

## Soil Test Interpretations and Fertilizer Recommendations in Kansas

Publication MF2586

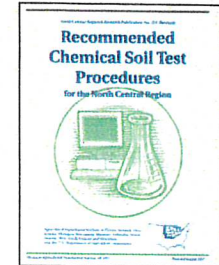
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Professor and soil fertility specialist



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## About the K-State Soil Testing lab

- Soil analysis: recommended methods
- Plant tissue analysis
- Support agronomy:
  - Diagnostic
  - Fertilizer recommendations
  - Analysis methods for KS
- Soil fertility working group



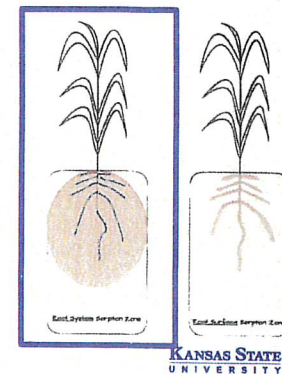
## Interpreting soil test results

- Interpretation depends on the lab procedures used
- Most nutrient tests are a measure of availability, not total concentration in the soil!
- Interpretation of mobile nutrient tests based on *mass balance*
- Interpretation of immobile nutrient tests based on *sufficiency*

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## Mass Balance – Mobile nutrients

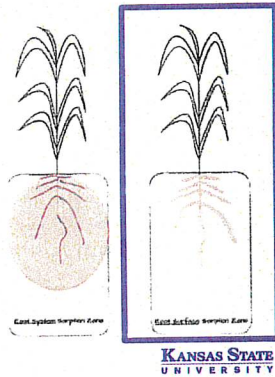
- Mobile nutrients easily taken up by plants
- Convert concentration to mass
- ppm to lbs/acre
- Profile-N =  $\text{NO}_3$  ppm x sample depth x 0.3



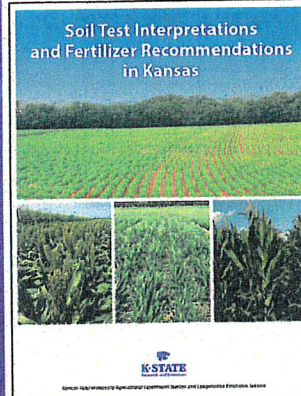
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### Immobile Nutrients

- Available when close to root surfaces (diffusion)
- Soil test must be calibrated (region/crop)
- Fertilizer recs when soil tests fall below a critical soil test value



### Publication MF2586 - revised 2024



- Some key changes:
- Nitrogen recommendation
  - Lime recommendations
  - Phosphorus categories
  - Potassium categories
  - Updated crop nutrient removal values



### Publication MF2586 - revised 2024

Why regular revisions/updates are needed?

- Changes in farming practices
- Crop yield potential
- Fertilization strategies
- Changes in crop genetics
- Better local field data



### Nitrogen fertilizer recommendation

#### Old equation

$$N \text{ Rec}^{2.2} = (\text{Yield Goal} \times 1.6) - (\% \text{ SOM} \times 20) - \text{Profile N} - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$

#### New equation

#### Corn

$$N \text{ (lb/a)} = (\text{ie/fe}) \text{ EY} - (\text{se}) \text{ Profile N} - (\% \text{ SOM} \times 20) - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$



### Definitions

- **Internal crop efficiency (IE)** = Amount of total plant N required to make one bushel
- Units of lbs of N/bushel

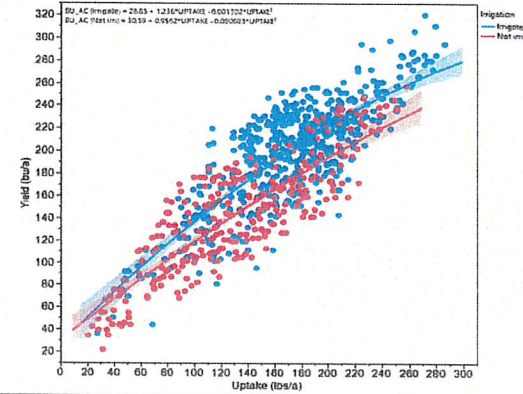
$$N \text{ (lb/a)} = (ie/fe) EY - (se) \text{ Profile N} - (\% \text{ SOM} \times 20) - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$

Corn: Plant N internal efficiency

	Bu/lbs	Lbs/bu
Irrigated	1.18	0.84
Non-Irrig	1.14	0.88



### Corn N uptake vs yield: (irrigated vs non-irrigated)



### Definitions

- **Fertilizer Efficiency (FE)** = The fraction of N applied as fertilizer that is recovered by the crop
- lbs N recovered / lbs N applied
- Timing, placement, and source of N can affect fertilizer recovery efficiency

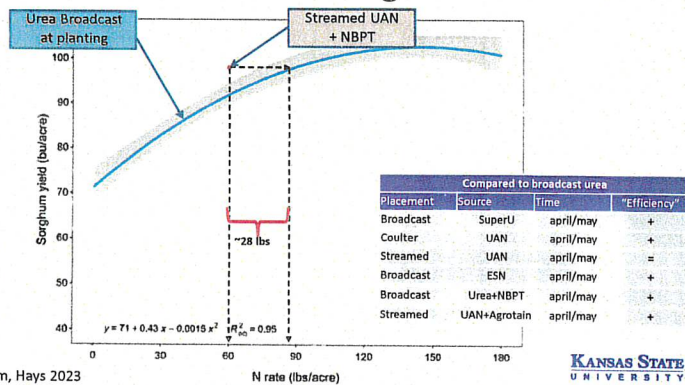
$$N \text{ (lb/a)} = (ie/fe) EY - (se) \text{ Profile N} - (\% \text{ SOM} \times 20) - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$

Corn: Fertilizer Efficiency

N recovery efficiency (fe)	lb N/lb N
High (injected + split)	0.65
Default (broadcast, fall-applied)	0.55



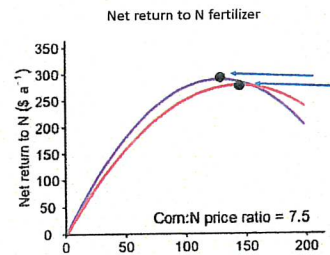
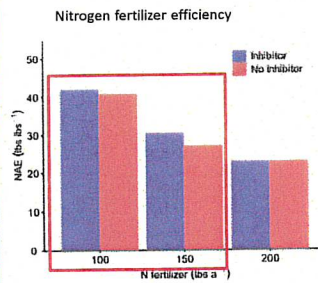
### Increase in fertilizer efficiency: Sorghum and N fertilizer management



Sorghum, Hays 2023



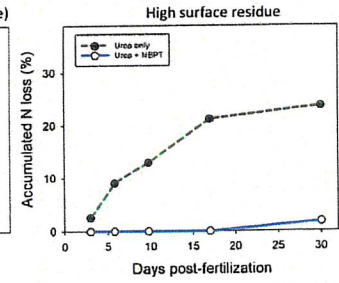
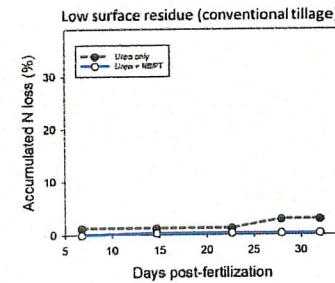
### Increase in fertilizer efficiency: use of nitrification inhibitor with anhydrous ammonia



(10 site years)

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### Increase in fertilizer efficiency: Nitrogen volatilization loss from top-dress urea in wheat



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### “Soil Efficiency” (SE) factor for profile N

- Soil Efficiency (SE) = Fraction of N measured with profile test that remains plant-available for the crop
- N can be lost through leaching or denitrification
- N losses typically highest in sandy soils and higher precipitation

$$N \text{ (lb/a)} = (ie/fe) EY - (se) \text{ Profile N} - (\% \text{ SOM} \times 20) - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$

Soil efficiency (se)	
Low N loss	1.0
High N loss	0.7

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### Example

$$N \text{ (lb/a)} = (ie/fe) EY - (se) \text{ Profile N} - (\% \text{ SOM} \times 20) - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$

Expected yield	240 bu
Profile N	30 lbs N
SOM (3% x 20= 60)	60 lbs N
Previous crop: Soybean	40 lbs N

Irrigated corn default fertilizer efficiency:

$$N \text{ (lbs/acre)} = (0.84/0.55) * 240 - 50 - 60 - 40$$

$$N \text{ (lbs/acre)} = 236 \text{ lbs N/acre}$$

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### Challenges and need for improvements

- The N supply from SOM during the season.
  - Good growing conditions equal to higher mineralization rate? (currently assuming linear)
- Refine the “efficiency” of nitrogen and profile soil NO3
  - If we measure 100 lbs of N in the profile (NO3) in the winter or spring, will 100% be available for uptake in the summer? West vs East KS? Texture?
- Contributions from legumes, cover crops (PCA)
- Add economic adjustments

### Phosphorus recommendations

#### Phosphorus Sufficiency Recommendations

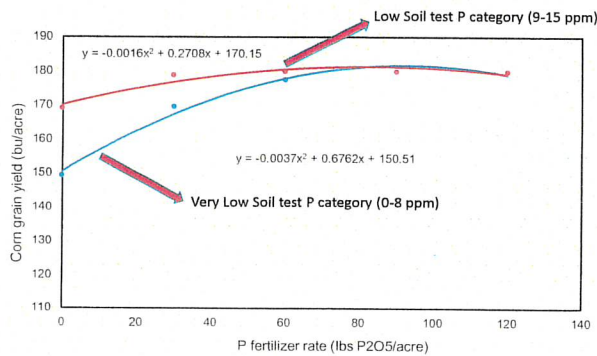
Mehlich-3 P Soil Test (ppm)	Category	Expected Yield (bu/a)				
		80	120	160	200	240
0-8	Very Low	55	60	65	70	80
9-15	Low	25	30	35	35	40
16-20	Medium	15	15	15	15	15
21-30	High	0	0	0	0	0
31+	Very High	0	0	0	0	0

#### Phosphorus Build-Maintenance Recommendations

Mehlich-3 P Soil Test (ppm)	Category	4-Year Build Time Frame, Expected Yield (bu/a)			6-Year Build Time Frame, Expected Yield (bu/a)			8-Year Build Time Frame, Expected Yield (bu/a)		
		80	160	240	80	160	240	80	160	240
0-8	Very Low	99	125	151	74	101	127	62	89	115
9-15	Low	62	89	115	50	77	103	44	71	97
16-20	Medium	35	62	89	32	59	85	31	57	84
21-30	High	26	53	79	26	53	79	26	53	79
31+	Very High	0	0	0	0	0	0	0	0	0

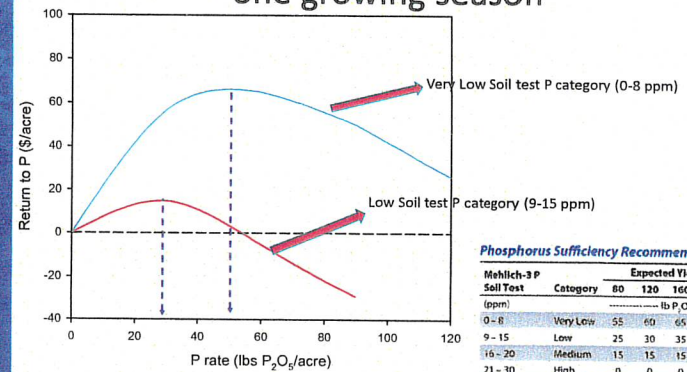
\*Recommended amounts of P<sub>2</sub>O<sub>5</sub> are based on crop nutrient removal only.

### Corn response to P fertilizer rate



31 locations across KS

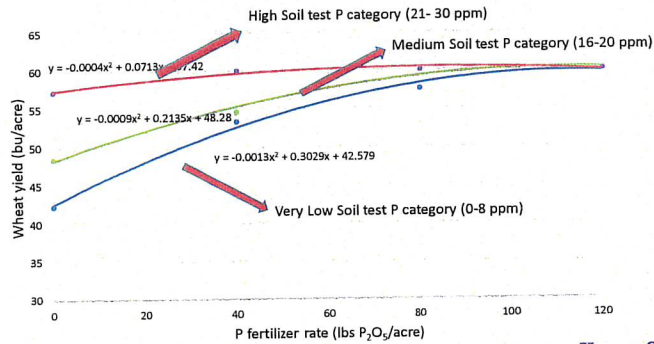
### Return to P fertilizer (\$0.8 P & \$4 corn) for one growing season



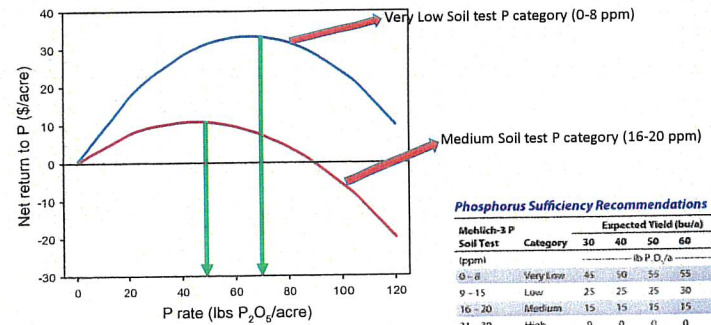
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0-8	Very Low	55	60	65	70	80
9-15	Low	25	30	35	35	40
16-20	Medium	15	15	15	15	15
21-30	High	0	0	0	0	0
31+	Very High	0	0	0	0	0

### Wheat response to P fertilizer rate



### Return to P fertilizer (\$0.8 P & \$6 wheat) for one growing season



Phosphorus Sufficiency Recommendations

Mehlich-3 P Soil Test (ppm)	Category	Expected Yield (bu/a)				
		30	40	50	60	70
0-8	Very Low	45	50	55	55	60
9-15	Low	25	25	25	30	30
16-20	Medium	15	15	15	15	15
21-30	High	0	0	0	0	0
31+	Very High	0	0	0	0	0

### Potassium recommendations

Potassium Sufficiency Recommendations

Extractable K Soil Test (ppm)	Category	Expected Yield (bu/a)				
		80	120	160	200	240
0-40	Very Low	75	85	90	95	105
41-80	Low	50	50	55	60	65
81-130	Medium	15	20	20	20	25
131-160	High	0	0	0	0	0
161+	Very High	0	0	0	0	0

Potassium Build-Maintenance Recommendations

Extractable K Soil Test (ppm)	Category	4-Year Build Time Frame, Expected Yield (bu/a)			6-Year Build Time Frame, Expected Yield (bu/a)			8-Year Build Time Frame, Expected Yield (bu/a)		
		80	160	240	80	160	240	80	160	240
0-40	Very Low	268	289	310	186	207	227	145	165	186
41-80	Low	177	198	219	125	146	167	99	120	141
81-130	Medium	76	97	118	58	78	99	48	69	90
131-160*	High	21	42	62	21	42	62	21	42	62
161+	Very High	0	0	0	0	0	0	0	0	0

\*Recommended amounts of K,D are based on crop nutrient removal only.

### Soil sample collection is a key step

- Attention to detail when collecting samples in the field
- 15+ cores per field/aoi
- Consistent sampling depth, especially in no-till
- Dry or refrigerate samples when testing N
- Get samples to lab as soon as possible

### Available tools and resources

- Soil Test Interpretation Fact Sheet MF-2586
- KSU fertilizer calculator (Excel program)
- Plant tissue app (web app)
- <https://www.agronomy.k-state.edu/outreach-and-services/soil-testing-lab/>

MF – 2586



Tissue test interpretation



K-State Soil Testing Lab



# Questions?

### Shipping samples to the lab

#### Sample Drop-off



You are welcome to bring your samples to the lab in room 2308 during business hours or put them in the drop box on the northwest side of the building after hours.

Shipping your samples instead? [Get a shipping label](#) through UPS.

[Meet our team](#) >