Nitrogen fertilizer management to increase efficiency

Dorivar Ruiz Diaz

Lucas Haag

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Overview

- Identifying nitrogen lost potential
- Management to increase N efficiency in corn
- The role of additives and other management tools

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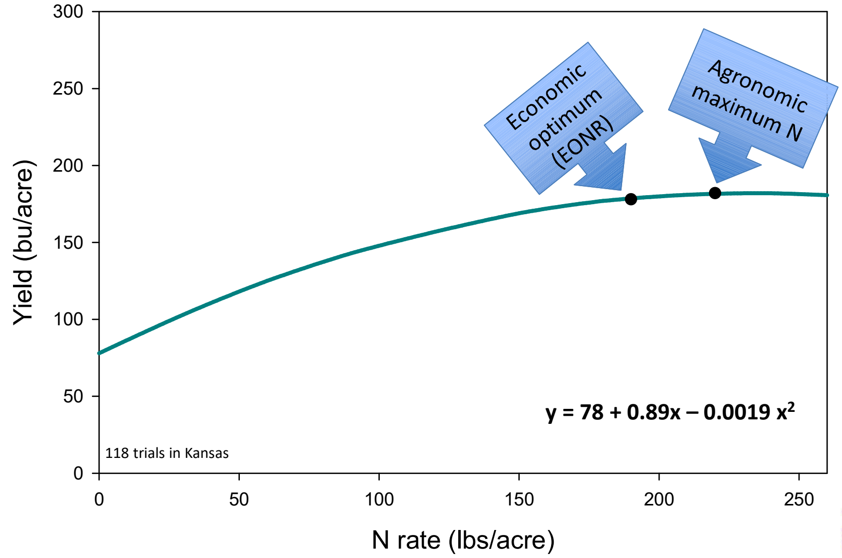
Economic optimum N vs maximum agronomic N?



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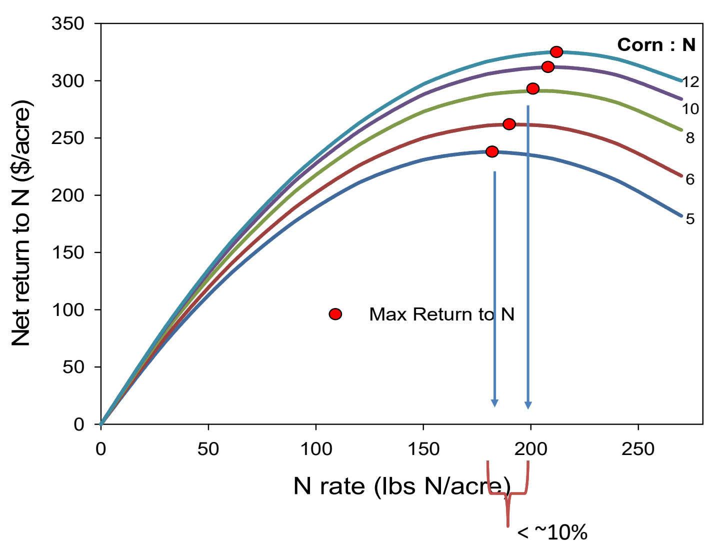
Should I cut back on N rates with current prices? How much?



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Managing nitrogen: key N processes affecting use efficiency

1. Volatilization
2. Denitrification
3. Leaching
4. Immobilization

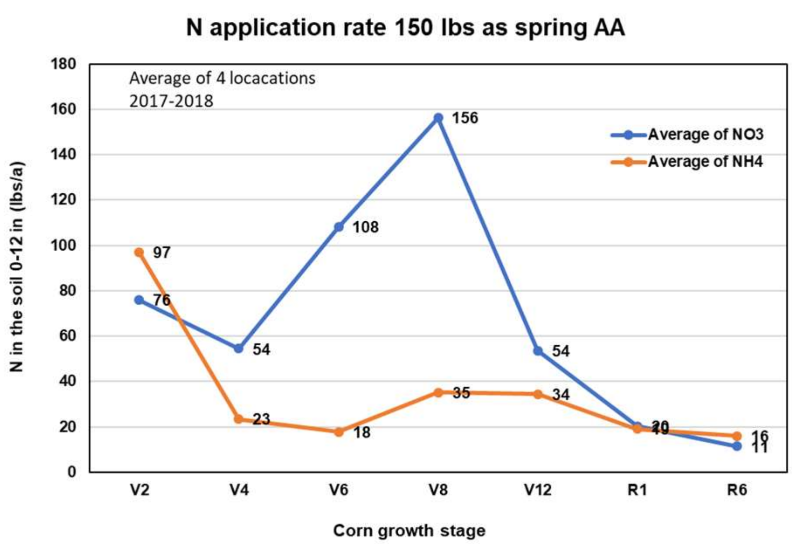
Soil temperature and nitrogen processes (driven by microbial activity)

- Nitrification ($NH_4 \rightarrow NO_3$): ~ 50 F
  - Also presence of oxygen in the soil
- Denitrification ($NO_3 \rightarrow$ gas-N): ~ 75 F and higher
  - Also waterlogged conditions (no oxygen)

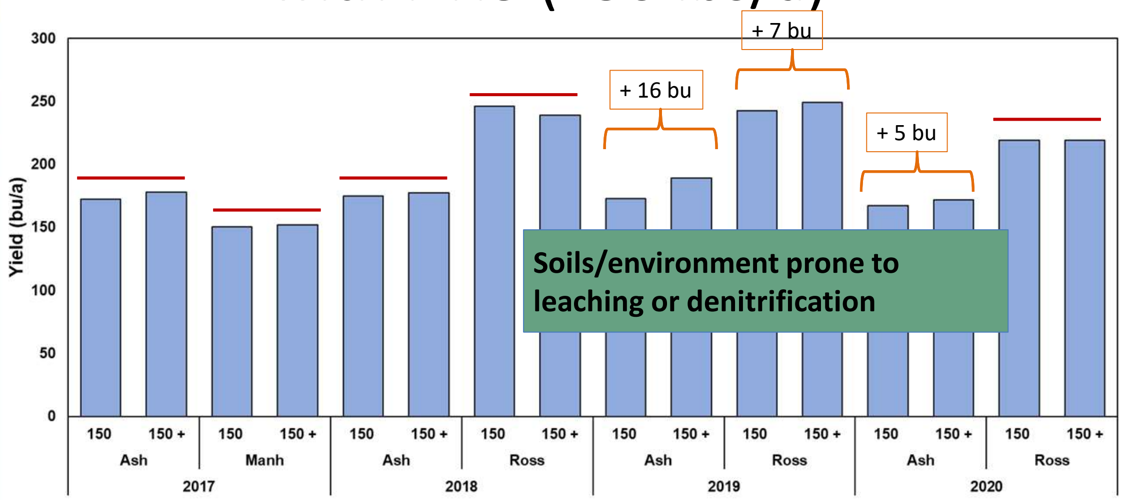
Soil temperature and duration of waterlogged conditions on denitrification

Length of Saturation	Soil Temperature	Nitrate-N Loss
(days)	(degrees F)	(% of NO3 present)
5	55 - 60	10
10	55 - 60	25
3	75 - 80	60

Soil N during the growing season



Use of nitrification inhibitor (N-serve) with NH3 (150 lbs/a)



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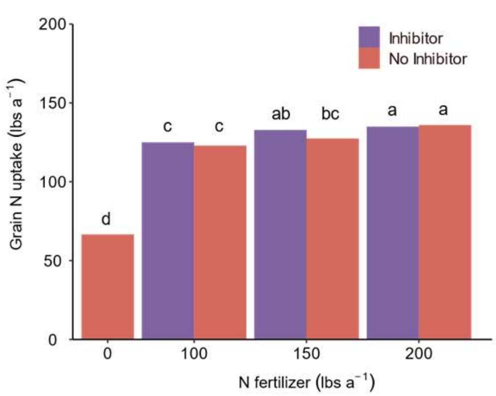
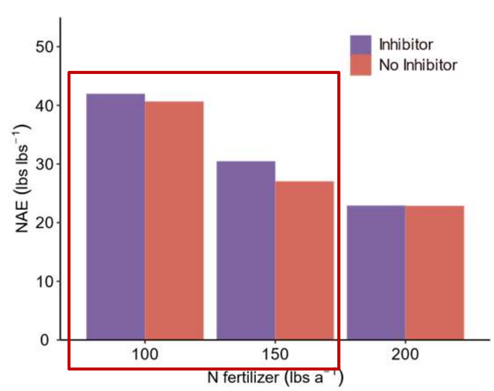
Use of nitrification inhibitor with anhydrous ammonia (over 10 site years)

Grain Nitrogen uptake with yield



Nitrogen fertilizer efficiency



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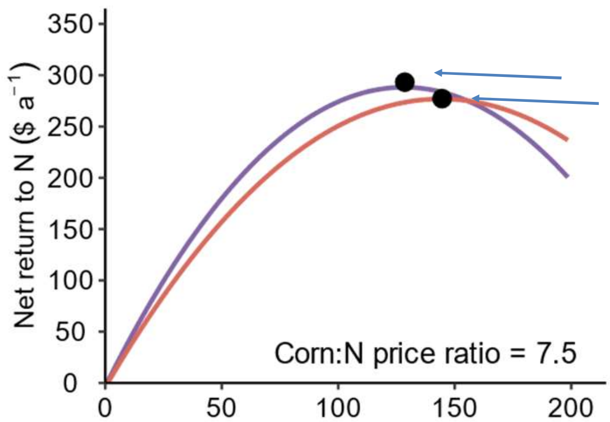
Use of nitrification inhibitor with anhydrous ammonia (over 10 site years)

Net return to N fertilizer



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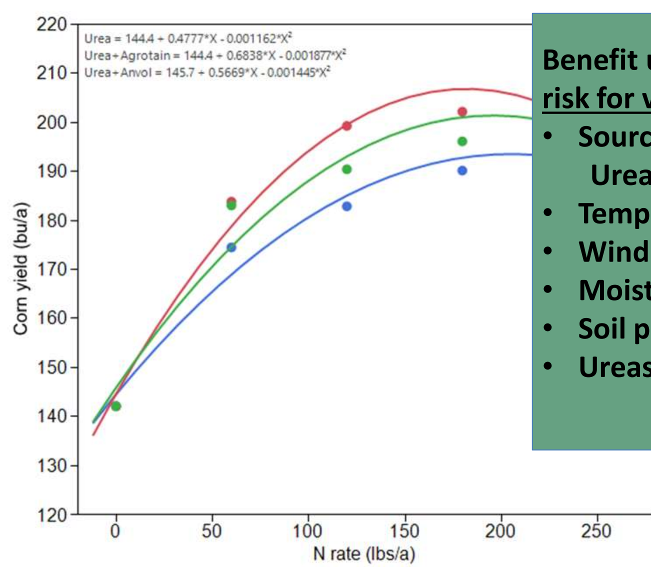
Urease inhibitors for side-dress urea



Benefit under <u>conditions with high risk for volatilization</u>

- **Source: urea!**
  Urea --> NH3 --> NH4
- **Temperature**
- **Wind**
- **Moisture**
- **Soil pH**
- **Urease in the soil (residue)**

2017-2018

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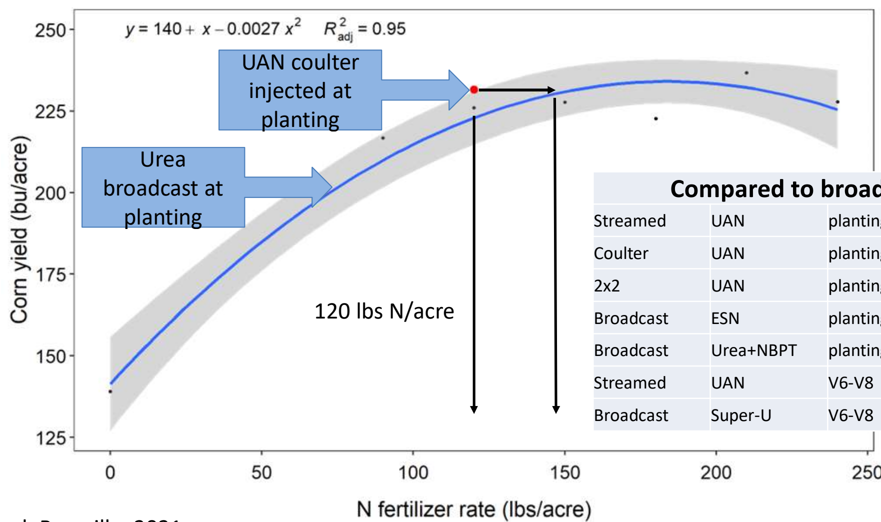
N fertilizer efficiency with improved management in corn



Compared to broadcast urea			
Streamed	UAN	planting	=
Coulter	UAN	planting	+
2x2	UAN	planting	+
Broadcast	ESN	planting	-
Broadcast	Urea+NBPT	planting	=
Streamed	UAN	V6-V8	-
Broadcast	Super-U	V6-V8	-

Irrigated, Rossville, 2021

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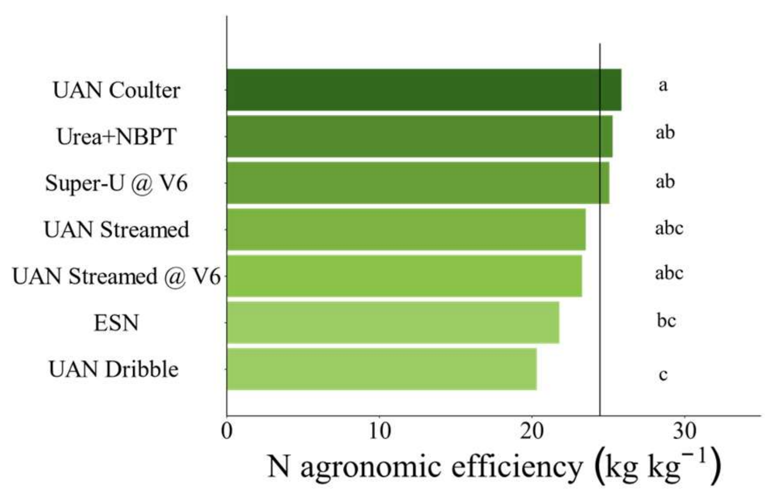
Nitrogen fertilizer source, time placement combinations to increase efficiency



4 sites 2022

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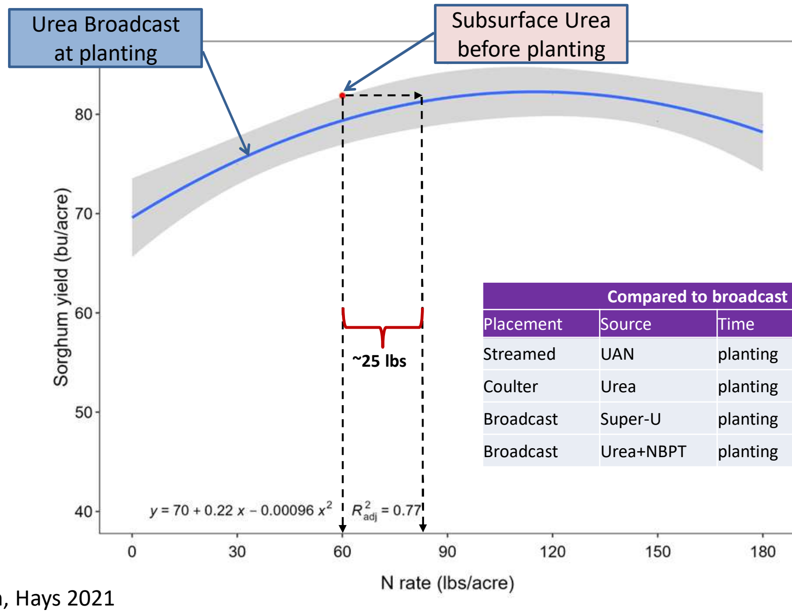
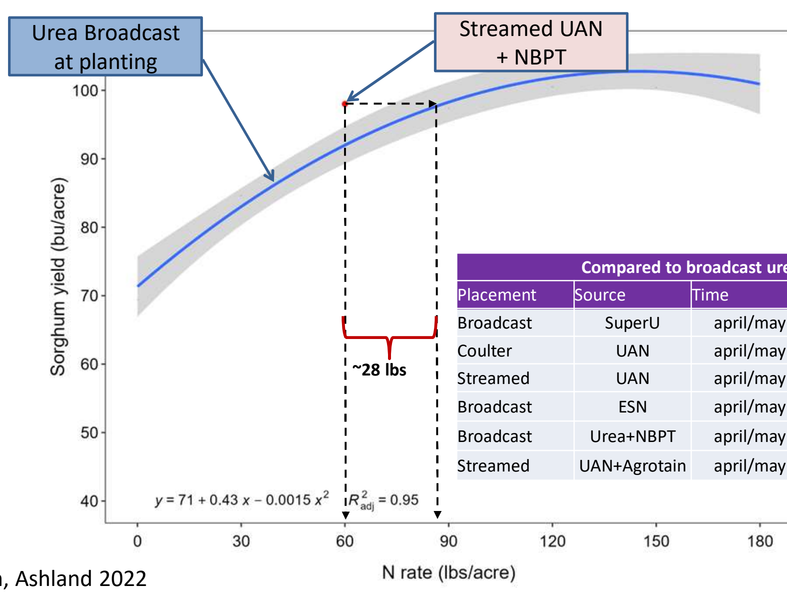
Sorghum and N fertilizer management



Compared to broadcast urea			
Placement	Source	Time	"Efficiency"
Streamed	UAN	planting	+
Coulter	Urea	planting	+
Broadcast	Super-U	planting	+
Broadcast	Urea+NBPT	planting	=

Sorghum, Hays 2021

Sorghum and N fertilizer management



Compared to broadcast urea			
Placement	Source	Time	"Efficiency"
Broadcast	SuperU	april/may	+
Coulter	UAN	april/may	+
Streamed	UAN	april/may	=
Broadcast	ESN	april/may	+
Broadcast	Urea+NBPT	april/may	+
Streamed	UAN+Agrotain	april/may	+

Sorghum, Ashland 2022

Managing nitrogen in season: key processes affecting N use efficiency

Loss process	N form	Management options

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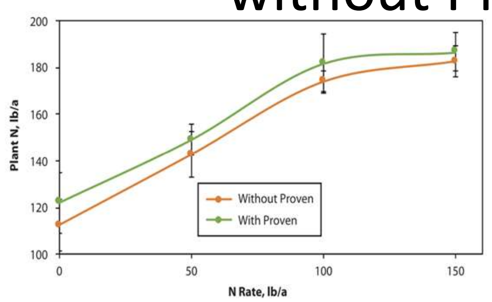
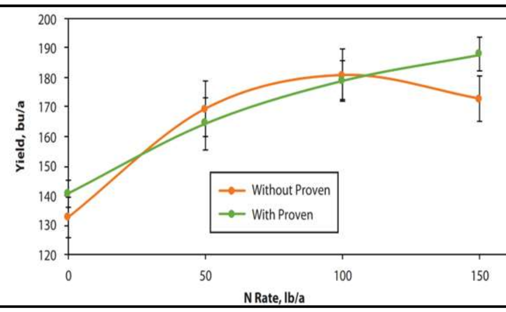
Corn response to N applied with and without PivotBio-Proven



Plant N uptake

Grain yield



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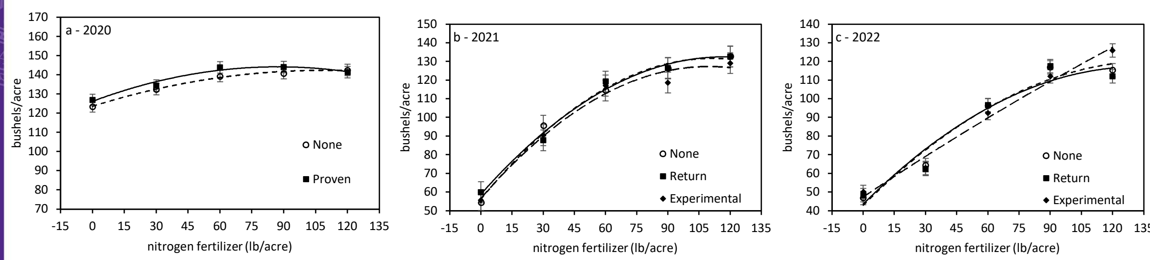
CW Rice, Manhattan, 2022

Grain sorghum response to N and PivotBio-Proven



Roozeboom, Haag, Ruiz Diaz, and Rice

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Increasing nitrogen use/ minimize loses

- Combination of source, placement and time based on risk for N loss for specific condition
- Use of inhibitors can help during years/conditions of N loses (consider “average” multi-year)
- Biologicals/inoculants for N fixing show inconsistent results for N in field conditions
  - Basic research show potential, and ongoing developments

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Manure nutrients

	% Dry Matter	Total N	NH_4	P_2O_5	K_2O
		- - - - - - - lbs/ton - - - - - -			
Dairy	21	9	5	4	10
Beef	50	21	8	18	26
Swine	18	8	5	7	7
Poultry	75	56	36	45	34

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Average animal manure micronutrient content of different sources

Manure source	Iron	Manganese	Boron	Zinc	Copper
	-----------------lb/wet ton---------------------				
Dairy solid	0.5	0.06	0.01	0.03	0.01
Swine solid	19.0	1.09	0.04	0.79	0.50
Poultry	3.0	0.61	0.08	0.48	0.66
	-----------------lb/1000 gal---------------------				
Dairy liquid	0.9	0.11	0.03	0.11	0.12
Swine liquid	2.5	0.23	0.06	1.03	0.62

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Manure nitrogen availability

- Inorganic N is all available.
- Organic N available the first year compared with fertilizer (MF-2562):
  - ✓ Liquid manure: 30%
  - ✓ Solid manure: 25%
  - ✓ Compost: 20%
- As for fertilizers, these numbers indicate potential availability.
- Assumes injection or incorporation and "best management practices".

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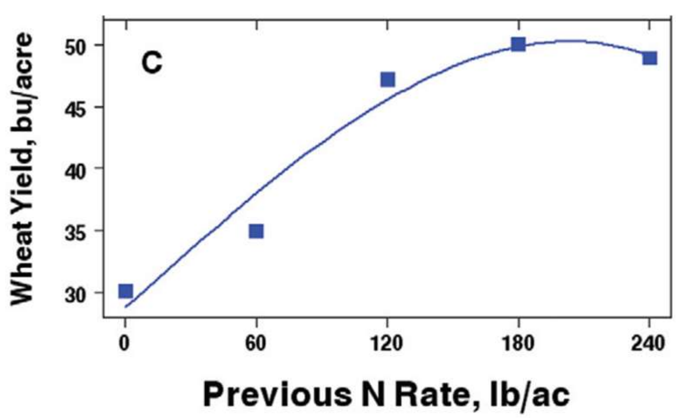
Residual soil nitrate: effects on wheat yield



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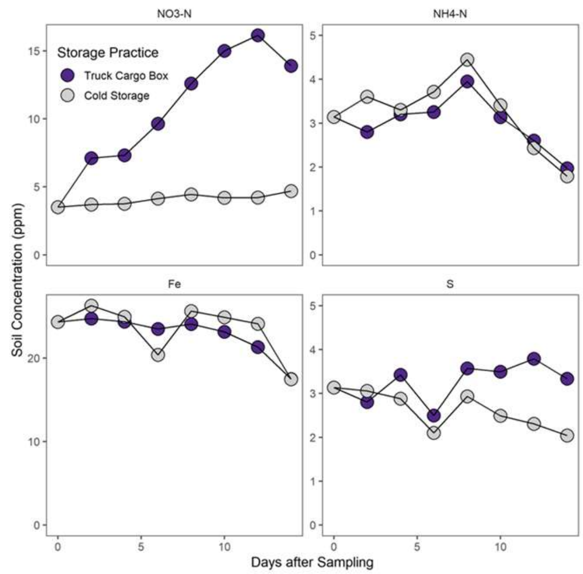
Soil sample handling: effects on NO3



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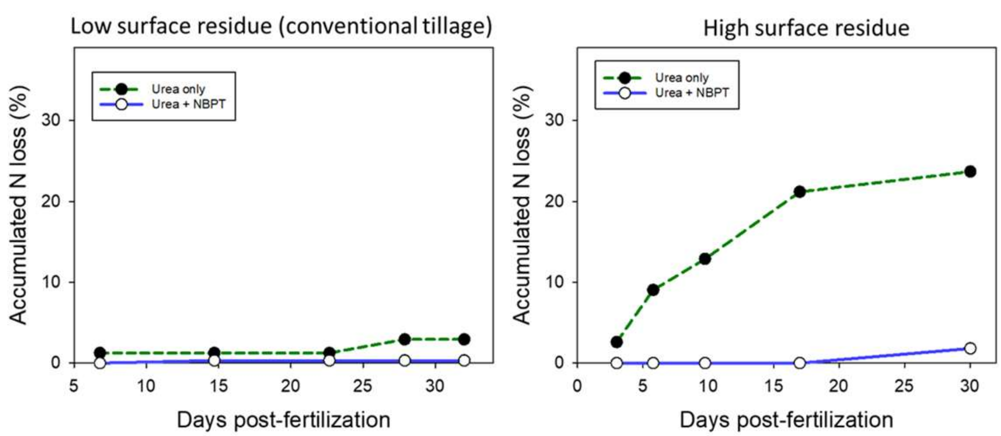
Nitrogen volatilization loss from top-dress urea in wheat



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Impact of sample handling practices on soil test results

Bryan Rutter
KSRE Soil Test Lab

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Research Questions

Current recs are to get samples to the lab asap…

- Common sense, but Murphy's Law…
- What happens if it takes a while to get samples into the lab?
- What if storage conditions aren't ideal in the mean time?

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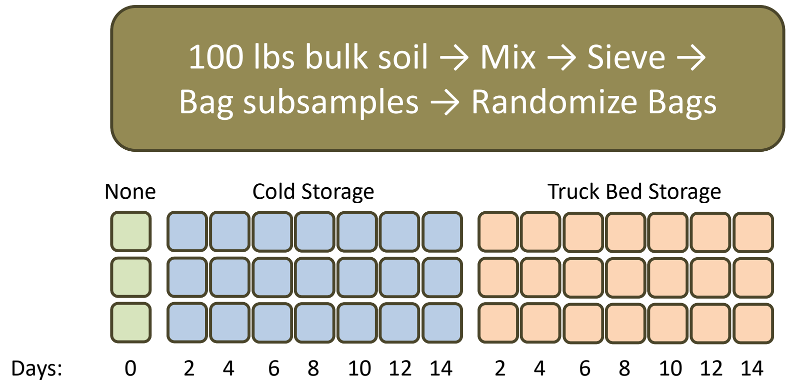
Lab Study: Experiment Design



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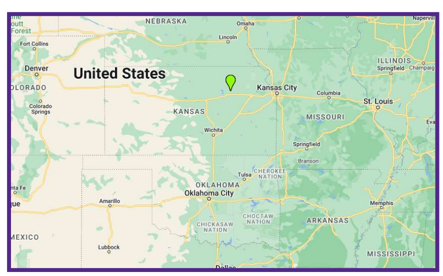
Lab Study: Site Description

Soil pH	SOM %	Sand %	Silt %	Clay %	CEC meq/100g
7.6	2.7	18	62	20	15

- Dryland, Strip-till
- Silt Loam
- Water content = 19 %



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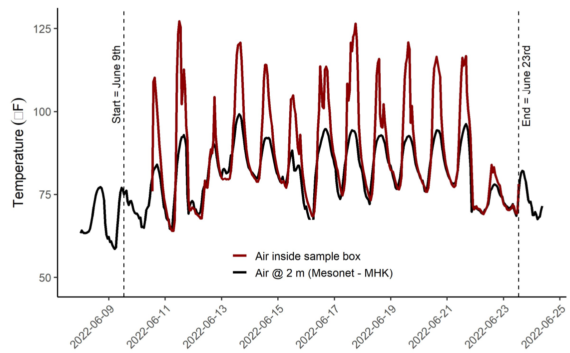
Box temperature



Soil Tests and Comparisons

Soil pH, Buffer pH, SOM, N, P, K, S, Cu, Fe, Mn, Zn

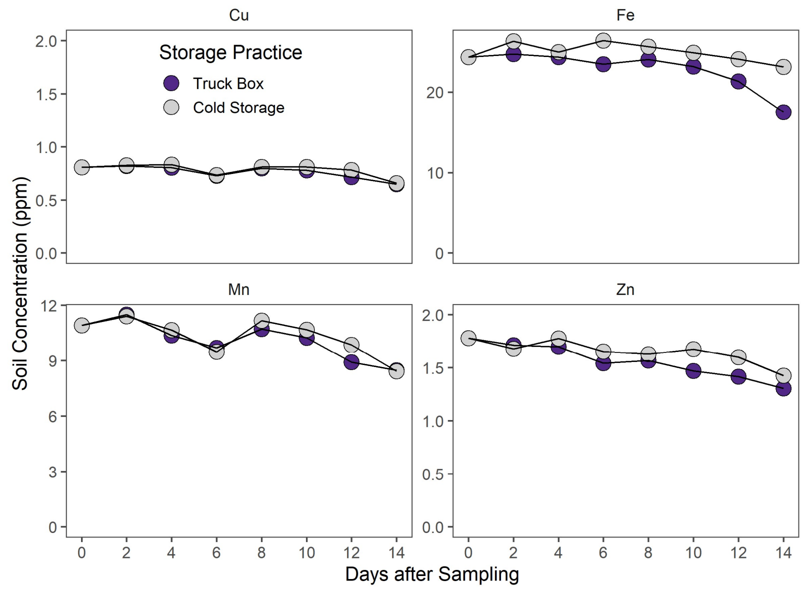
- Storage Environment
- Time
- Storage x Time

Soil tests grouped by effects

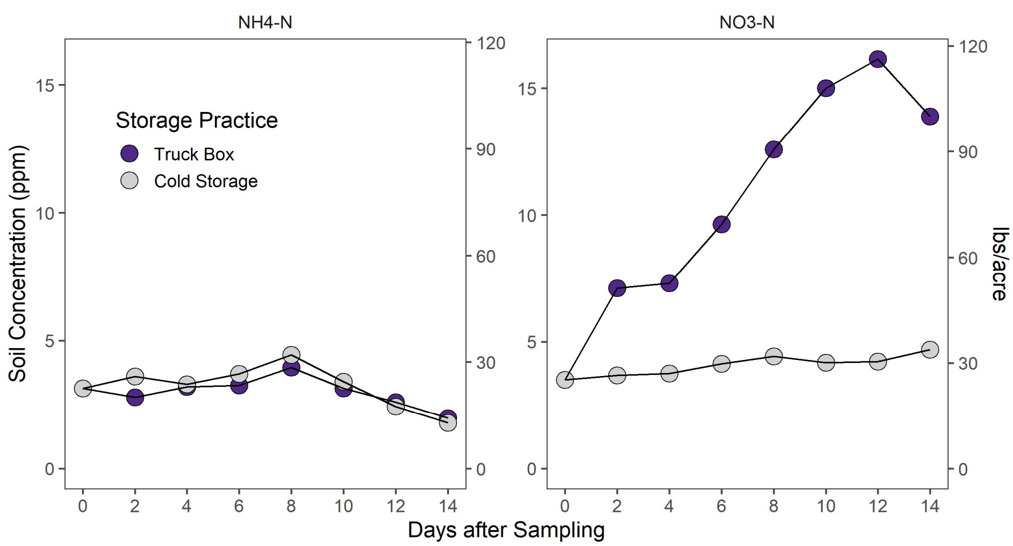
No Changes	Change Over Time Only	Time x Storage
Soil pH	Cu	NO_3-N
Buffer pH	Fe	S
SOM	Mn	
P	Zn	
K		
NH_4-N		

Micronutrients

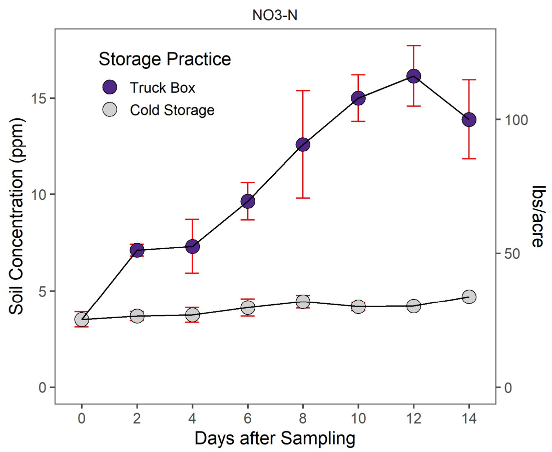
- Statistical significance
- Agronomic significance?

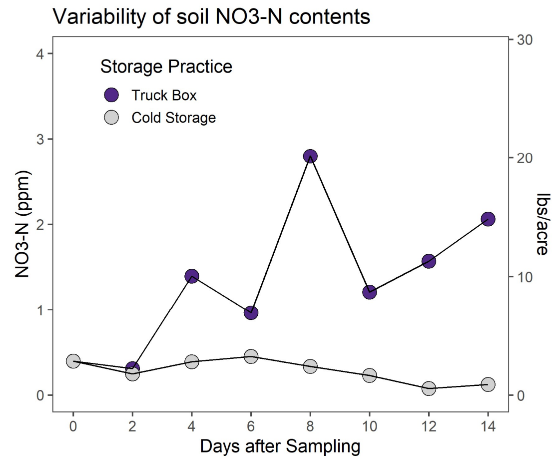


Closer look at Nitrogen



Effects on variability?





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Conclusions

- Sample handling affects soil tests, especially N
- Warm storage temps corresponded to large increases in NO_3 over time
- Warm temps may increase NO_3 variability

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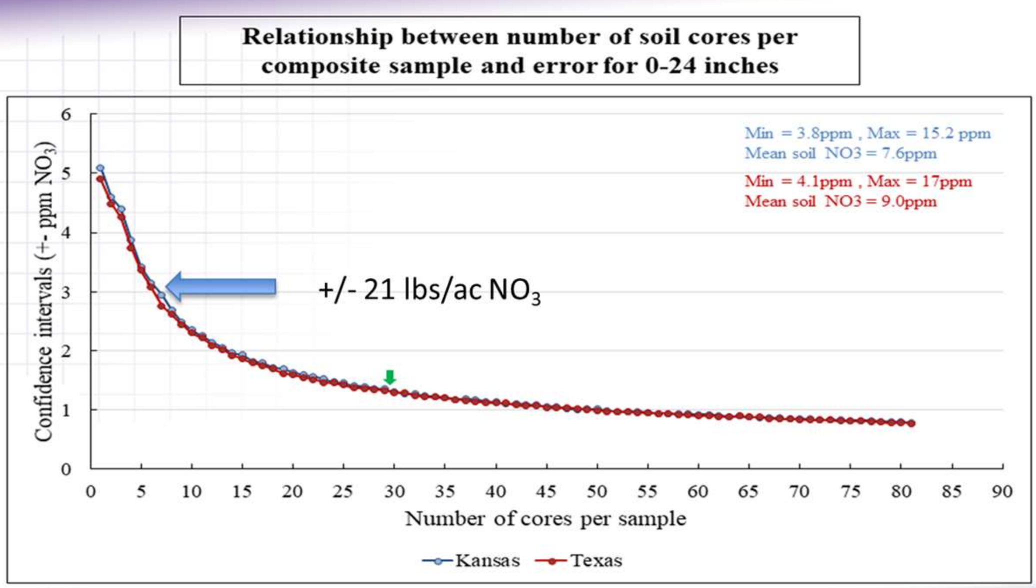
Recommendations and Guidelines

- Get samples to the lab A.S.A.P
  - Let this be my problem, not yours…

If unable to get to the lab soon:

- Air-dry if you can
- Refrigerate < 40 F if you can't air-dry



Haag, Patel, Tomlinson, and Rajan, unpublished, data, 2021

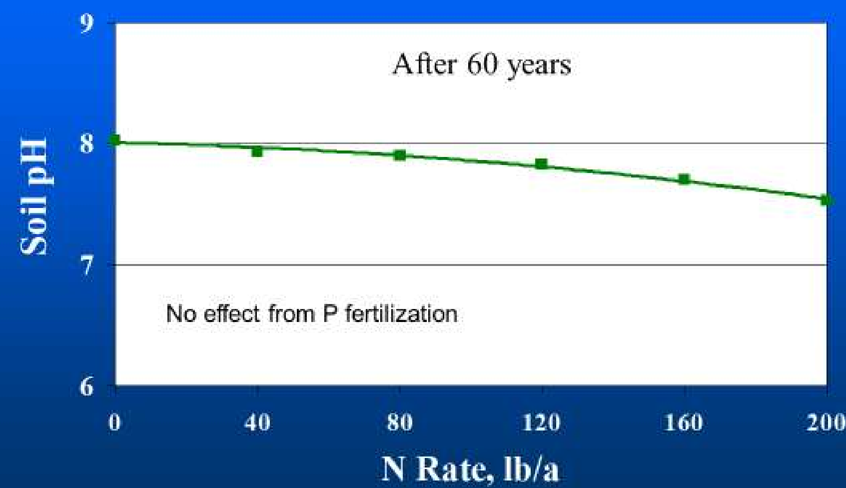
Summary - Corn

pH decreased ~ 0.5 unit by N

SOM increased ~ 0.3% by N & P

Soil test P not maintained with 40 P

Long-term Corn Fertility



0-6", Tribune, KS 2020

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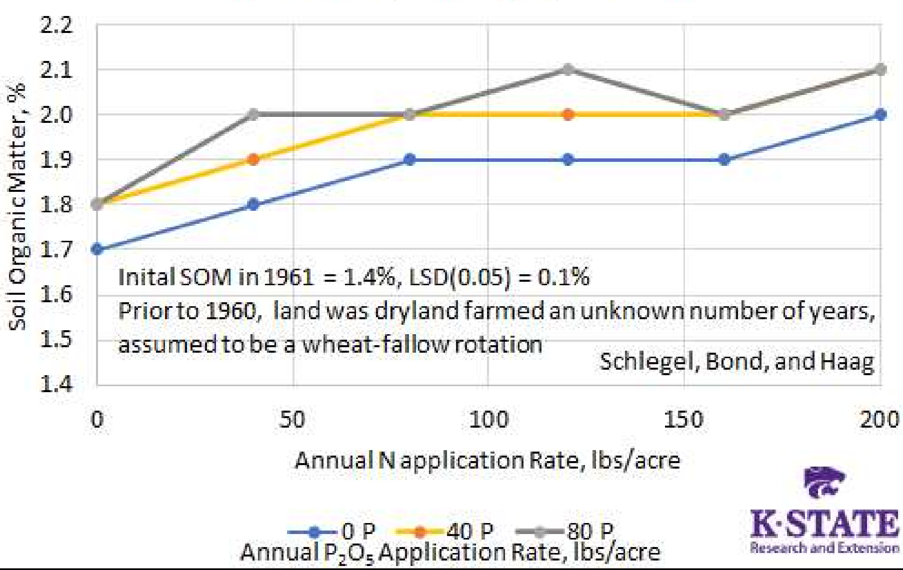
SOM after 60 years of N and P Fertilization
Irrigated Continuous Corn, Conventional Tillage
K-State SWREC, Tribune, KS, 1961-2020



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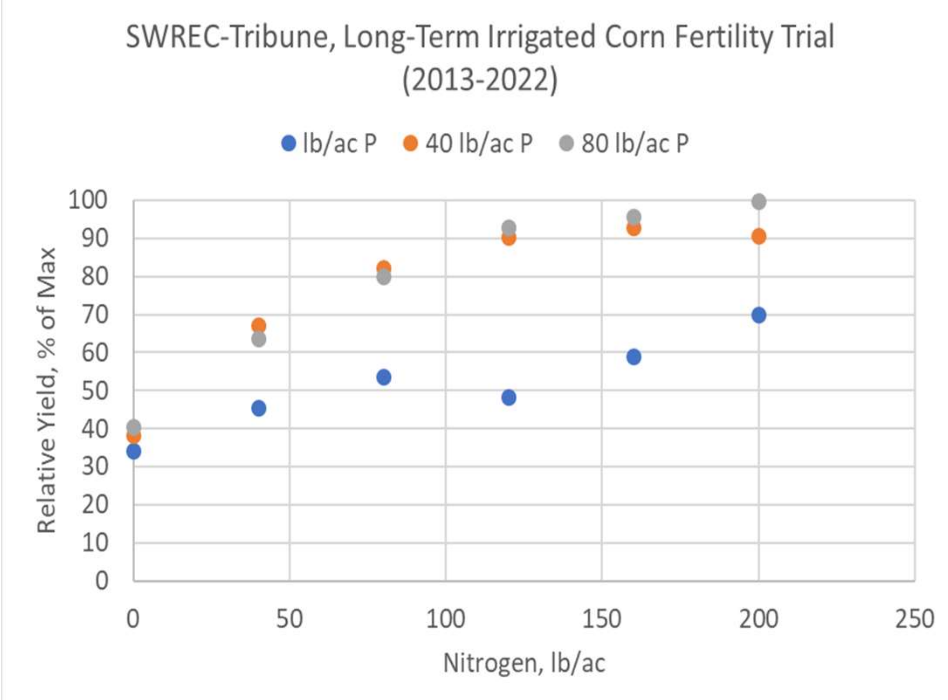
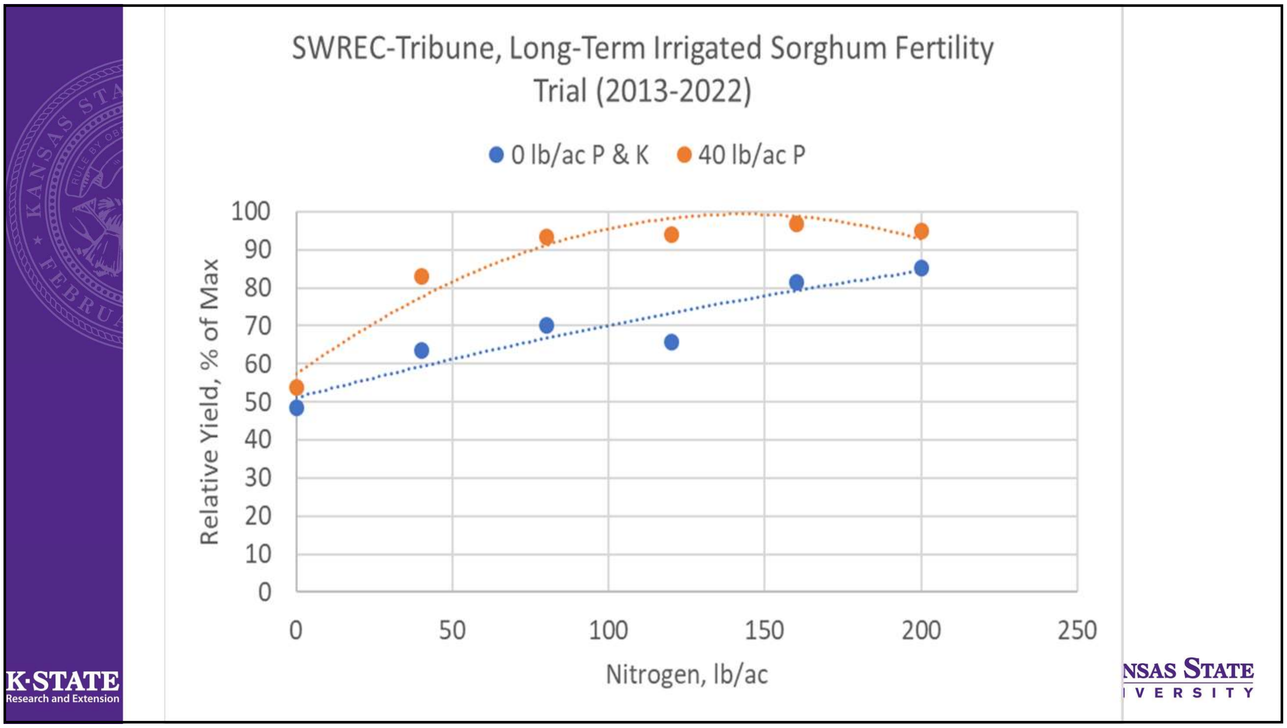


Summary – Grain Sorghum

- pH decreased ~ 1.2 unit by N
- SOM increased ~ 0.5% by N & P
- Soil test P increased with 40 P



SWREC-Tribune, Long-Term Irrigated Sorghum Fertility Trial (2013-2022)
0 lb/ac P & K
40 lb/ac P
Relative Yield, % of Max
100
90
80
70
60
50
40
30
20
10
0
0
50
100
150
200
250
Nitrogen, lb/ac
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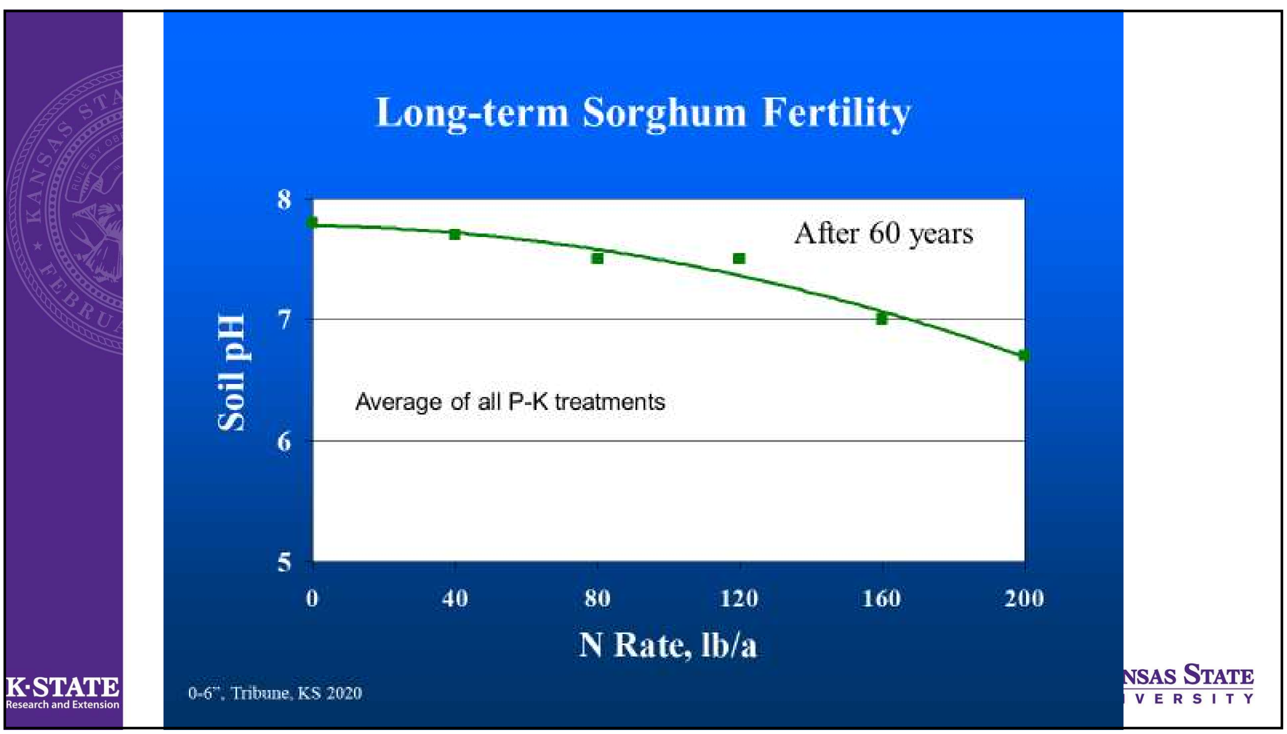

Long-term Sorghum Fertility
8
7
6
5
Soil pH
After 60 years
Average of all P-K treatments
0
40
80
120
160
200
N Rate, lb/a
0-6", Tribune, KS 2020
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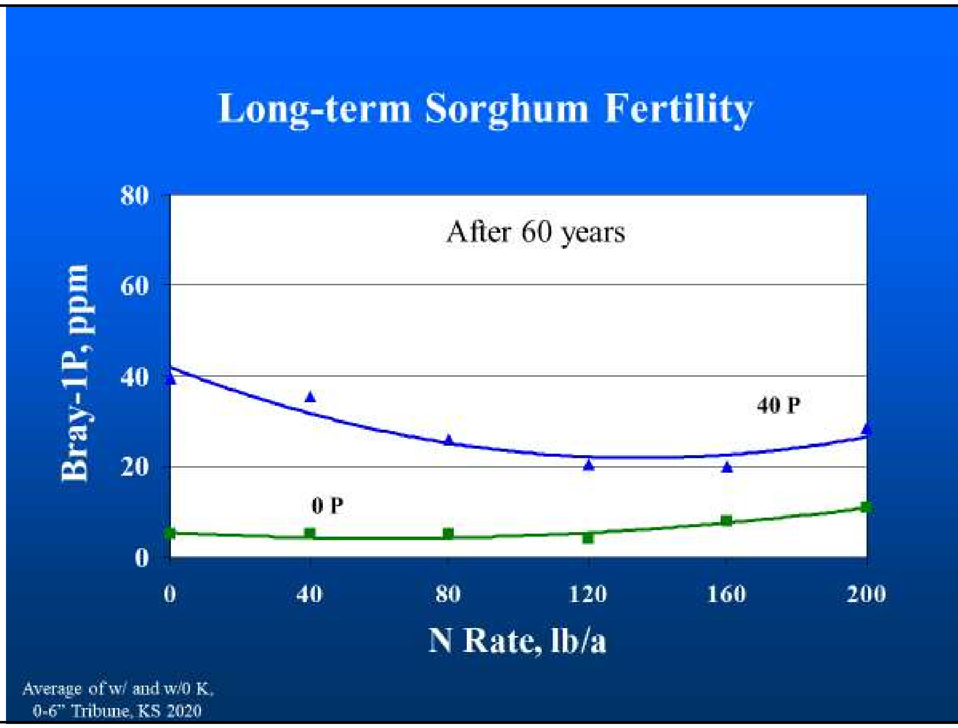

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Discussion on New Recommendations

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Questions/ Discussion

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