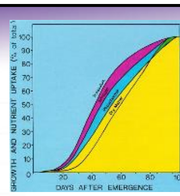

Economics of Soil Fertility Management

Lucas Haag Ph.D., Asst. Professor/Northwest Area Agronomist
K-State Northwest Research-Extension Center, Colby

With Cooperation Of:
Terry Kastens, Ph.D., Emeritus Professor, Agricultural Economics, K-State
Kevin Dhuyvetter, Ph.D., Technical Consultant, Elanco

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Knowledge for Life

Where are we now?

- Drivers of Profitability
- Historical and Current Price Ratios
- Understanding Crop Response to Fertilizer
- Economics of Soil Testing and Data Quality
- Implications for site-specific management
- Products and Placement

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What Drives Farm Profitability?

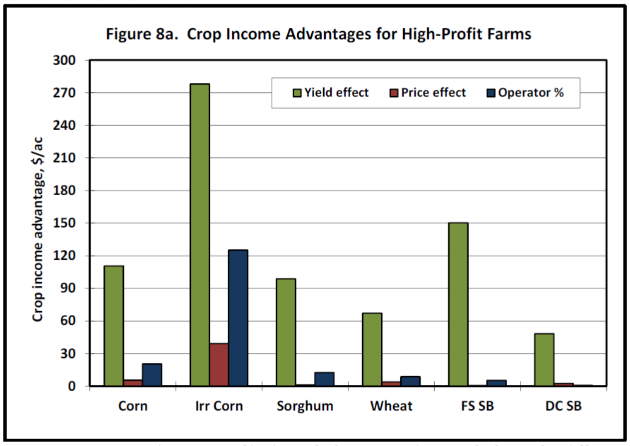

Figure 8a. Income advantages of high-profit farms over low-profit farms for different crops analyzed (sum of three bars equals the total income advantage).

Dhuyvetter and Ward, 2014.

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Non-Irrigated Corn

Non-Irrigated Corn

KFMA Years	Fertilizer Expense by Profit Category: High 1/3	Mid 1/3	Low 1/3	Difference between High and Low 1/3: Fertilizer Cost		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
2002-2006	$ 32.34	$ 34.35	$ 48.11	$ (15.77)	-33%	$ 91.13	17%	7%
2007-2009	$ 60.06	$ 57.47	$ 67.48	$ (7.42)	-11%	$ 140.72	5%	17%
2011-2013	$ 85.95	$ 91.43	$ 88.64	$ (2.69)	-3%	$ 149.62	2%	54%

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Irrigated Corn

Irrigated Corn

KFMA Years	Fertilizer Expense by Profit Category High 1/3	Mid 1/3	Low 1/3	Difference between High and Low 1/3 Fertilizer Cost		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
2002-2006	$ 41.45	$ 39.13	$ 58.03	$ (16.58)	-29%	$ 138.74	12%	9%
2007-2009	$ 82.37	$ 87.89	$ 108.51	$ (26.14)	-24%	$ 256.98	10%	9%
2011-2013	$ 138.51	$ 124.26	$ 125.62	$ 12.89	10%	$ 334.73	4%	59%

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Non-Irrigated Grain Sorghum

Non-Irrigated Sorghum

KFMA Years	Fertilizer Expense by Profit Category High 1/3	Mid 1/3	Low 1/3	Difference between High and Low 1/3 Fertilizer Cost		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
2002-2006	$ 25.60	$ 25.48	$ 31.44	$ (5.84)	-19%	$ 81.38	7%	24%
2007-2009	$ 40.94	$ 49.38	$ 44.76	$ (3.82)	-9%	$ 126.60	3%	29%
2011-2013	$ 73.79	$ 58.86	$ 64.82	$ 8.97	14%	$ 134.30	7%	37%

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Wheat

Wheat

KFMA Years	Fertilizer Expense by Profit Category: High 1/3	Mid 1/3	Low 1/3	Difference between High and Low 1/3 Fertilizer Cost		Difference in Net Returns	Fertilizer % of NR Difference	Difference in Yields %
2002-2006	$ 22.09	$ 19.38	$ 25.02	$ (2.93)	-12%	$ 65.39	4%	11%
2007-2009	$ 36.35	$ 46.88	$ 51.67	$ (15.32)	-30%	$ 125.28	12%	21%
2011-2013	$ 54.97	$ 63.73	$ 51.45	$ 3.52	7%	$ 116.24	3%	32%

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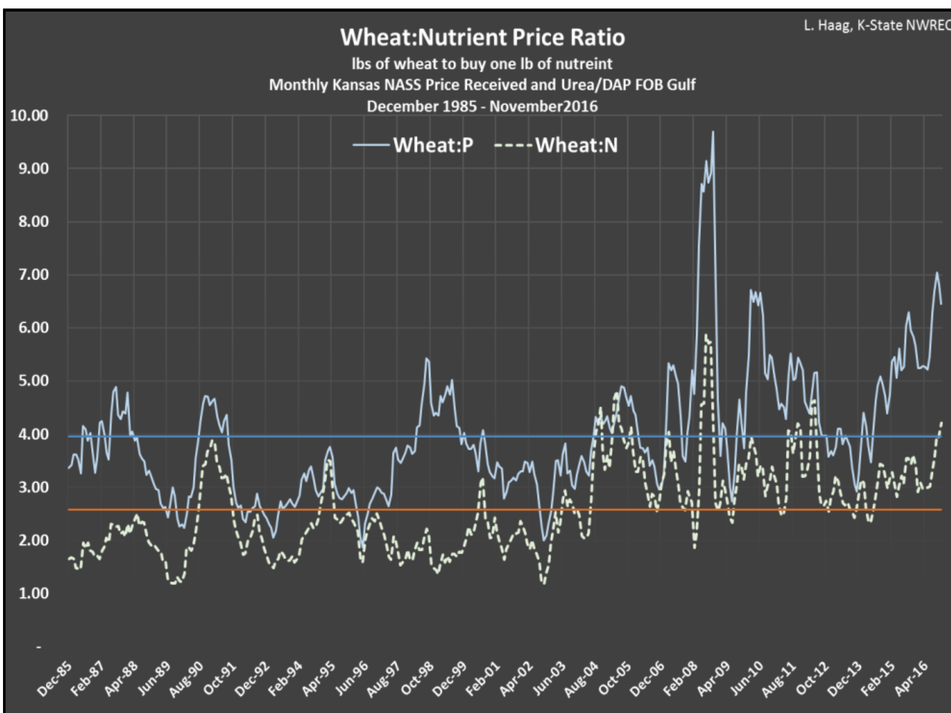

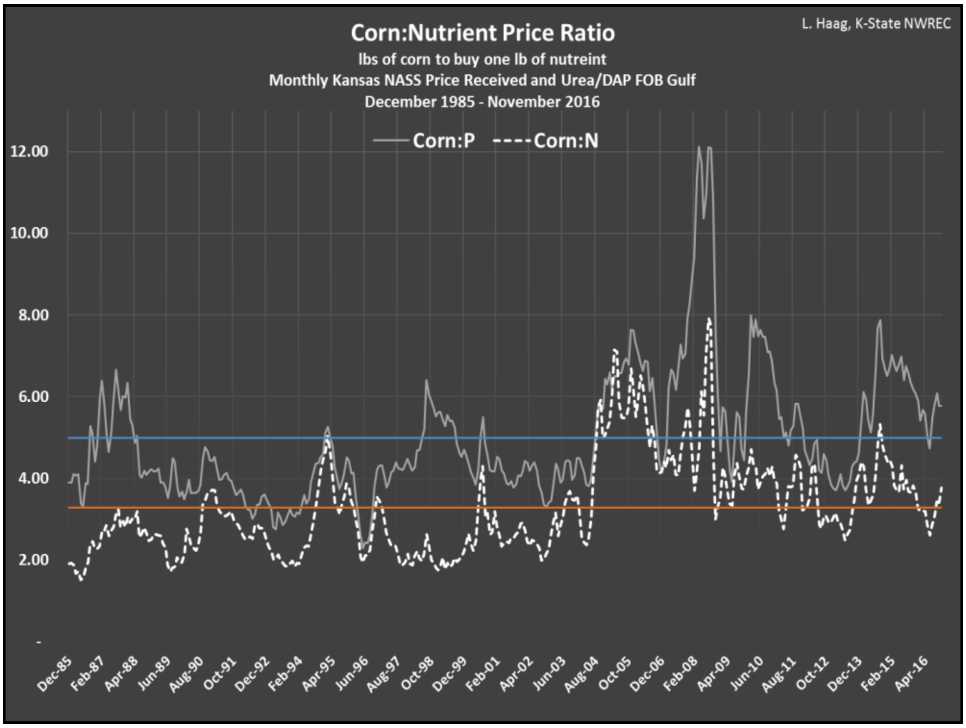

Grain:Nutrient Price Ratios

	Historical	Nov. 2016
Corn:Nitrogen	3.28	3.77
Wheat:Nitrogen	2.58	4.22
Corn:Phosphorus	4.99	5.77
Wheat:Phosphorus	3.96	6.46

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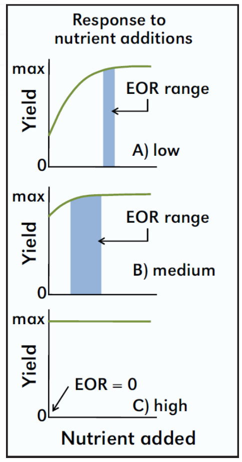
Understanding Crop Response to Fertilizer



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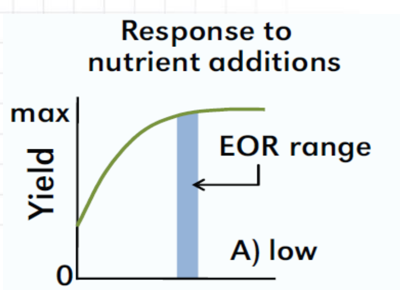
Understanding Crop Response to Fertilizer Low Soil Test Levels



- Low yields without additional fertilizer
- EOR range is narrow
- Optimum rate is minimally affected by grain:nutrient price ratio

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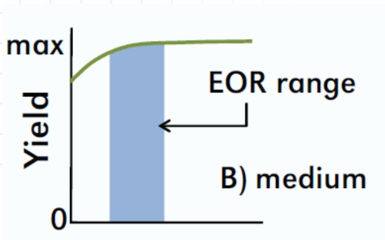
Understanding Crop Response to Fertilizer
Medium Soil Test Levels



- Expected yield without fertilizer is higher
- Range of potentially optimal rates is wider
- In a single-year decision framework, EOR is very sensitive to grain:nutrient price ratio
- As price ratio↓ EOR ↑

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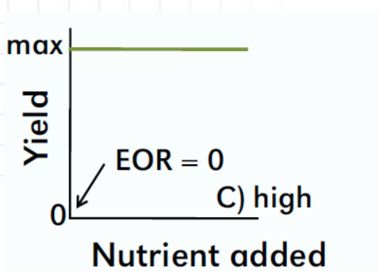
Understanding Crop Response to Fertilizer
High Soil Test Levels



- No or minimal response to added fertilizer

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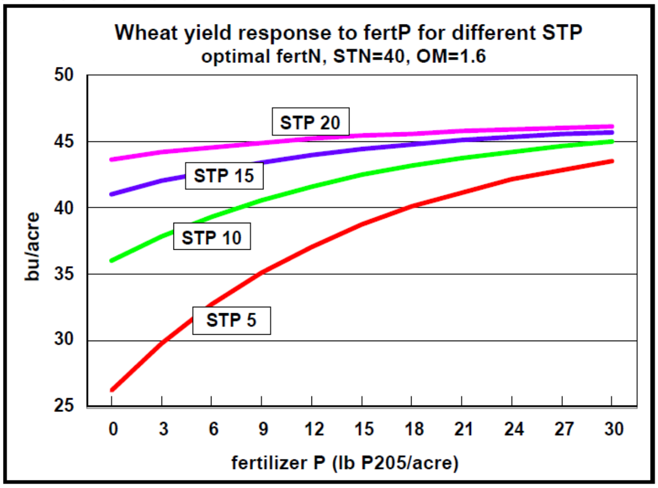
Wheat Response to Soil Test P Level



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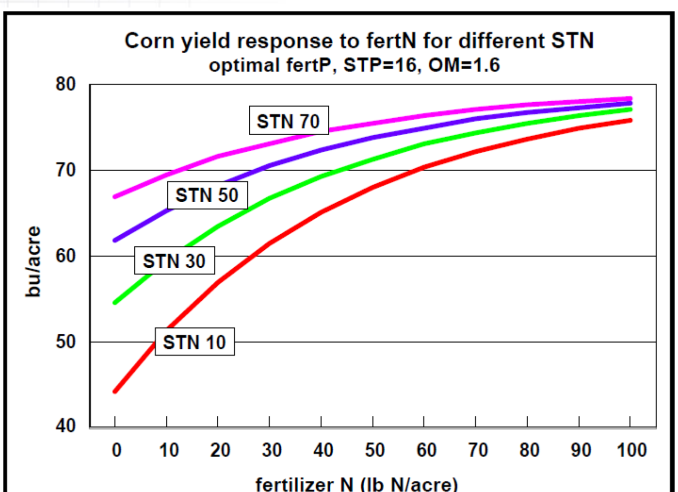
Corn Response to Soil Test N Level



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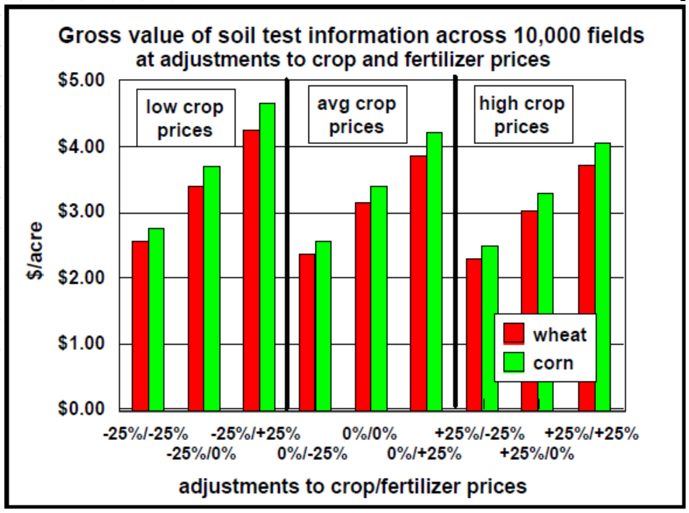
Economic Value to Soil Testing



A 25% increase in fertilizer cost results in a 35% increase in returns to soil sampling

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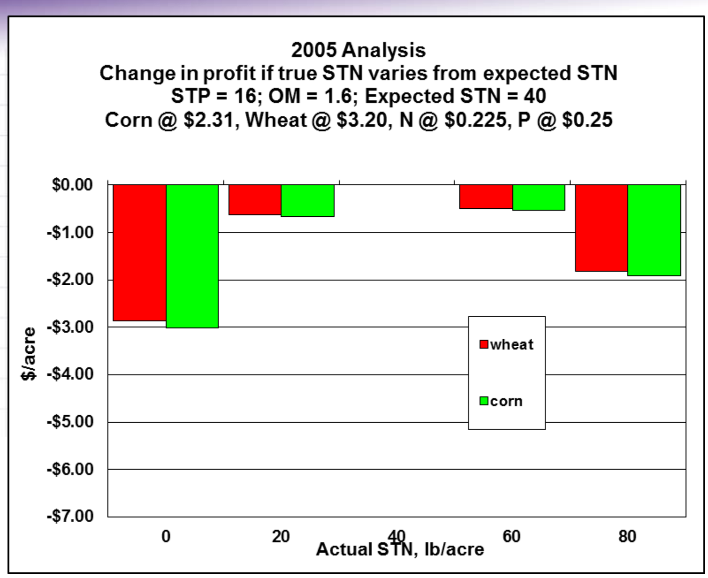

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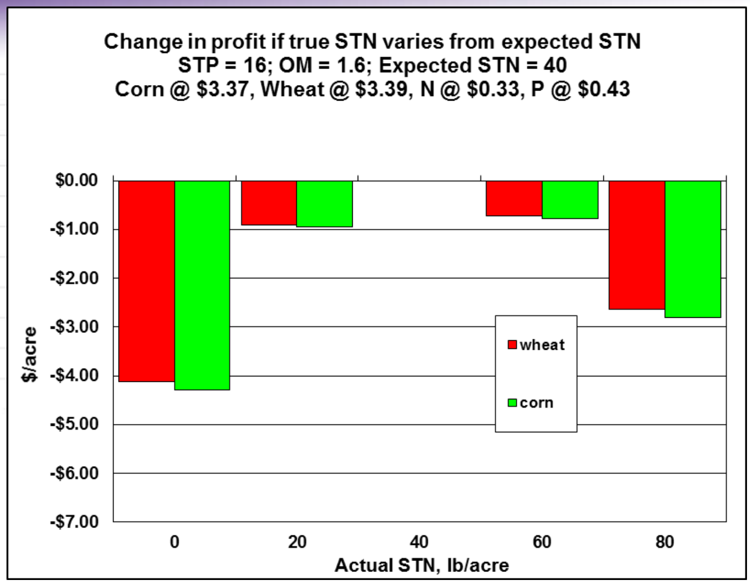

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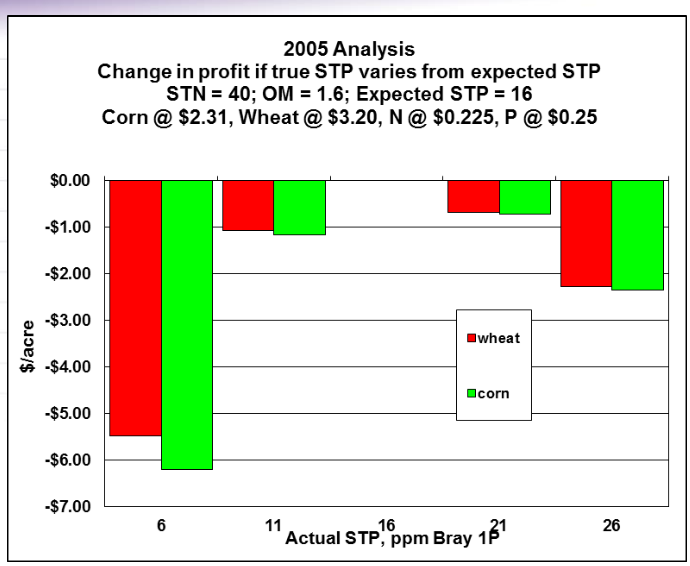

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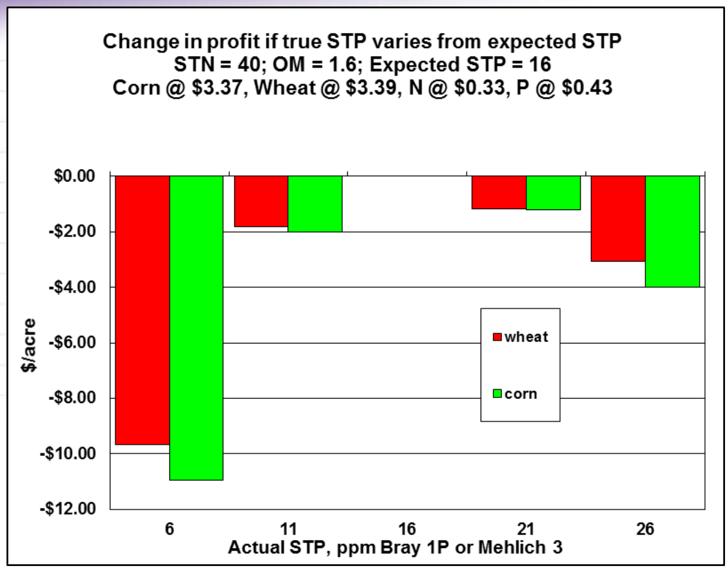

Data Quality

- The proceeding economics are based on having good data, as good of a representation of "truth" as we can reasonably obtain.
- Good decisions require good data
- Good soil test data comes from good procedures in the field

Number of Cores to Make a Good Sample

- Soils vary across very short distances in nutrient supply due to many factors including:
  - Position on the landscape
  - Past erosion
  - Parent material of the soil
- We also induce variability on the soil
  - Band applications
  - Livestock grazing
- To account for this variation you should take 10-20 cores per sample

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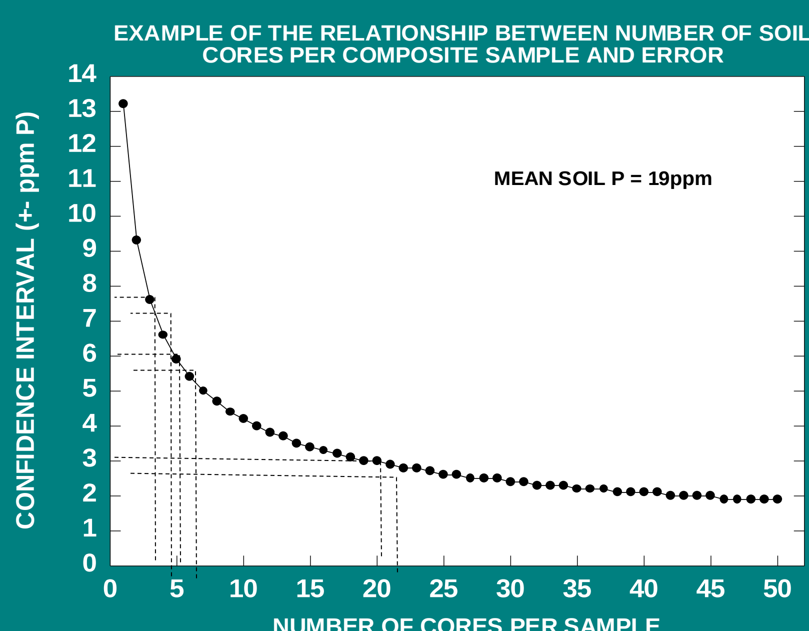

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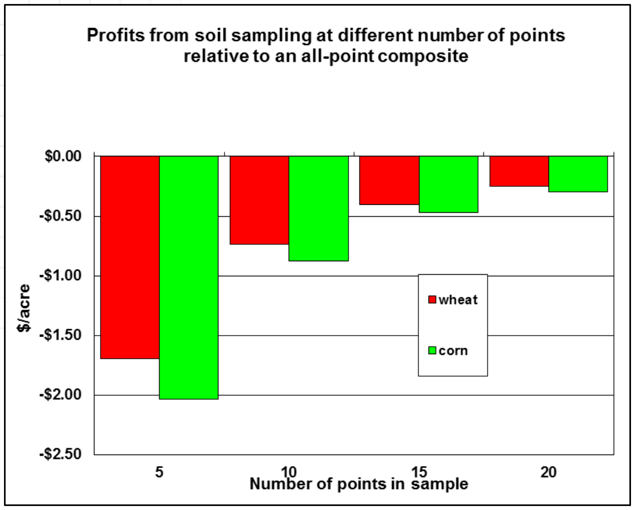
Economics of Accuracy



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The Role of Soil Testing

- Generating profits from soil testing is dependent on the tradeoff between the cost of gathering the information (labor and lab fees), and the benefits from having that information (more appropriate fertilizer rates)

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VRT Phosphorus Example

- No other data is available (i.e. yield data)
- Field is located in NW Kansas and was grid sampled on 2.5 ac grids
- Samples consisted of 15 cores, so an estimated CI of +/- 3.5 ppm

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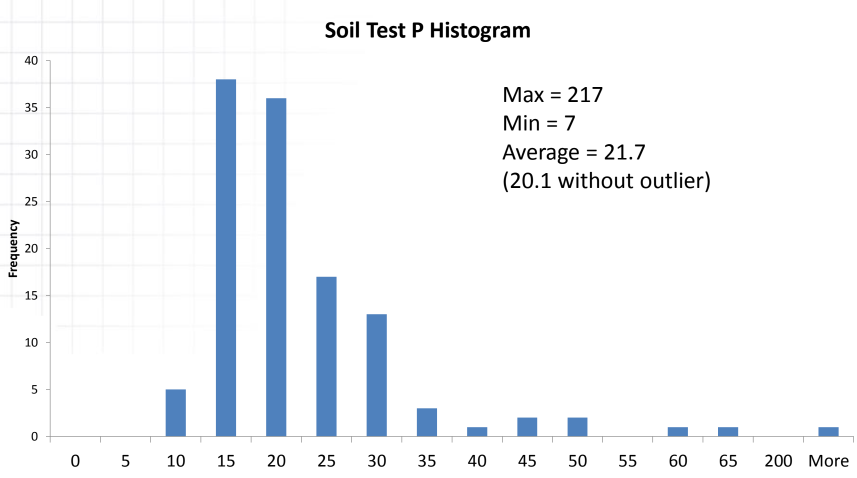
Soil Test Bray P1



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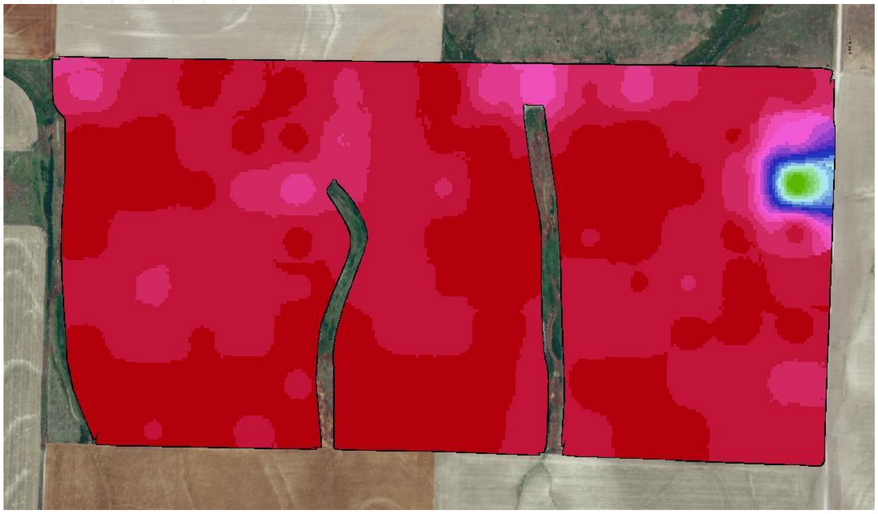
Interpolated Soil Test Phosphorus



NOT A GOOD EXAMPLE OF INTERPOLATION!

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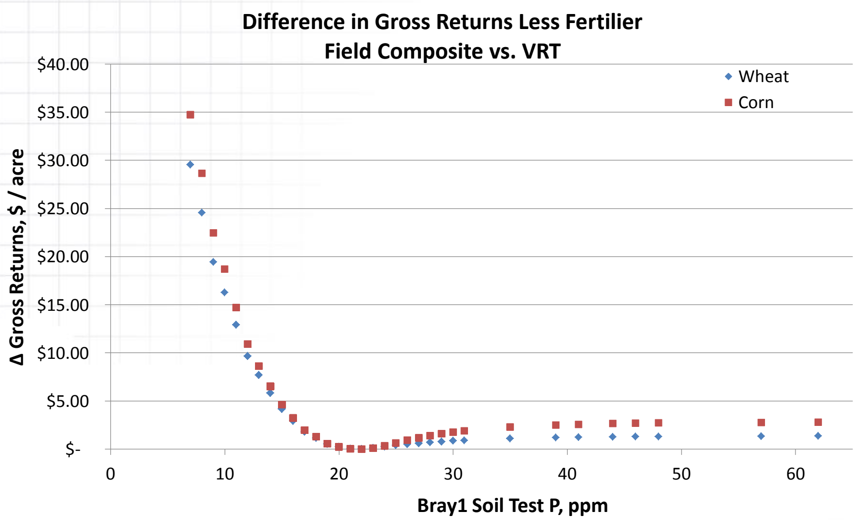
Returns to VRT



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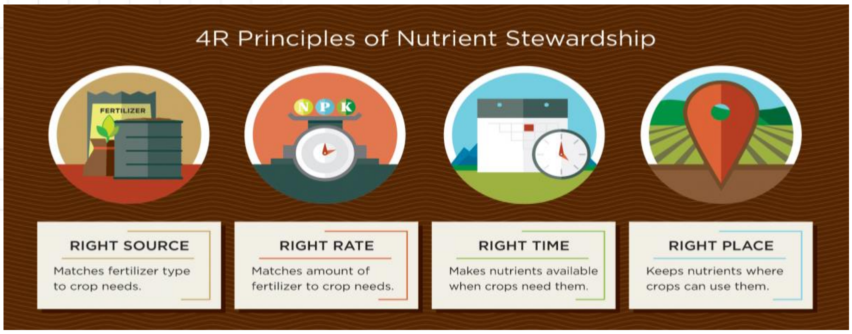
Returns to VRT

- Average gross return on VRT P for wheat = ***$3.81/acre/year***
- Average gross return on VRT P for corn = ***$4.49/acre/year***
- The above gross figures would need to cover sampling cost and the portion of machinery and labor cost related to VRT implementation

Can we stretch the value of intensive sampling?

- ROI on intensive sampling increases dramatically as the number crops benefiting from the information increases (spreading fixed cost)
- Checkbook approach for nutrients using initial intensive soil test and removal rates from yield monitor data

Management Decisions



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Source

- Cost per lb. of nutrient
  - Always do the math!
- Equipment Considerations
  - VRT Equipment
- Source vs. Timing of Application

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Timing

- Some limitations in dryland, but still important
  - Moisture to move N into profile
  - Avoiding "tie-up", minimizing volatilization potential
- Great opportunities with fertigation

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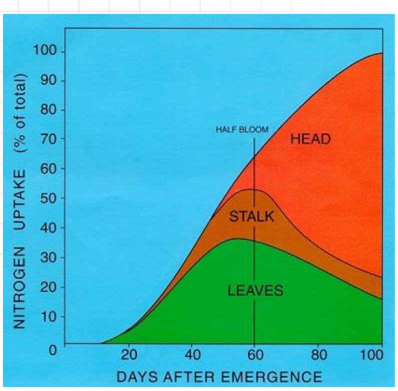
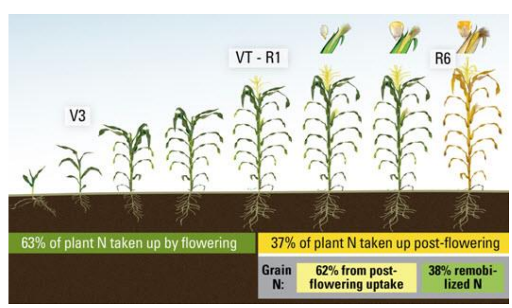
Nitrogen Uptake and Key Timings





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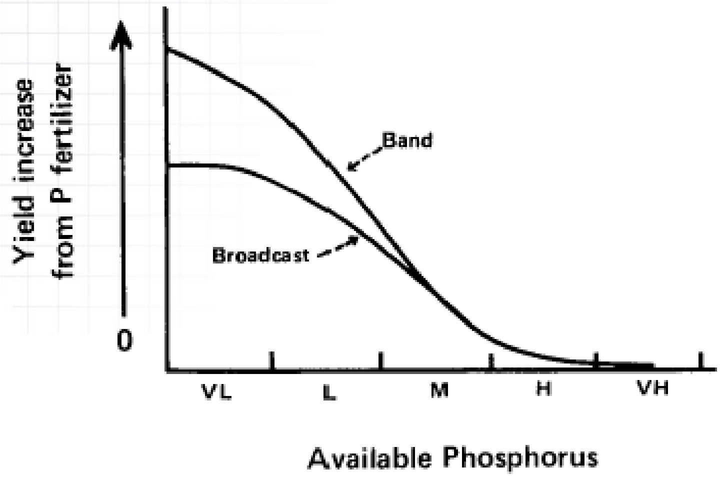
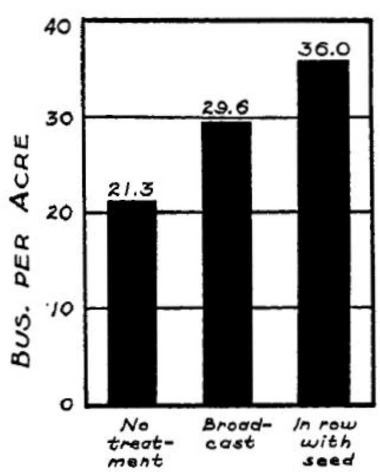
Soil test P and application method



Common generalized depiction of broadcast vs. band

Interest in fertilizer efficiency through placement



KS, 1932

FIG. 18.—Graphs showing effect on yield of wheat of applying superphosphate broadcast and in the row with the seed.

Phosphorus removal values

Crop	Unit	P_2O_5 (lb)
Corn	bushel	0.33
Grain Sorghum	bushel	0.40
Wheat	bushel	0.50
Sunflowers	pound	0.02
Oats	bushel	0.25
Soybeans	bushel	0.80

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Crop Removal – the next step

- Calculate crop removal
- Depending on over/under applications after crop removal, soil test levels will change.
- 18 lbs P_2O_5 is required to change STP one ppm.

- One cycle of a W-C-F rotation (using field averages)
  - Wheat yield = 60 bu/a, Corn yield = 110 bu/ac
  - STP = 22 ppm, P_2O_5 applied during seeding = 30 lb/a
  - Wheat Removal = 60 * 0.50 = 30 lbs P_2O_5 removed
  - Corn Removal = 110 * 0.33 = 36 lbs P_2O_5 removed
  - Total Crop Removal = 30+44 = 66 lbs P_2O_5 removed
  - STP change = 66-30=36 lb net removal, 36/18 = 2 ppm estimated drop
  - Final STP = 22 – 2.4 = 19.6 ppm

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Crop Removal – the next step

- Perform crop removal and STP calculations at a site-specific scale for the field
- Potential Decision Rules
  - Land ownership/tenancy makes a difference
  - Decisions based on STP
    - IF STP > 30 then apply 0 or very minimal amount (intentional mining)
    - IF STP is >20 and <30 then apply removal rates
    - IF STP is <20 then apply removal + build (build rate?)
- VRT apply P to meet management goals

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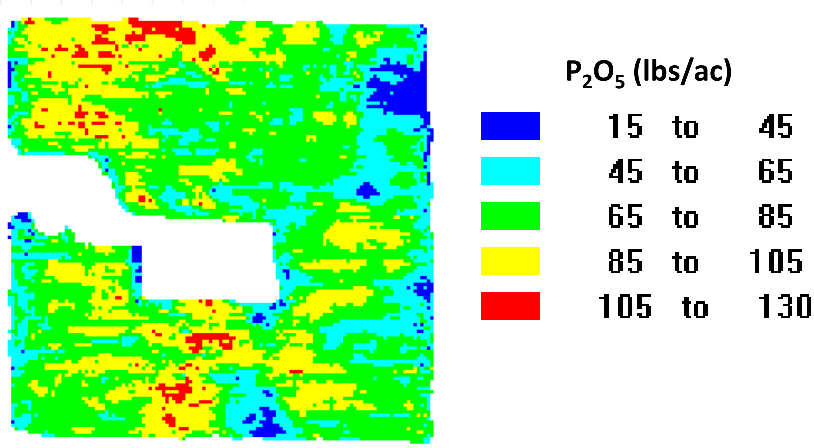
Using yield monitor data to look back… 4 Years of P Removal



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Questions?

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Twitter: @LucasAHaag