

Fertilizer Economics with High Prices

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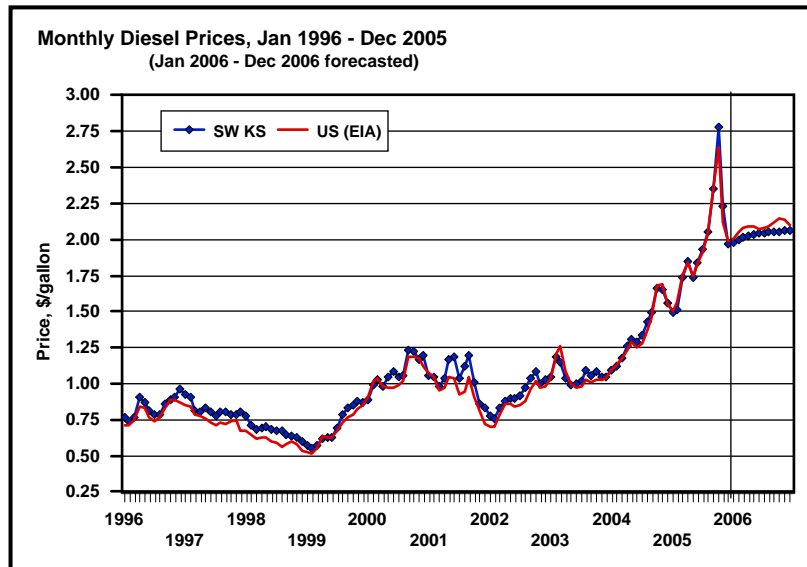
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McPherson, KS, Jan. 25-26, 2006



Forecasts for 2006 diesel prices are down from recent levels, but they are still at very high levels...



Futures-based forecast based on 1/13/06 closing futures prices

Historical and forecasted diesel prices during principal farming months...

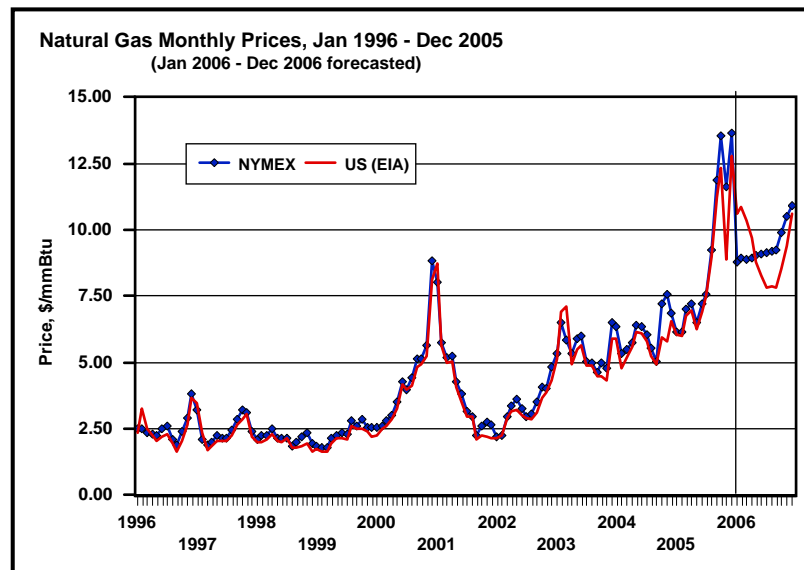
Diesel Prices

Year	Mar-Oct Diesel Price			Year-to-year percent change		
	SW KS	US (EIA)	Average	SW KS	US (EIA)	Average
2000	\$1.09	\$1.04	\$1.07	----	----	----
2001	\$1.09	\$0.98	\$1.04	0.6%	-6.1%	-2.7%
2002	\$0.94	\$0.88	\$0.91	-14.1%	-10.0%	-12.1%
2003	\$1.05	\$1.05	\$1.05	12.1%	18.6%	15.3%
2004	\$1.37	\$1.34	\$1.36	30.0%	28.4%	29.2%
2005	\$2.04	\$2.02	\$2.03	48.5%	49.9%	49.2%
2006 (F)	\$2.04	\$2.10	\$2.07	0.3%	4.1%	2.2%
05 - Avg(00-04)	\$0.93	\$0.96	\$0.94	83.5%	90.2%	86.8%
06 - Avg(00-04)	\$0.93	\$1.04	\$0.98	84.0%	97.9%	90.8%

F = forecast

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Natural gas prices are at historically high levels...



Futures-based forecast based on 1/13/06 closing futures prices

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Historical and forecasted natural gas prices during principal farming months...

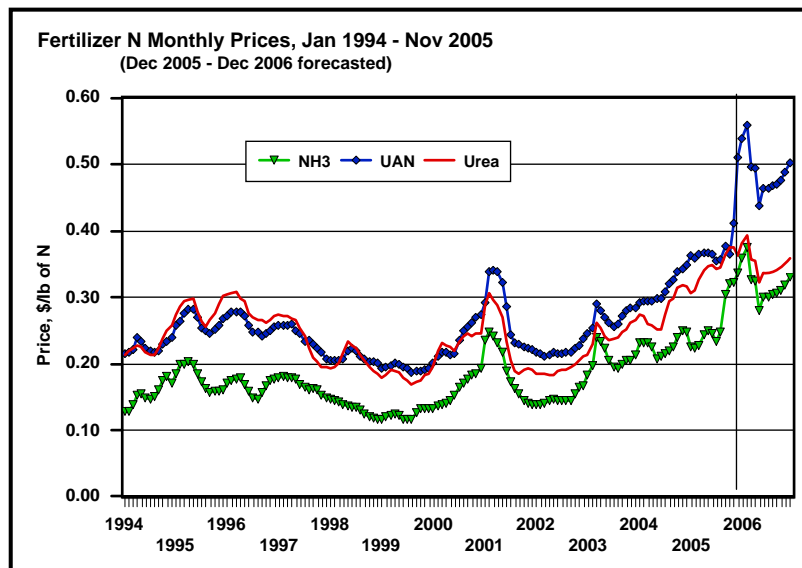
Natural Gas Prices

Year	Mar-Oct Natural Gas Price			Year-to-year percent change		
	NYMEX	US (EIA)	Average	NYMEX	US (EIA)	Average
2000	\$4.04	\$3.85	\$3.95	-----	-----	-----
2001	\$3.69	\$3.49	\$3.59	-8.6%	-9.3%	-9.0%
2002	\$3.35	\$3.12	\$3.23	-9.2%	-10.7%	-10.0%
2003	\$5.35	\$5.24	\$5.30	59.5%	68.2%	63.7%
2004	\$5.99	\$5.63	\$5.81	11.9%	7.5%	9.7%
2005	\$8.77	\$8.37	\$8.57	46.5%	48.6%	47.5%
2006 (F)	\$9.19	\$8.65	\$8.92	4.8%	3.3%	4.1%
05 - Avg(00-04)	\$4.28	\$4.11	\$4.20	95.5%	96.3%	95.9%
06 - Avg(00-04)	\$4.70	\$4.39	\$4.55	104.9%	102.9%	103.9%

F = forecast

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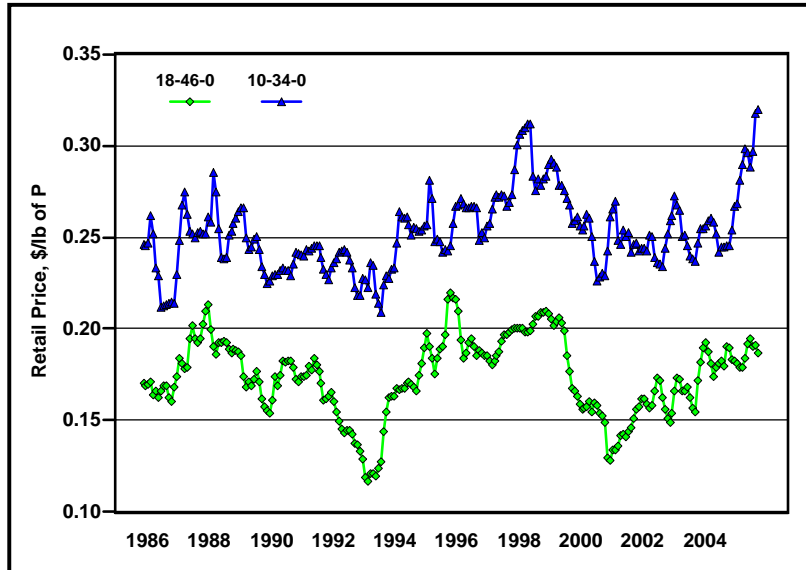
Nitrogen fertilizer prices are at historically high levels...



Forecasts made in December 2005

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Historical monthly phosphorus fertilizer prices...



N is valued at simple average of NH₃, urea, and UAN prices

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Soil Test Interpretations and Fertilizer Recommendations

Department of Agronomy

MF-2586

Nutrient Management

KSU nitrogen recommendations...

Corn and grain sorghum

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

Wheat

$$\text{N rec} = (\text{Yield Goal} \times 2.4) - (\% \text{SOM} \times 10) - \text{Profile N} - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments} + \text{Tillage Adjustments} + \text{Grazing Adjustments}$$

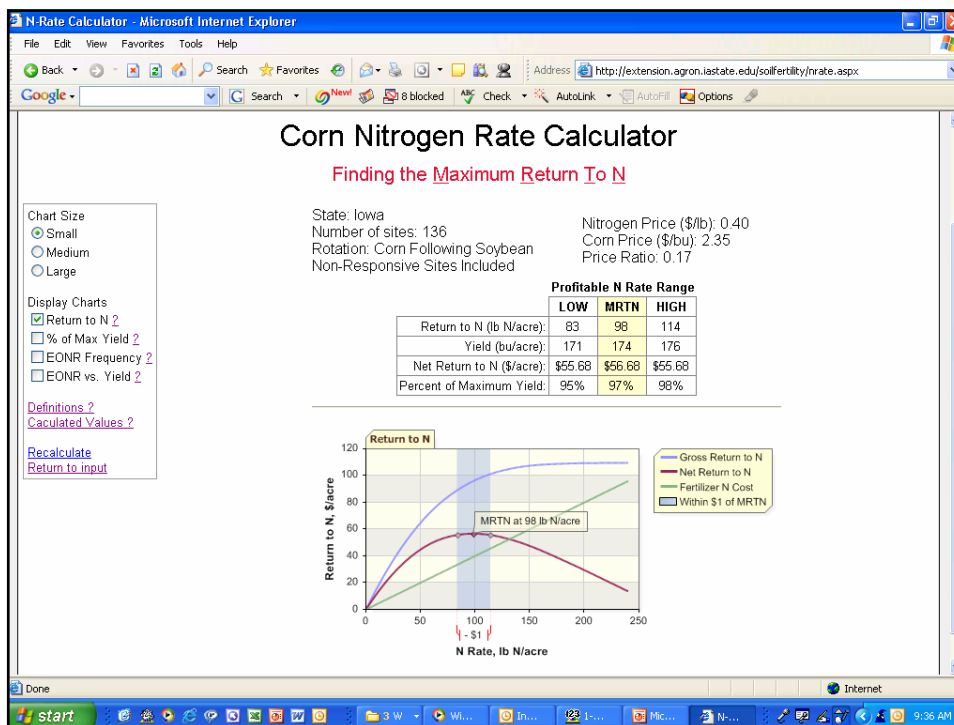
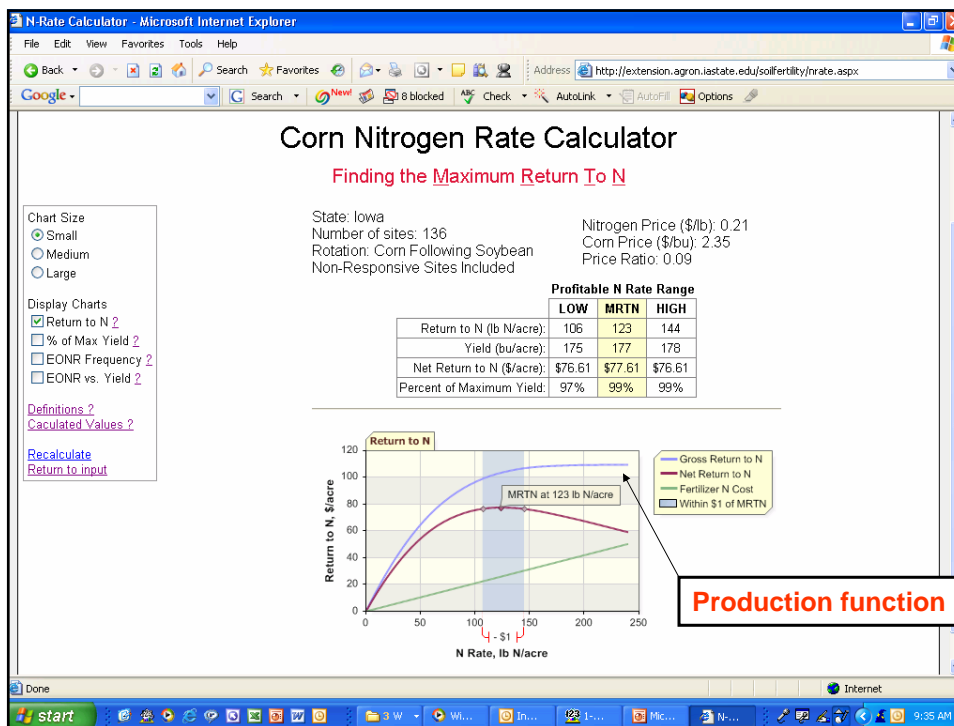
Sunflowers

$$\text{N rec} = (\text{Yield Goal} \times 0.075) - (\% \text{SOM} \times 20) - \text{Profile N} - \text{Manure N} - \text{Other N Adjustments} + \text{Previous Crop Adjustments}$$

KSU nitrogen recommendations vs. N price

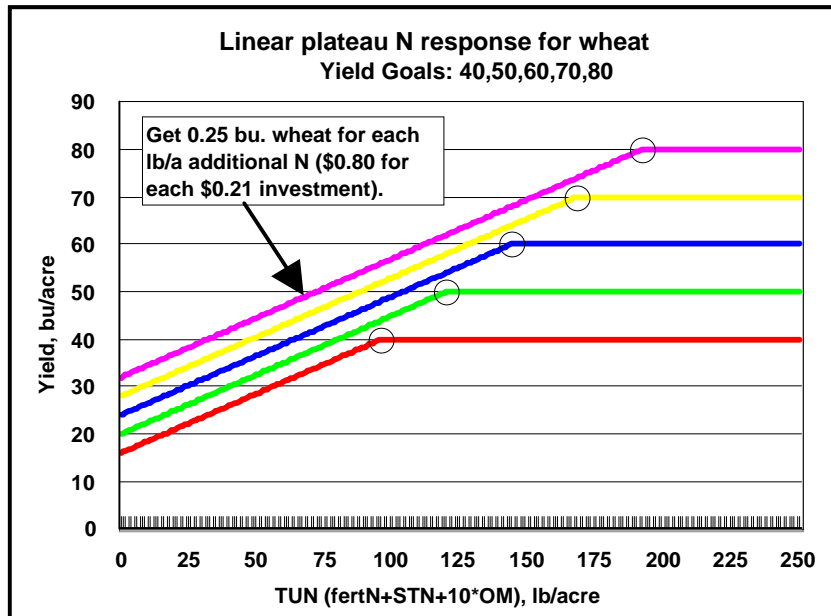
- Recommendations do not explicitly include prices
- Mathematical relationship between expected yield and nitrogen (i.e., production function) is needed in order to adjust recommendations for prices
- Similar issues pertain to P & K recommendations (i.e., no way to adjust them for prices)
- We assume KSU had in mind these prices:
 - Wheat \$3.20/bu
 - Corn \$2.35/bu
 - fertN \$0.21/lb N

The screenshot shows a Microsoft Internet Explorer browser window displaying the Iowa State University Agronomy Extension website. The page title is "Corn Nitrogen Rate Calculator" and the URL is "http://extension.agron.iastate.edu/soilfertility/nrate.aspx". The page content includes a navigation menu, a header for Iowa State University, and a main section titled "Corn Nitrogen Rate Calculator" with the subtitle "Finding the Maximum Return To N". Below this, there is a paragraph explaining the calculator's purpose. The calculator interface is divided into two tabs: "Single Price Ratio" and "Multiple Price Ratios". Under "Single Price Ratio", there is a "Choose state" dropdown menu with "Iowa" selected, a "Choose rotation pattern(s)" section with radio buttons for "Corn following soybean" and "Corn following corn", and a checkbox for "Include non-responsive sites". Under "Multiple Price Ratios", there is a "Set corn and nitrogen prices" section with a "Nitrogen price (\$/lb)" input field containing the value "0.22". A red-bordered box on the right side of the calculator interface contains the text "Data to enter:" followed by a list: "- state", "- rotation", "- nitrogen price", and "- corn price". The browser's status bar at the bottom shows the time as 9:31 AM.



Nitrogen production function...

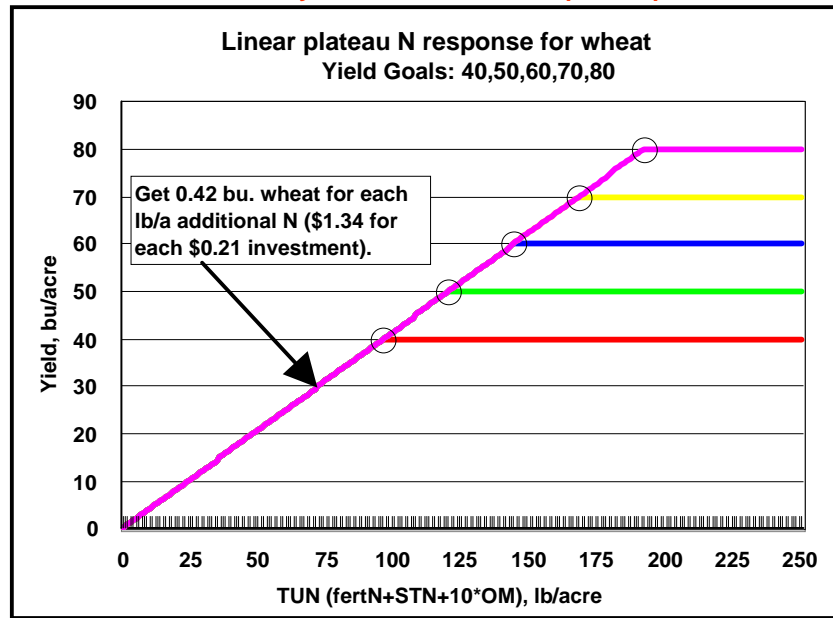
- In a limiting factor framework, it is generally believed that relationship between N and yield is linear for any given year and location (implies linear plateau production function)
- Linear plateau production function implies that optimal N will either be 0 or level where yield plateaus



Price won't matter until fertN = \$0.80/lb, then optimal is 0 lb/acre

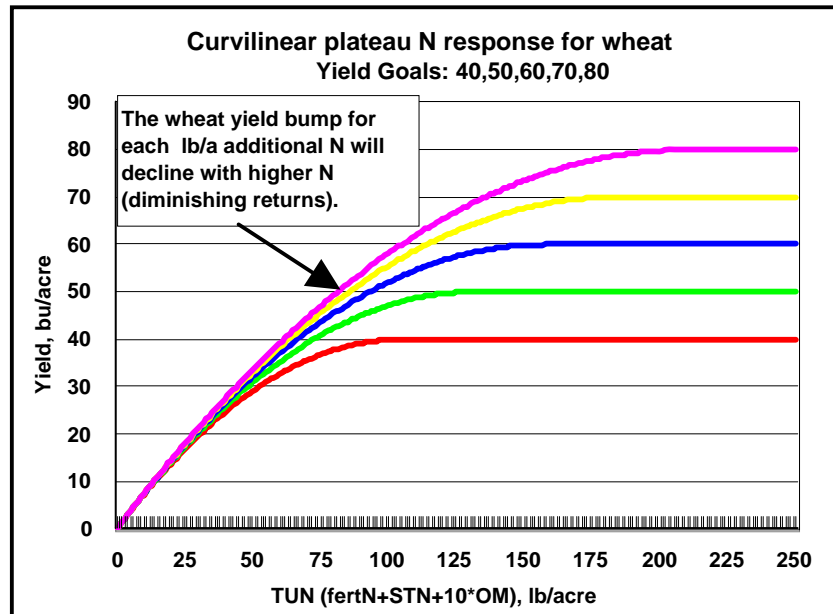
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Functions could and likely should have 0-intercept if response is to total N



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Functions might be curvilinear

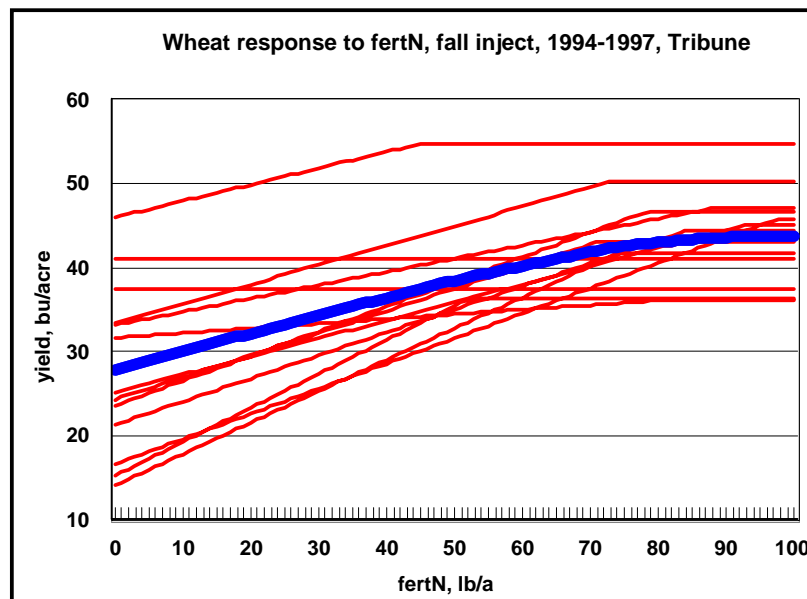


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Fertilizer N research in late 2005
Kastens, Dhuyvetter, Schlegel, and Dumler

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Average of linear plateaus can become non-linear...

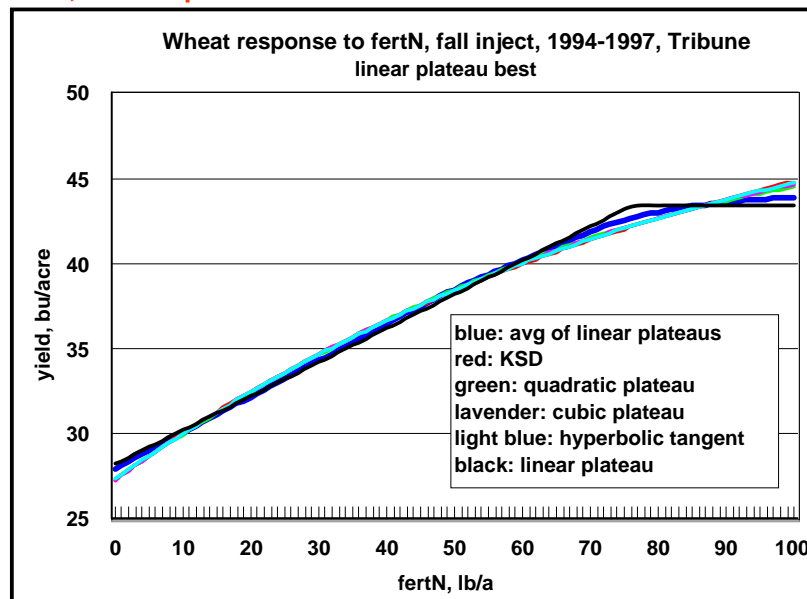


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Functional form...

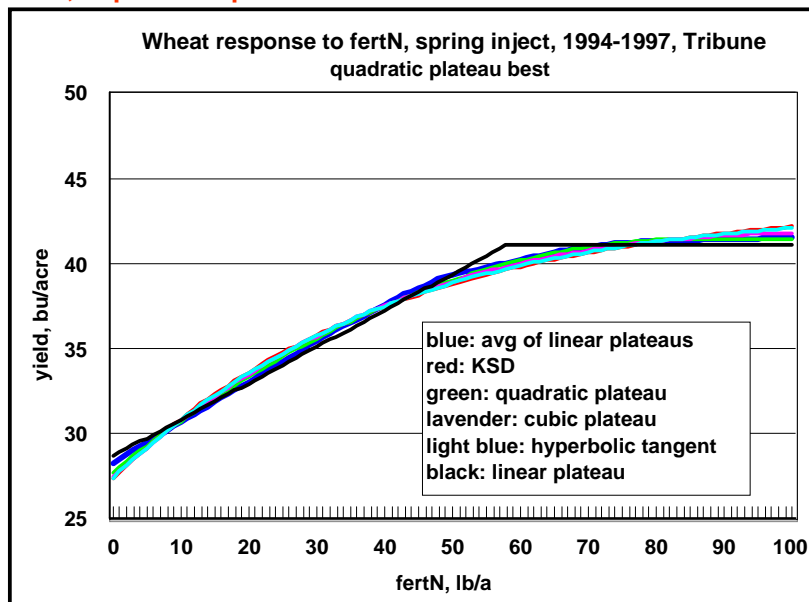
- Numerous functional forms could be used that would meet objectives. We considered:
 - Linear plateau, along with four different curvilinear forms
- Based on nitrogen fertilizer research studies from north central and western Kansas on wheat, corn, and milo, quadratic plateau model fit data better than alternatives most often

Here, a linear plateau fit blue line the best



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Here, a quadratic plateau fit blue line the best

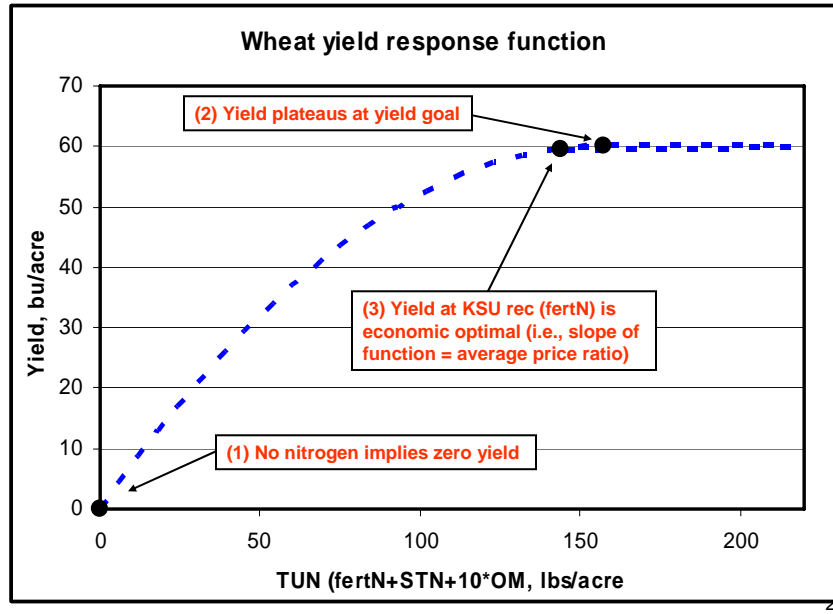


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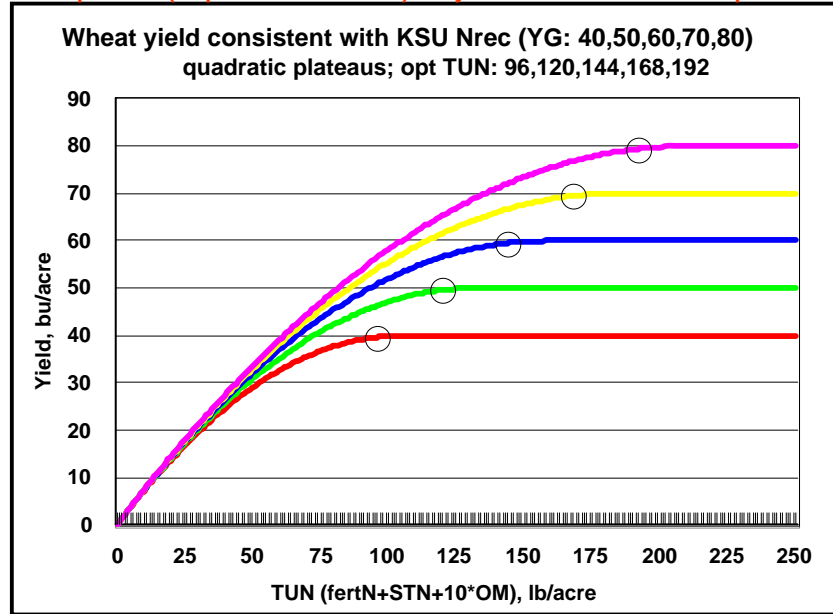
Nitrogen production function...

- Nice property of non-linear production function is that it implies diminishing marginal returns and thus prices matter
- Assumed functional form is quadratic plateau which allows diminishing returns – consistent with linear plateau in any given year
- Estimate model parameters such that
 - KSU Nrec is economic optimum at historical average prices
 - Yield plateau is equal to yield goal
 - Intercept goes through origin (i.e., 0 N equates to 0 yield)

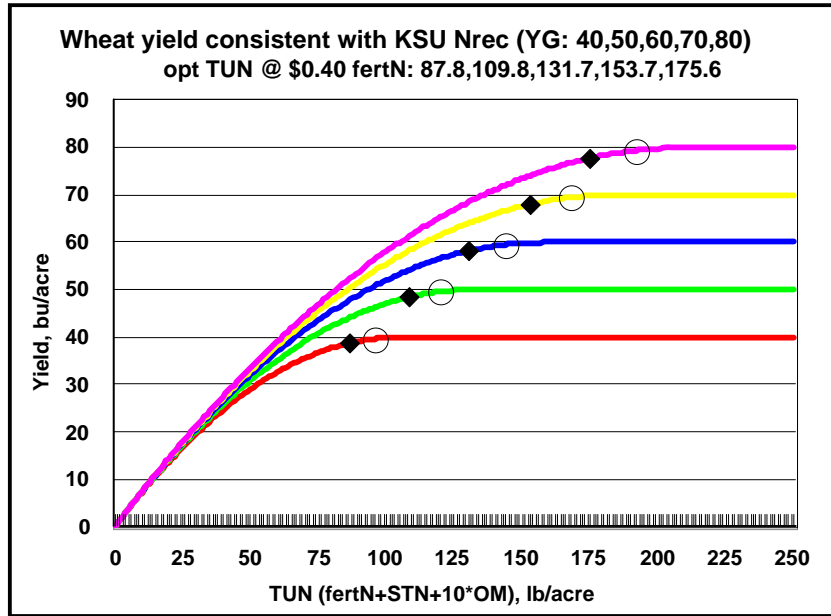
Defined points that allowed quadratic-plateau function to be defined...



Same optimal N (slope there = 0.21/3.20) but yields about 1% lower than plateau



Slope at diamonds is 0.40/3.20



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Adjustments to KSU Nrecs at various N prices

Nitrogen Recommendations for Wheat

Yield goal, bu/ac	40	50	60	70	80
KSU N rec, lbs/ac	46	70	94	118	142
N price	Price adjusted N rec, lbs/ac				
\$0.25	44	68	91	115	139
\$0.30	42	65	88	111	134
\$0.35	40	62	85	107	130
\$0.40	38	60	82	104	126
\$0.45	36	57	78	100	121

N price	Price adjusted N rec reduction				
\$0.25	3.7%	3.1%	2.8%	2.6%	2.4%
\$0.30	8.4%	6.9%	6.2%	5.8%	5.5%
\$0.35	13.1%	10.8%	9.6%	9.0%	8.5%
\$0.40	17.8%	14.6%	13.1%	12.1%	11.5%
\$0.45	22.5%	18.5%	16.5%	15.3%	14.6%

SOM=2.0; STN=30; Wheat price=\$3.20

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Adjustments to KSU Nrecs at various N prices

Nitrogen Recommendations for Corn

Yield goal, bu/ac	60	90	120	150	180
KSU N rec, lbs/ac	26	74	122	170	218
N price	Price adjusted N rec, lbs/ac				
\$0.25	24	72	119	166	213
\$0.30	23	69	115	161	208
\$0.35	21	66	111	157	202
\$0.40	19	63	107	152	196
\$0.45	17	60	104	147	190

N price	Price adjusted N rec reduction				
\$0.25	5.9%	3.1%	2.5%	2.3%	2.1%
\$0.30	13.3%	7.0%	5.7%	5.1%	4.8%
\$0.35	20.7%	10.9%	8.8%	7.9%	7.4%
\$0.40	28.1%	14.8%	12.0%	10.7%	10.0%
\$0.45	35.4%	18.7%	15.1%	13.6%	12.7%

SOM=2.0; STN=30; Corn price=\$2.35

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AgManager: Providing Agricultural Economic Information on Crops, Livestock, Marketing and Outlo - Microsoft Internet Explorer

Address: <http://www.agmanager.info/>

AG MANAGER.INFO
Kansas State University & Extension

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A Website Providing Information and Tools For The Competitive Business

www.agmanager.info

Site Updates

- [Monthly NH3 and Diesel Price Forecasts](#)
January 14, 2006 by Kevin Dhuyvetter
- [Updated Crop Basis Tool](#)
January 11, 2006 by Kevin Dhuyvetter
- [Updated Cattle Databases](#)
December 23, 2005 by Jim Mintert
- [Livestock and Hay Charts](#)
December 23, 2005 by Jim Mintert
- [Crop Basis Maps](#)
December 21, 2005, by Kevin Dhuyvetter
- [In The Cattle Markets](#)
December 20, 2005 by Jim Mintert/LMIC
- [Grain Outlook](#)
December 15, 2005 by Mike Woolverton
- [KSU-Crop Budgets 2006.xls](#)
December 13, 2005 by Dhuyvetter et al.
- [Modifying Fertilizer Recs to Reflect Price](#)
December 7, 2005 by Kvaerner et al.
- [Impact of Energy Prices on KS Farm Costs](#)
December 2, 2005 by Dhuyvetter et al.

Ag Profitability Conferences

Contact Us: Department of Agricultural Economics 342, Waters Hall, Manhattan, KS 66506 (785) 532-5823

Excel spreadsheet for calculating optimal N and irrigation levels

Department of Agricultural Economics | KS State Research & Extension | College of Agriculture | Kansas State University

Dryland optimal fertilizer N values @ \$0.21/lb N

Comparison of Crop Returns with Nitrogen Fertilizer and Irrigation Water at Economic Optimum Levels					
Crop/System	Wheat	Corn	Sorghum	Soybean	Sunflower
Rotation (1 or 2, if none enter 0)	1	1	1	1	1
Percent of rotation (total - 100%)	52%	5%	25%	10%	3%
Yield Goal (YG), bu/ac	55.0	85.0	85.0	34.0	1600.0
Enter 0 for Dryland or 1 for Irrigated	0	0	0	0	0
Annual rainfall	30.0	30.0	30.0	30.0	30.0
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0
Nitrogen fertilizer cost, \$/lb	\$0.21	\$0.21	\$0.21	\$0.21	\$0.21
Irrigation energy cost, \$/inch	\$3.10	\$3.10	\$3.10	\$3.10	\$3.10
KSU recommended nitrogen, lbs/ac	92.0	76.0	76.0	0.0	60.0
Econ Optimum fertN, lbs/ac	92.2	75.1	76.3	0.0	59.9
Econ Optimum Irrigation Amount, in	0.0	0.0	0.0	0.0	0.0
Yield at optimal N and I, bu/ac	54.6	84.4	84.4	30.6	1591.8

Optimal rates are very close to KSU recommendations because prices are similar to long-term averages

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Dryland optimal fertilizer N values @ \$0.40/lb N

Comparison of Crop Returns with Nitrogen Fertilizer and Irrigation Water at Economic Optimum Levels					
Crop/System	Wheat	Corn	Sorghum	Soybean	Sunflower
Rotation (1 or 2, if none enter 0)	1	1	1	1	1
Percent of rotation (total - 100%)	52%	5%	25%	10%	3%
Yield Goal (YG), bu/ac	55.0	85.0	85.0	34.0	1600.0
Enter 0 for Dryland or 1 for Irrigated	0	0	0	0	0
Annual rainfall	30.0	30.0	30.0	30.0	30.0
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0
Nitrogen fertilizer cost, \$/lb	\$0.40	\$0.40	\$0.40	\$0.40	\$0.40
Irrigation energy cost, \$/inch	\$6.50	\$6.50	\$6.50	\$6.50	\$6.50
KSU recommended nitrogen, lbs/ac	92.0	76.0	76.0	0.0	60.0
Econ Optimum fertN, lbs/ac	81.1	64.0	64.5	0.0	51.5
Econ Optimum Irrigation Amount, in	0.0	0.0	0.0	0.0	0.0
Yield at optimal N and I, bu/ac	53.6	82.8	82.6	30.6	1570.2

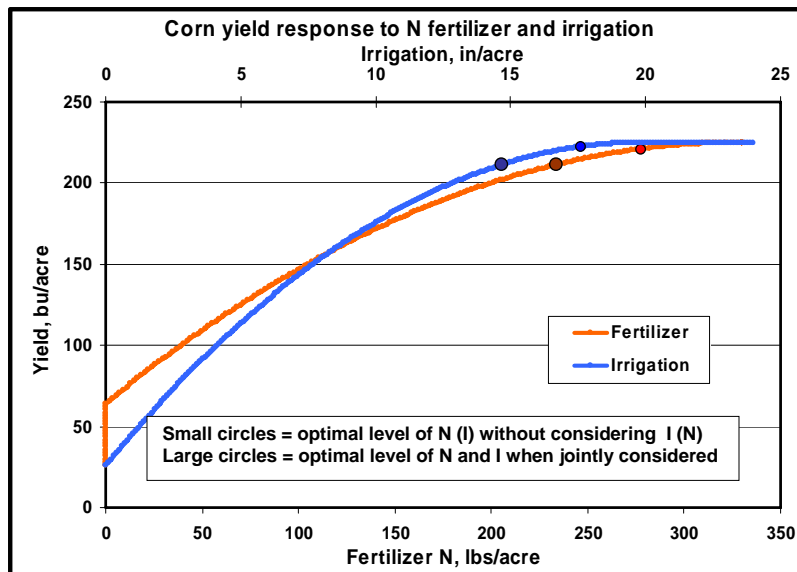
Optimal rates are about 10-15% less than KSU recommendations at high N price

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Extensions to research:
 1) irrigation
 2) phosphorus
 3) value of soil sampling

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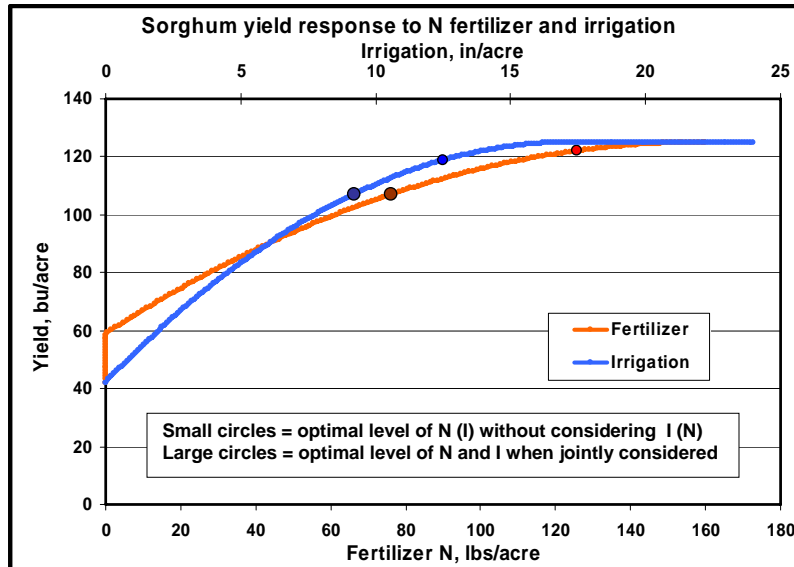
When considering irrigation and N together, optimal values decrease significantly...



Corn price = \$2.35/bu, N price = \$0.40/lb, irrigation cost = \$6.50/inch

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When considering irrigation and N together, optimal values decrease significantly...



Sorghum price = \$2.10/bu, N price = \$0.40/lb, irrigation cost = \$6.50/inch

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Irrigated optimal fertilizer N values @ \$0.21/lb N & \$3.10/in

Comparison of Crop Returns with Nitrogen Fertilizer and Irrigation Water at Economic Optimum Levels

Crop/System	Wheat	Corn	Sorghum	Soybean	Sunflower
Rotation (1 or 2, if none enter 0)	1	1	1	1	1
Percent of rotation (total - 100%)	24.0%	49.0%	7.5%	6.0%	1.0%
Yield Goal (YG), bu/ac	75.0	225.0	125.0	65.0	2800.0
Enter 0 for Dryland or 1 for Irrigated	1	1	1	1	1
Annual rainfall	18.0	18.0	18.0	18.0	18.0
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0
Nitrogen fertilizer cost, \$/lb	\$0.21	\$0.21	\$0.21	\$0.21	\$0.21
Irrigation energy cost, \$/inch	\$3.10	\$3.10	\$3.10	\$3.10	\$3.10
KSU recommended nitrogen, lbs/ac	140.0	300.0	140.0	0.0	150.0
Econ Optimum fertN, lbs/ac	112.3	278.3	113.5	0.0	124.6
Econ Optimum Irrigation Amount, in	12.6	17.1	12.8	16.6	15.0
Yield at optimal N and I, bu/ac	71.1	221.0	119.5	58.5	2706.4

Optimal rates are below KSU recommendations because of irrigation

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Irrigated optimal fertilizer N values @ \$0.40/lb N & \$3.10/in

Comparison of Crop Returns with Nitrogen Fertilizer and Irrigation Water at Economic Optimum Levels					
Crop/System	Wheat	Corn	Sorghum	Soybean	Sunflower
Rotation (1 or 2, if none enter 0)	1	1	1	1	1
Percent of rotation (total - 100%)	24.0%	49.0%	7.5%	6.0%	1.0%
Yield Goal (YG), bu/ac	75.0	225.0	125.0	65.0	2800.0
Enter 0 for Dryland or 1 for Irrigated	1	1	1	1	1
Annual rainfall	18.0	18.0	18.0	18.0	18.0
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0
Nitrogen fertilizer cost, \$/lb	\$0.40	\$0.40	\$0.40	\$0.40	\$0.40
Irrigation energy cost, \$/inch	\$3.10	\$3.10	\$3.10	\$3.10	\$3.10
KSU recommended nitrogen, lbs/ac	140.0	300.0	140.0	0.0	150.0
Econ Optimum fertN, lbs/ac	96.7	250.7	95.9	0.0	110.3
Econ Optimum Irrigation Amount, in	10.9	15.6	11.1	16.6	13.5
Yield at optimal N and I, bu/ac	68.0	215.6	114.5	58.5	2630.3

Optimal rates decrease 10-15% at high N price

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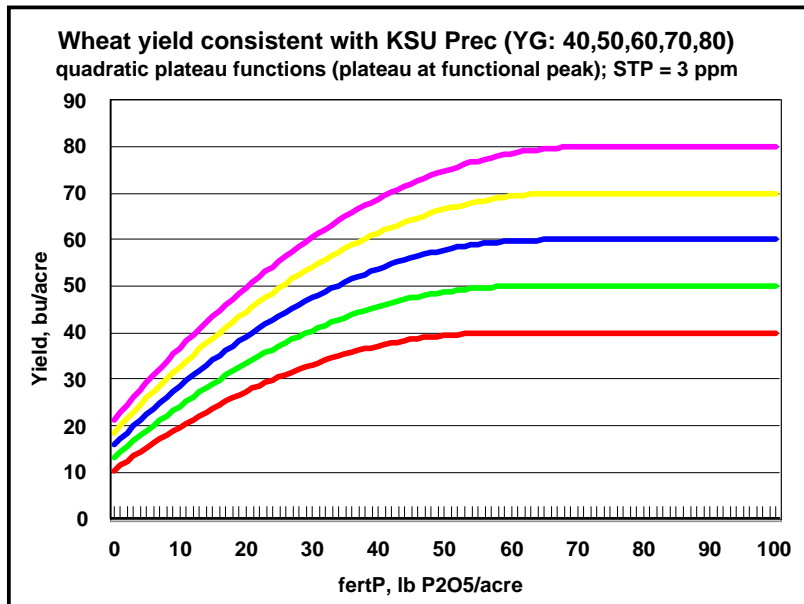
Irrigated optimal fertilizer N values @ \$0.40/lb N & \$6.50/in

Comparison of Crop Returns with Nitrogen Fertilizer and Irrigation Water at Economic Optimum Levels					
Crop/System	Wheat	Corn	Sorghum	Soybean	Sunflower
Rotation (1 or 2, if none enter 0)	1	1	1	1	1
Percent of rotation (total - 100%)	24.0%	49.0%	7.5%	6.0%	1.0%
Yield Goal (YG), bu/ac	75.0	225.0	125.0	65.0	2800.0
Enter 0 for Dryland or 1 for Irrigated	1	1	1	1	1
Annual rainfall	18.0	18.0	18.0	18.0	18.0
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0
Nitrogen fertilizer cost, \$/lb	\$0.40	\$0.40	\$0.40	\$0.40	\$0.40
Irrigation energy cost, \$/inch	\$6.50	\$6.50	\$6.50	\$6.50	\$6.50
KSU recommended nitrogen, lbs/ac	140.0	300.0	140.0	0.0	150.0
Econ Optimum fertN, lbs/ac	66.5	224.9	66.9	0.0	82.7
Econ Optimum Irrigation Amount, in	7.6	14.2	8.3	15.2	10.6
Yield at optimal N and I, bu/ac	59.2	208.6	102.7	58.5	2419.5

At high N and irrigation costs, optimal rates decrease significantly

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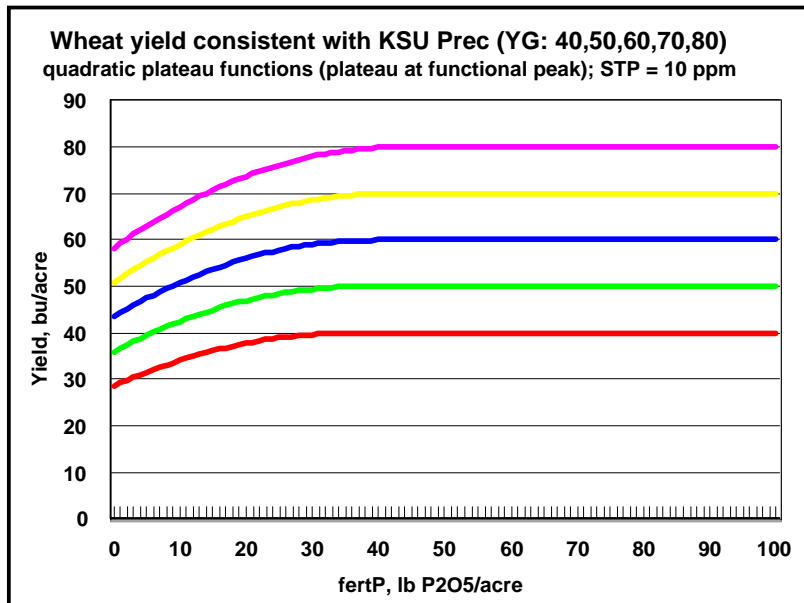
The framework works on P as well as N (here showing STP of 3 ppm)



Now can't do a P-encompassing x-axis however



The framework works on P as well as N (here showing STP of 10 ppm)

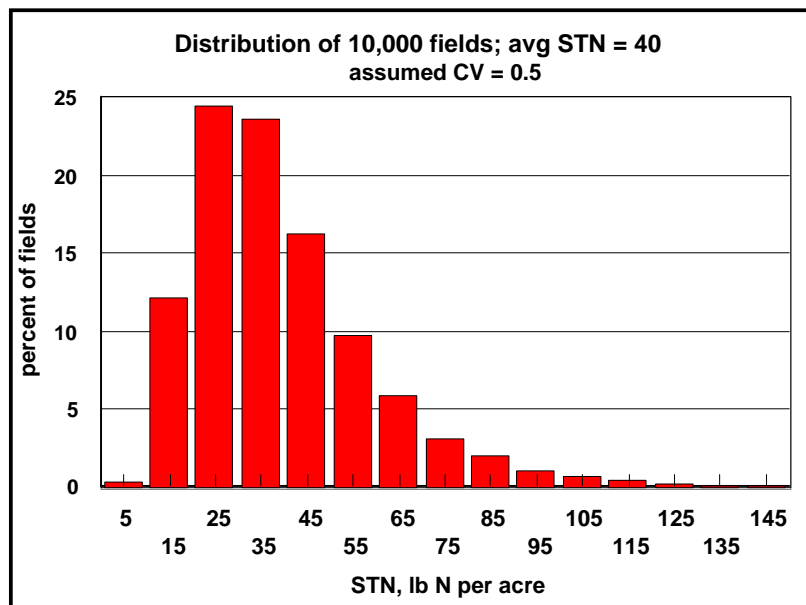


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Soil testing considerations

- If STN varies but the variation is unknown it will be more profitable to apply more fertN than KSU or model recommends from a broad-area soil sample
 - because 1 lb/a above optimal rate will lose less money than a deficiency of 1 lb/a
 - Effect can be large in terms of fertN rate, perhaps 10-20 lb/a difference
 - How much STN variation is assumed in a single soil sample?
 - Do KSU Nrecs assume wide variation in STN for sample?
 - No, KSU assumes STN is constant across sample area.
 - Nrecs based on a soil sample taken across the whole farm would recommend an N rate that is too low to maximize profit

Assume considerable variation of soil tests across fields



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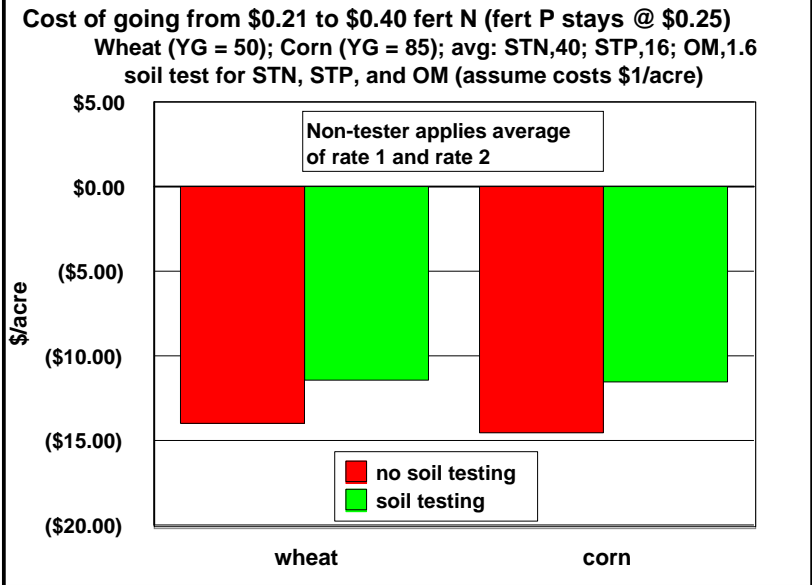
Manager who doesn't soil test: assumptions

- Application style: uniform rate across all fields in farm
- Application rate:
 1. Manager has a “feel” for typical or average STN on farm, perhaps from occasional random field sampling; applies this STN to KSU Nrec formula or model
 2. Manager has a “feel” for the uniform rate applied to his farm that would have maximized profits over space and time

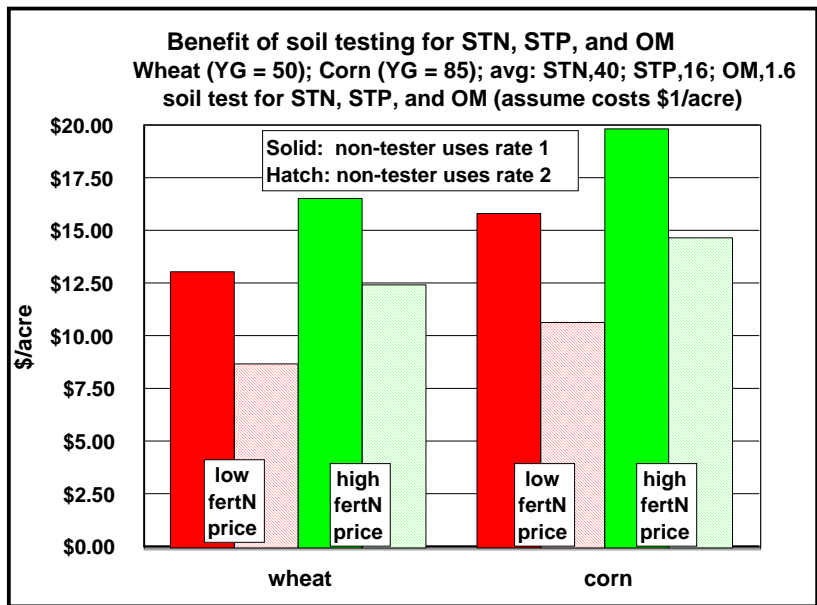
Across 10,000 simulated fields we:

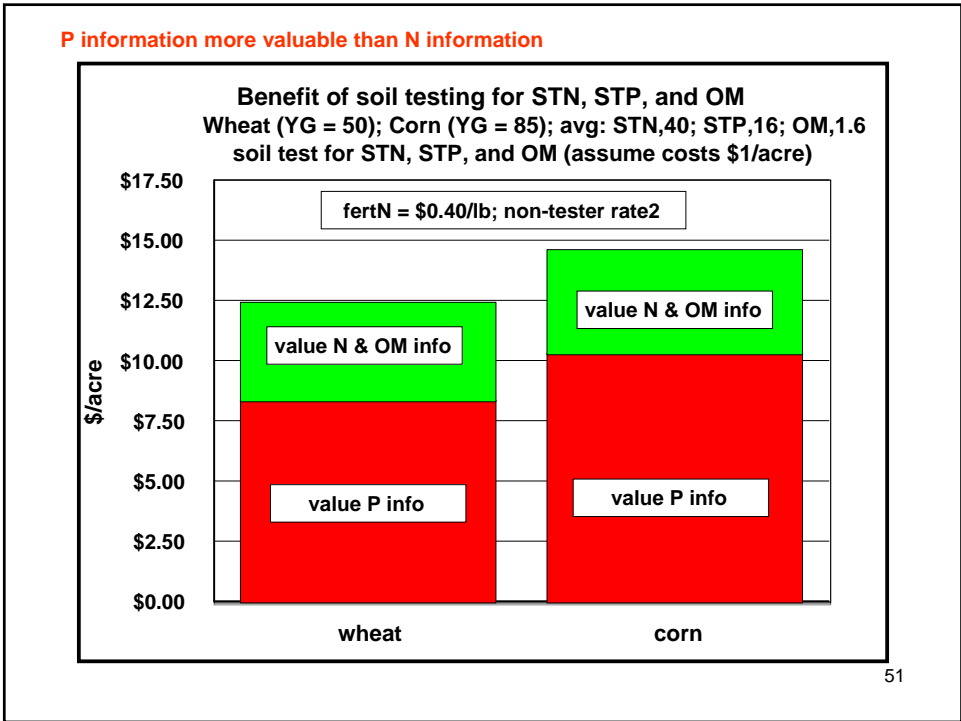
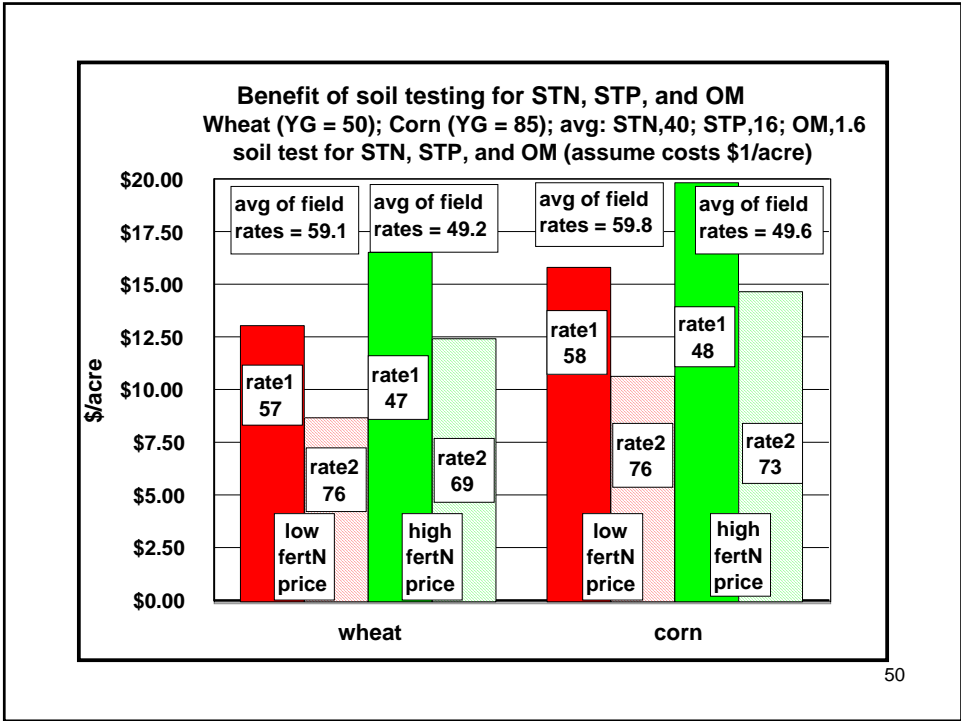
- Represent rate 1 by plugging the single 10,000-field average, for each of STN, STP, and OM into the model
- Represent rate 2 by finding the uniform rate that maximizes total profit across all fields
 - **Notice that this rate could not be formally known by non-tester (but may be informally known)**
- Represent soil-tester by applying each field's unique rate coming from model
 - **No consideration of sub-field variability and possible impact on optimal rates**

Assume \$5.00/acre N application charge can be foregone if 0 N rate best



Assume \$5.00/acre N application charge can be foregone if 0 N rate best





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Contact Us: Department of Agricultural Economics 342, Waters Hall, Manhattan, KS 66506 (785) 532-5823

Questions ?

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Site Updates

- Updated Crop Basis Tool**
January 4, 2006 by Kevin Dhuyvetter
- Monthly NR3 and Diesel Price Forecasts**
December 30, 2005 by Kevin Dhuyvetter
- Updated Cattle Databases**
December 23, 2005 by Jim Mittert
- Livestock and Hay Charts**
December 23, 2005 by Jim Mittert
- Crop Basis Maps**
December 21, 2005 by Kevin Dhuyvetter
- In The Cattle Markets**
December 20, 2005 by Jim Mittert/LMIC
- Grain Outlook**
December 16, 2005 by Mike Woolverton
- KSU-Crop Budgets 2006.xls**
December 13, 2005 by Dhuyvetter et al.
- Modifying Fertilizer Recs to Reflect Price**
December 2, 2005 by Katsens et al.
- Impact of Energy Prices on KS Farm Costs**
December 2, 2005 by Dhuyvetter et al.

http://www.agmanager.info/crops/budgets/proj_budget/default.asp

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