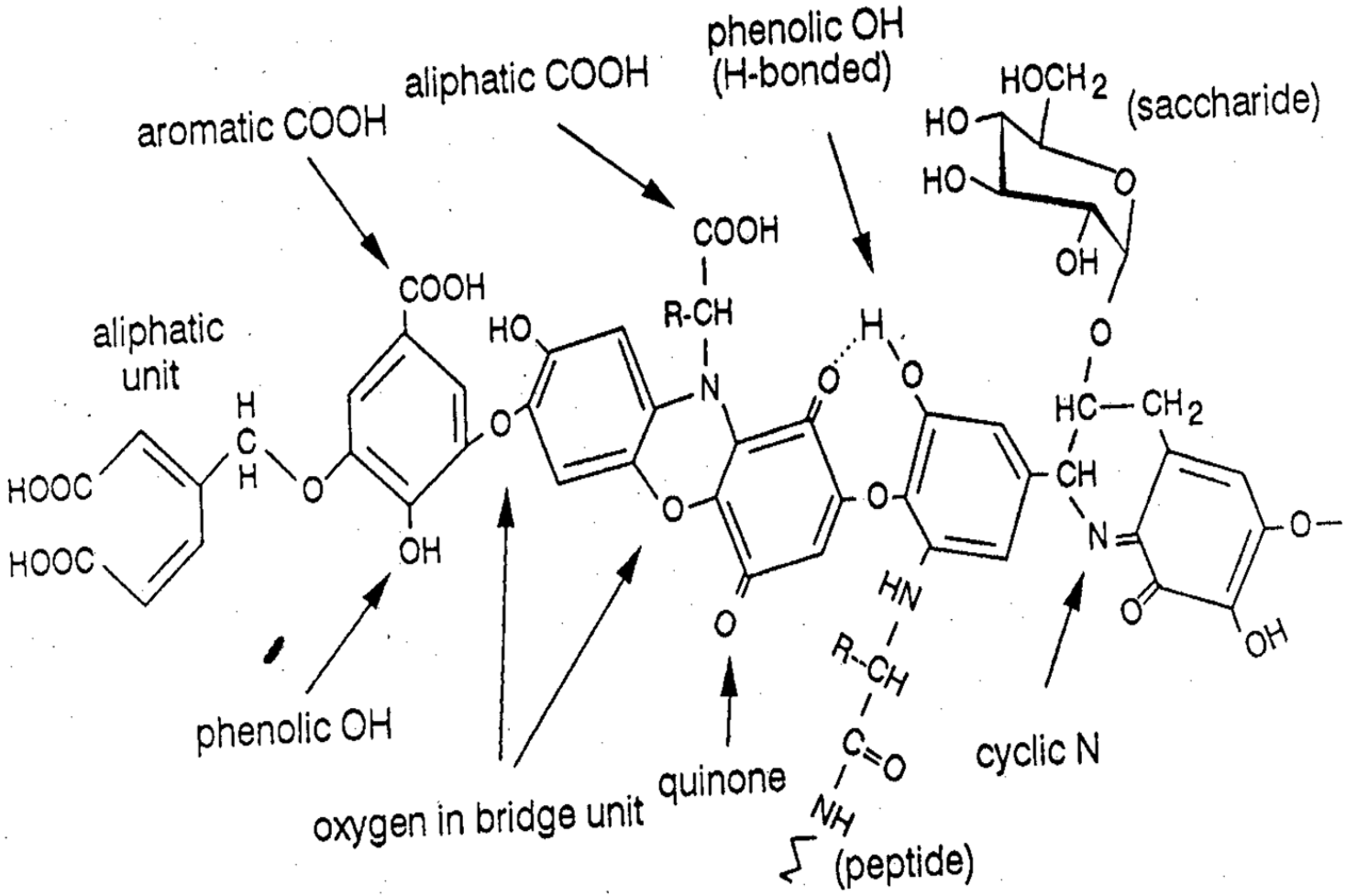
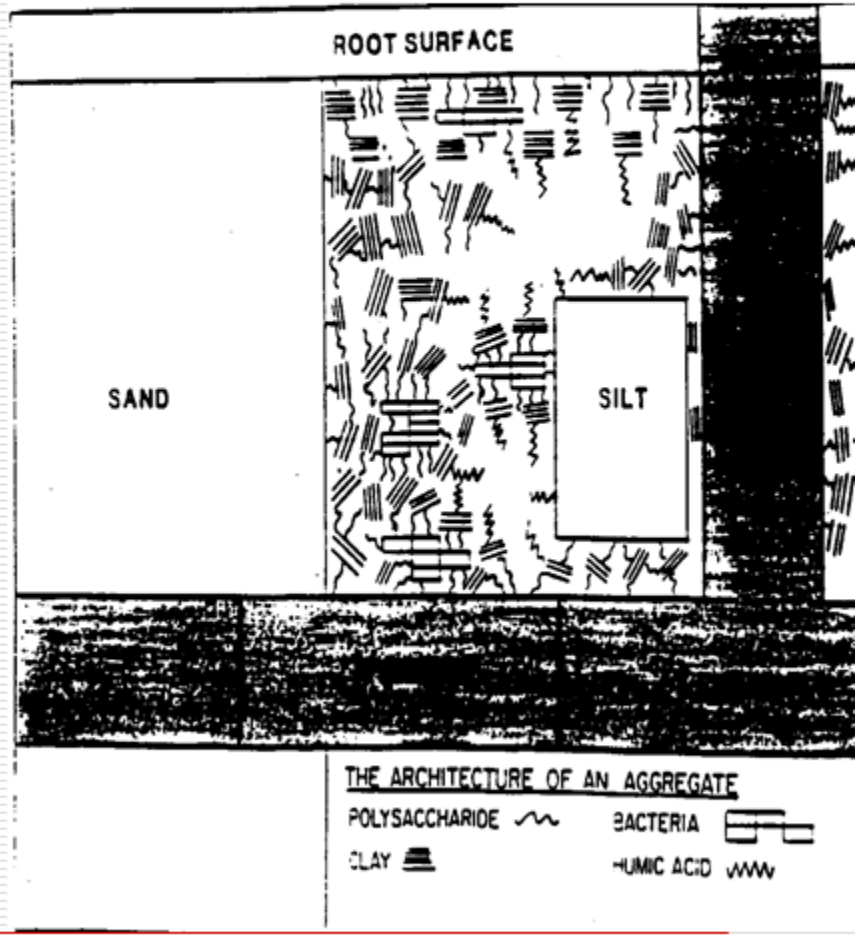


Fig. 1.11 Representative structure unit of a humate molecule showing the presence of free and bound phenolic OH groups, quinones, oxygen and N as bridge units, and —COOH groups variously placed on the molecule. Adapted from Stevenson.[15]

Building Soil Organic Matter

- **Polysaccharides, humic acids bond soil particles together; promote soil aggregation.**



Mycorrhizal colonization of plant roots promotes soil aggregation in the rhizosphere

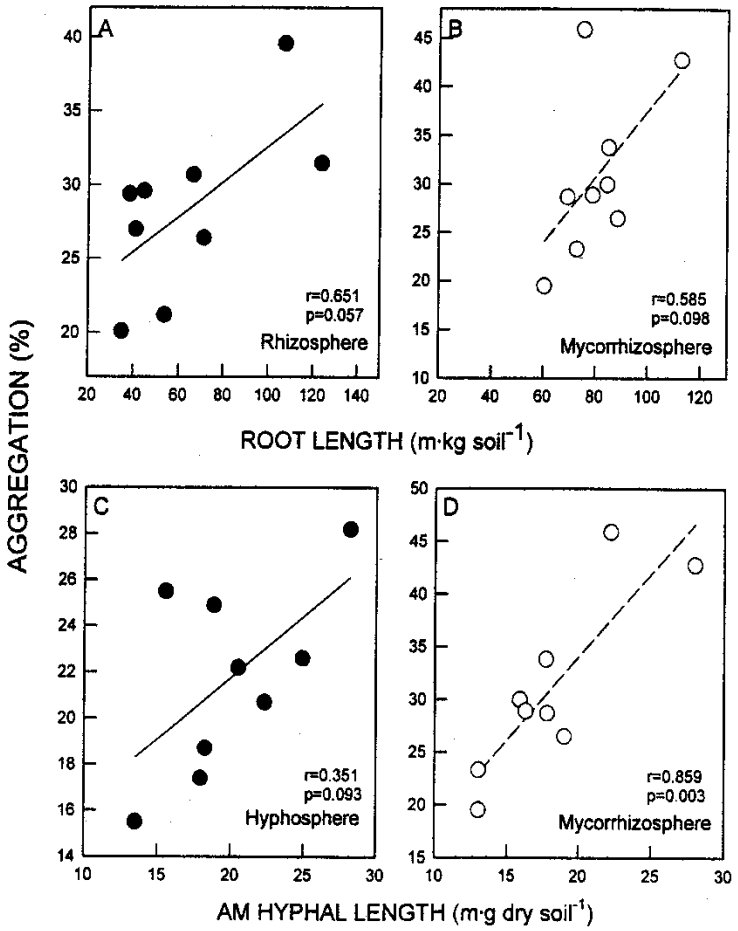
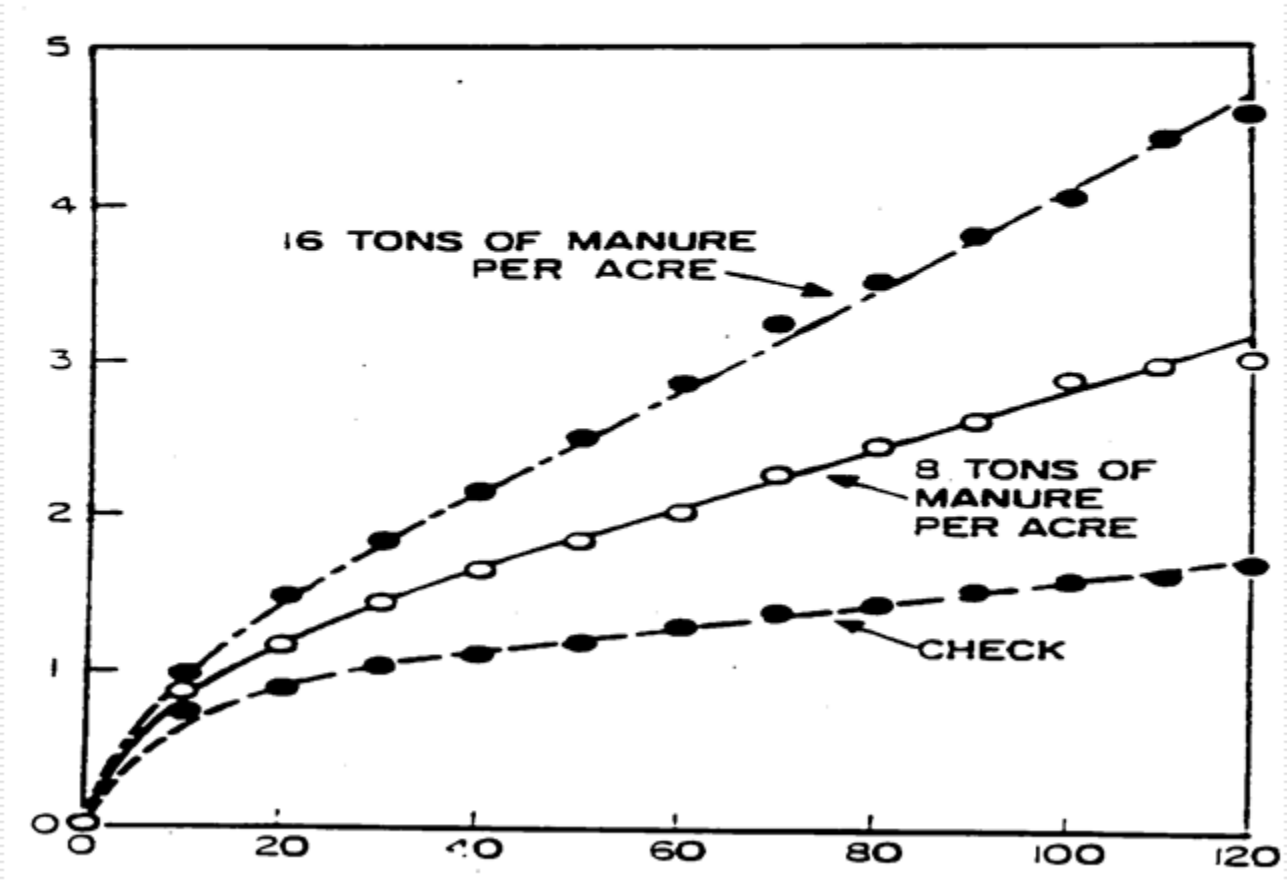


Figure 2. Relationships between arbuscular mycorrhiza (AM) development and soil aggregation. Split-root sorghum plants were grown in multi-compartment containers. Soils in the compartments were classified as rhizosphere soil (nonAM roots only), hyphosphere soil (AM hyphae only) and mycorrhizosphere soil (AM roots and AM hyphae). Each datum point represents an individual measurement.

Manure Effects on Aggregation and Plastic Limit

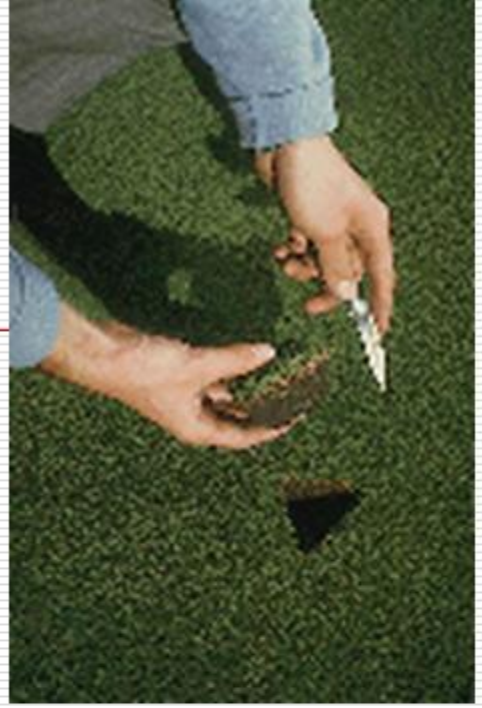
Manure Rate (%)	Water stable aggregates (%)	Plastic Limit (%)
0	6.9	24.1
2	10.5	25.1
4	17.7	26.0
6	19.6	30.8
10	20.5	32.2

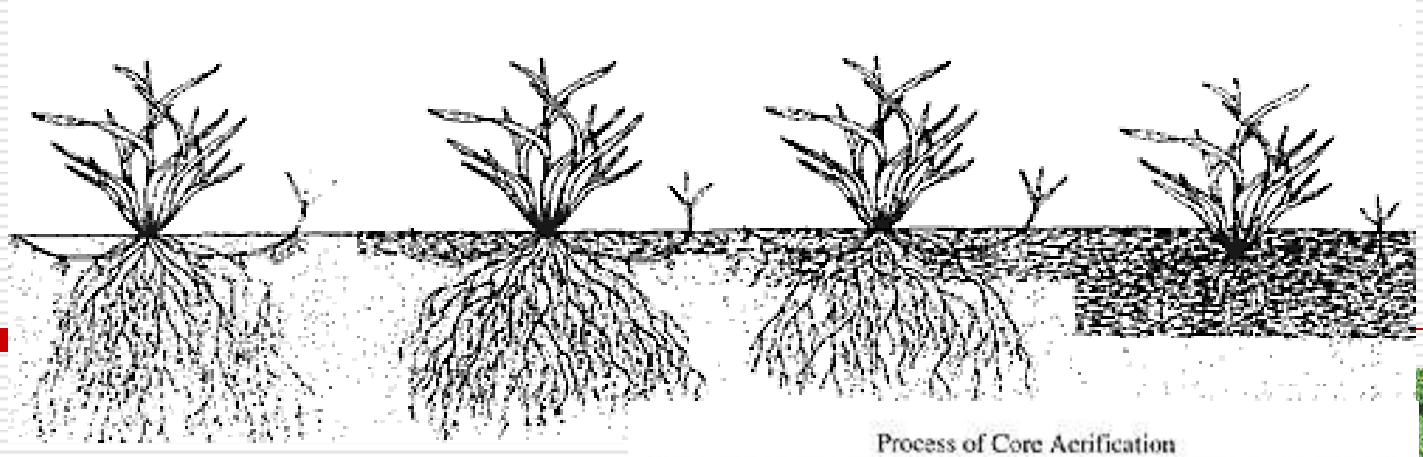
Manure Effects on Water Infiltration



Thatch Buildup in Turf

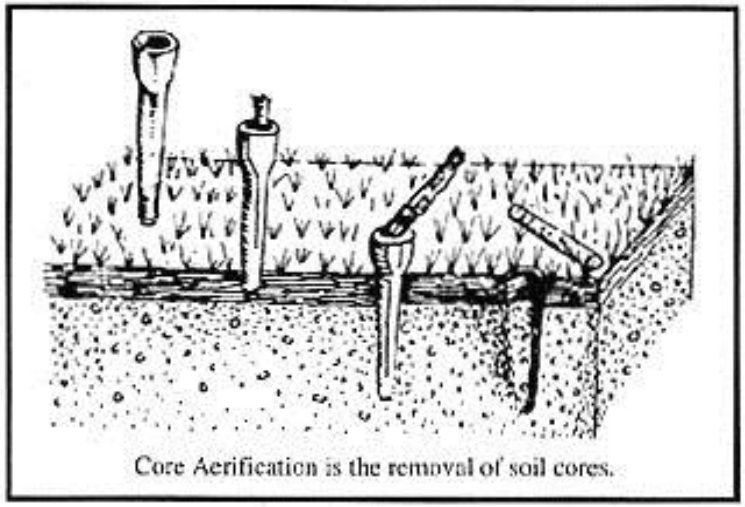
- Dead and decaying tissue located between the green vegetation and the soil surface.
- Buildup of high lignin materials from stems, roots; not leaves
- Excess fertilization: biomass production exceeds decomposition
- Extreme pH's, waterlogging slow decomposition



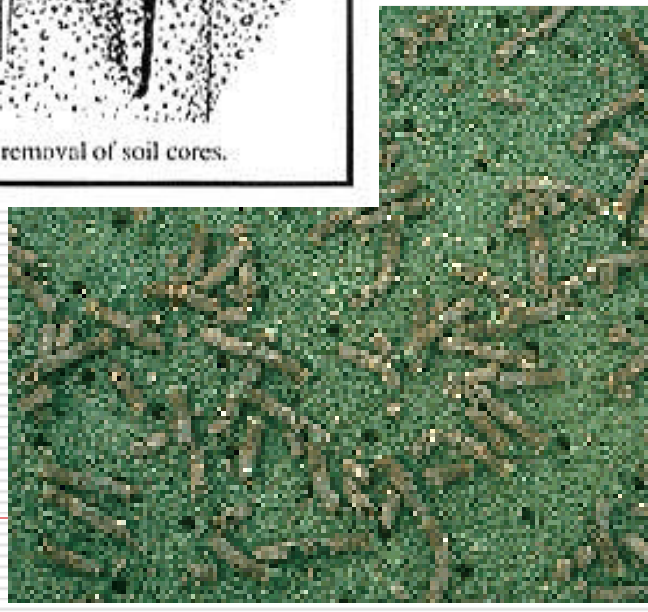


- <0.5 in. thatch increases turf resiliency, water retention, wear and soil temperature insulation
- >0.5 in.: problems with insects, diseases, water infiltration, decreased root penetration

Process of Core Aerification



Core Aerification is the removal of soil cores.



Organic Matter Summary

- Organic matter plays an essential role in determining soil physical, chemical and biological characteristics and functions.
- OM is a key soil quality indicator, usually positive, and occasionally negative.

Basic Soil Fertility Units & Dimensions

Primary Question #1: Am I Dealing With…

- English (common U.S.) or Metric (scientific and international standard)
- Liquid, Gas, or Solid
- Volume or Mass
- Amount or Concentration
- Elemental or Molecular Expressions of Nutrients
- Amount of Elemental or Molecular Charge, Mass, or Number of Atoms or Molecules

Basic Soil Fertility Units & Calculations

Primary Question #2: What are my conversion factors and how do I use them?

- Commit to memory English to metric conversions:
  - 1 pound = 0.453 kilogram; 1 kg = 2.2 lb
  - 1 acre = 0.405 hectare; 1 ha = 2.47 A
  - 1 acre furrow slice (AFS) = volume of soil in top 6-7” of an acre, weighing~2,000,000 lbs of soil.
  - 1 hectare = 10,000 sq m; 1 acre = 43,560 sq ft
  - 1 foot = 0.30 meters; 1 m = 3.28 ft
  - 1 gal = 3.79 liters; 1 L = 0.2642 gal
  - 1 ppm = 1 part per million = 1 mg/kg or 1 mg/L

Basic Soil Fertility Units & Calculations

Primary Question #2: What are my conversion factors and how do I use them?

- Commit to memory ionic charges of essential plant nutrients
- Atomic weights will be provided.

Basic Soil Fertility Units & Calculations

Primary Question #3: What equation is required to calculate the desired conversion?

- Keep track of units throughout the calculation
- Figure out the information and units that you have, and then determine the units you need for your answer, and write an equation that gets you there.
- Cancel common units that appear in numerator and denominator of multiplicative calculations.

Example 1: An acre furrow slice is sampled and tests assays at 25 ppm NO_3-N. How many lbs N/acre and kg N/ha does this soil have in this volume of soil?

- 25 ppm N = 25 lb N/1,000,000 lb soil.
- $\frac{25 \text{ lb N}}{1{,}000{,}000 \text{ lb soil}} \times \frac{2{,}000{,}000 \text{ lb soil}}{\text{acre furrow slice}} = \frac{50 \text{ lb N}}{\text{acre-6”}}$
- $\frac{50 \text{ lb N}}{\text{acre-6”}} \times \frac{0.453 \text{ kg N}}{\text{lb N}} \times \frac{2.47 \text{ acres} - 6”}{\text{hectare -0.15 m}} = \frac{55.9 \text{ kg N}}{\text{hectare -0.15 m}}$

Example 2: Organic matter of an intensively tilled soil declines from 4% to 3% OM in the surface 6" layer. Assuming 58% of Soil Organic Matter (SOM) is made up of Soil Organic Carbon (SOC), how much SOC has been lost from the surface 6" layer (lb SOC/acre - 6")?

$$\frac{1\ \cancel{lb\ SOM}}{100\ \cancel{lbs\ soil}} \times \frac{.58\ lb\ SOC}{1\ \cancel{lb\ SOM}} \times \frac{2{,}000{,}000\ \cancel{lb\ soil}}{acre-6"} = \frac{11{,}600\ lb\ SOC}{acre-6"}$$

*Complete Assnmt 1.4 for practice in soil fertility units and calculations