Wisconsin Soils and Biosolids Nutrients:

The Big Picture

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Conservation of Mass
Everything Goes Somewhere

All Animal Wastes Contain Nutrients Needed For Plant Growth

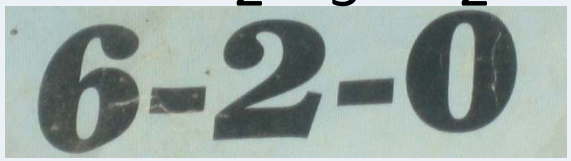
Full List

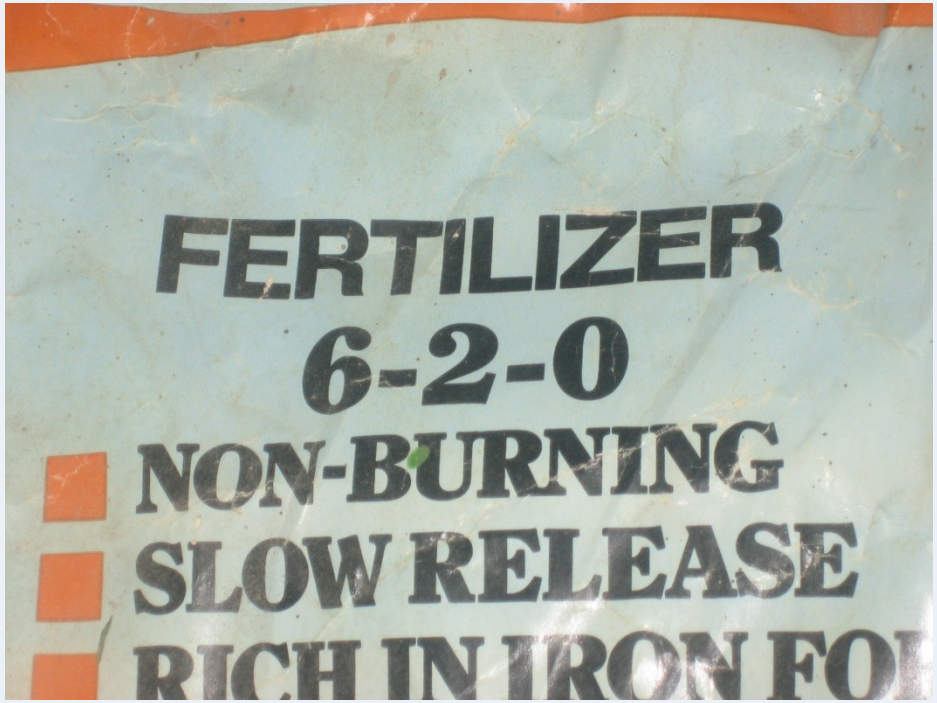
Nitrogen
Phosphorus
Potassium
Calcium
Sulphur
Magnesium
Boron
Chlorine
Manganese
Iron
Zinc
Copper
Molybdenum
Nickel

Big three:

Nitrogen (N)
Phosphorus (P_2O_5)
Potassium (K_2O)

N P_2O_5 K_2O



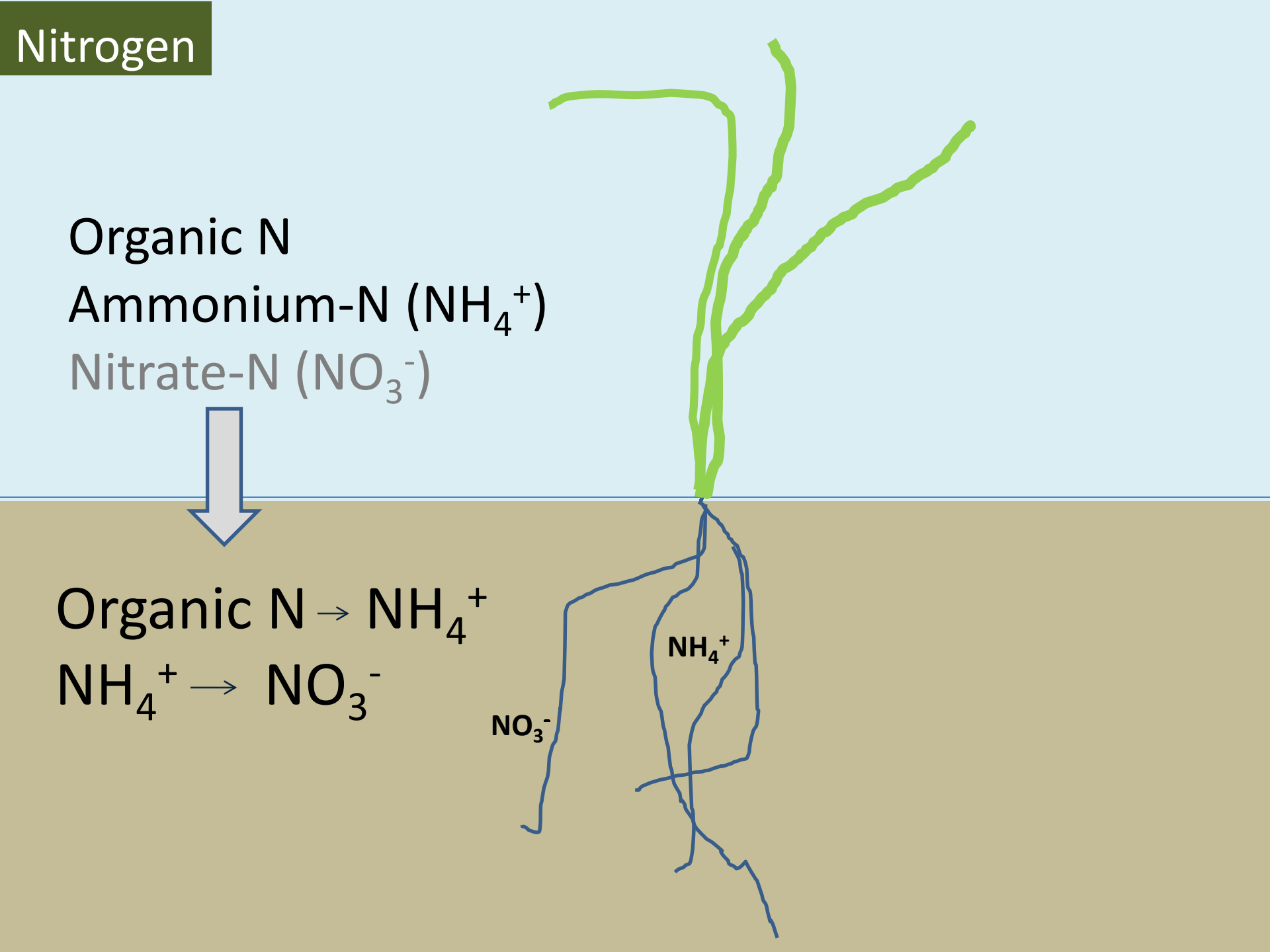


Nitrogen

Organic N

Ammonium-N (NH_4^+)

Nitrate-N (NO_3^-)



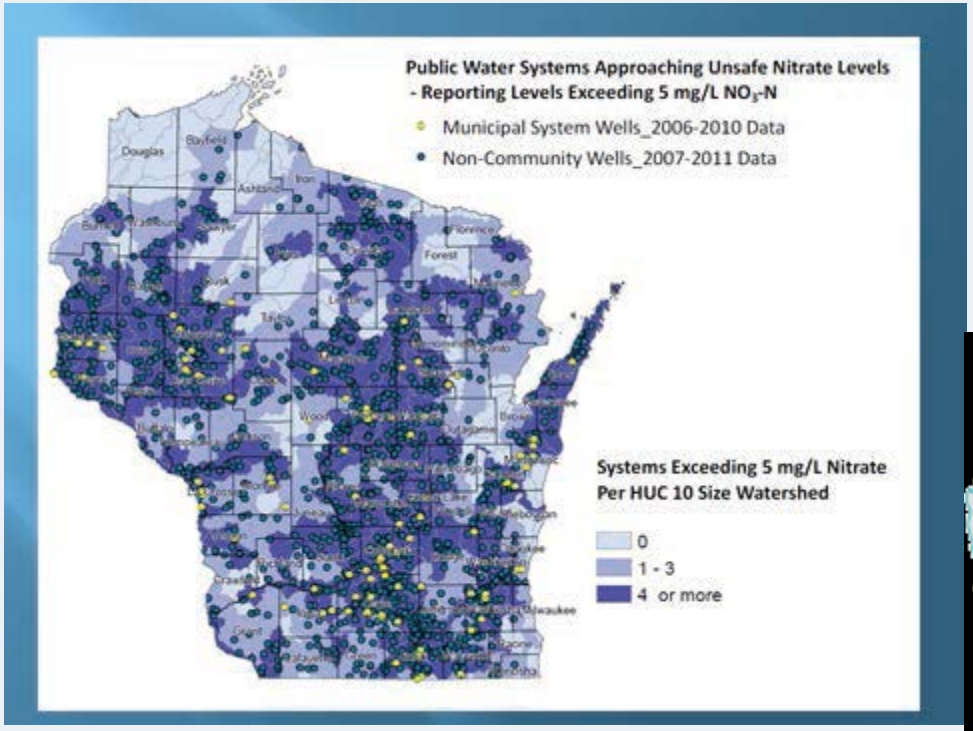
$Organic\ N \rightarrow NH_4^+$

$NH_4^+ \rightarrow NO_3^-$

What happens when crops don't get enough N?

Why do we care about N over-application?

Locally: Drinking water

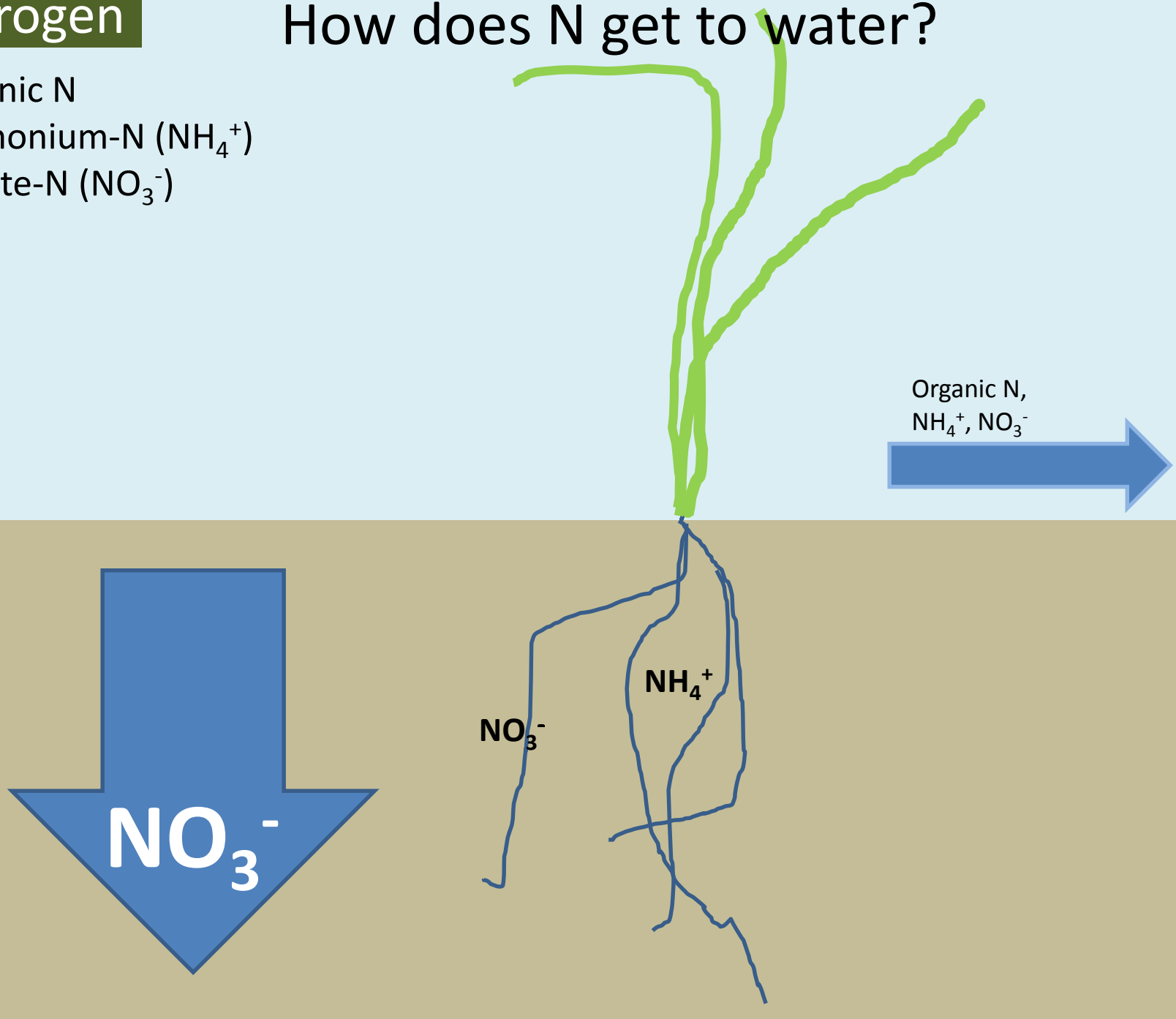


Globally: Dead zones

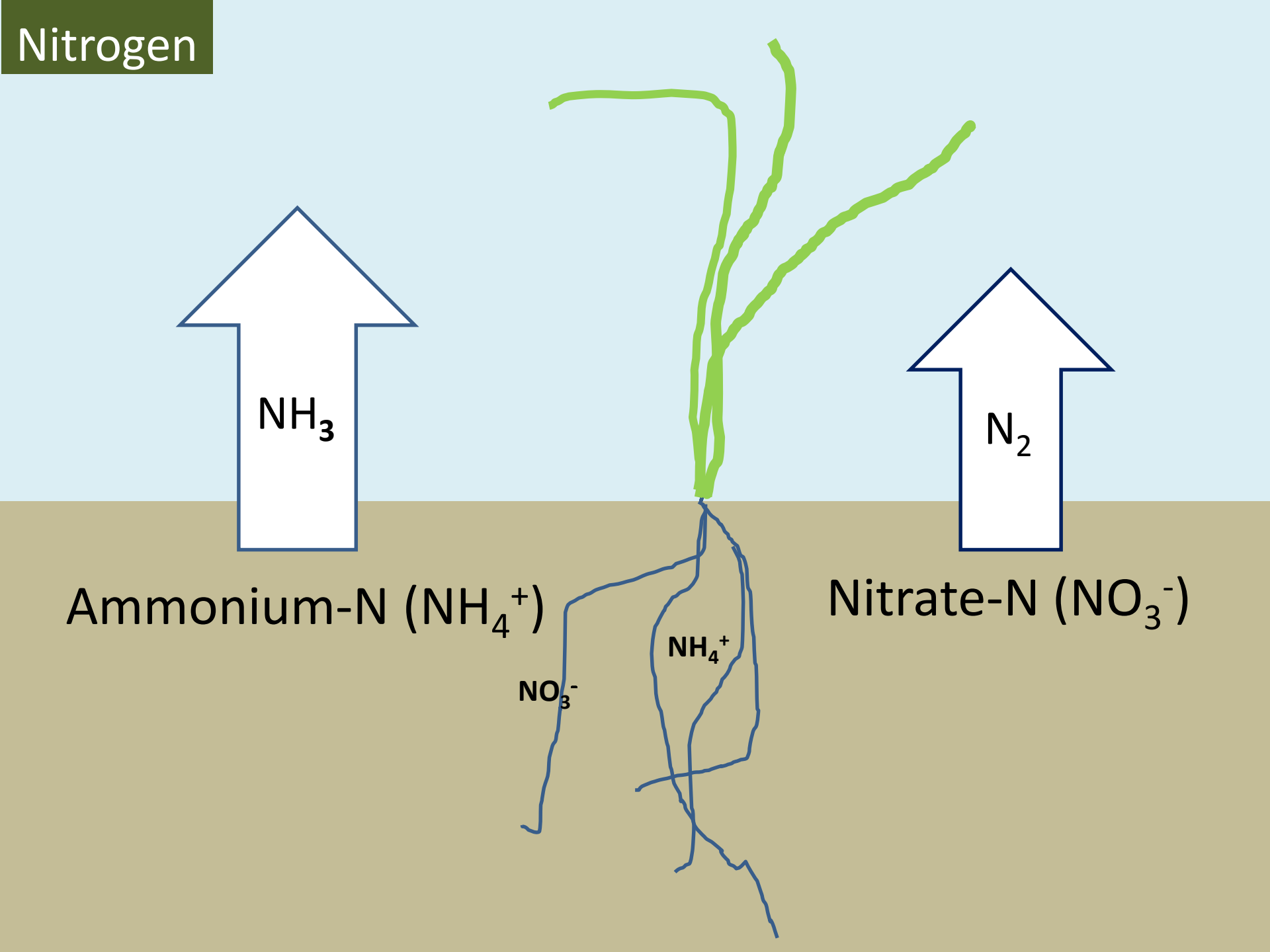
Nitrogen

How does N get to water?

Organic N
Ammonium-N (NH_4^+)
Nitrate-N (NO_3^-)



Nitrogen



Nitrogen

Nitrogen *Changes*

Biosolids Available Nitrogen

Organic N

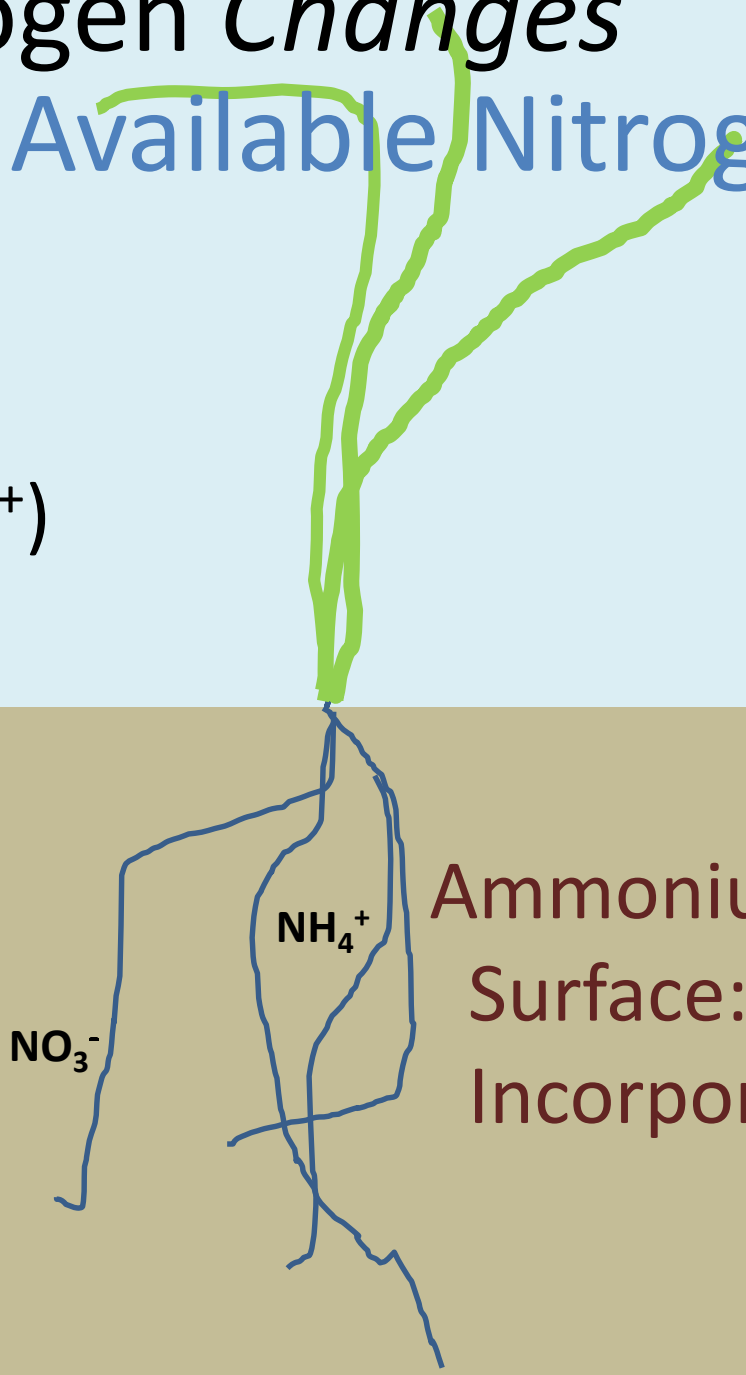
Ammonium-N (NH_4^+)

Organic N

Yr 1: 25%,

Yr 2: 12%,

Yr 3: 6%



Ammonium-N

Surface: 50%

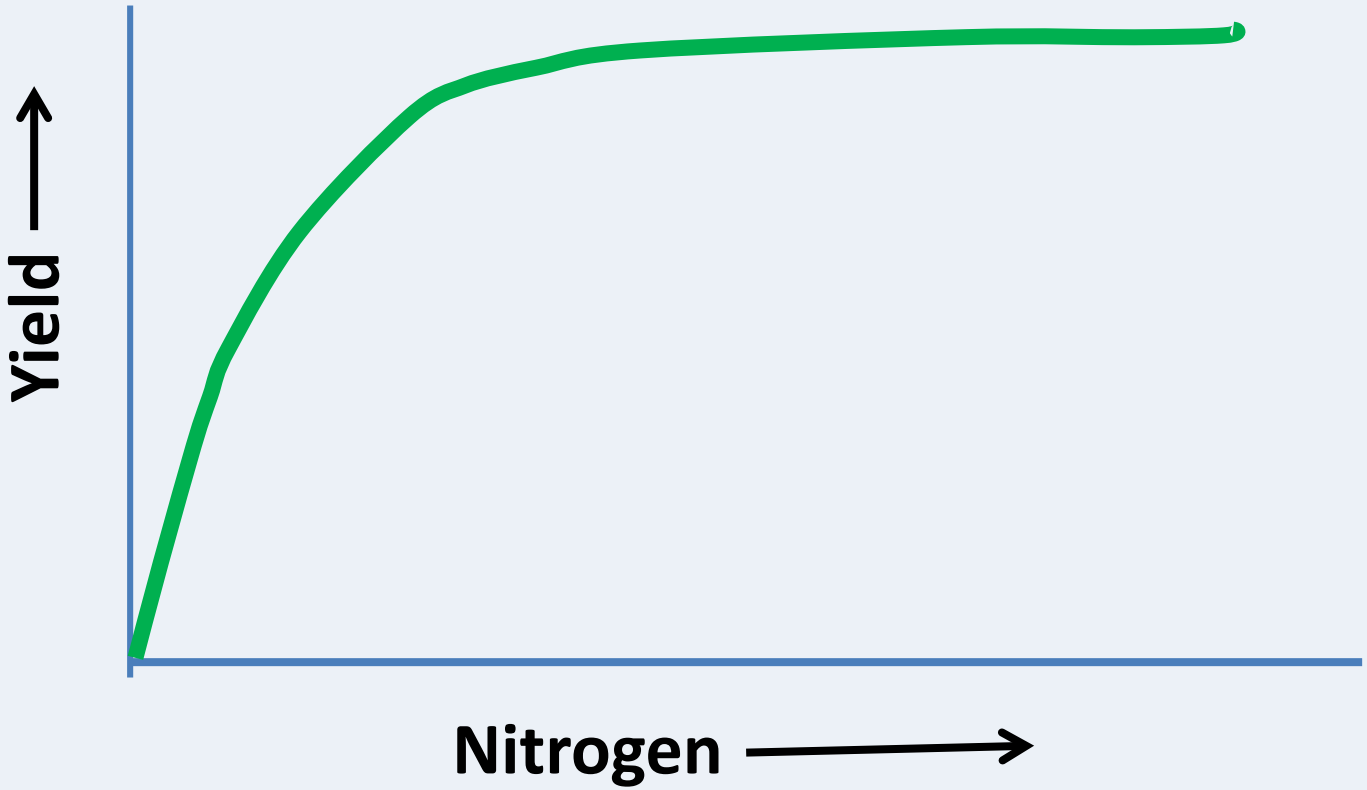
Incorporated: 100 %

Nitrogen *Changes*

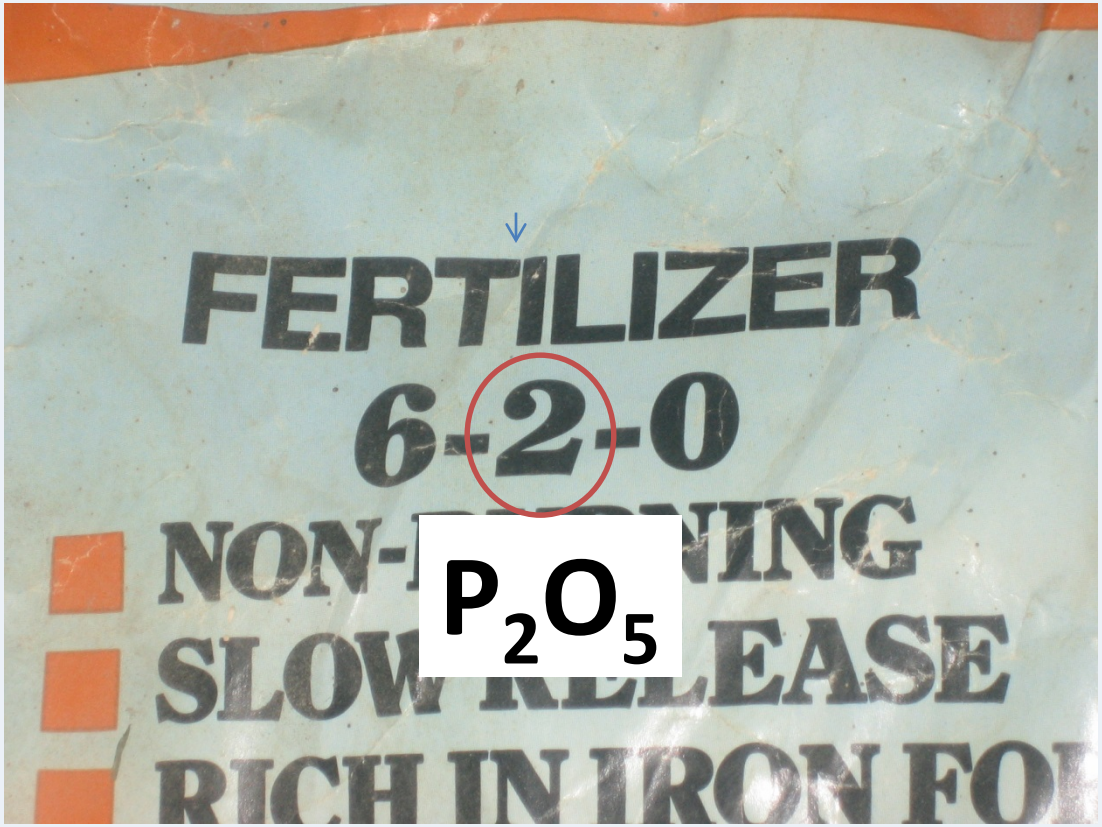
No routine soil test

Guidelines For N Applications

Based on most profitable application rates for N fertilizer



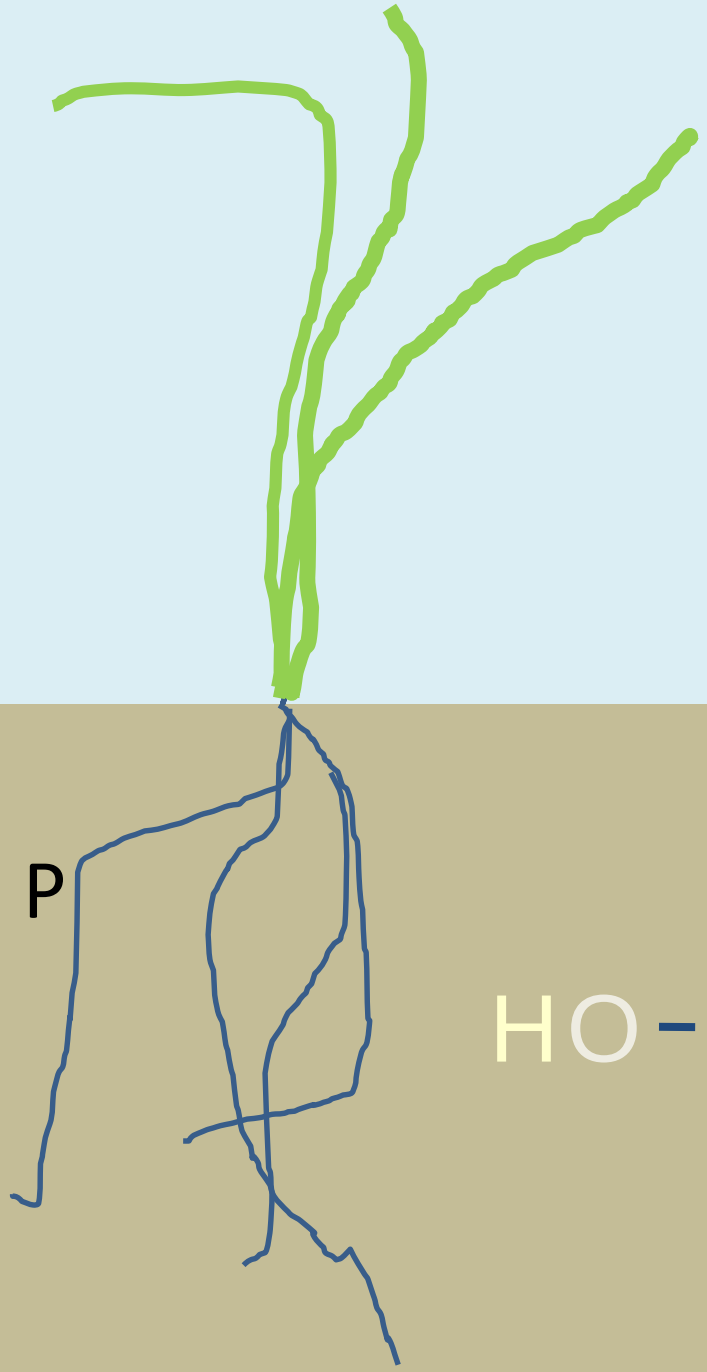
Phosphorous

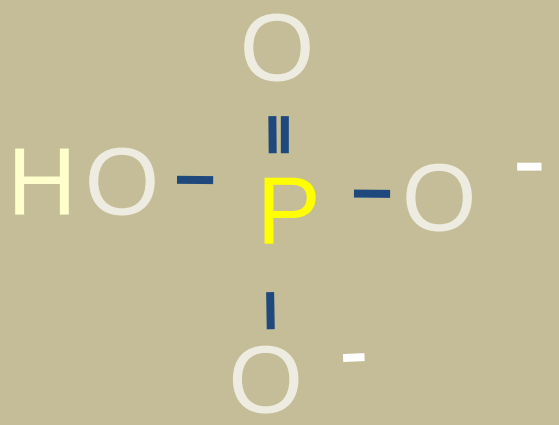


Phosphorus

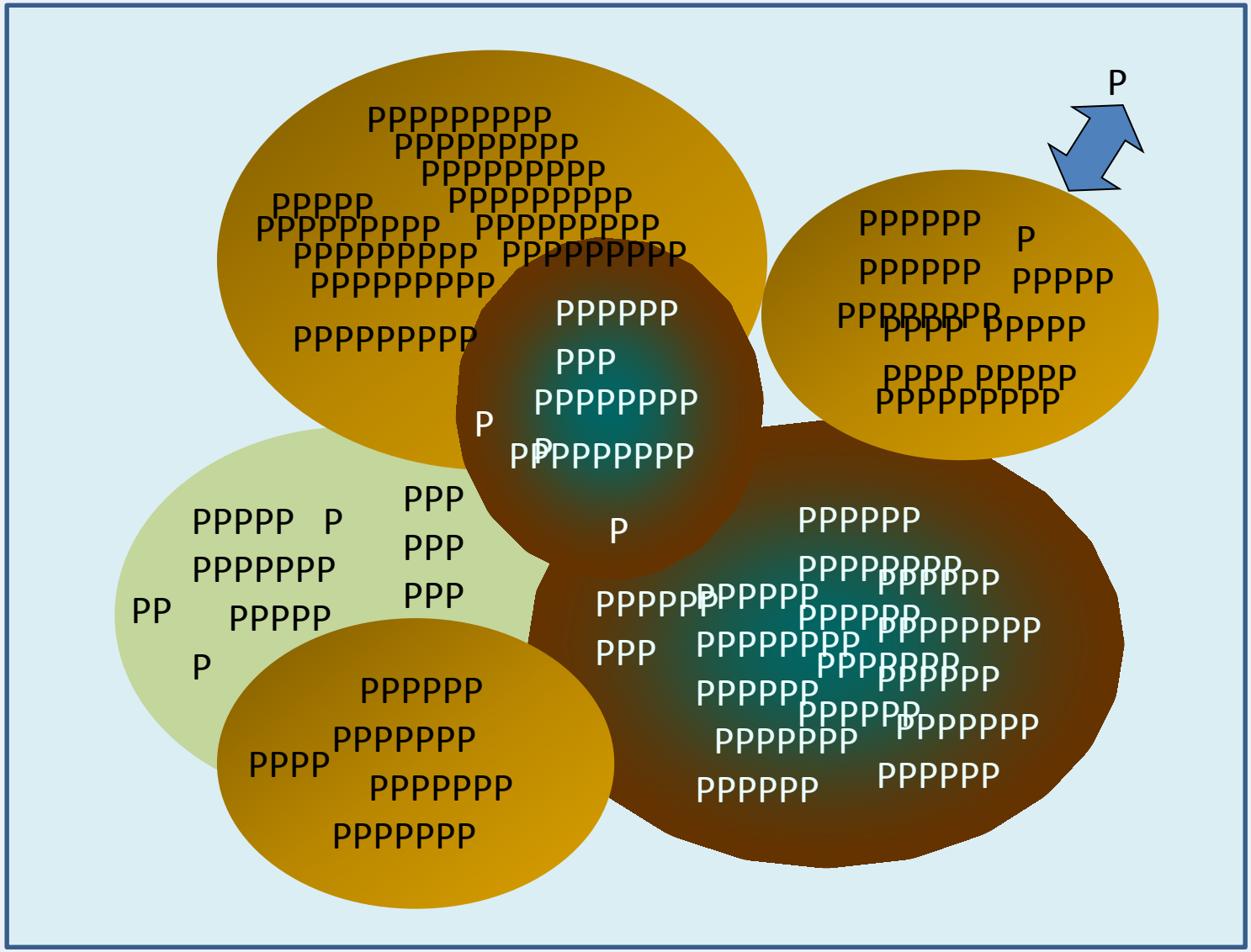
Organic P
Inorganic P

Organic P → Inorganic P





Phosphorus Sticks Tight (Mostly)



What happens when crops don't get enough P?

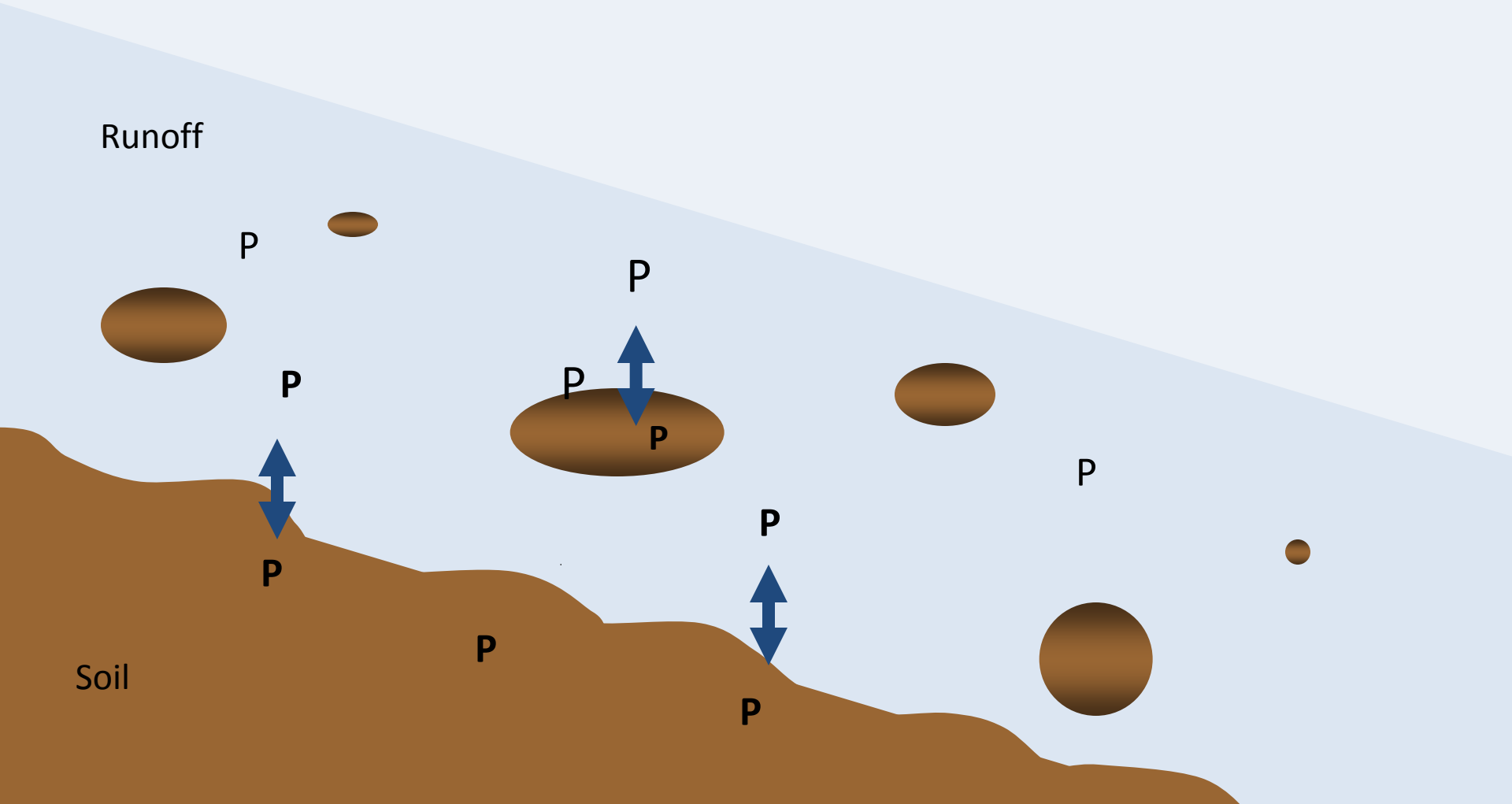
Photo: Mary Ann Hanson, Virginia Polytechnic Institute

Why do we care about excess P?

Schindler, D.W. 1977. Evolution of phosphorus limitation in lakes. *Science*, 195:260-262

How does P get to Water?

Runoff (mostly)



Phosphorus Concentrations

Runoff
0.1 -10 ppm

Soil Total
100 – 1000 ppm

Soil Plant Available
10 – 100 ppm

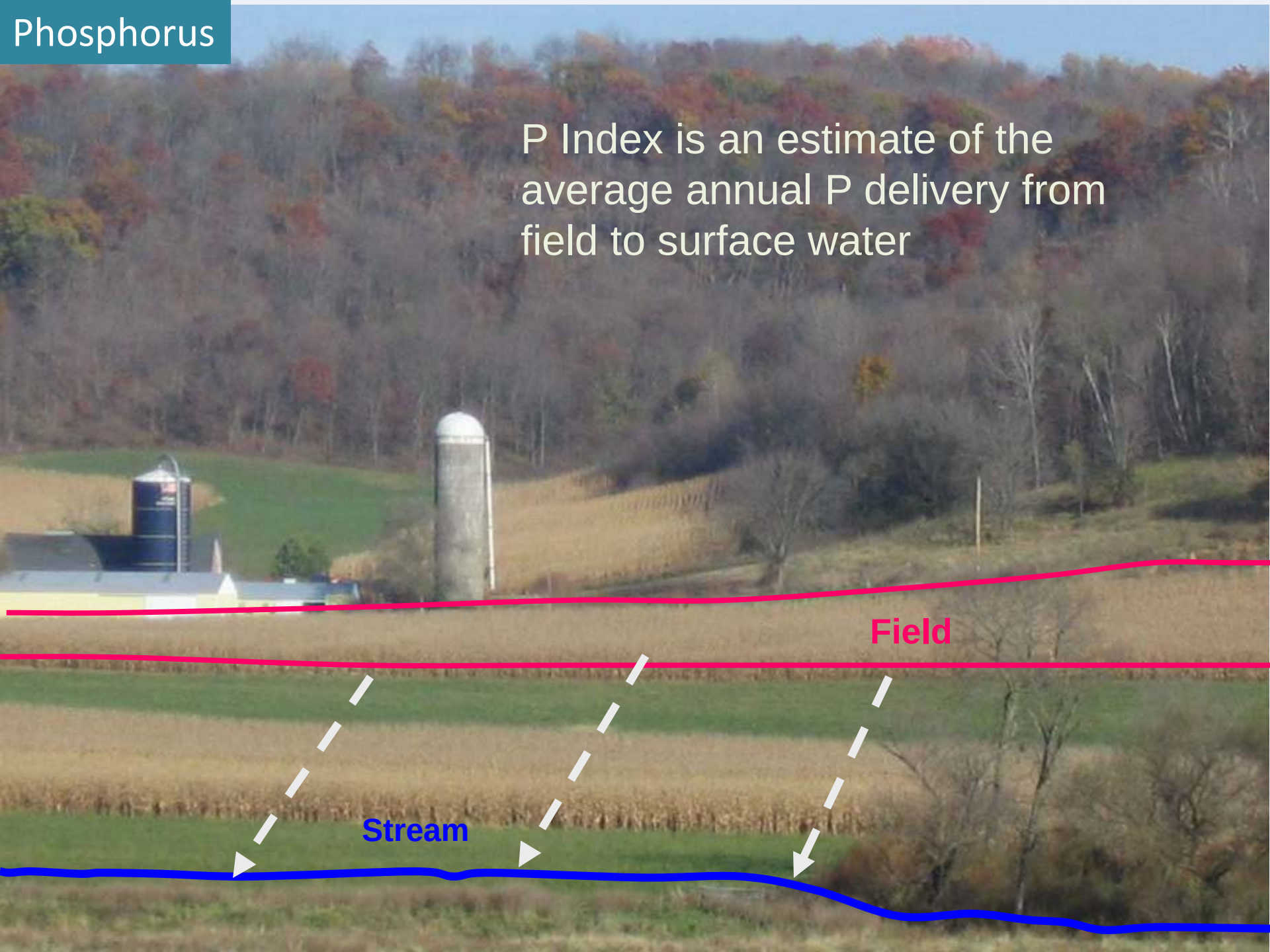
Water bodies
0.01-2 ppm

0.03 – 0.1 ppm
can lead to algal growth

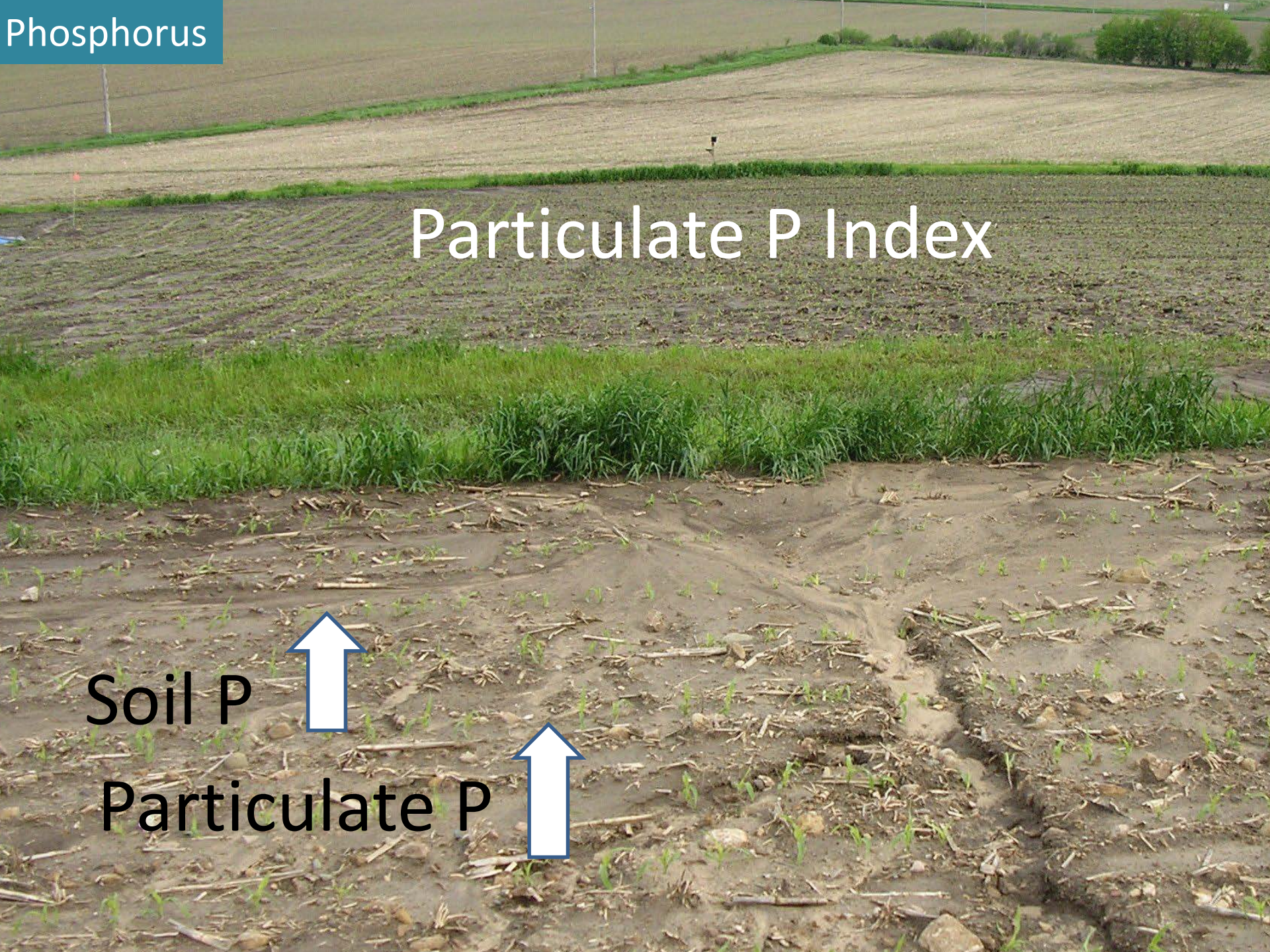
WI P Index

Purpose: Guide field management to protect water quality

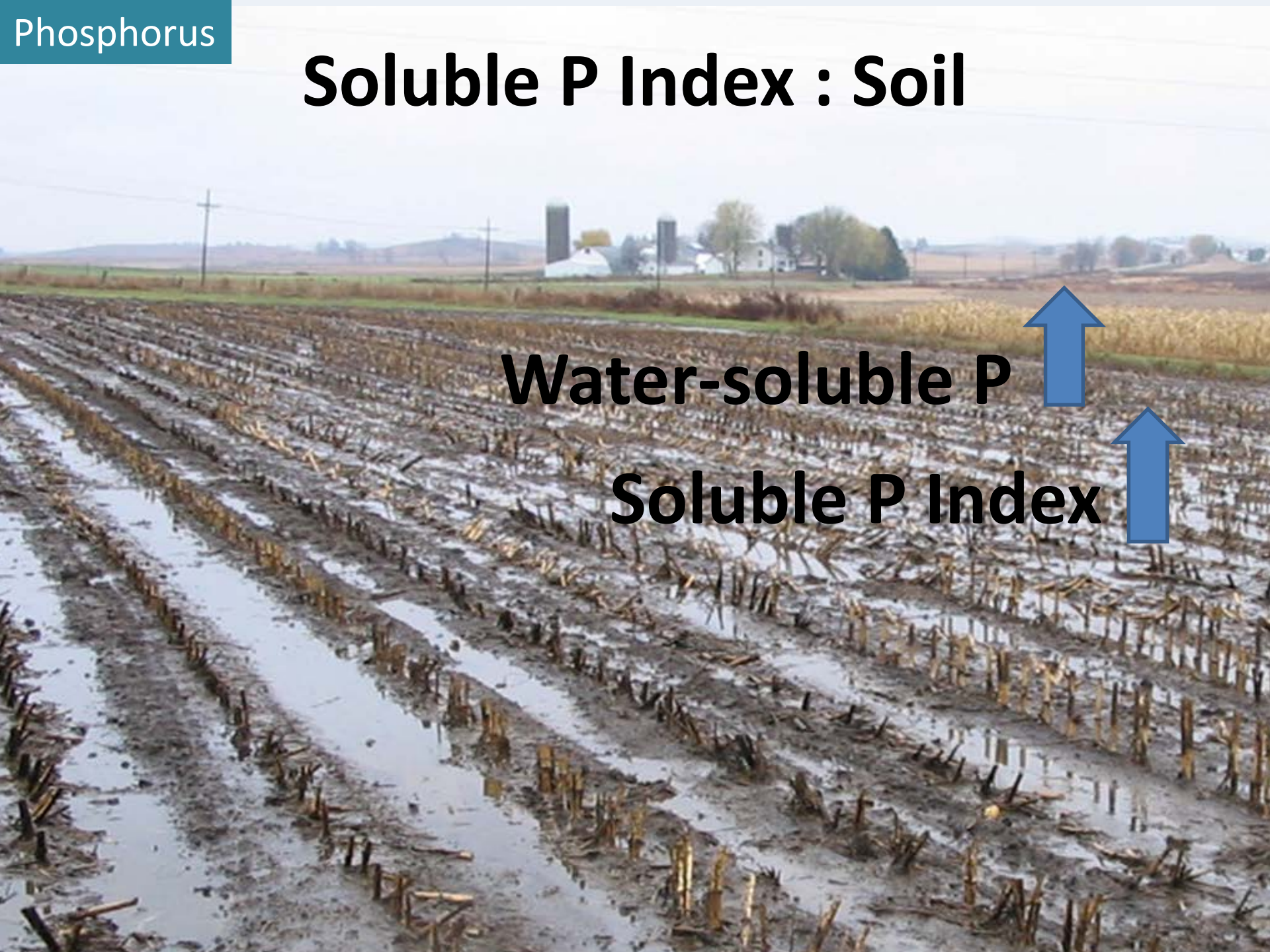
Phosphorus


P Index is an estimate of the average annual P delivery from field to surface water
Field
Stream


P Index includes calculation of
average annual runoff and erosion


Particulate P Index
Soil P
Particulate P

Soluble P Index : Soil



Soluble P Index: Surface Amendments

P Index Soil P Calculations

- Soil total P and water-soluble P related to soil test P
- Software keeps track of total P added and removed to calculate soil test P changes
- P_2O_5 expected to change soil test P by 1 ppm:

Sands: 12 lb/acre

Silt loams: 18 lb/acre

Not all biosolids fit the rule of thumb

Biosolids treatment type	P_2O_5 lb/acre required to raise soil test P by 1 ppm	Estimate of soil test P change using "thumb rule"
Lime	19	close
Biological	14	under
Alum	26	over
Iron	25	over

Source: Dick Wolkowski, soil test P in 2008 following 3 consecutive years of biosolids applications at Arlington.

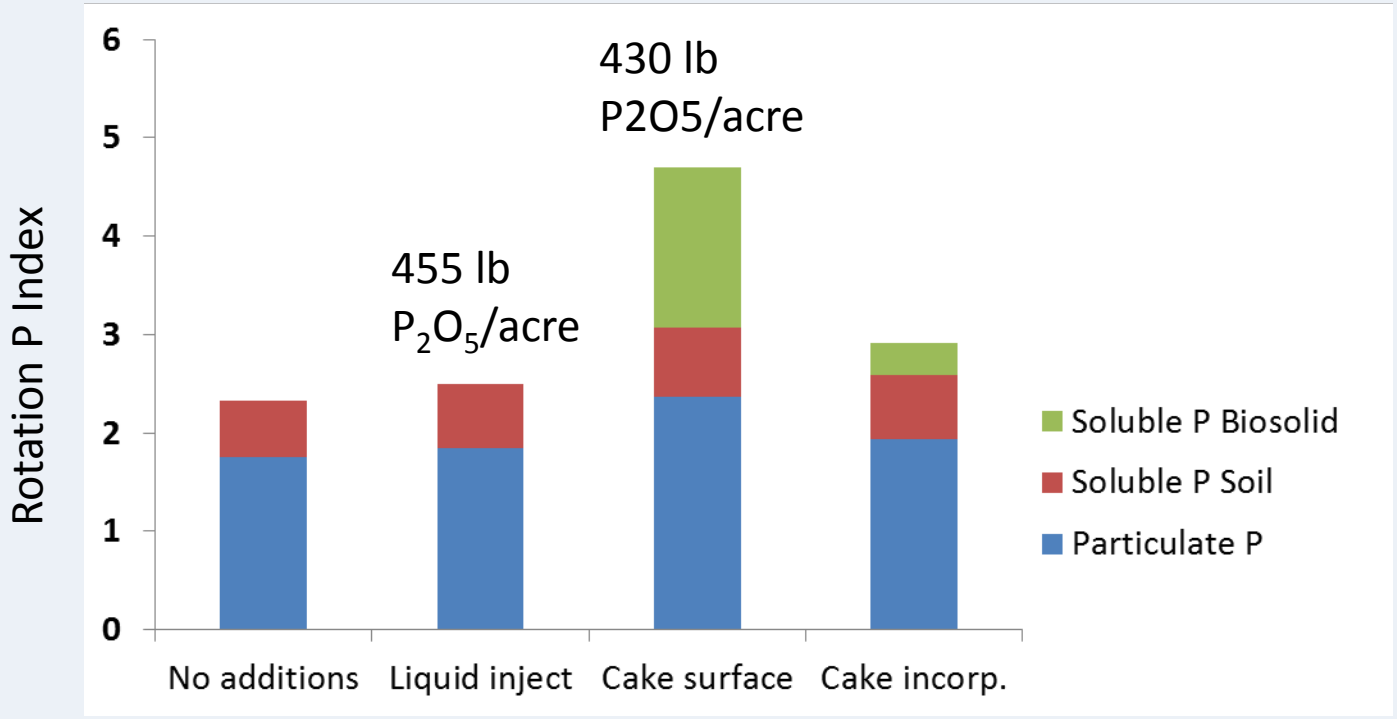
Available Nutrient Contents of Selected Liquid Soil Amendments

	Solids	N surf	N inject.	P_2O_5	K_2O
	%	lb/1000 gallons			
Dairy Slurry	6	7	12	6	17
Beef Slurry	3	5	8	6	12
Septic	3	1	2	4	0.4
Biosolid	2	2	3	5	0.5
Biosolid	5	13	20	36	4

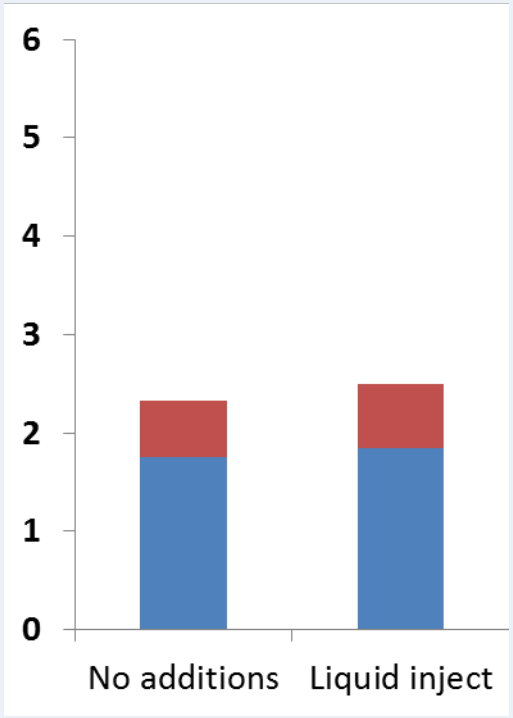
Assume same P plant availability as manure – 80%
Assume same water-soluble P as dairy manure – 40%

Example P Index Values

Dane County silt loam, 4% slope
Corn-soy-wheat rotation, chisel plowed
1.1 T/a/yr soil loss, Soil Test P 120



Building soil test P will lead to incremental increase in the P Index



	lb P_2O_5/acre
Biosolids	+ 455
Corn-Soy-Wheat	- 170
	285

Expected soil test P rise over rotation:

285 /18 = 16 ppm

Soil testing will help you understand the plant availability of the material you spread

What do we know?

- Excetra has valuable nutrients
- Nitrogen additions needed every year
- Phosphorus stays put, mostly
- Even a little bit of P can lead to algal blooms
- Apply to fields with low erosion and runoff potential to keep P Index values below the standard