Something to Ponder About ? ? ? ?

It is the boring Repetition of what we do, that will put us beyond the masses.

Soil Respiration

Soil Quality Test Kit

By Clarence Chavez

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Mycorrhiza fungi extending from a root

Soil Respiration Demonstration

CO_2
Carbon Losses

O_2
Oxygen into the Soil

Soil Food Web

Nothing more than organic matter decomposing: root exudates, glomalin, crop residues, predator pray relationships, humus, etc…

Pressure Factor

What you must know before we start:

A pressure of 1 atm (one atmosphere) can also be stated as:

≡1.013 25 bar

≡101.3 25 Centibar (used in a tensiometer)

≡ 1013.25 millibars (mbar, also mb)

≈ 29.92 in-Hg, 0 °C, subject to revision as more precise measurements of mercury's density become available [C] (Used in the Example)

≈ 14.69 pounds-force per square inch (psi)

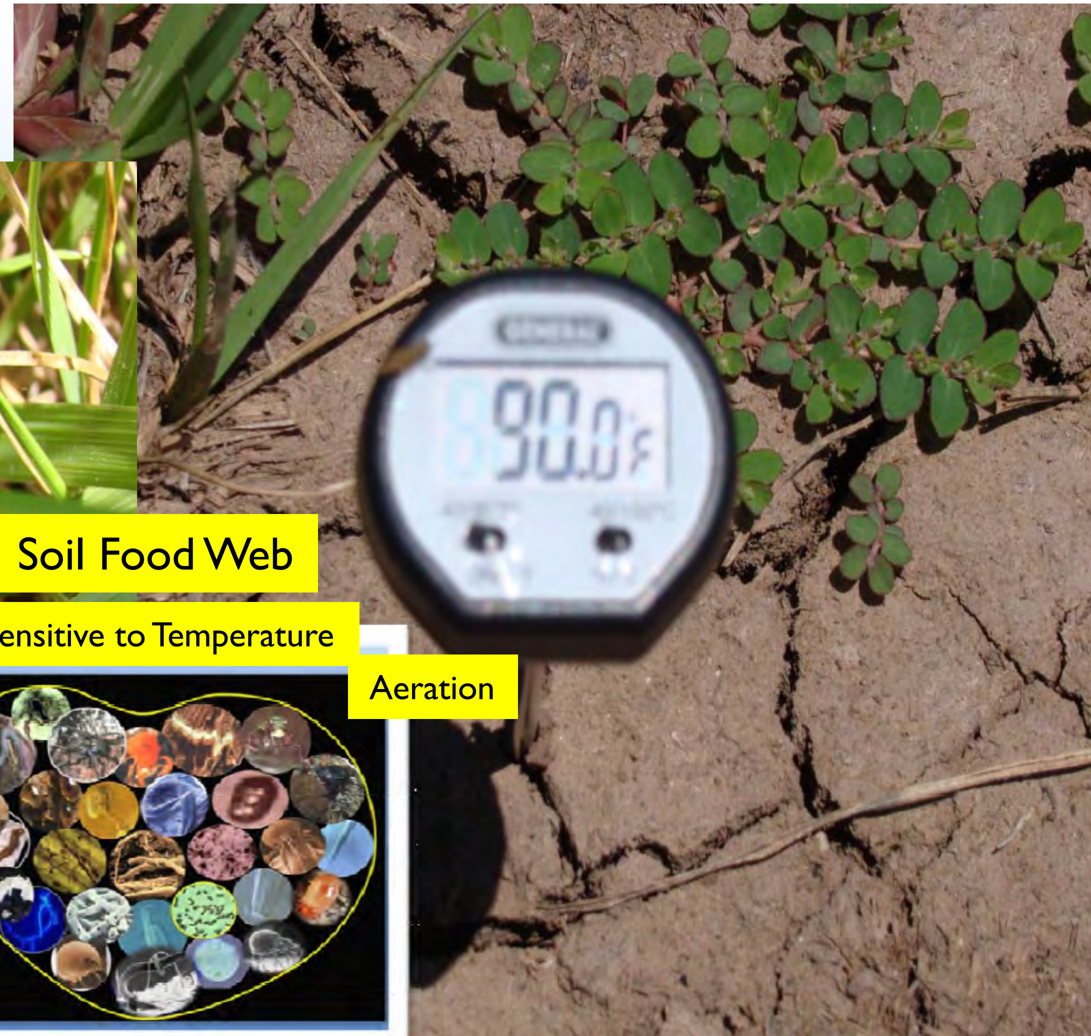
PF = Pressure Factor = "Raw Barometric Pressure in Inches Hg / 29.9 inches Hg

PF = 29.6 in-Hg / 29.9 in-Hg = 0.996

This is a constant

Caution: This must be site specific for your location

Soil Temperature Conversion



Must convert soil temperature from degrees Fahrenheit to Degrees Celsius.

A = Degrees Celsius Temperature

Conversion: Degrees Celsius = 5/9 x (Degrees Fahrenheit - 32)

A = 22.0 degrees Celsius = 5/9 x (71.6 – 32)

Reading the Dreager Tube:

B = Draeger Tube %CO_2 (n-5) = 0.75

Two Scales on the Draeger Tube:
Scale "n=5" = 500cc of sample %CO_2
Scale "n=1" = 100cc of sample %CO_2

Given the scale that is used on the Draeger tube, draw either the of 100cc or the 500cc sample of %CO_2 from a 100cc syringe supplied in the Kit.

The reading of CO_2 should be an estimate of the highest point purple of the shaded area on the Dreager tube.

This is 0.75 % CO_2

Soil Respiration Ring Depth:

Note: 1” inch = 2.54 cm

H = inside height of ring = 5.08 cm
(2 inches)

The 6 inch (across) ring should be pounded into the Soil at least 3 inches leaving 2 above ground.

Basic Soil Respiration: Calculation

"data from previous slides"

Step 1: In the Field collect Temperature and % CO_2

Soil Respiration (lbs CO2-C/acre/day) =

PF x ((A + 273)/270) x (B – 0.035) x 22.91 x H

Example:

- 0.996 X ((22 + 273)/273)x (0.75-0.35) x 22.91 x 5.08= _?_ (lbs CO2-C/acre/day)

- 0.996 X (1.08) x (0.4) x 22.91x5.08 = 50.07 **(lbs CO2-C/acre/day)**

PF = Pressure Factor = "Raw barometric pressure in inches Hg/29.9 inches Hg.

Note: this adjustment is necessary at elevations >

H = inside height of ring = 5.08 cm (2 inches)

A = Degrees Celsius Temperature

Conversion: Degrees Celsius = 5/9 x (Degrees Fahrenheit - 32)

B = Draeger Tube %CO_2 (n-5) = 0.75

Advanced Soil Respiration Calculations for Standardized Soil Respiration rate: caution

- **Optional Calculations: Further Information in Soil Quality Book.**
- **Soil temperature corrections can be performed using the general rule that biological activity increases by a factor of 2 with each 10 degree C increase in temperature. The following equation can be used to standardize (to 25 degree C) for differences in soil temperature that are between 15 and 35 degrees C.**
- **Step 2 Standardized Soil Respiration rate at 25 degrees Centigrade**

soil respiration rate X $2^{[(25-T)/10]}$ =

Or

For Temperatures between 0 and 15 degrees Centigrade use

soil respiration rate X $4^{[(25-T)/10]}$ =

Advanced Soil Respiration Calculations for Standardized Soil Respiration rate: caution

- **Optional Calculations: Further Information in Soil Quality Book.**

- **Step 3**

  Soil water content (g/g)

  = (weight of moist soil - weight of oven dry soil)/ weight of oven dry soil

  Used to assess soil moisture content on a dry weight basis.

- **Step 4**

  Soil bulk density (g/cm^3)

  bulk density = oven dry weight of soil /volume of soil

  Used to assess soil compaction, available water & soil porosity as they relate to soil texture & structure. (IWM-3)

- **Step 5**

  Volumetric Water Content (g/cm^3)

  = Soil water content (g/g) X bulk density (g/cm3)

  (to convert Gravimetric to percent by volumetric)

Advanced Soil Respiration Calculations for Standardized Soil Respiration rate: caution

- **Optional Calculations: Further Information in Soil Quality Book.**

- **Step 6**

Water Filled Pore Space (saturation)

WFPS%= (Volumetric water content X 100) / [1 – (soil bulk density / 2.65)]

Used to asses pore space percent, water content and air space.

Water Filled Pore Space gives an indication of how well aerated the soil is at the time of sampling.

Advanced Soil Respiration Calculations

for Standardized Soil Respiration rate: caution

Optional Calculations: Further Information in Soil Quality Book.

WFPS = Water Filled Pore Space (WFPS) at two concentrations of water

- Step 7 if - soils with 30 to 60% WFPS

  Soil Respiration$_{60}$

  = Soil respiration rate X (60 / measured %WFPS)

  From Step 3 & Step 7

  This soil was freshly tilled in the spring to prep for planting, (OM 1.5 – 2.0).
- OR
- Step 7 if - soils with 60 to 80% WFPS

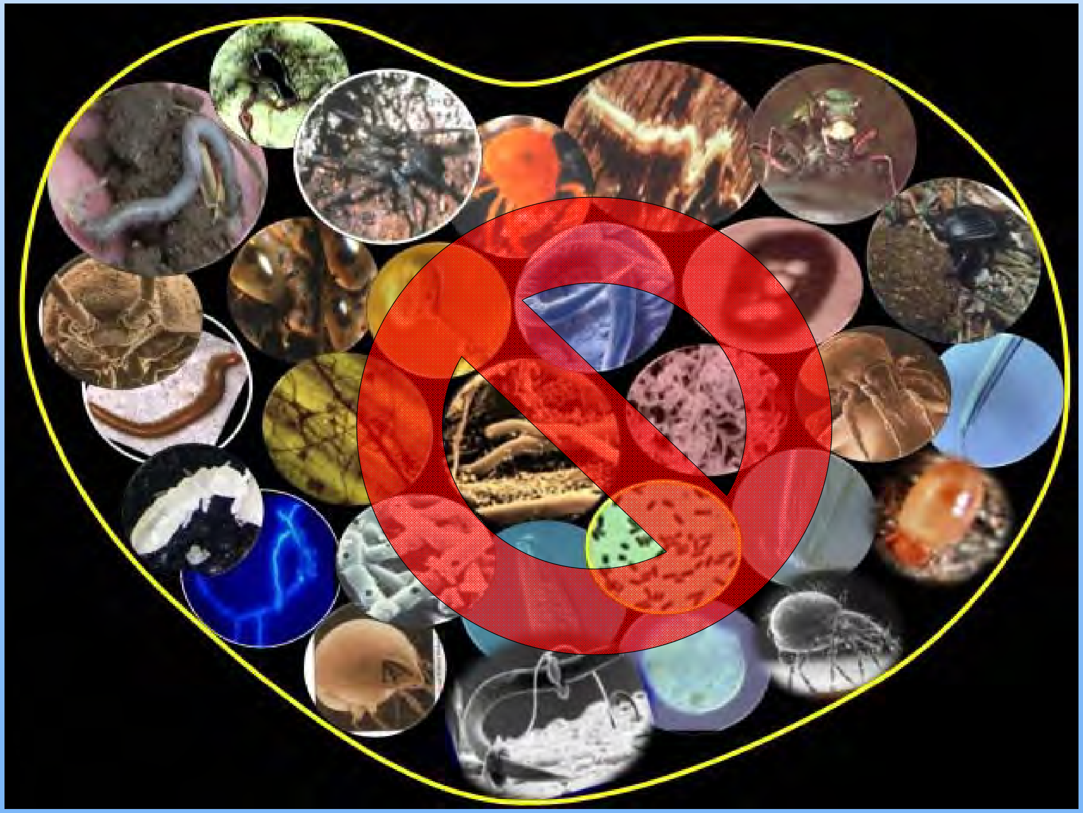
  Soil Respiration$_{80}$

  = Soil respiration rate X (80 / measured %WFPS)

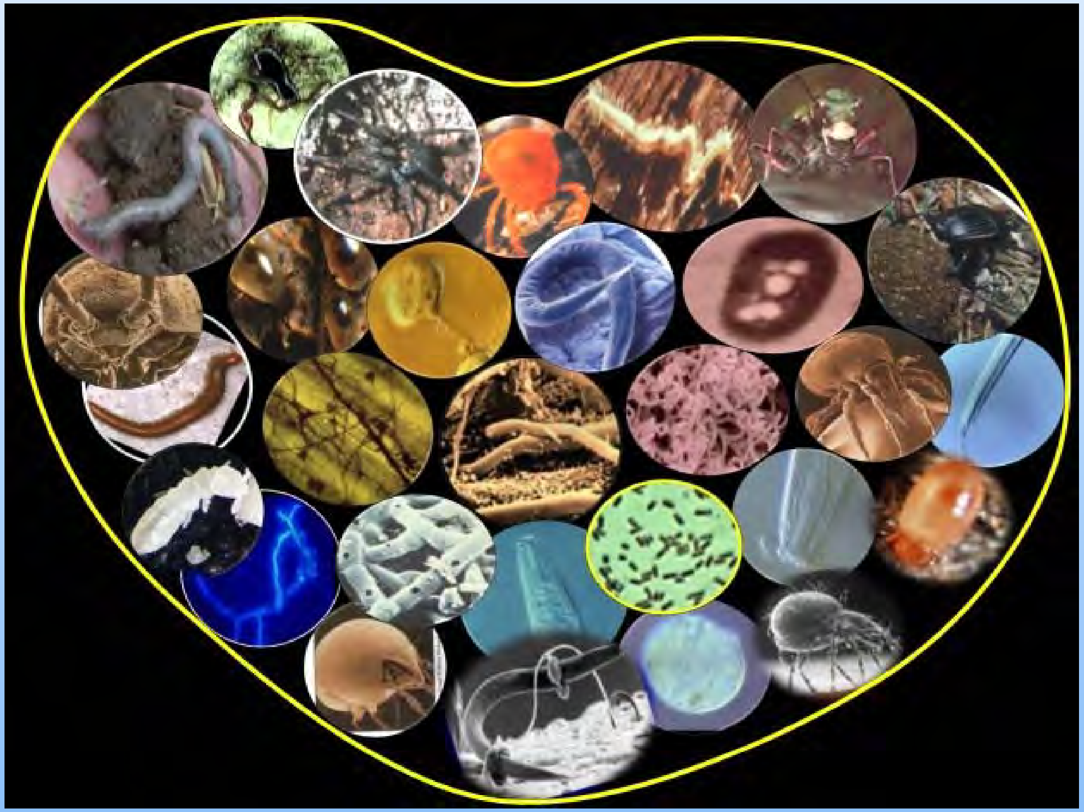
  From Step 3 & Step 7
- Reference: Agronomy Tech Note 76 Sec. 15d Soil Quality Kit

Water Filled Pore Space (WFPS): is the percentage of total water in the pore space.

- **When the WFPS% is below 30% saturation, "microbial activity generally decrease".**

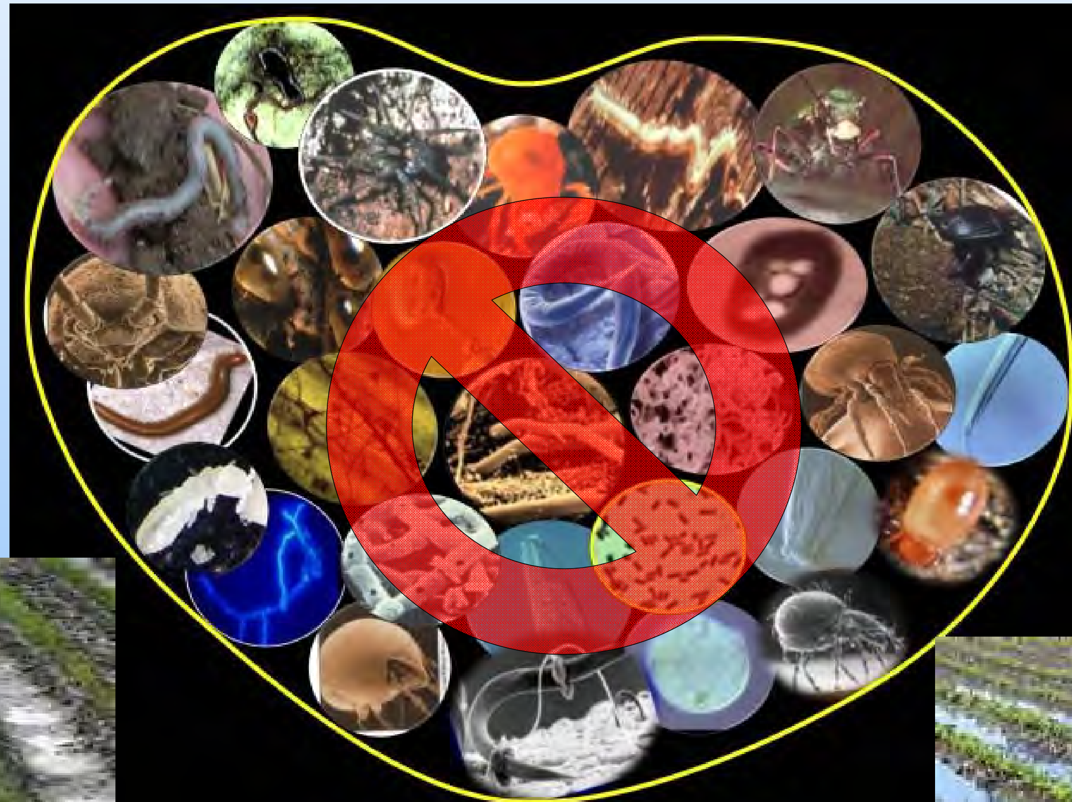


When the WFPS% is above 60% saturation, "microbial activity generally occurs".



Water Filled Pore Space (WFPS): is the percentage of total water in the pore space.

When the WFPS exceeds 80% “saturation, soil respiration may be restricted by the wet conditions and should not be measured”.



Water Filled Pore Space (WFPS): is the percentage of total water in the pore space.

Respiration Interpretation (Caution)

Soil Respiration (lbs CO_2-C/a/d)	Class	Soil Condition (Table 1. pg. 53) (Class ratings & soil conditions at optimum soil temp. & moisture)
0	No soil activity	Soil has no biological activity and is virtually sterile
< 9.5	Very low soil activity	Soil is very depleted of available OM and has little biological activity.
9.5 - 16	Mod. low soil activity	Soil is somewhat depleted of available OM, and biological activity is low.
16 - 32	Medium soil activity	Soil is approaching or declining from an ideal state of biological activity.
32 – 64	Ideal soil activity	Soil is in an ideal state of biological Activity has adequate OM and active populations of microorganisms
> 64	Unusually high soil activity	Soil has a vary high level of microbial activity and has high levels of available OM, possibly from the additions of large quantities of fresh OM or manure.

"Factors Influencing Soil Respiration"

Caution: You should not use the Soil Respiration number alone with out considering?

Temperature, Moisture, Soil Biota, EC, pH, Root Depth etc..

Use Common Scene

Soil Food Web

Winter Cover Crops

Timing Early Spring or Mid Summer

Type and Time of Tillage

Caution: You should not use the Soil Respiration number alone with out considering?

???????

High Salts

Crop Residue & Irrigation

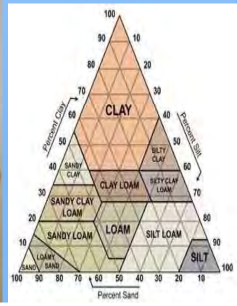
Manure or Compost Applications

To Much Water

Not enough Water

Winter Fallow

Soil Type , Depth, Structure, Texture



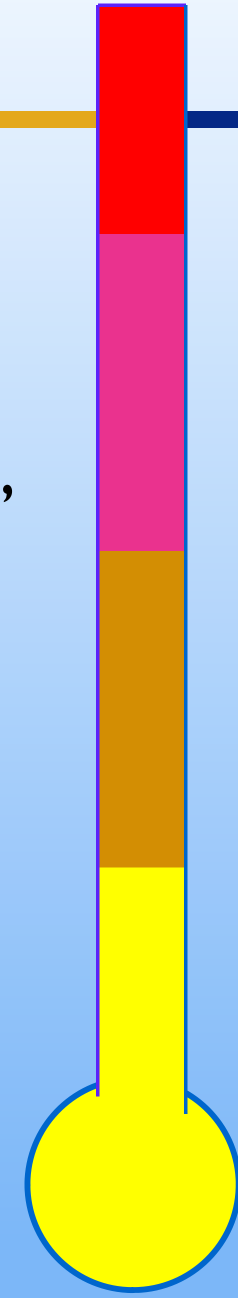
65 -95 Degrees °F

Soil Food Web

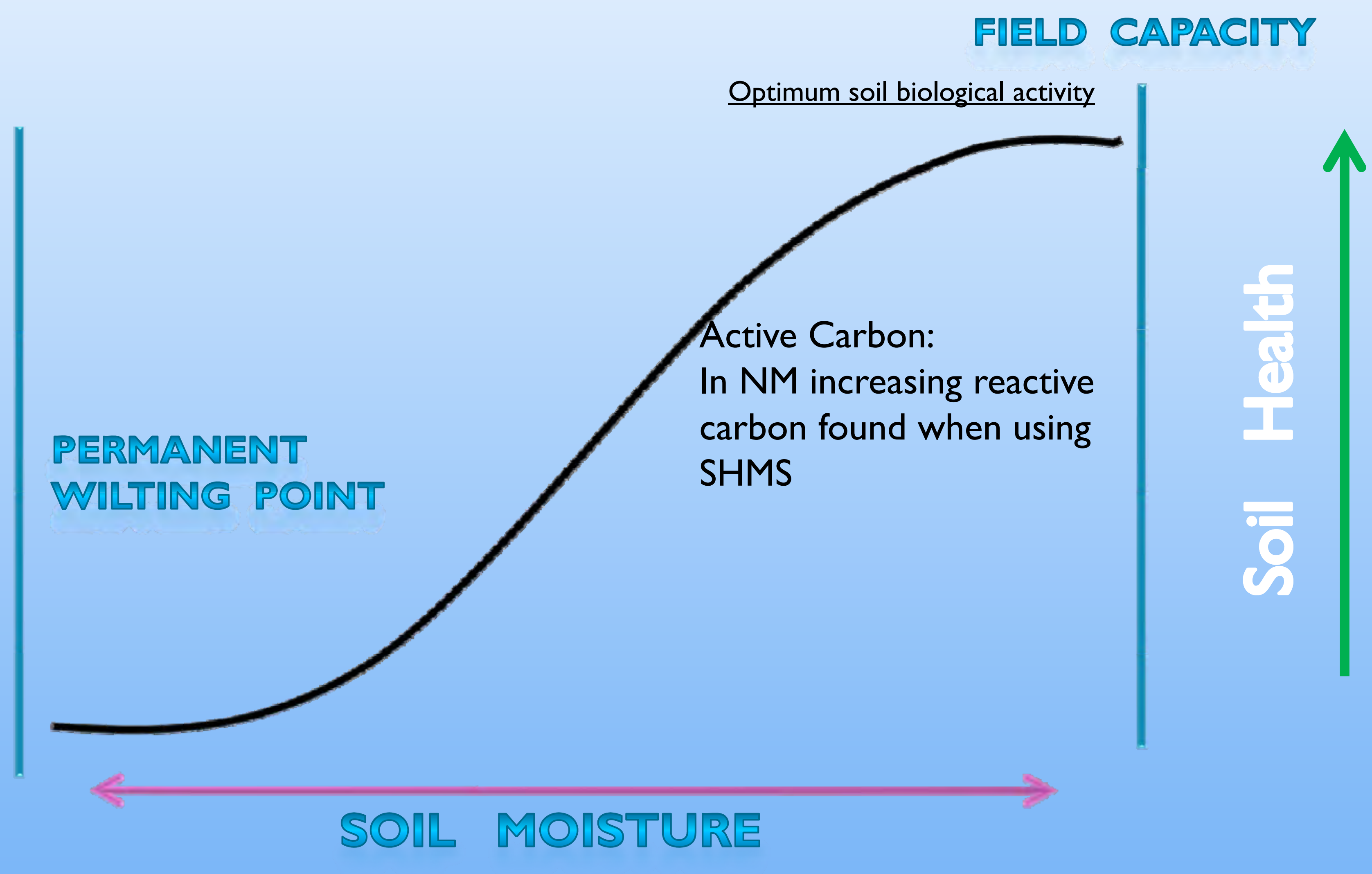
Environment
For soil biota and crop roots (i.e., increased nutrient cycling and water use efficiency at lower temperature)

Soil Temperatures: Fahrenheit

- 140 degrees F, soil bacteria die.
- 101-130 degrees F, 100% moisture lost through evaporation and transpiration. "Some species of bacteria, arthropods, start to die"
- 95 -100 degrees F, 15% moisture used for growth, 85% moisture lost through evaporation and transpiration.
- 65 - 95 degrees F, 100% moisture used for growth. "Ideal for Soil Biota activity".



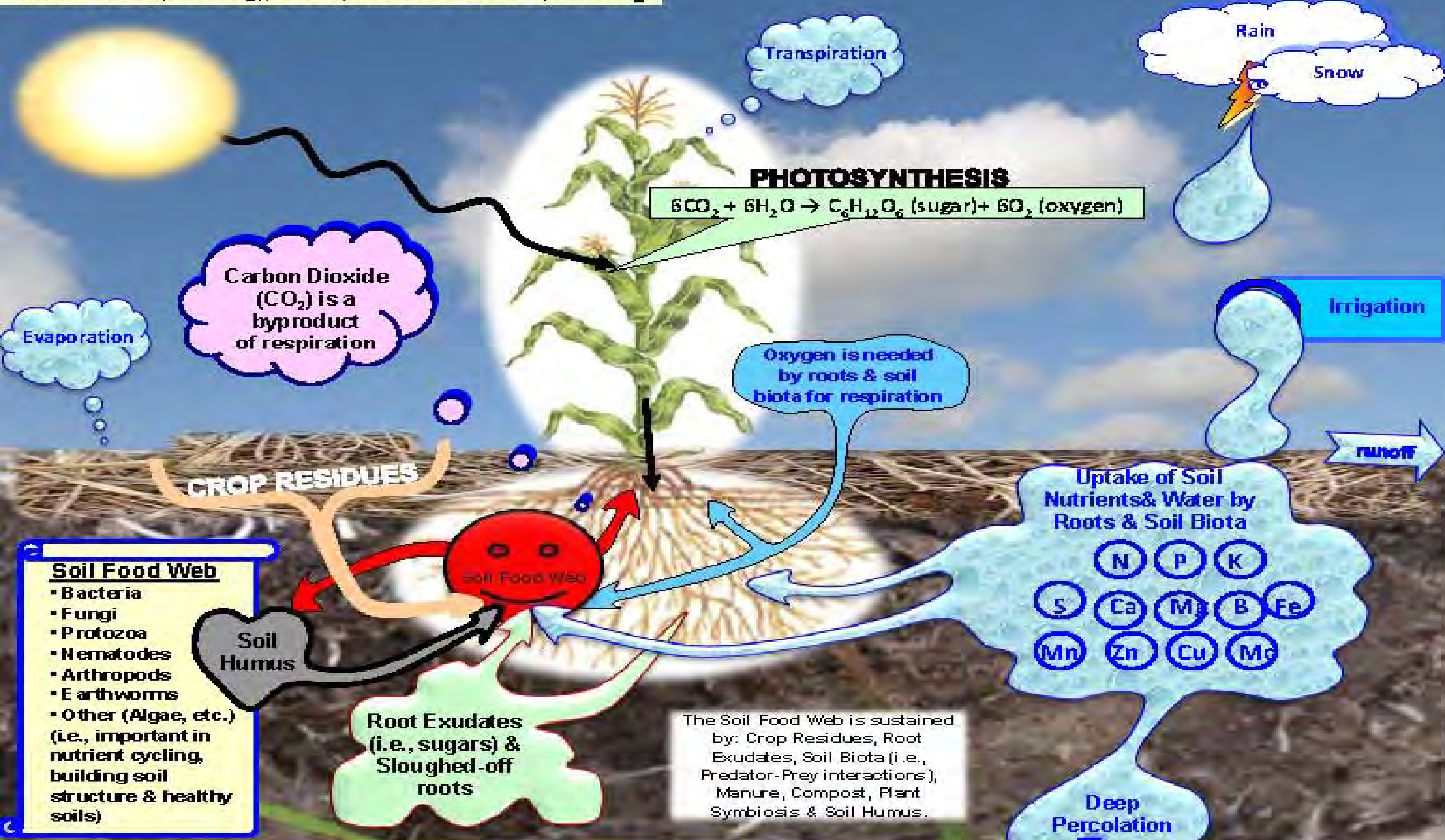
Generalized Relationship Between Soil-Water retention, Active Carbon and Microbial Counts



SHMAs = Soil Health Management System

Soil Primer -- Soil Food Web

Section 1 of 22 (1c- Energy, Carbon, Nutrients & Water Cycle Guide)



Agronomy Tech Note 76 (http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html)

Soil Carbon and Nitrogen Cycles

- The carbon and nitrogen cycles are important natural processes that involve the uptake of nutrients due to mineralization from soil microbes.

- The return of organic matter to the soil and its decomposition by soil biota is how nutrients are cycled in the soil ecosystem.

- These cycles are related to the hydrologic cycle, since water functions as the primary medium for chemical transport

pH and Nutrient Availability

pH -- is the measure of the acidity or alkalinity of a soil, which affects the availability of plant nutrients, activity of microorganisms, and the solubility of soil minerals

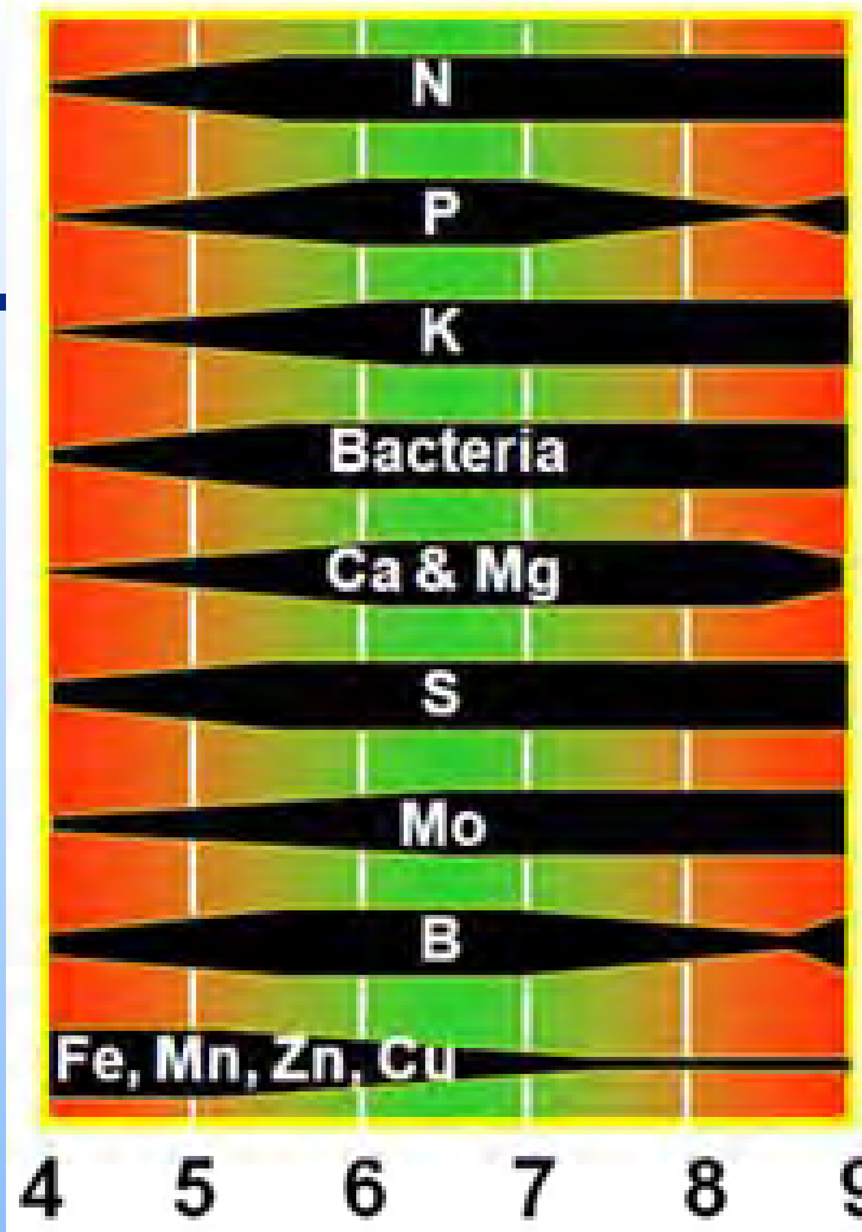
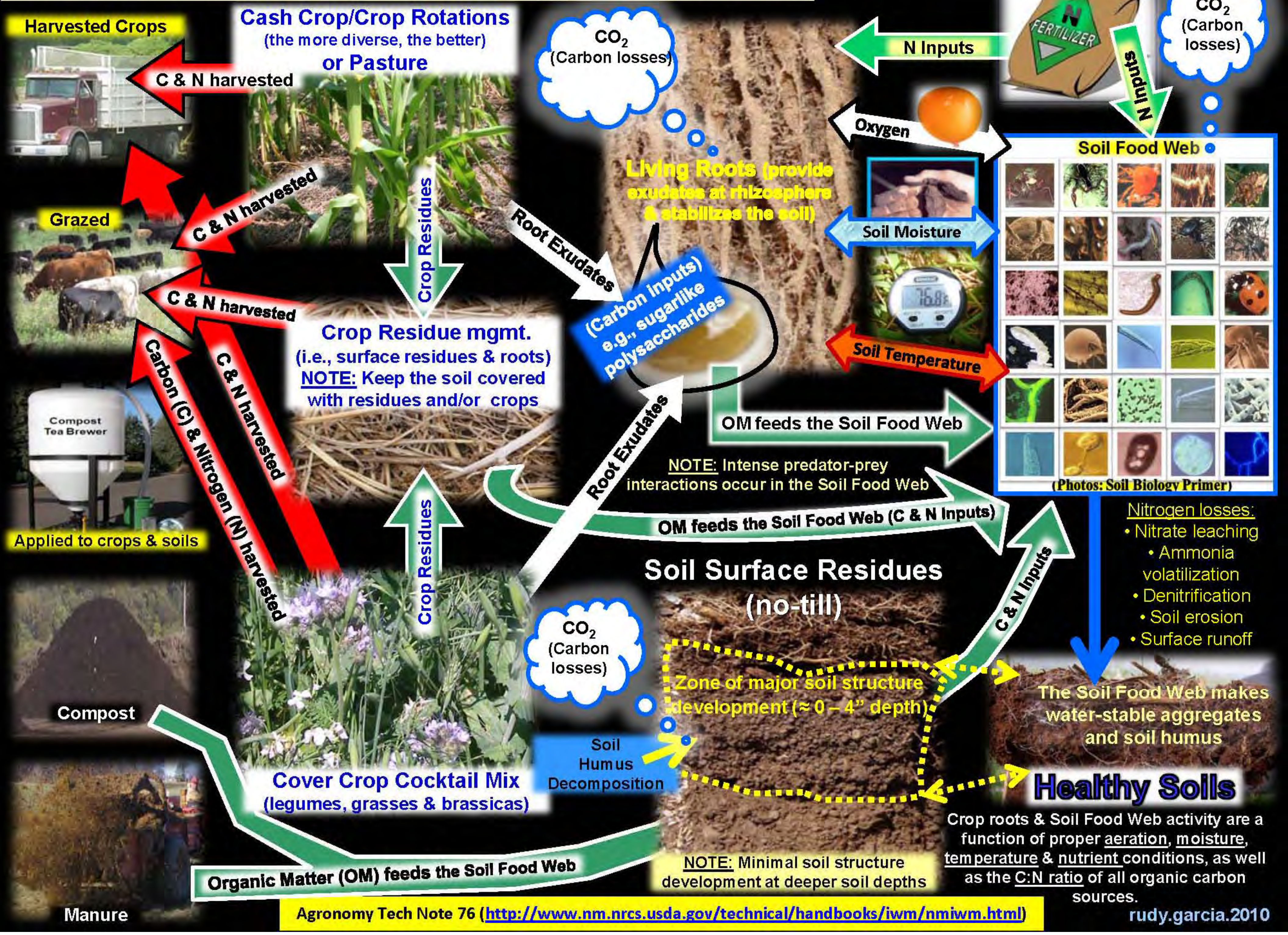


Figure 2. Effect of soil pH on nutrient availability. Nutrients reach maximum availability near pH 6.5. Figure courtesy of University of Arkansas.

Introduction to Section 1 (1b – Managing Organic Matter & Nitrogen Inputs to Improve the Soil Resource)



Soil Respiration: Cover Crops

Use of cover crops helps control erosion :

- Reduce weed pressure
- Fix Nitrogen in a legume crop
- Grazed for additional income
- Harvested as a hay crop
- Improve Soil tilth
- Increase organic matter levels
- Enhance water infiltration
- Lessen pests
- Enhance Soil Biota diversity

Why do we need to know about "Soil Health" ?

1. **Increases Nutrient Cycling**
2. **Increases Organic Matter**
3. **Increases Carbon Sequestration**
4. **Increases Structure/Glomalin Glues**
5. **Increases Re-active Carbon**
6. **Increases Aggregate Stability**
7. **Increases Infiltration**
8. **Increase the Leaching Potential**

For more information Please Contact Your Local Office of the:

Natural Resources Conservation Service

or

Soil and Water Conservation District

USDA NRCS

Non-Discrimination Statement

- "The U.S. Department of Agriculture (USDA) prohibits discrimination in all of its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex (including gender identity and expression), marital status, familial status, parental status, religion, sexual orientation, political beliefs, genetic information, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD)."

USDA NRCS

United States Department of Agriculture
Natural Resources Conservation Service