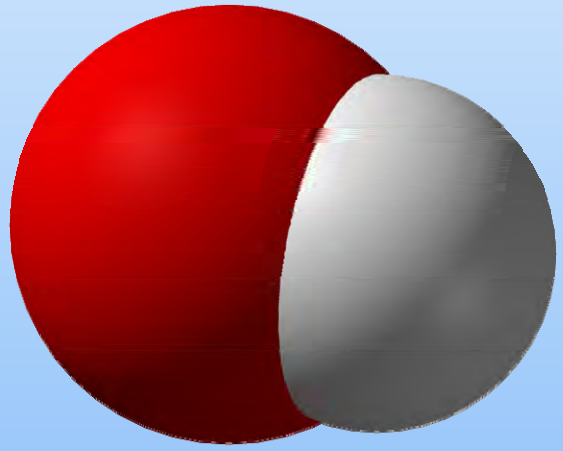
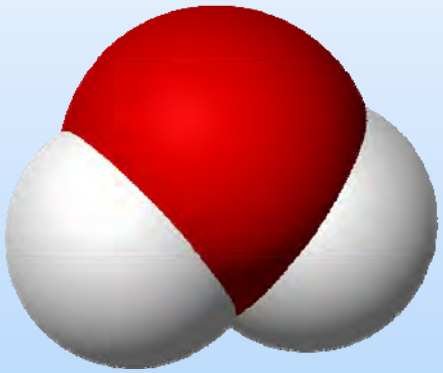
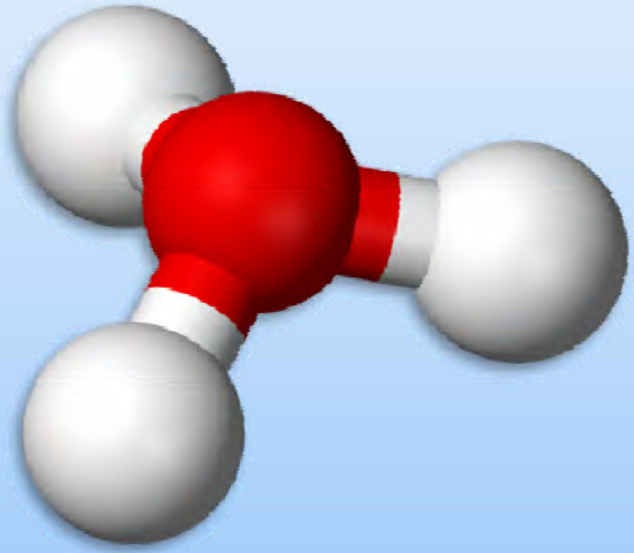
Hydroxide Ion / Hydronium Ion



hydroxide ion
HO^-



Water
Molecule
H_2O^+



aqueous
cation
H_3O^+

Soil pH (Hydroxide Ion / Hydronium Ion)

- $C(OH)_4 \rightarrow HCO_3^- + H_3O^+ \; HCO_3^- + H^+ \; H_2CO_3$ carbonic acid,
- $Na_2CO_3 + 2\,H_20 \rightarrow 2Na^+ + 2\,OH^- + H_2CO_3$
  - Sodium carbonate
- Ca(OH)2 + HCO3-1aq → CaCO3 + OH-1aq + H2O
  calcium hydroxide + bicarbonate ion = calcium carbonate + hydroxyl ion + water
- 6CO2 + 12H20 + 686 kcal → C6H12O6 + 6H20+ 6O2
  Photosynthesis
- Carbon dioxide + water + light energy → glucose + water + oxygen

pH and CEC Cation Exchange Capacity

Here is a table of approximate CEC's of organic matter and various common clays taken near pH=7.0:

Soil Component	CEC (cmol/kg)
humus	200
Vermiculite	150
smectites	100
Illite	30
chlorite	30
kaolinite	8
Fe, Al oxides	4

Types of Clays

Here is a partial list of cations ordered by adsorption strength:

Al > H > Ca > Mg > K > Na

Cation exchange capacity (CEC) is the amount of negative charge in soil that is available to bind positively charged ions (cations).

James J. Camberato
Clemson University, Crop and Soil Environmental Science

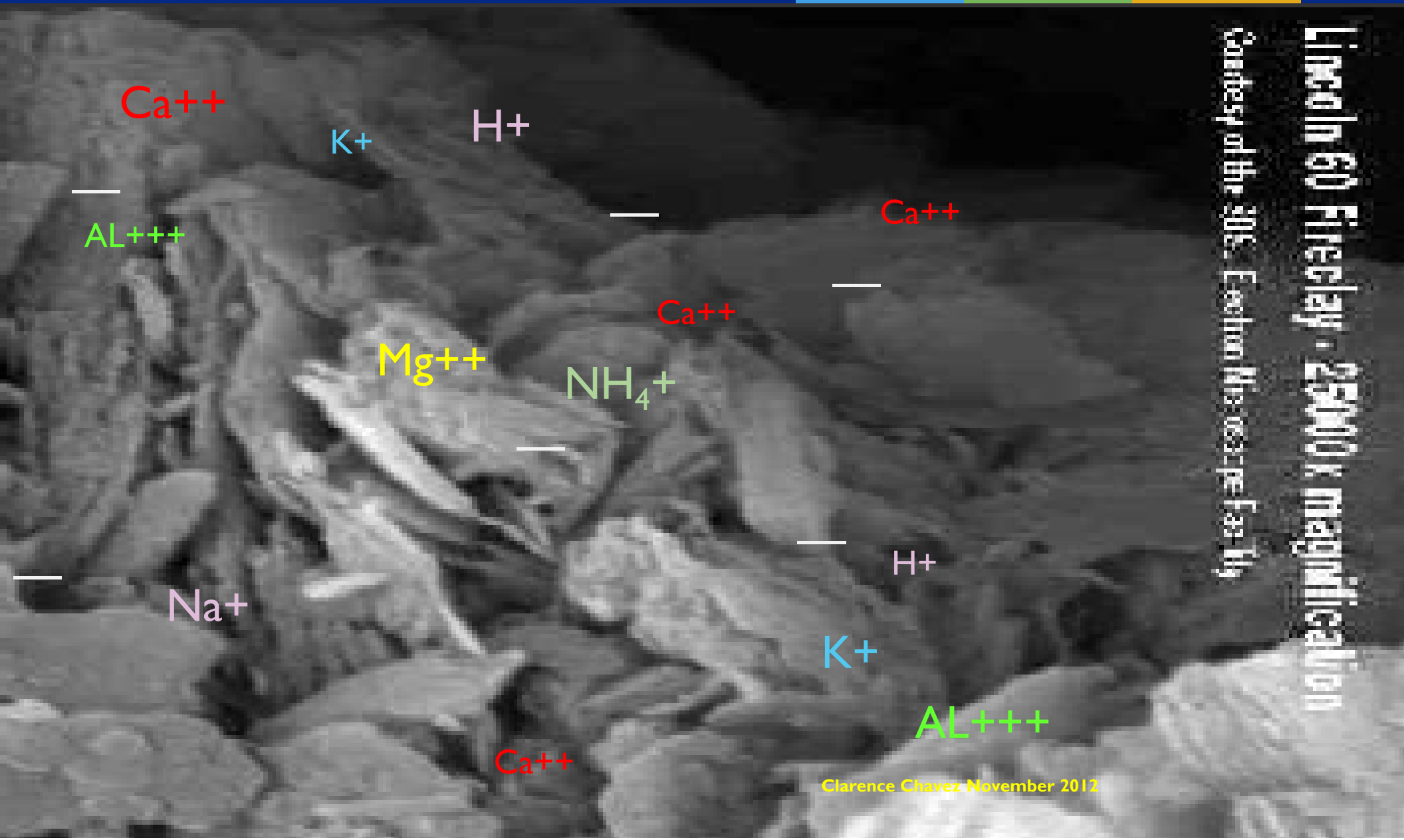
CEC – Cation Exchange

Cation characteristics and amount of various cations in pounds per acre equal to 1meq/100 g in one acre soil to a depth of 6 inches.

Cation	Charge	Molecular Weight	Amount in 1 acre soil 6 inch depth at 1 meq cation/100g
Aluminum	3+	27	180
Calcium	2+	40	400
Hydrogen	1+	1	20
Magnesium	2+	24	240
Potassium	1+	39	780
Sodium	1+	23	460

NRCS is an equal opportunity provider and employer.

CEC: Clay Particle has a ⁻ charge.



Clarence Chavez November 2012

Soil pH (a measure of the acidity or alkalinity of the soil)

Acid - 1

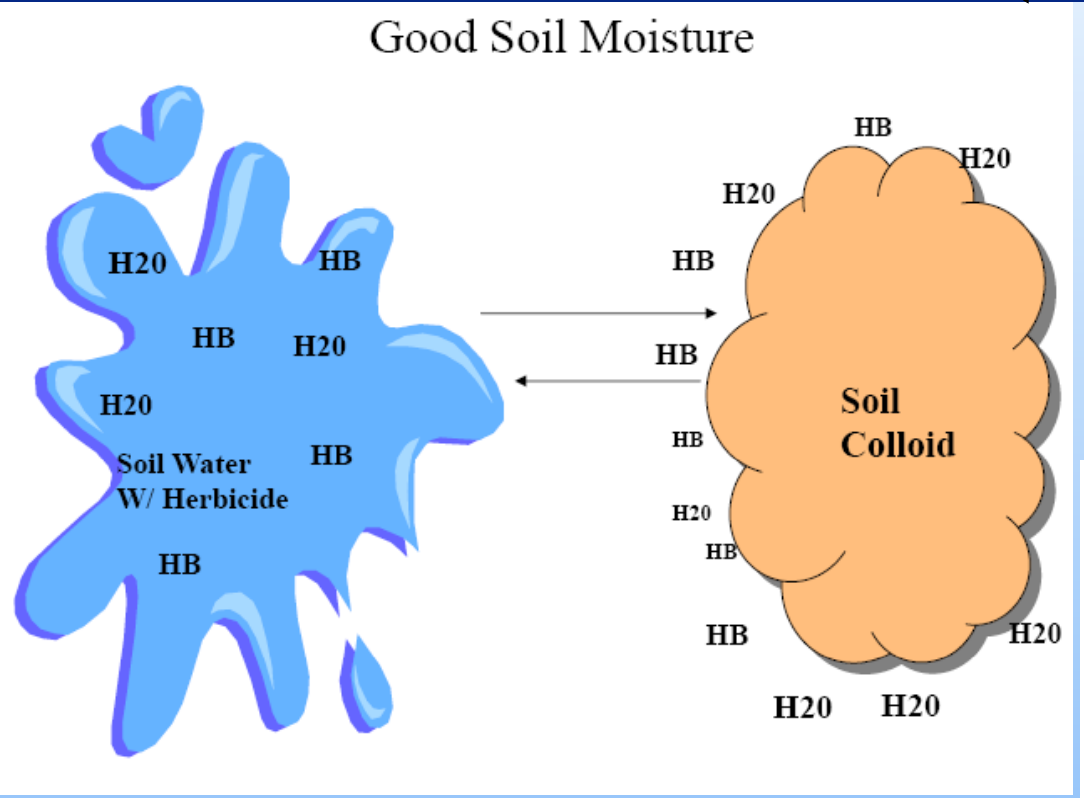
Neutral – 7.0

Basic - 14.0
Or Alkaline

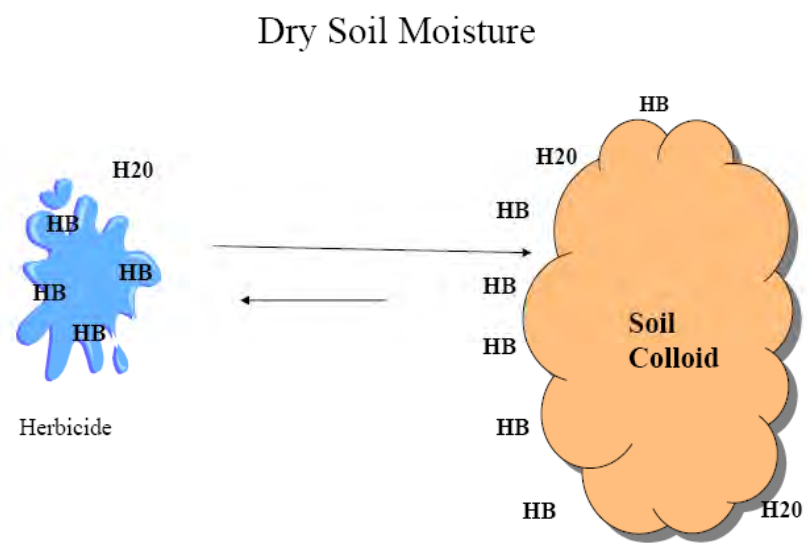
Relative amount oh H+ or OH- in a soil or Water. This affects the availability of plant nutrients, activity of microorganisms, growth of plants and the solubility of soil minerals

pH Demo

Soil pH is one of the most important soil properties that affects the availability of nutrients Fertilizers, Pesticides, Herbicides. (Soil Temperature also)

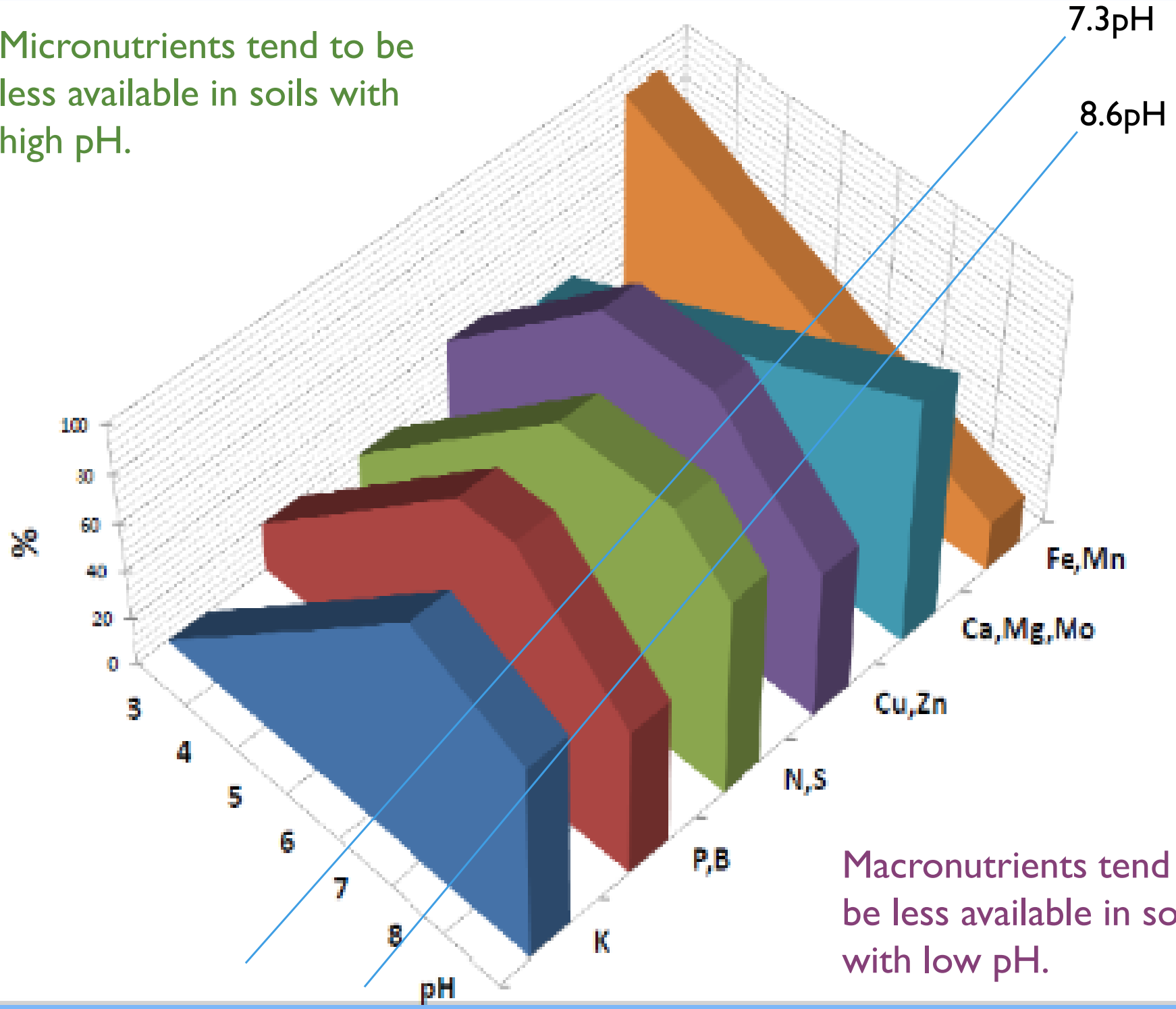


Absorption – penetrates into plant tissue, in water.



Adsorption binding of the herbicide to the surface of soil particle . (bonded electrically)

Micronutrients tend to be less available in soils with high pH.



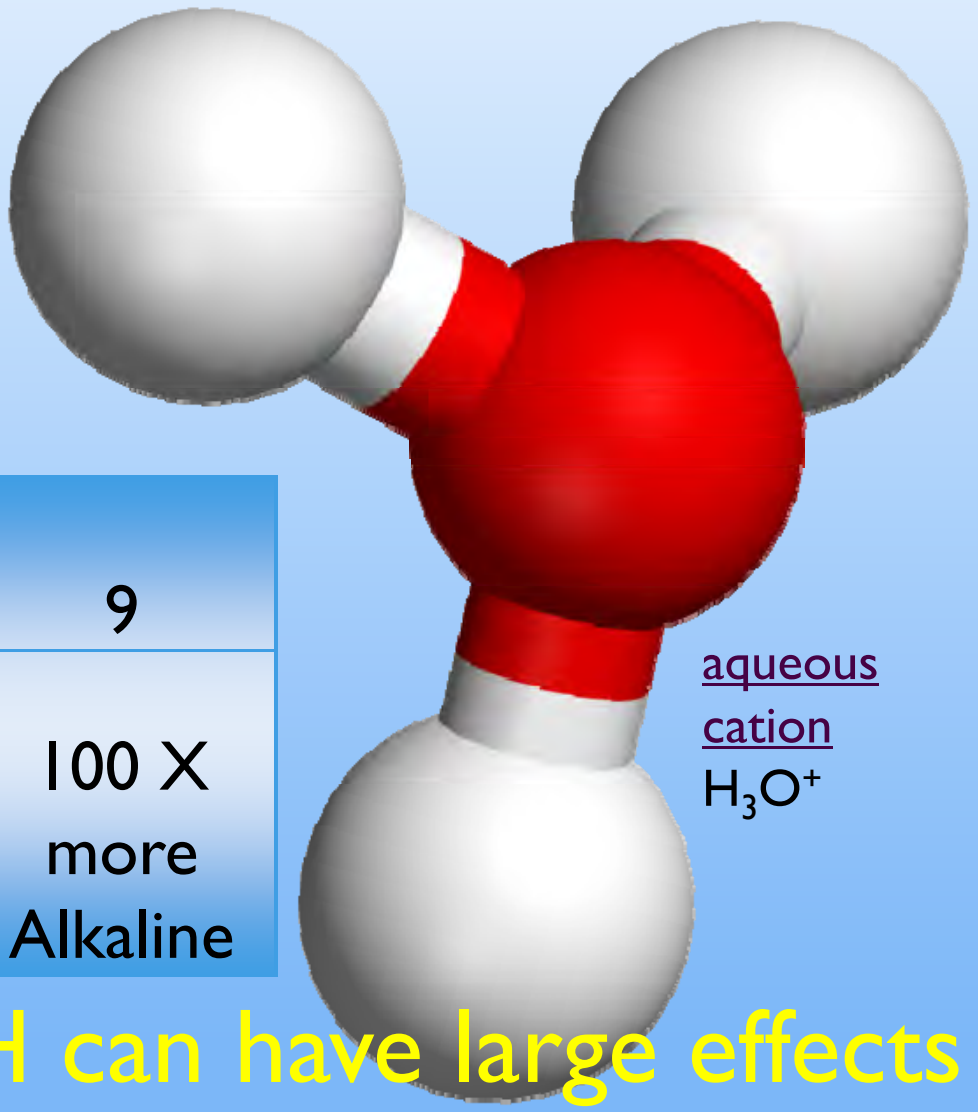
Macronutrients tend to be less available in soils with low pH.

Soil pH (a measure of the acidity or alkalinity of the soil)

The soil pH scale is logarithmic, meaning that each whole number is a factor of 10 X larger or smaller than the ones next to it.

pH and Factor from pH 7.0

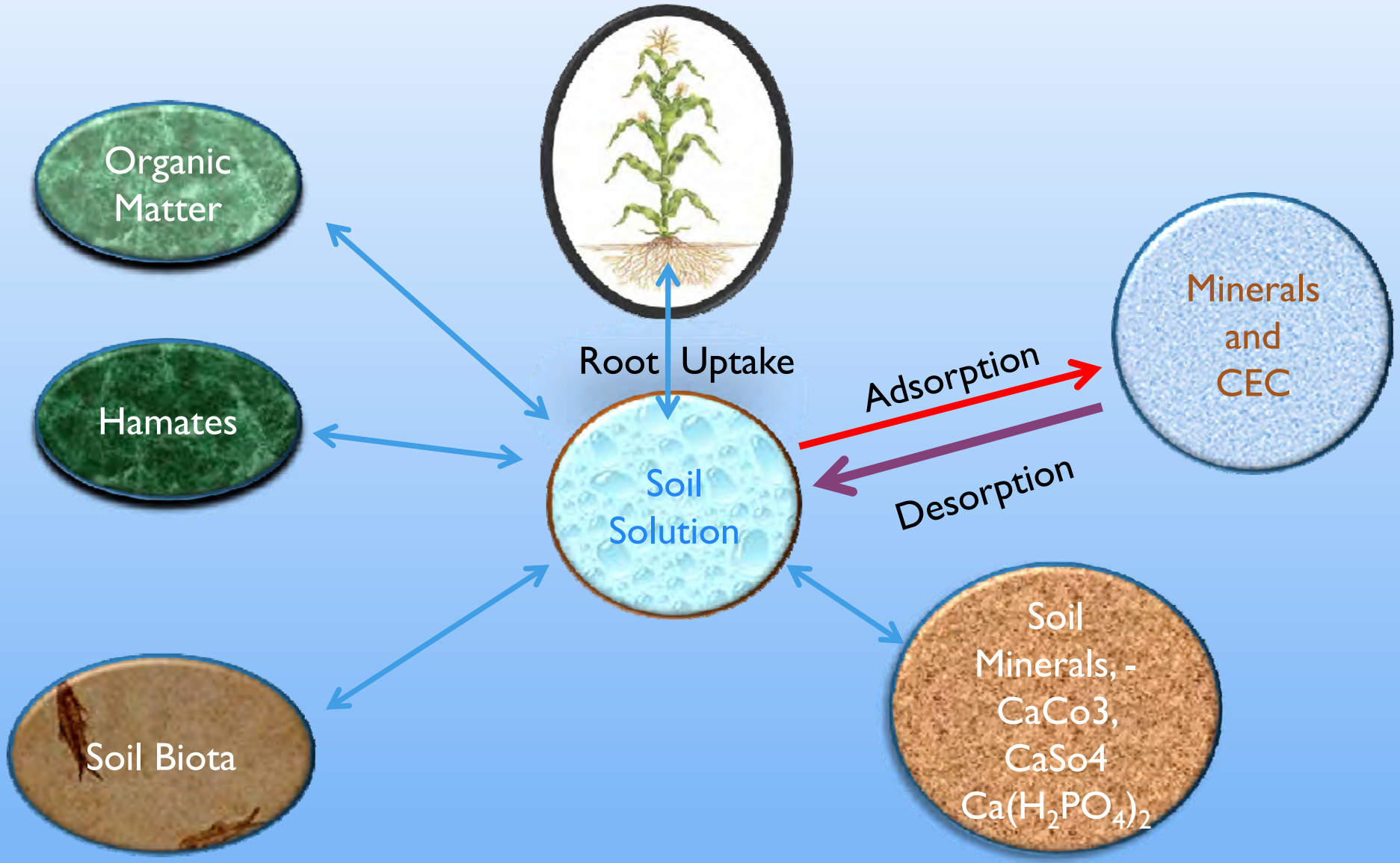
5	6	7	8	9
100 X more Acid	10 X more Acid	0	10 X more Alkaline	100 X more Alkaline



aqueous cation H_3O^+

small changes in a soil pH can have large effects

pH affects the Nutrient Pool

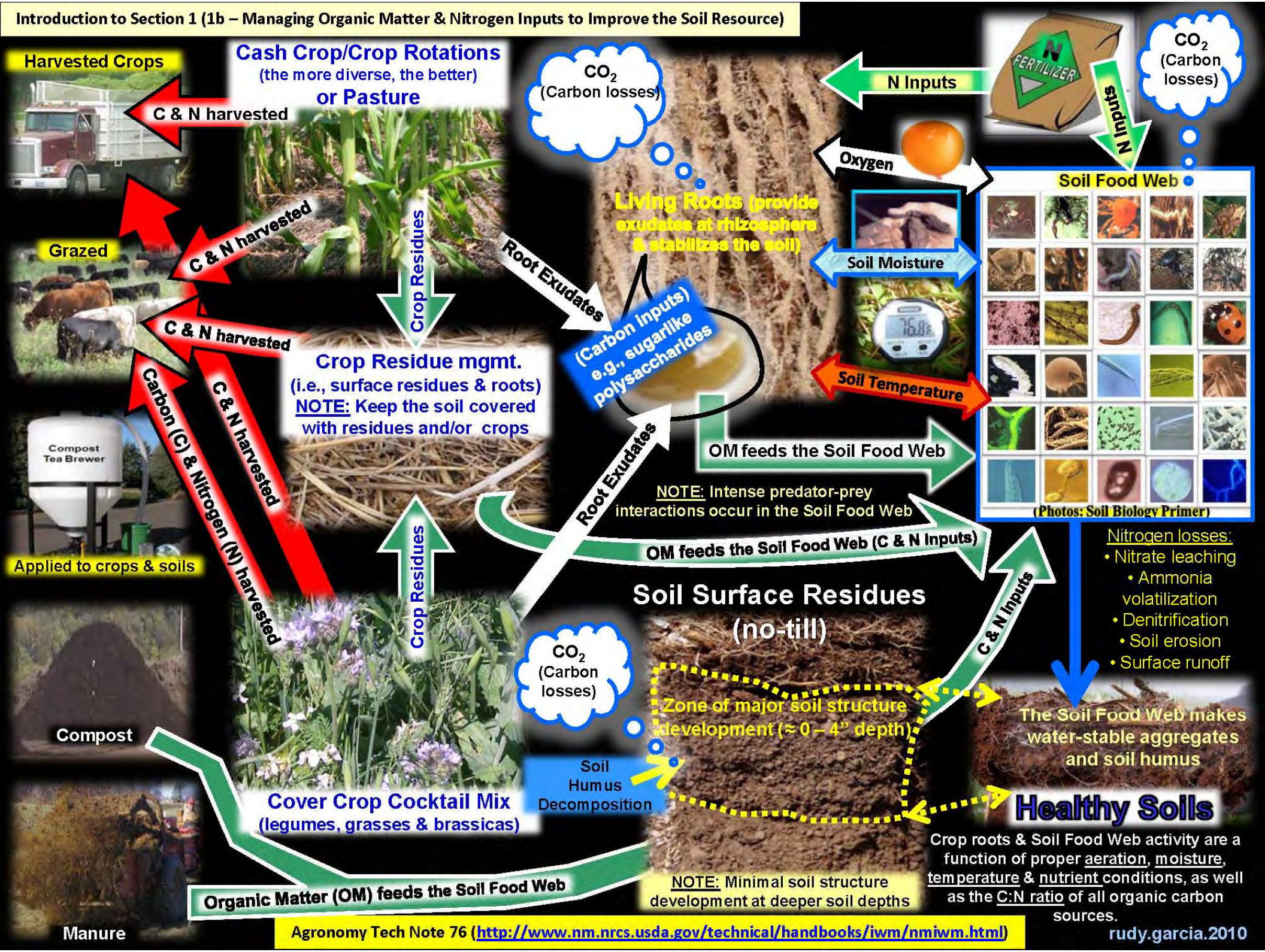


C. Chavez 2011

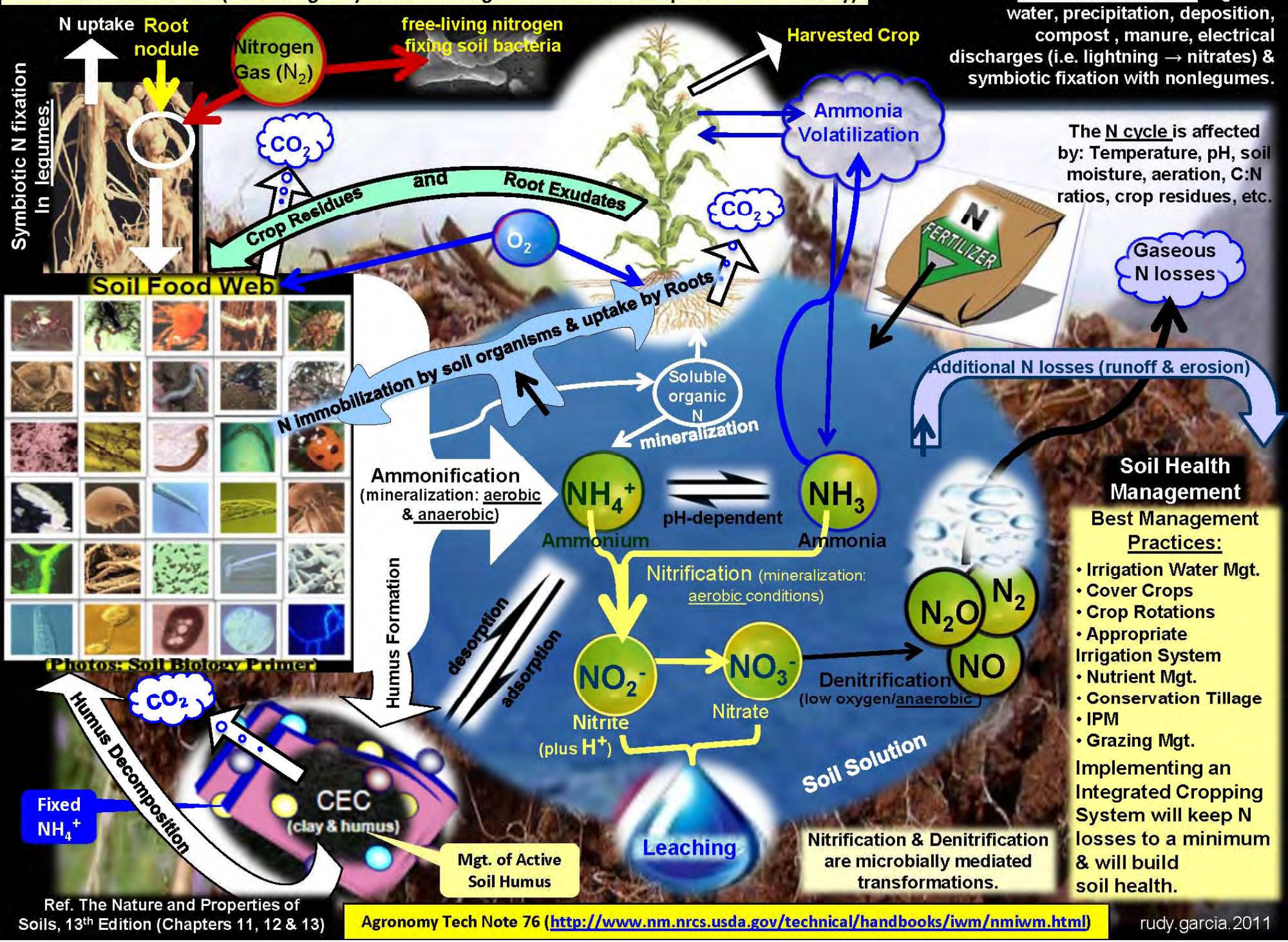
pH affects the Nutrient Pool

Special Note:

- In general, fungi function at a wide pH range.
- Bacteria and Actinomycetes function better at intermediate and higher pH range.


Introduction to Section 1 (1b – Managing Organic Matter & Nitrogen Inputs to Improve the Soil Resource)
Harvested Crops
Cash Crop/Crop Rotations
(the more diverse, the better)
or Pasture
C & N harvested
Grazed
C & N harvested
C & N harvested
Crop Residues
Root Exudates
Crop Residue mgmt.
(i.e., surface residues & roots)
NOTE: Keep the soil covered with residues and/or crops
Carbon (C) & Nitrogen (N) harvested
C & N harvested
Compost Tea Brewer
Applied to crops & soils
Crop Residues
Compost
Manure
Cover Crop Cocktail Mix
(legumes, grasses & brassicas)
Organic Matter (OM) feeds the Soil Food Web
CO2 (Carbon losses)
Living Roots (provide exudates at rhizosphere & stabilizes the soil)
(Carbon inputs) e.g., sugarlike polysaccharides
Root Exudates
OM feeds the Soil Food Web
NOTE: Intense predator-prey interactions occur in the Soil Food Web
OM feeds the Soil Food Web (C & N Inputs)
Soil Surface Residues
(no-till)
CO2 (Carbon losses)
Zone of major soil structure development (≈ 0 – 4" depth)
Soil Humus Decomposition
NOTE: Minimal soil structure development at deeper soil depths
N Inputs
FERTILIZER
N Inputs
CO2 (Carbon losses)
Oxygen
Soil Moisture
Soil Temperature
Soil Food Web
(Photos: Soil Biology Primer)
Nitrogen losses:
• Nitrate leaching
• Ammonia volatilization
• Denitrification
• Soil erosion
• Surface runoff
C & N Inputs
The Soil Food Web makes water-stable aggregates and soil humus
Healthy Soils
Crop roots & Soil Food Web activity are a function of proper aeration, moisture, temperature & nutrient conditions, as well as the C:N ratio of all organic carbon sources.
Agronomy Tech Note 76 (http://www.nm.nrcs.usda.gov/technical/handbooks/iwm/nmiwm.html)
rudy.garcia.2010

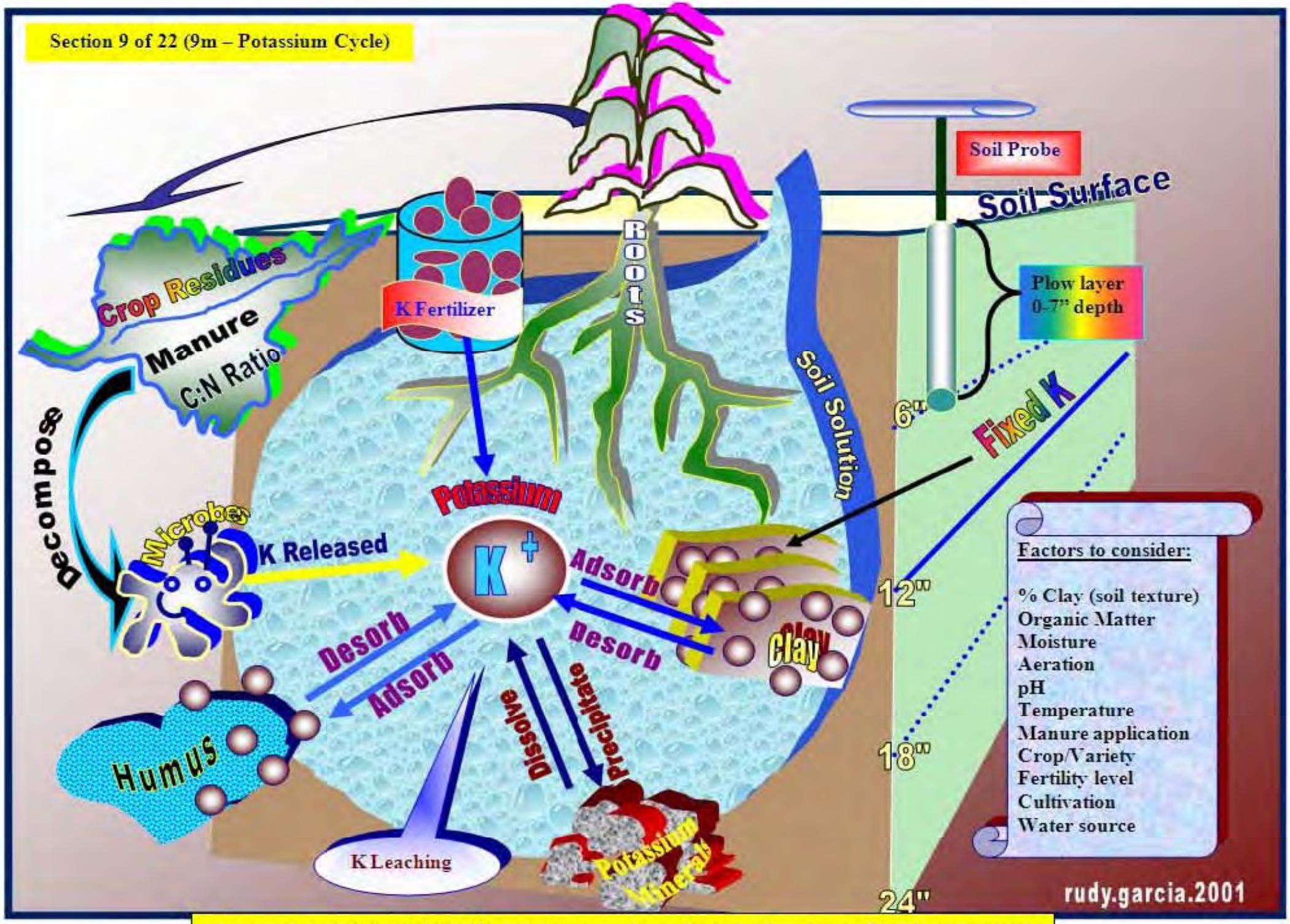
Introduction to Section 1 (1d – Nitrogen Cycle: Best Management Practices to improve N use efficiency)



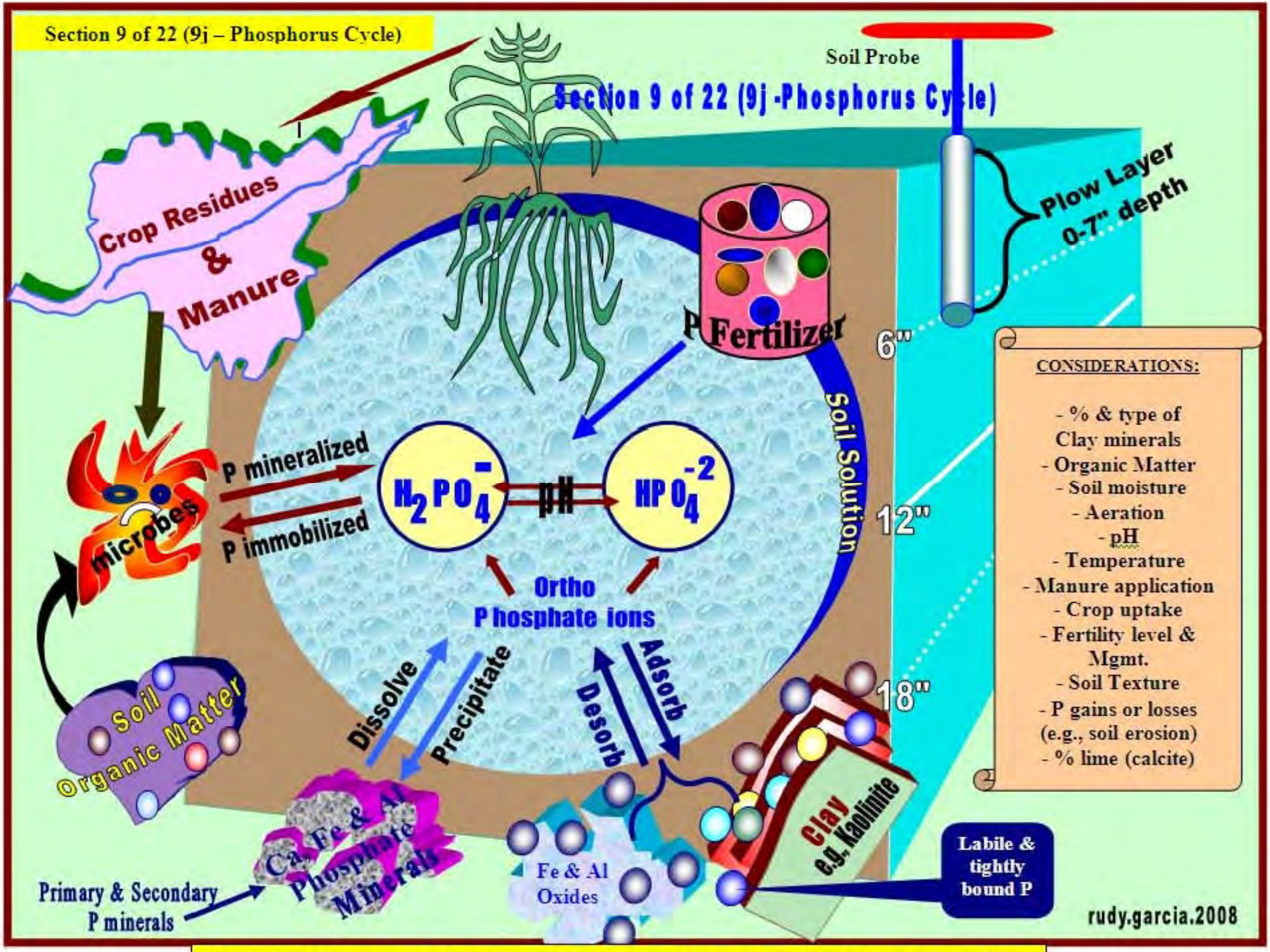
Ref. The Nature and Properties of Soils, 13th Edition (Chapters 11, 12 & 13)

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

rudy.garcia.2011



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


Section 9 of 22 (9j -Phosphorus Cycle)
Soil Probe
Crop Residues & Manure
Plow Layer 0-7" depth
P Fertilizer
6"
12"
18"
Soil Solution
P mineralized
P immobilized
microbes
$H_2PO_4^-$
pH
HPO_4^{-2}
Ortho Phosphate ions
Dissolve
Precipitate
Desorb
Adsorb
Soil Organic Matter
Ca, Fe & Al Phosphate Minerals
Fe & Al Oxides
Clay e.g., Kaolinite
Labile & tightly bound P
Primary & Secondary P minerals
CONSIDERATIONS:
- % & type of Clay minerals
- Organic Matter
- Soil moisture
- Aeration
- pH
- Temperature
- Manure application
- Crop uptake
- Fertility level & Mgmt.
- Soil Texture
- P gains or losses (e.g., soil erosion)
- % lime (calcite)
rudy.garcia.2008

Soil pH: Cover Crops

Use of cover crops helps control erosion as well as improve:

- pH
- Soil tilth
- Increase organic matter levels
- Enhances water infiltration
- Lessens pests
- Enhances Soil Biota diversity

Recap: Why do we need to know about Soil Health.

1. Nutrient Cycling
2. Beneficial Soil Biota
3. Organic Matter
4. Root growth
5. Carbon Sequestration
6. Soil Structure/Glomalin Glues
7. Active Carbon Testing and Trend
8. Reduce Salts
9. Root Diversity (crop rotations)
10. Integrated Pest Management (Insects and Weeds)

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