Maximizing Crop Yield: Interpreting Soil Analysis and Understanding Fertility Management in Varying Production Systems

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Proper Fertility Programs

- Fertility Management
  1. Soil Sampling
  2. Soil Analysis
  3. Soil Test Interpretation
  4. Recommendations
  5. Application

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Proper Fertility Programs

- Fertility Management
  1. Soil Sampling
  2. Soil Analysis
  3. **Soil Test Interpretation**
  4. Recommendations
  5. **Application**

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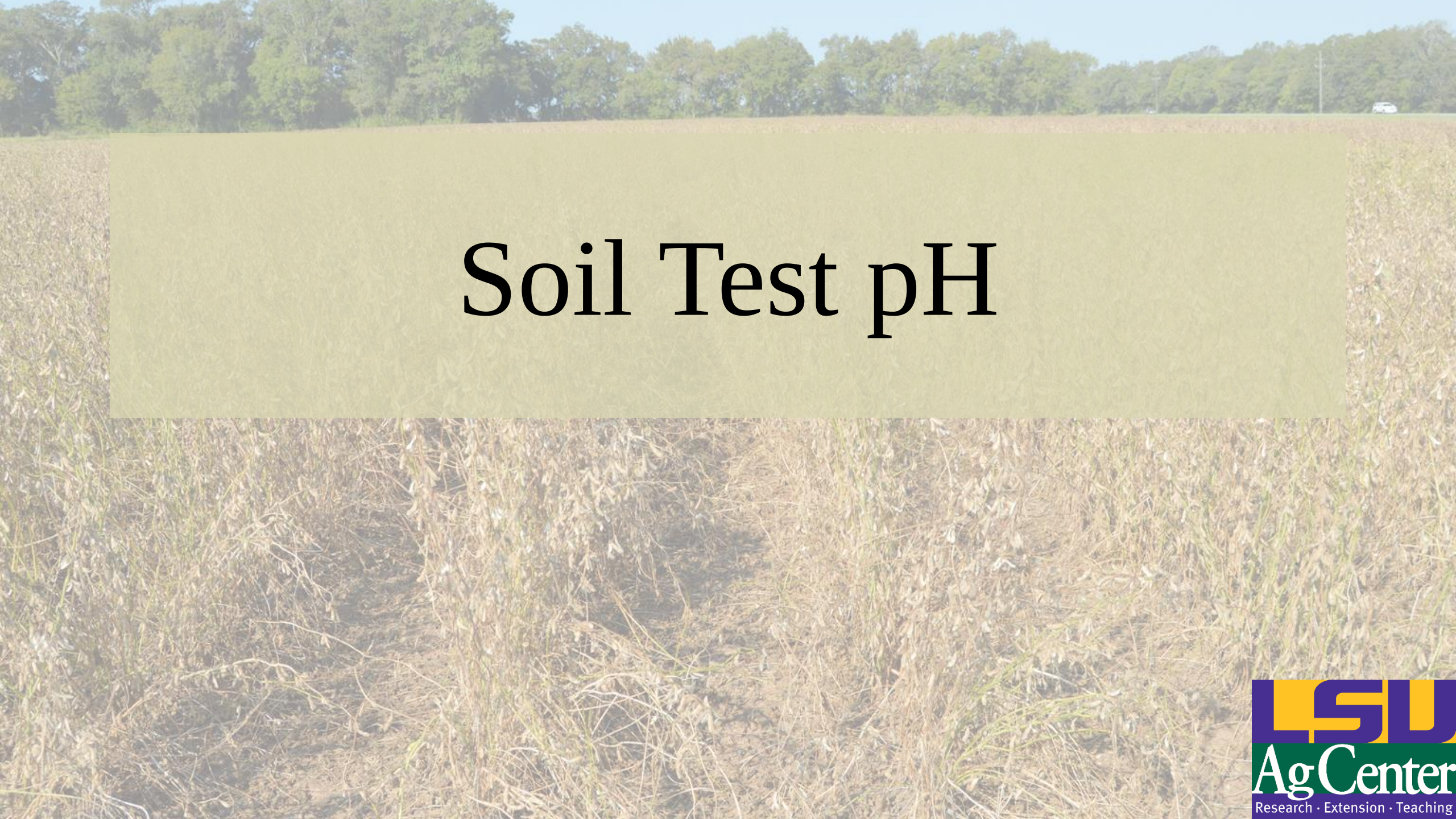
Soil Test pH



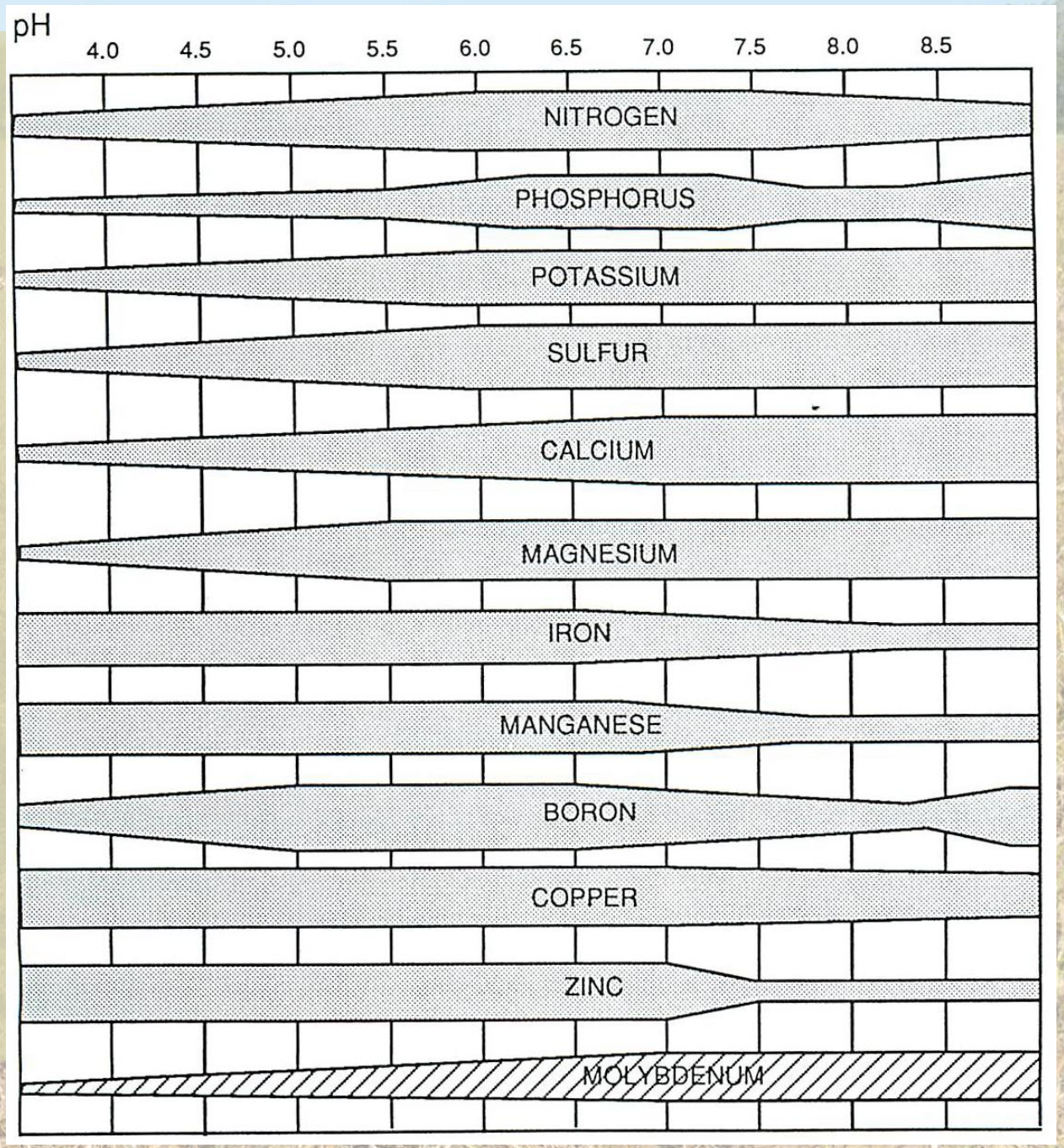
Soil Test pH

- pH – negative (-) log of the concentration of hydrogen ions (H^+)
  - pH = -log (10^{-7}) = 7
- More H^+ = lower pH (This is why NH_4^+ lowers the pH when reduced to NO_3^-)
- Less H^+ = higher pH
- Suitable pH for most crops typically range from 6 - 7.5.

Soil Test pH

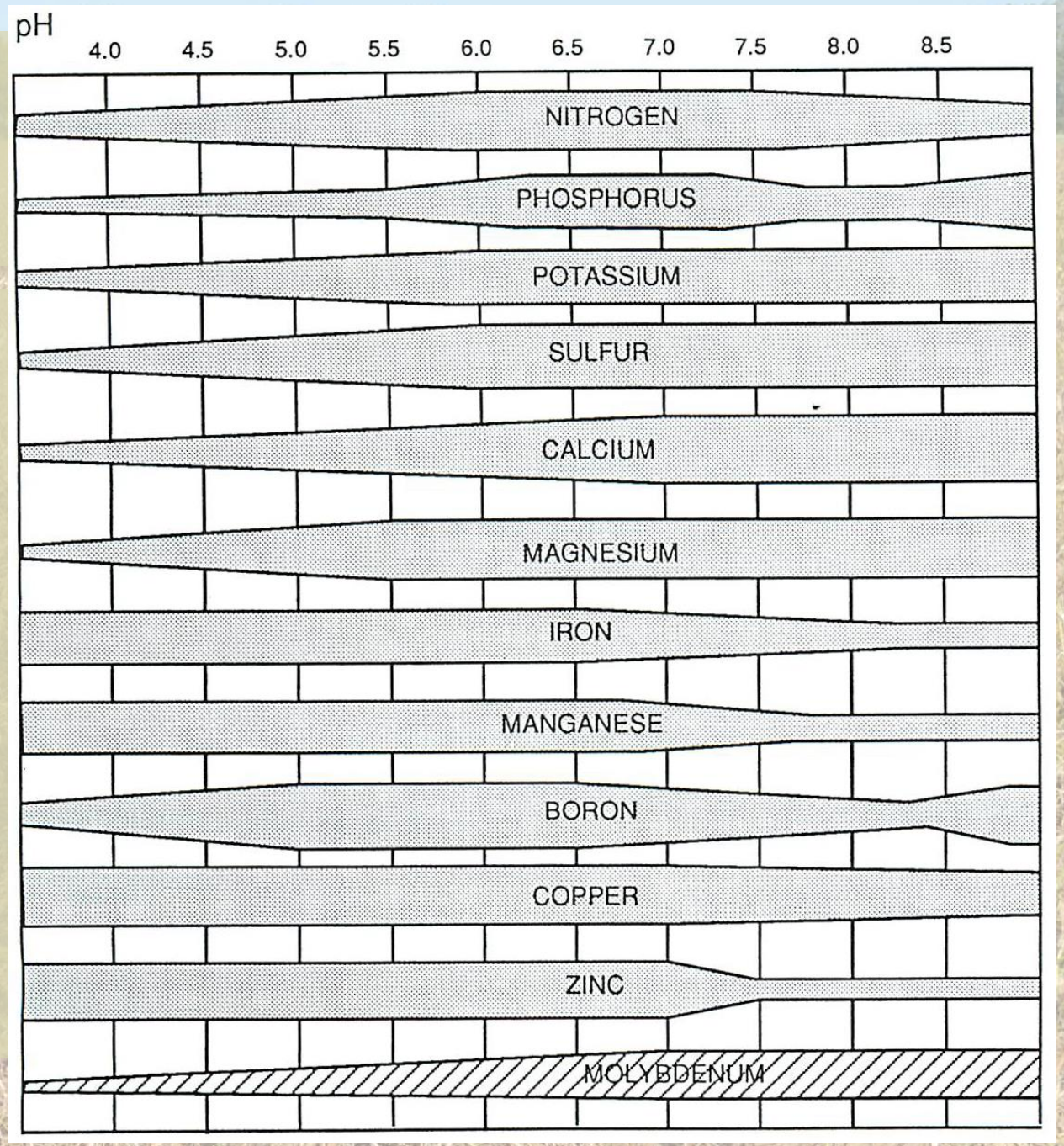
- NH_4^+ volatilization losses increase with increased pH

- Phosphorus
  - pH < 5.5 – $H_2PO_4^-$ forms less soluble compounds with iron (Fe) and aluminum (Al)
  - pH >7.5 – HPO_4^{2-} forms less soluble compounds with calcium (Ca) and magnesium (Mg)



Soil Test pH

- Molybdenum – Required for nitrogen fixation and becomes increasingly unavailable at pH<6.2
- Iron – Fe3+ ions react within hours to become unavailable at pH>7.5
- Toxicity
  - Manganese at pH<5.2
  - Aluminum at pH<5.0



Soil Test pH – Liming Considerations

- Lime quality
  - Calcium Carbonate Equivalent (CCE)
  - Fineness Factor
  - **Effective Calcium Carbonate**

Calcium Carbonate Equivalent		
Lime Material	**Chemical Composition**	**CCE (%)**
Calcium Carbonate	$CaCO_3$ (pure)	reference
Calcitic Lime (Ag Lime)	$CaCO_3$	80-100
Dolomitic Lime	$CaMg(CO_3)_2$	95-100

Fineness Factor	
Particle Size	**Availability**
> 8 mesh	0.0%
8 – 60 mesh	0.5%
< 60 mesh	1.0%

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Soil Test pH – Liming Considerations

- For best results lime should be incorporated to improve distribution and soil-lime contact

- No-Till Lime Applications (Beegle, 1998)
  - Lime applied 3 year intervals at 3 tons A^{-1}
  - Only 0-2” sample was affected with 1 application
  - 4 applications (12 years) was needed to increase pH to adequate levels at 4-6”.
  - **Fix pH issues before committing to no-till systems**

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Soil Test Availability: P & K

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Soil Test Availability Rating

Rating	Expected Yield Potential	Fertilization
Very Low	<50%	Plant response expected
Low	50-75%	Plant response expected
Medium	75-95%	Plant response expected
High	100%	Fertilization may be needed to maintain “high” rating
Very High	100%	No fertilization needed

Phosphorus

- Soybean requirements
  - Removal – 0.8 lb P_2O_5 bu^{-1} A^{-1}
  - Total Uptake – 1.2 lb P_2O_5 bu^{-1} A^{-1}

- Crop Deficiencies
  - Symptoms occur in old growth
  - Leaves are dark green or purple color with leaf cupping
  - Typically delays bloom and maturity
  - Especially noticeable with cool, wet soils

Phosphorus

- $H_2PO_4^-$ is the predominant ion available to plants in acid soils
  - pH < 5.5 - forms less soluble compounds with iron and aluminum
- HPO_4^{2-} is the predominant ion available in soils at pH > 7
  - pH > 7.5 - forms less soluble compounds with calcium and magnesium

Phosphorus Retention

- Factors affecting P retention
  - pH – forms less soluble compounds at both low and high pH with iron and aluminum or calcium and magnesium, respectively
  - Soil texture – retention most often occurs in clay fraction of soils; precipitation of Fe and Al oxides
  - Time – initial fast reaction; one hour after water-soluble P is added, a weak acid cannot extract most of the P, one year later this amount is even less

Phosphorus

- Minimal-Till
  - Broadcast applications will often only increase soil test level P in surface 1” and increase the proportion bound in less soluble compounds
  - Can be banded with small amounts of NH^{4+} or sulfur to slightly reduce the pH in the immediate area to improve availability

Potassium

- Soybean requirements
  - Removal – 1.4 lb K_2O bu^{-1} A^{-1}
  - Total Uptake – 4 lb K_2O bu^{-1} A^{-1}

- Soybean Deficiencies
  - Symptoms occur in old growth
  - Interveinal chlorosis and along leaf margins
  - May occur under waterlogged soils, dry soils, or during peak seed fill when K use is maximized late in the season

Photo Credit: University of Missouri Extension

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Potassium

- Fall vs Spring Applications
  - Fall applications should be avoided in coarse-textured soils, especially those with Cation Exchange Capacity (CEC) < 6 meq/100grams
- No-Till – Surface applications are effective with little to no incorporation

Depth (inches)	No-Till	Moldboard Plow
	---------- ppm K ----------	
0-2	170 (47%)	132 (39%)
2-6	104 (29%)	113 (33%)
6-12	86 (24%)	95 (28%)
Blevins et al., 1986		

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Soybean Uptake and Removal

Yield Level	Phosphorus (P)		Potassium (K)	
	Uptake	Removal	Uptake	Removal
40	48	32	160	56
60	72	48	240	84
80	96	64	320	112

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Nutrient Removal - Scenario

- Corn and Soybean rotation (1:1) – 7 years

Corn (160 bu A^{-1})		Soybean (60 bu A^{-1})	
P_2O_5 Removal	K_2O Removal	P_2O_5 Removal	K_2O Removal
211 lb A^{-1}	139 lb A^{-1}	144 lb A^{-1}	252 lb A^{-1}
Total Removal			
P_2O_5		K_2O	
355 lb A^{-1}		391 lb A^{-1}	
Soil Test ppm Reduction			
P_2O_5		K_2O	
13 – 30 ppm		25 – 49 ppm	

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Nutrient Removal - Soil Test Range

- P_2O_5
  - 12 – 28 lb to raise soil test levels 1ppm
- K_2O
  - 8 – 16 lb to raise soil test levels 1ppm

Soil Test P ratings (Mehlic 3) (ppm/recommendation P_2O_5 lb A^{-1})				
	VL	L	M	H
	0-10/80	10-20/60	20-35/30	>35/0
Soil Test K ratings (Mehlic 3) (ppm/recommendation K_2O lb A^{-1})				
	VL	L	M	H
Clay-Loam	0-159/80	159-227/60	227-341/30	341-364/0
Silt-Loam	0-91/80	91-136/60	136-182/30	182-205/0

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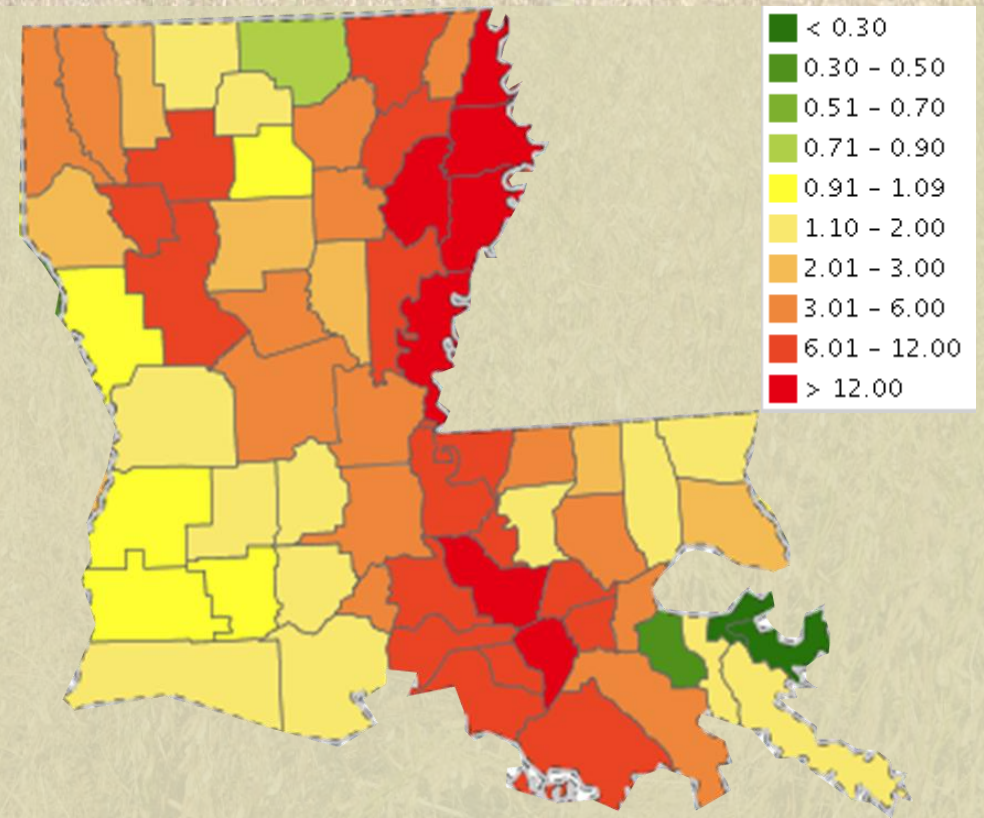
Nutrient Removal

- Less than 30% of LA soybean acres received K or P in 2015.

- Top 15 soybean parishes (2012)
  - K - Removal:Replacement = 6:1
  - Net Balance = -54 lb K_2O A^{-1}



Adapted from: *nugis.ipni.net*

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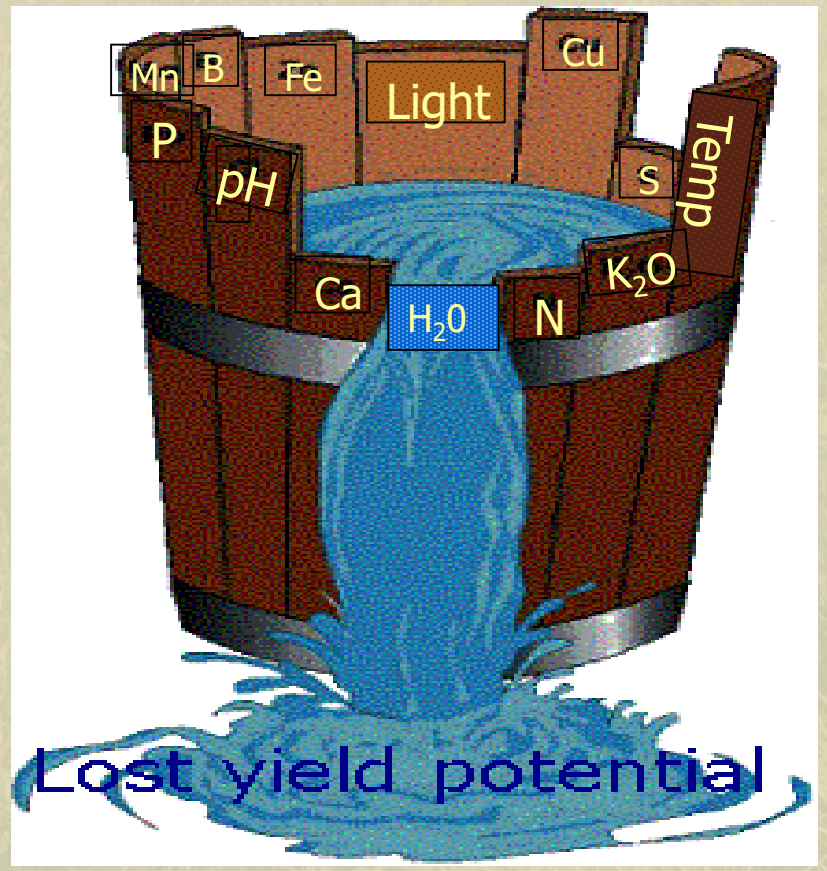

Our goal is to ensure that the most limiting factor is one out of our control.

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