Soil Fertility and Nutrient Management

Hailin Zhang

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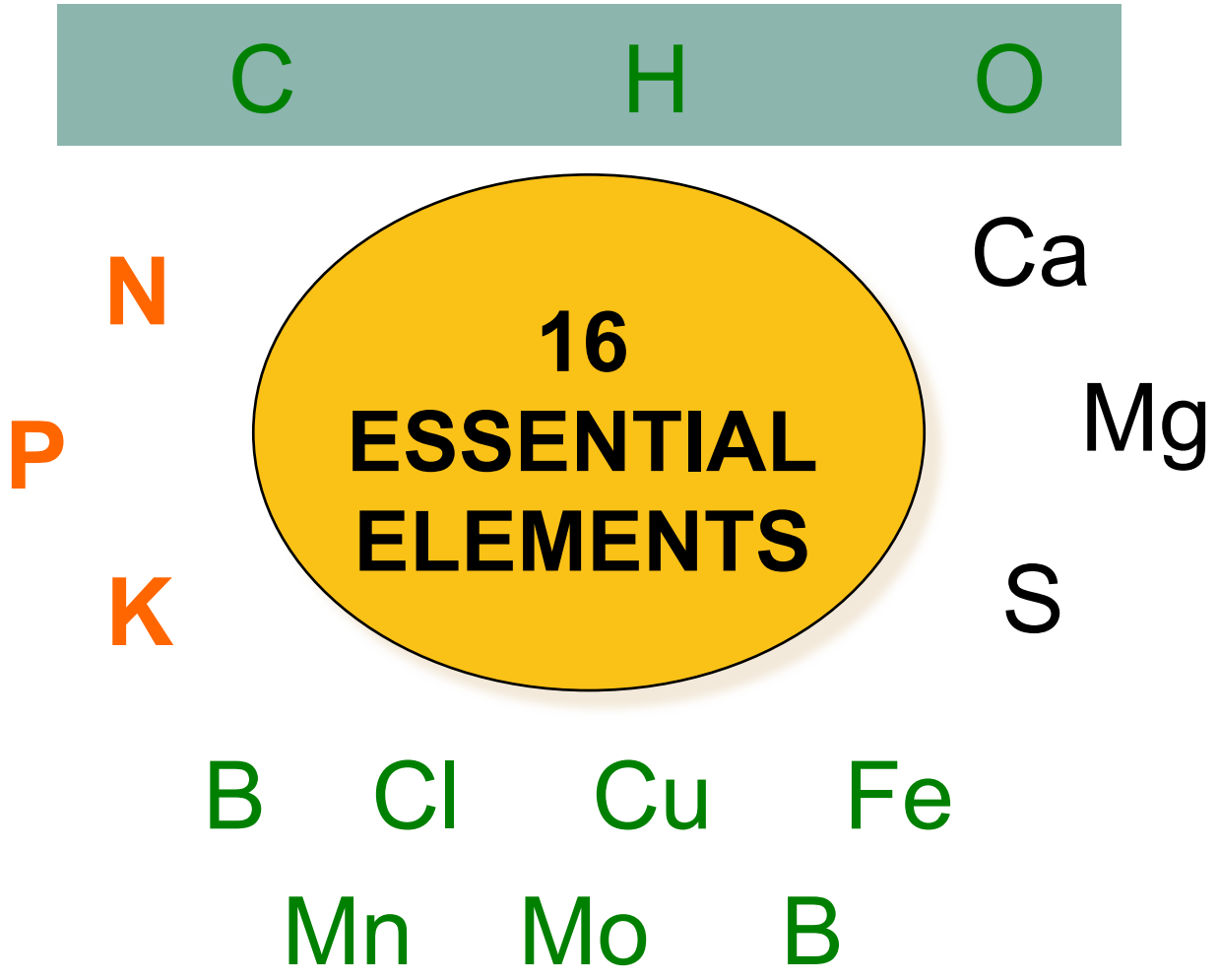

C H O
N
P
K
16 ESSENTIAL ELEMENTS
Ca
Mg
S
B Cl Cu Fe
Mn Mo B

NON-MINERAL NUTRIENTS

Carbon (C)

Hydrogen (H)

Oxygen (O)

Used in photosynthesis

MINERAL NUTRIENTS

Major nutrients

Nitrogen (N)
Phosphorus (P)
Potassium (K)

Secondary nutrients

Calcium (Ca)
Magnesium (Mg)
Sulfur (S)

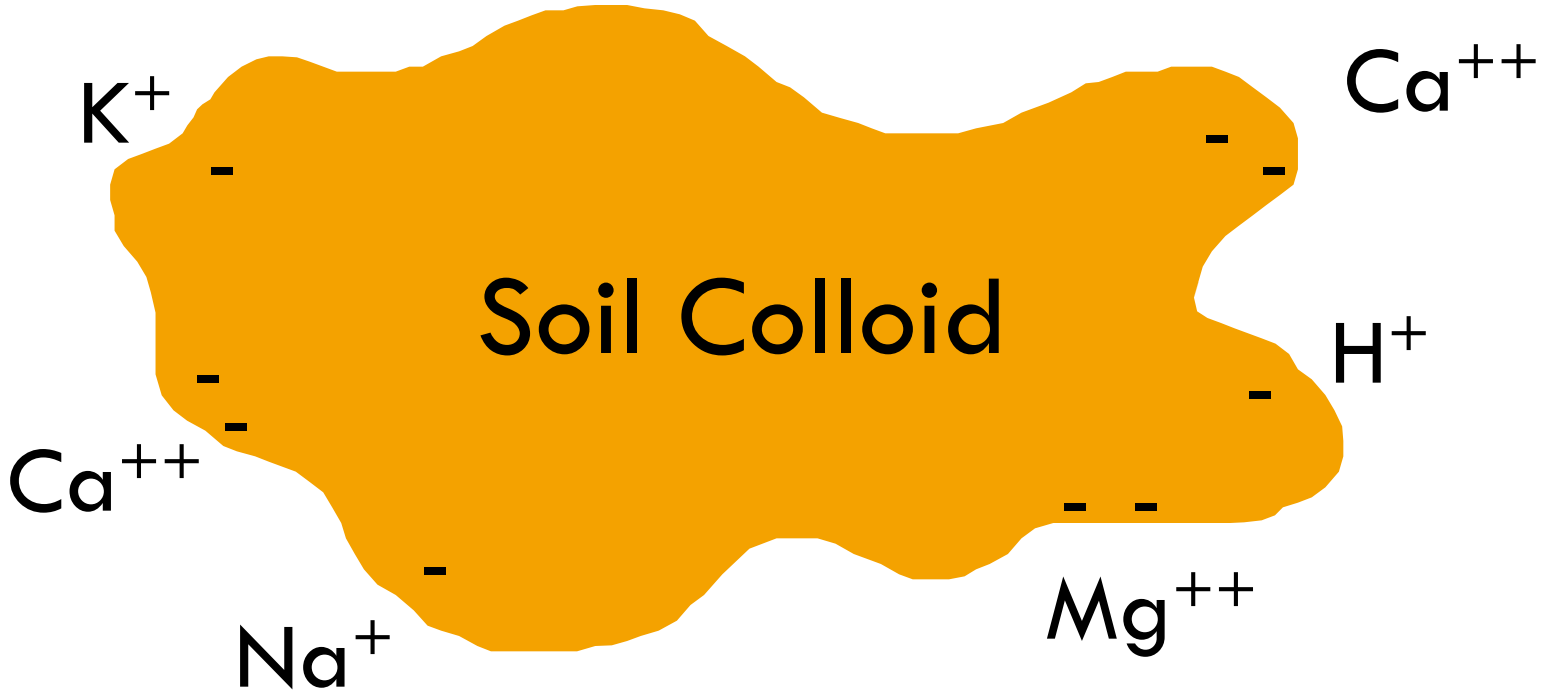
Micronutrients

Boron (B)
Chloride (Cl)
Copper (Cu)
Iron (Fe)
Manganese (Mn)
Molybdenum (Mo)
Zinc (Zn)

Positively Charged Ions Are Called Cations

Nutrient	Chemical symbol	Ionic form
Potassium	K	K^+
Sodium	Na	Na^+
Ammonium	NH_4	NH_4^+
Hydrogen	H	H^+
Calcium	Ca	Ca^{++}
Magnesium	Mg	Mg^{++}

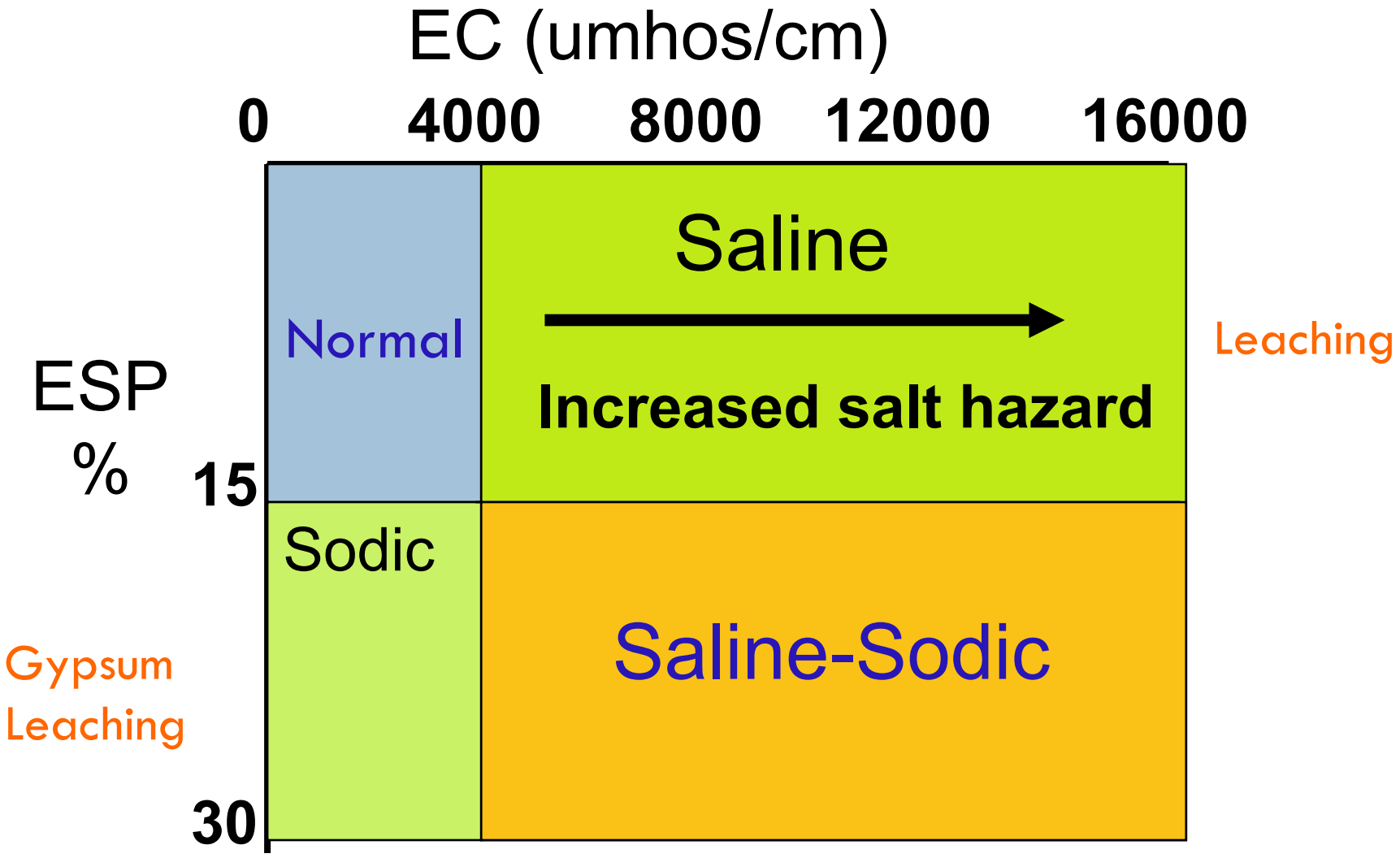
NEGATIVELY CHARGED COLLOIDS ATTRACT CATIONS



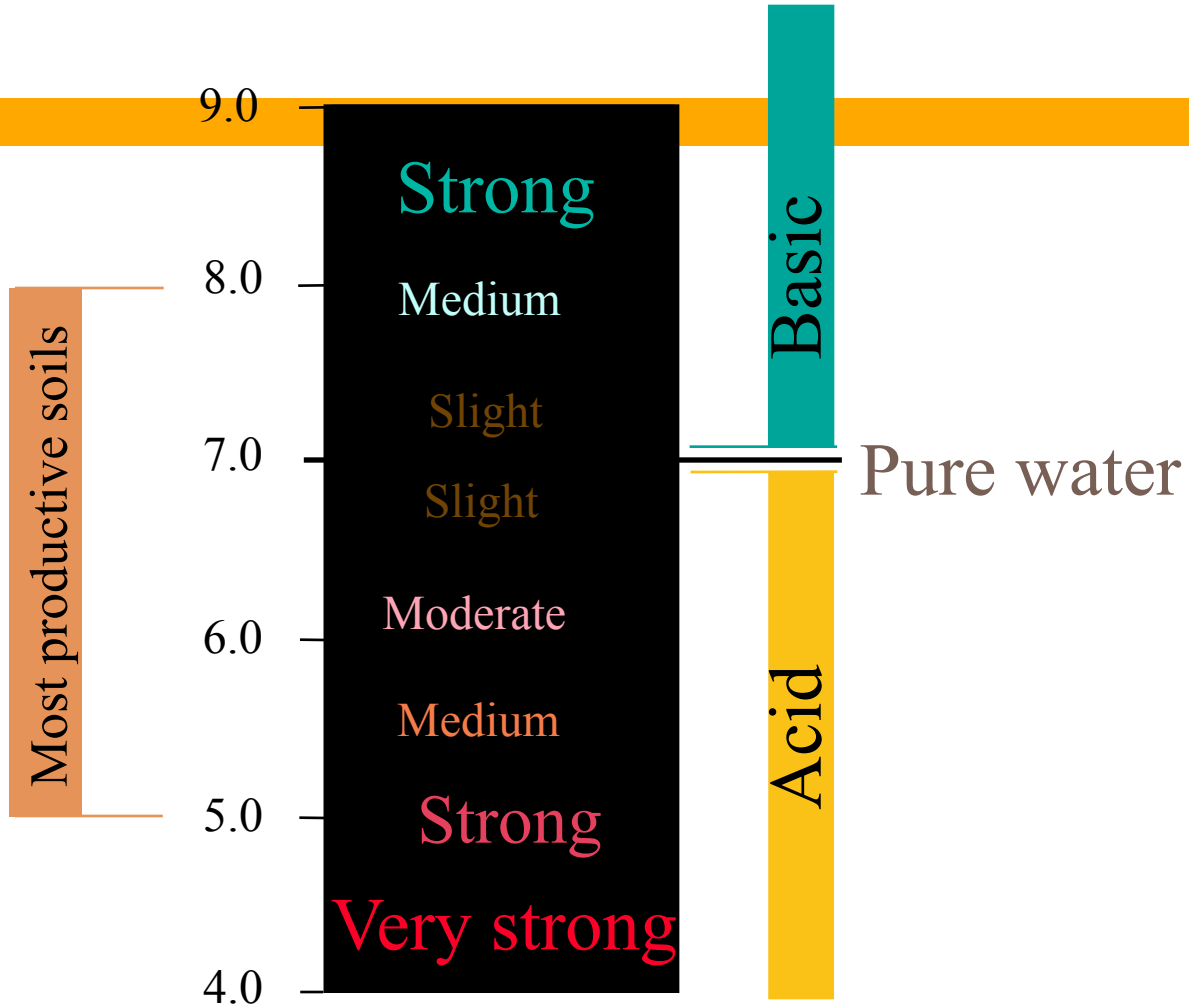
Negatively Charged Ions Are Called Anions

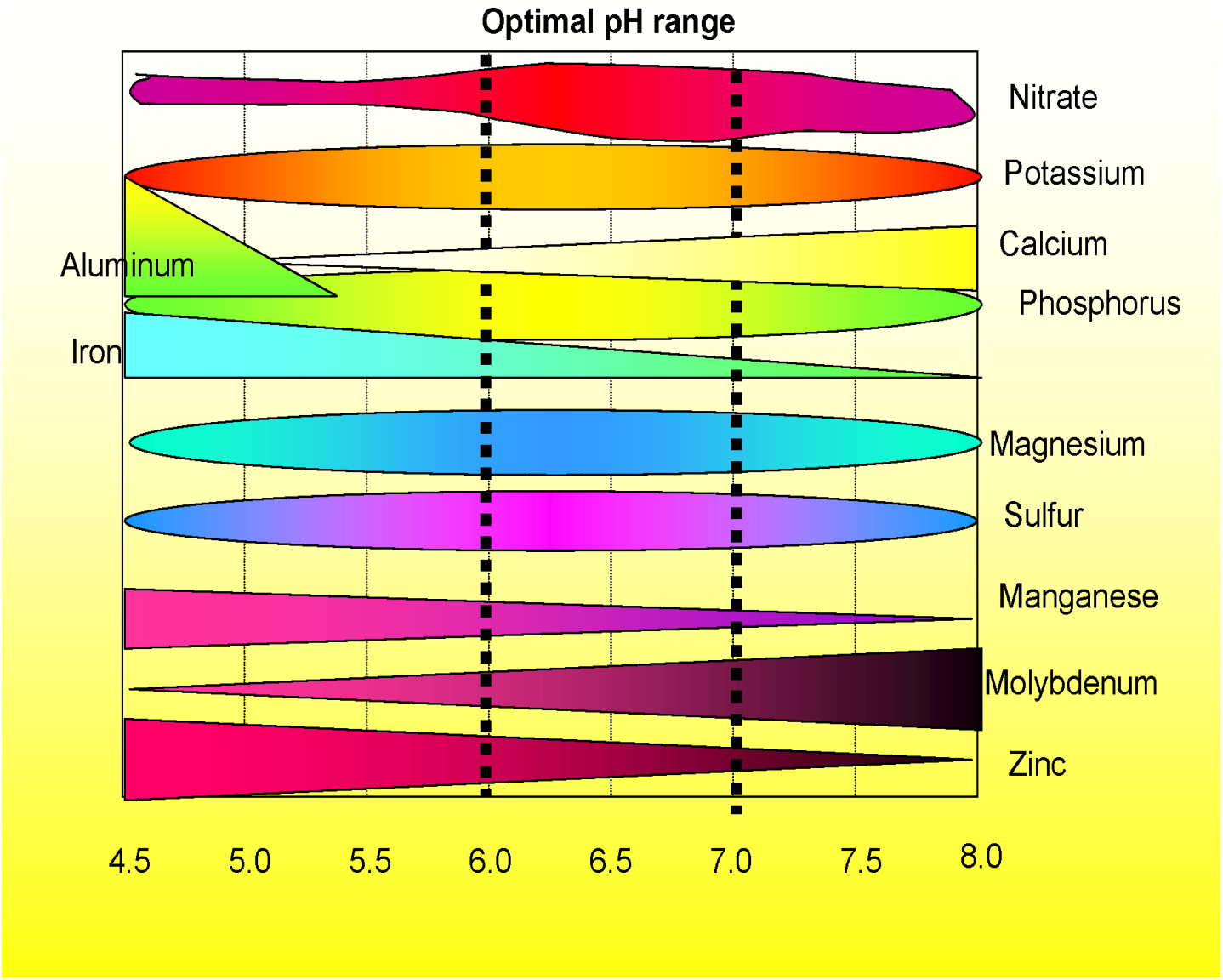
Nutrient	Chemical symbol	Ionic form
Chloride	Cl	Cl^-
Nitrate	N	NO_3^-
Sulfate	S	$SO_4^=$
Borate	B	BO_3^{3-}
Phosphate	P	$H_2PO_4^-$

Manage Saline and Sodic Soils



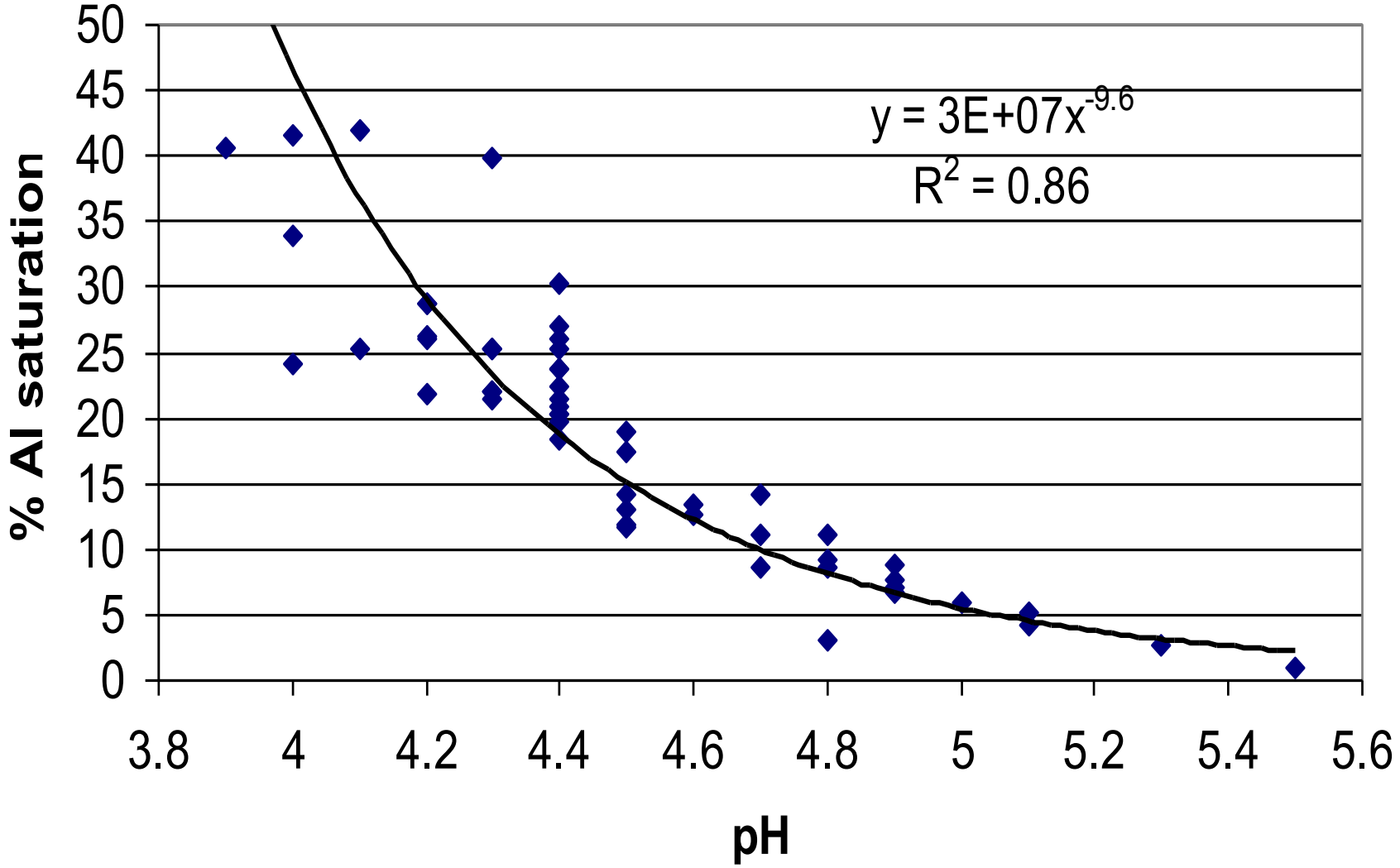
pH value defines relative acidity or basicity





Soil pH affects nutrient availability to plants

Active Al Increased by Soil Acidity

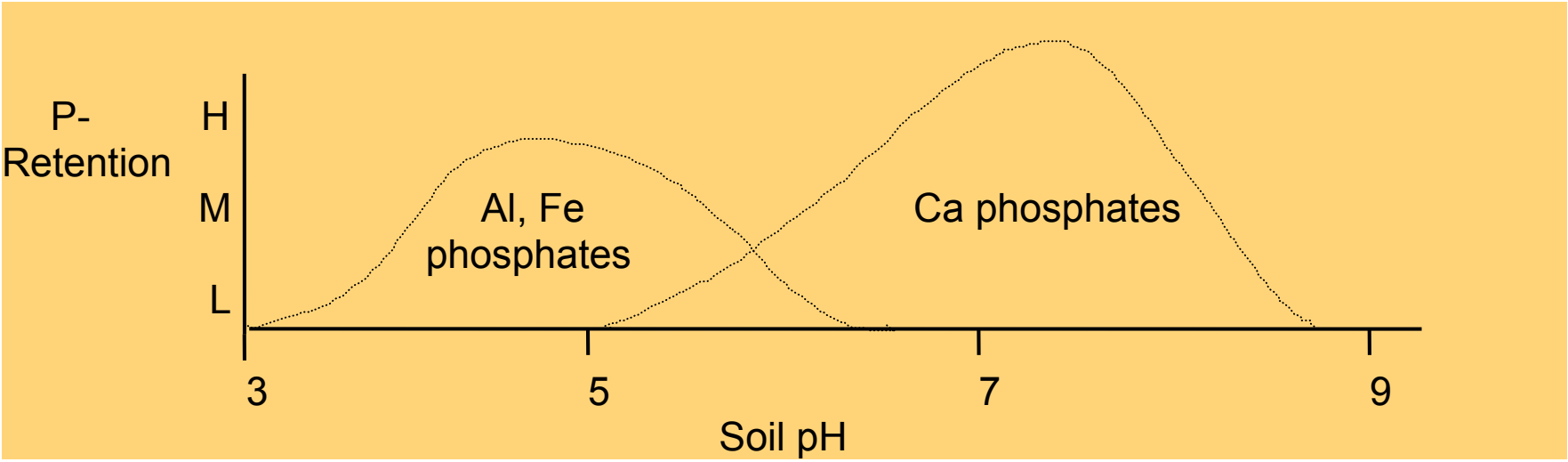


Mobility of Nutrients in Soil

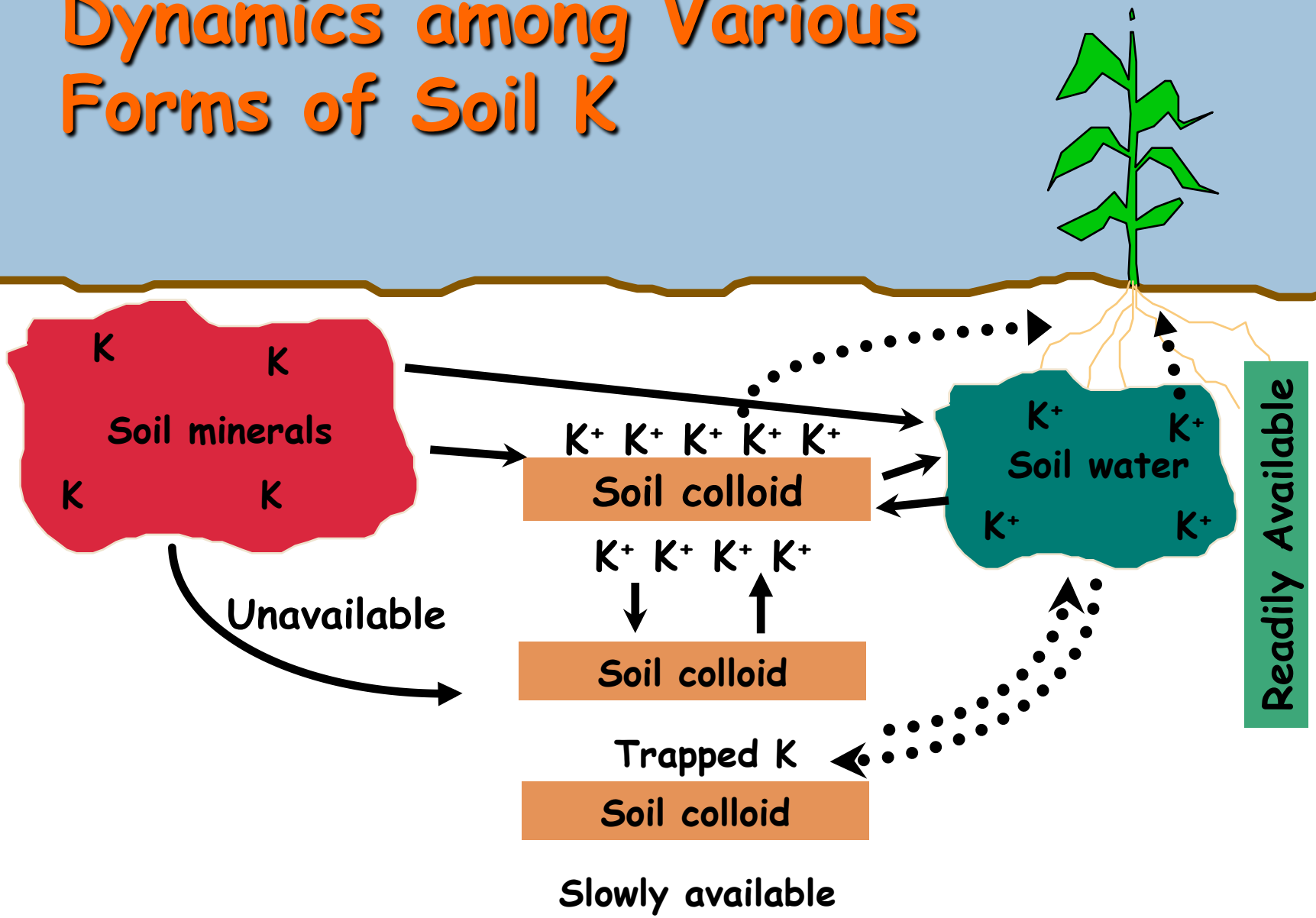
Mobile Nutrients	Immobile Nutrients
Nitrogen	Phosphorus (P)
Sulfur	Potassium (K)
Boron	Calcium (Ca)
Chlorine	Mg, Fe, Mn, Cu, Zn, Mo
(Fuel Tank)	(Crankcase)

Characteristics of solid-P?

- Phosphate ions form Al and/or Fe phosphate at low soil pH
- Phosphate ions form Ca phosphate at high soil pH
- Neither forms are plant available



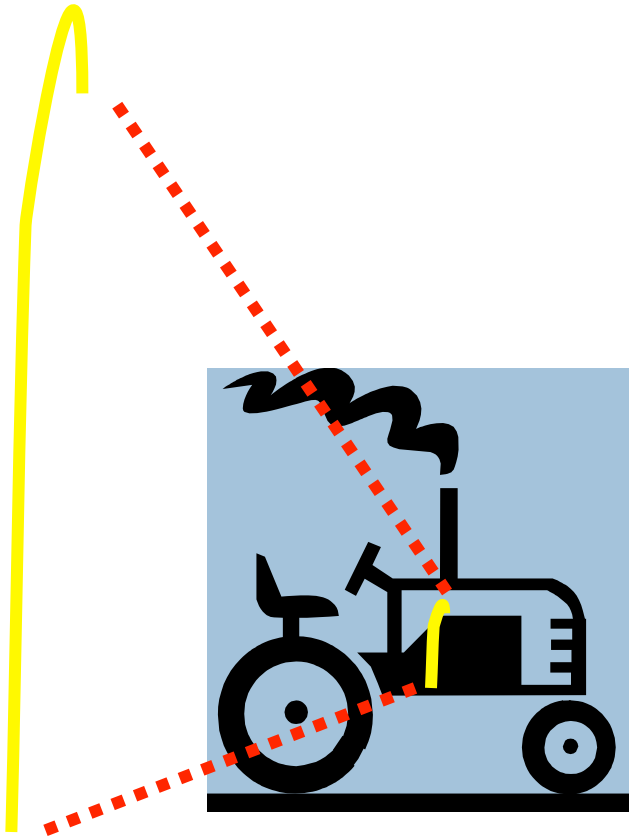
Dynamics among Various Forms of Soil K



Soil Test-P is like Dip Stick for engine

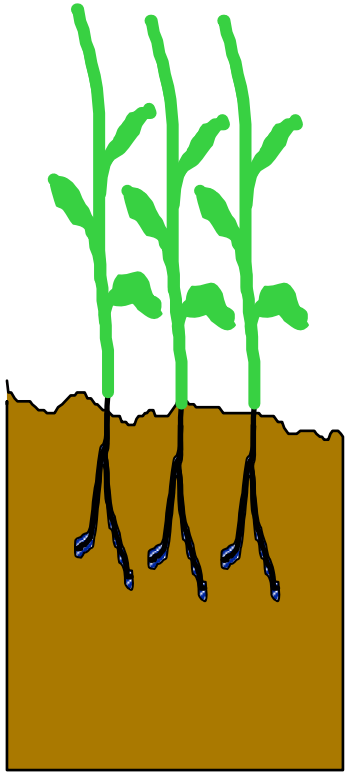
- Dip Stick

Test	Rec. (add)
Full	None
1/2qt.	0-1/2 qt.
1 qt.	1 qt.



- Soil Test (wheat)

Test	Rec. (add)
65	None
40	20 lb
20	40 lb



Processes to Make Fertilizer Recommendation

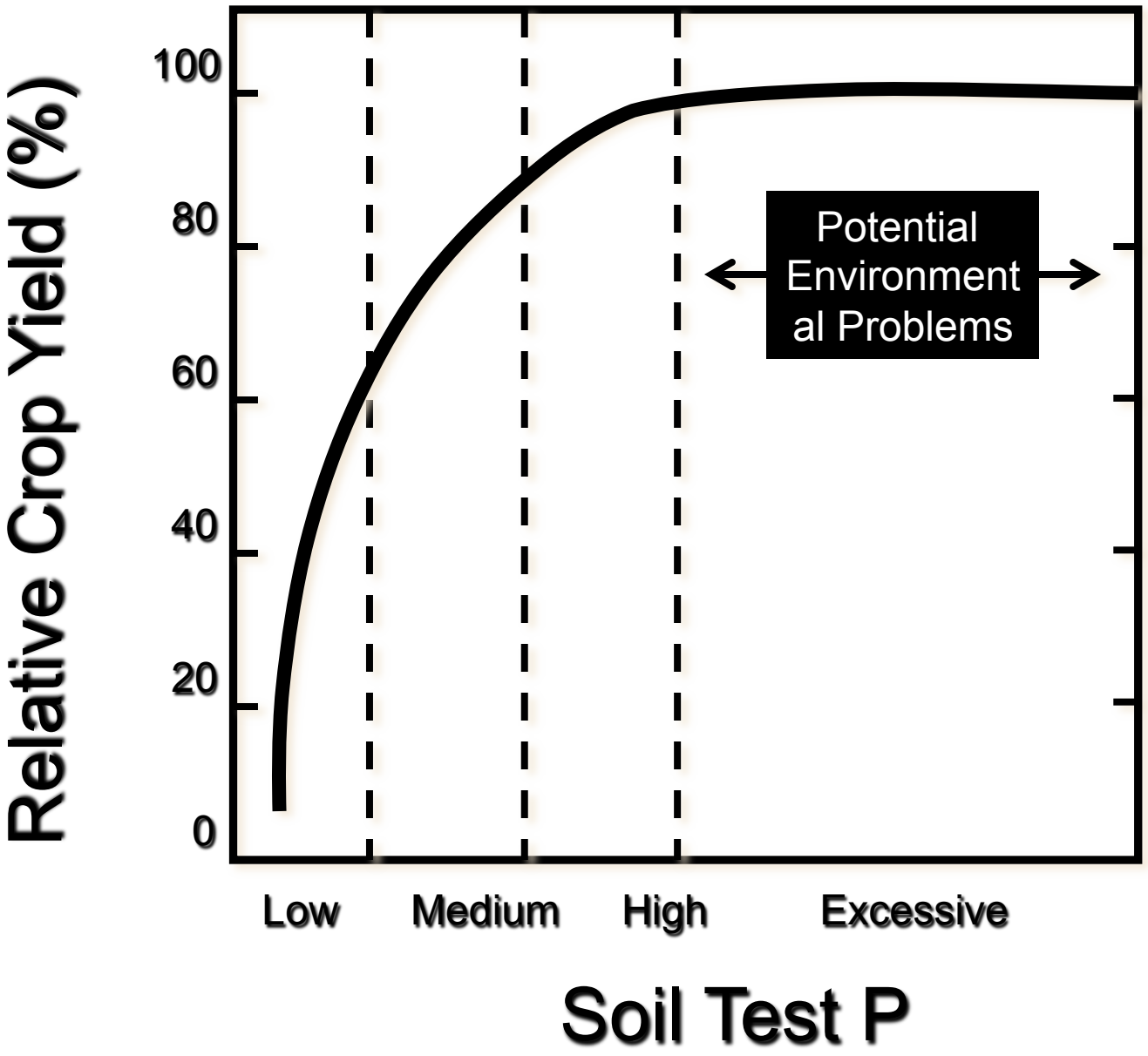
- Soil Test Correlation --- to select the best soil test method for a particular nutrient of the area
- Soil Test Calibration --- to describe soil test results in easily understood terminology
- Fertilizer recommendation

Nitrogen Requirement

- Crop to be grown
- Yield goal
- N requirement
- N needs = N requirement - Soil NO_3-N
- Credits for subsurface and manure N

Phosphorus Requirement

- Soil test P index (Mehlich 3 method)
- Percent sufficiency
- P requirement (P_2O_5 lbs/acre)


Relative Crop Yield (%)
100
80
60
40
20
0
Potential Environmental Problems
Low
Medium
High
Excessive
Soil Test P

P Recommendation

P soil test index	Sufficiency (%)	P_2O_5 (lbs/A)
0	25	80
10	45	60
20	80	40
40	90	20
65+	100	0

Soil Tests Serve Two Basic Functions

- ☐ Provide a starting point for developing fertilizer and liming program

- ☐ Monitor nutrient level to keep the fertilizer program on track

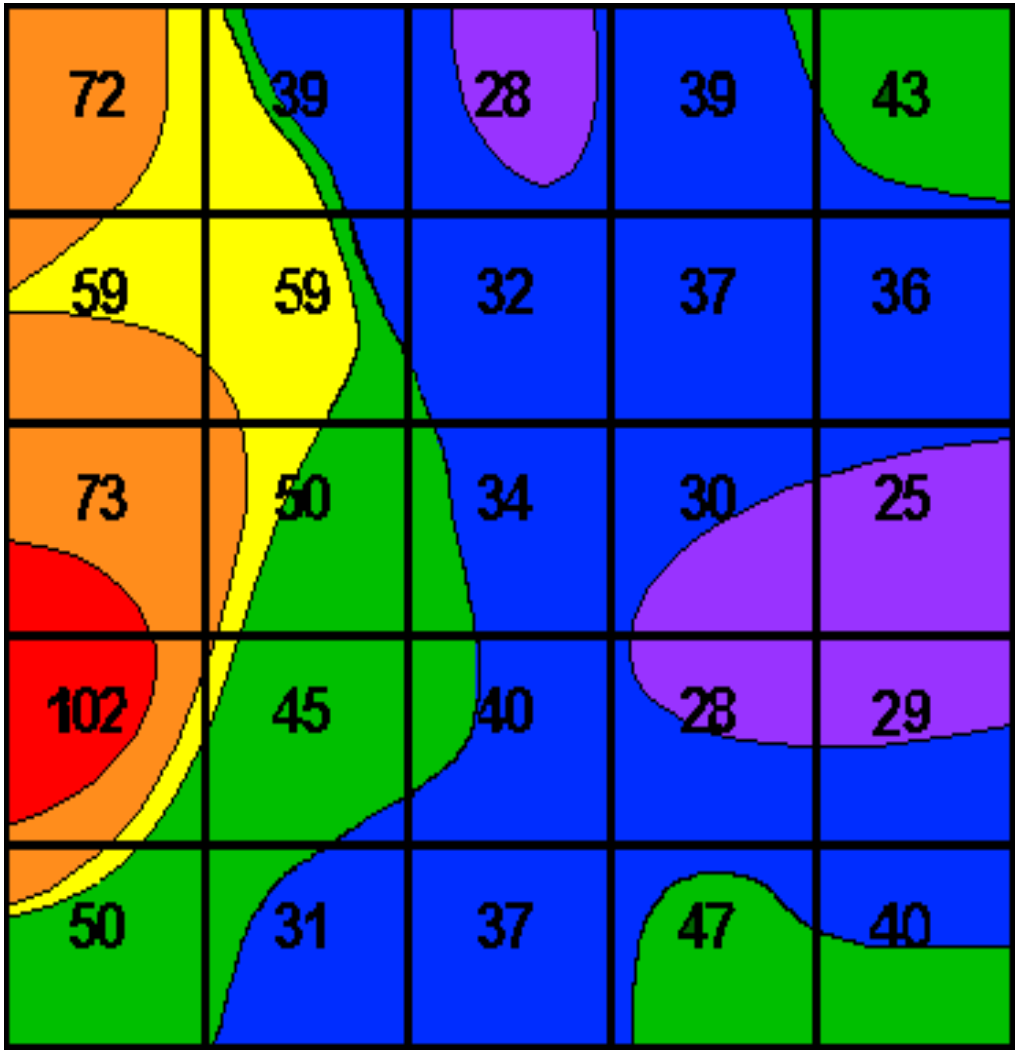

The greatest potential
for error in soil testing
is in taking the sample

Recognize Field Nutrient Variability

Nitrate - Nitrogen

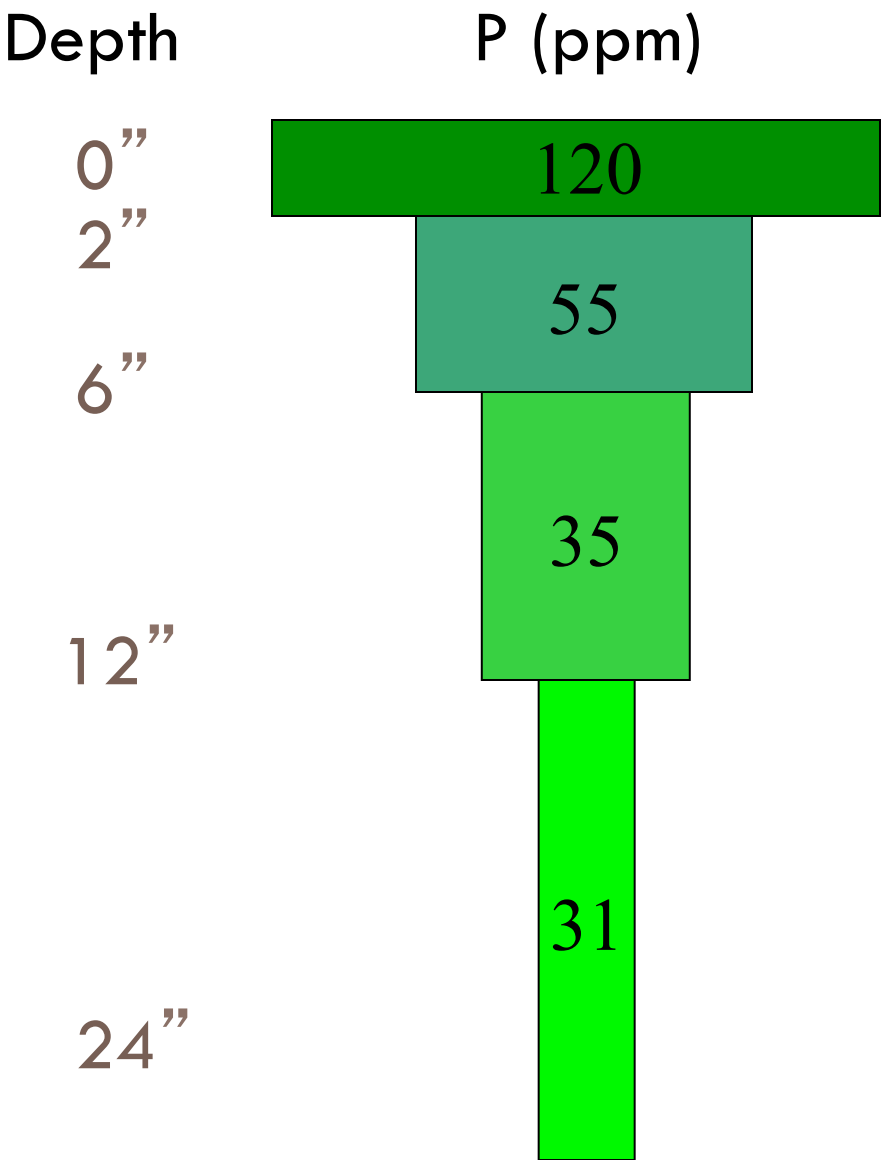
lbs/acre

0-30	
31-40	
41-50	
51-60	
61-80	
>80	



(Nitrate-N within a 75' x 75' plot)

P Changes with Depth (no-till)




Get a Useful Sample
15-20 cores
Soil Probe
Right Depth
(plow layer or 6
inches
Clean Bucket

Soil Tests at OSU

Routine

pH
Buffer Index
Nitrogen
Phosphorus
Potassium

Subsoil Nitrate

Secondary Nutrients

Sulfate-Sulfur
Magnesium
Calcium

Micronutrients

Iron
Zinc
Boron

Soil Organic Matter, Soil Texture, Soil Salinity

SOIL, WATER & FORAGE ANALYTICAL LABORATORY

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Email: soils_lab@agr.okstate.edu
Website: http://clay.agr.okstate.edu/extensio/swfal/intro.htm

SOIL TEST REPORT

SOIL CLINIC/HAY SHOW
MUSKOGEE CTY EXT OFC
1440 S CHEROKEE
MUSKOGEE, OK 74403

Name: [redacted]

Location:

Lab I.D. No.:	241511
Customer Code:	351
Sample No:	10
Received:	10/04/00
Report Date:	10/06/00

TEST RESULTS

Soil Reaction		NO3-N (lbs/acre)		Test Index	
pH:	5.6	Surface:	8	P:	9
Buffer Index:	6.8	Subsoil:		K:	143

Secondary nutrients		Micronutrients	
Surface SO4-S (lbs/acre):		Ca (lbs/acre) :		Fe (ppm):	
Subsoil SO4-S (lbs/acre):		Mg (lbs/acre):		Zn (ppm):	
				B (ppm):	

INTERPRETATIONS AND REQUIREMENTS FOR *Bermudagrass* (YIELD GOAL = *No Yield Goal Provided*)

Test	Interpretation	Requirement	Recommendations and Comments
pH	Lime needed	1.2 tons ECCE/acre to pH 6.8	
Nitrogen	Needs yield goal	Determined from yield goal	
Phosphorus	64% Sufficient	62 lbs/acre P2O5 annually	
Potassium	84% Sufficient	45 lbs/acre K2O annually	

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1440 S CHEROKEE
MUSKOGEE, OK 74403

Name: Lonnie Benton

Location:

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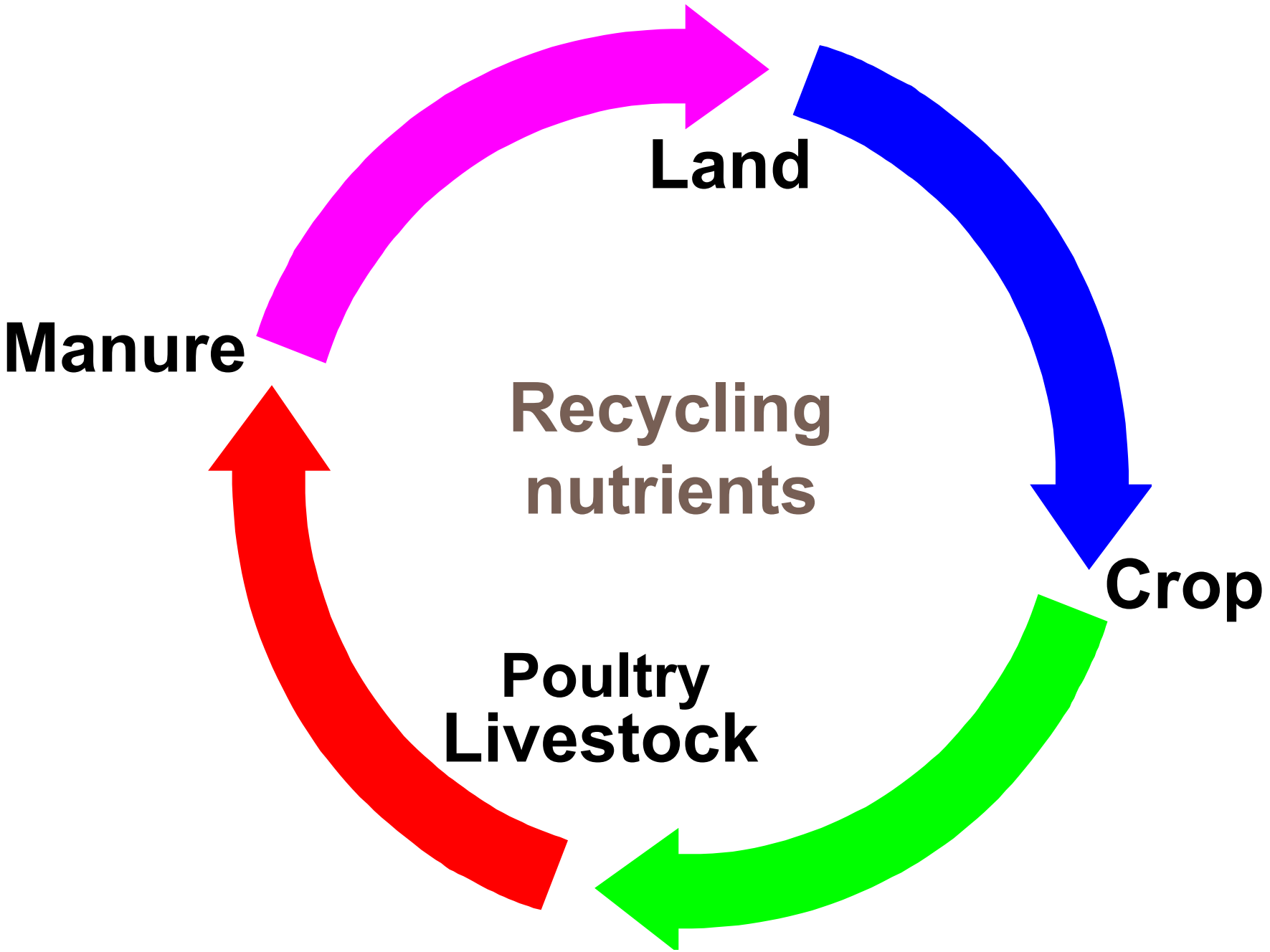
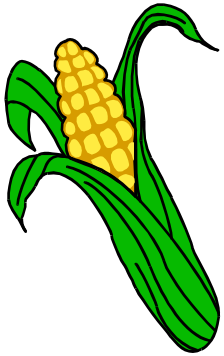
Animal Manure


Land
Crop
Poultry
Livestock
Manure
Recycling
nutrients

N to P_2O_5 Ratio

Plants

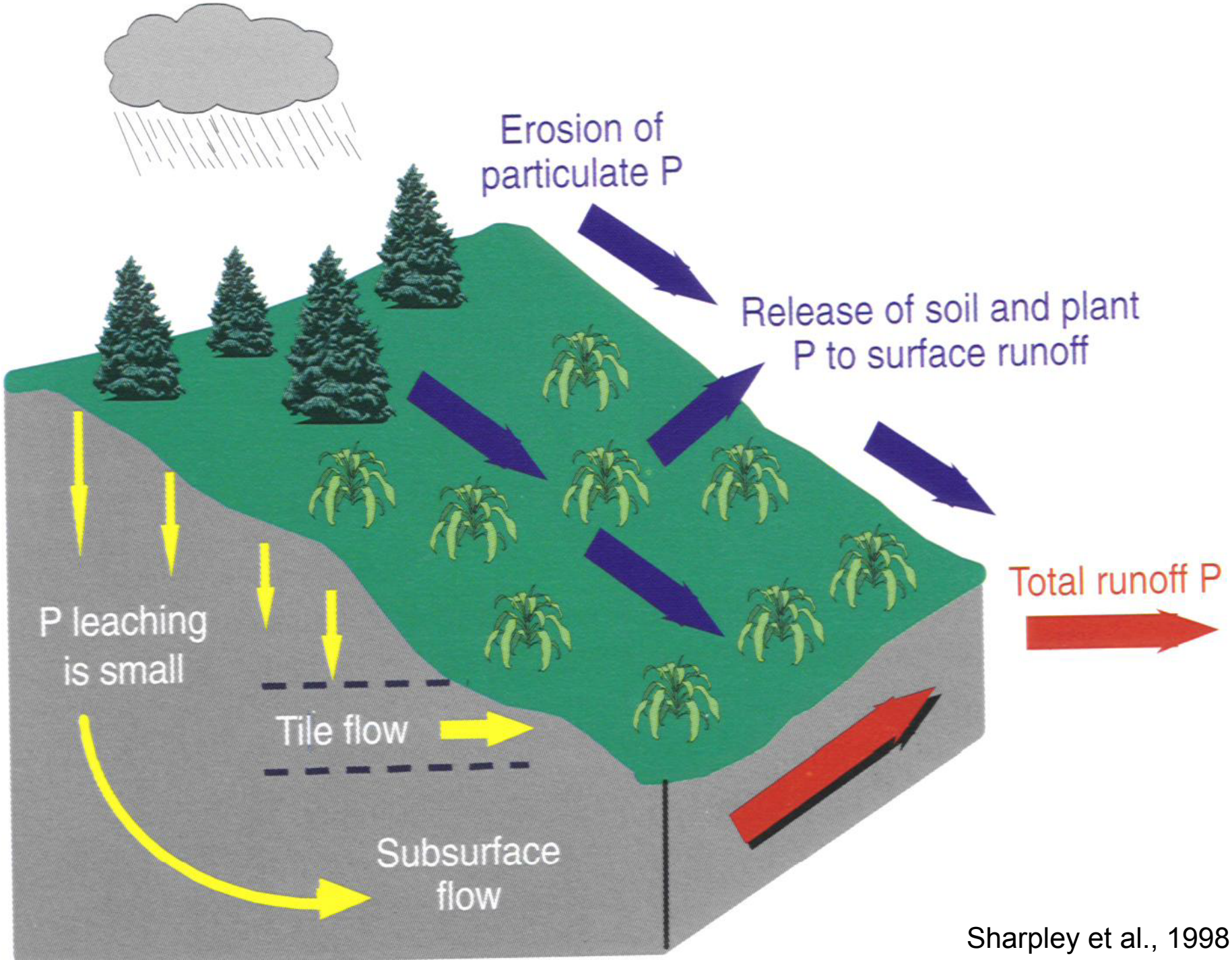


4-8 to 1

Manure

1 to 1

Need to consider both N and P when deciding how much manure/compost to use



Sharpley et al., 1998

Factors Considered for P Management

- **Source factors**
  - Soil test P level, manure, fertilizers
  - Rate and method of P application
- **Transport factors**
  - Monthly runoff volume, erosion potential
- **Receiving water body sensitivity?**
  - TMDL (total maximum daily load) or state water quality standard
- **BMPs (best management practices)**
  - Distance to water bodies, cattle exclusion, alternative watering sources
  - Buffer strips, riparian establishment and restoration
  - Soil and/or amendments

Summary

- There are 16 essential plant nutrients
- The chemistry of nutrients determines their mobility in the soil and how they are recommended to certain crops
- Soil pH is a very important soil property
- Soil testing is important for a successful nutrient management program
- Consider soil and water quality when managing manure nutrients