

## Optimal Nitrogen Fertilizer Rates Given Current Fertilizer and Crop Prices

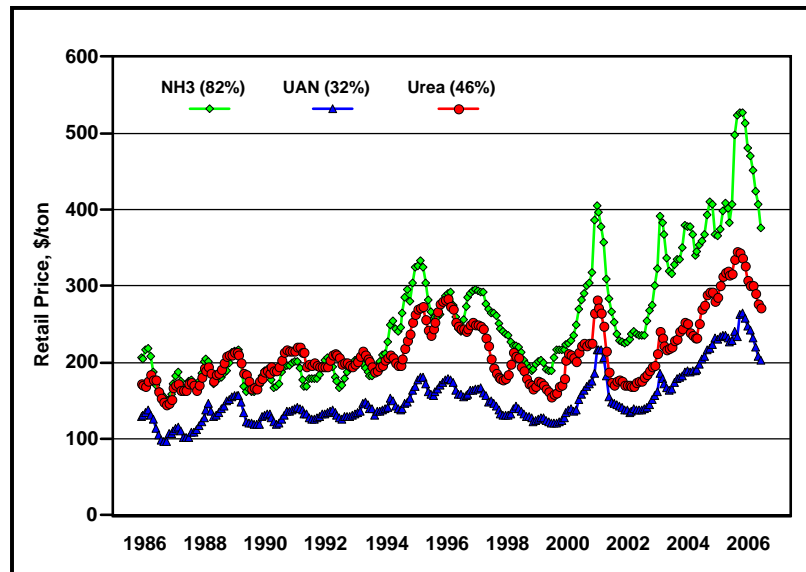
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Department of Agricultural Economics  
Kansas State University  
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August 17-18, 2006 Manhattan, KS

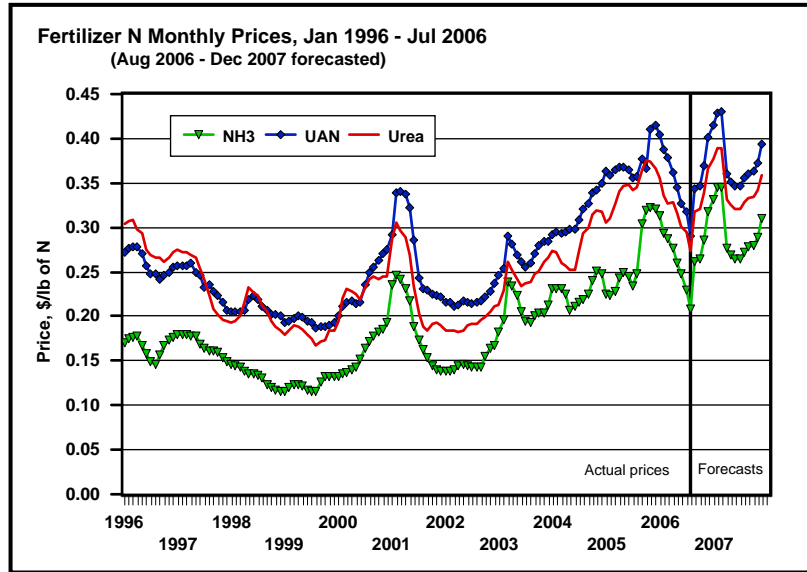


### Historical monthly nitrogen fertilizer prices, Corn Belt



After reaching highs last winter, nitrogen prices have been falling throughout 2006...

### Historical and forecasted nitrogen prices, Corn Belt



... unfortunately, forecasts suggest prices are going to increase back to previous highs.

### World Natural Gas Costs

2005F - \$US/MMBtu



Protectionist policies could be very costly to U.S. agriculture

Source: Fertecon, PotashCorp

## Forecasted N fertilizer prices are at historically high levels...

### Nitrogen Fertilizer Prices, Corn Belt

Year	Nitrogen Source / Time Period							
	NH3 (82%)		UAN (32%)		Urea (46%)		Weighted Average*	% chg
	Oct-Dec	Feb-Apr	Oct-Dec	Feb-Apr	Oct-Dec	Feb-Apr		
1999/00	\$0.132	\$0.138	\$0.191	\$0.215	\$0.181	\$0.226	\$0.176	-----
2000/01	\$0.187	\$0.240	\$0.269	\$0.338	\$0.243	\$0.297	\$0.256	45.5%
2001/02	\$0.141	\$0.141	\$0.224	\$0.213	\$0.191	\$0.184	\$0.177	-31.0%
2002/03	\$0.162	\$0.223	\$0.229	\$0.275	\$0.206	\$0.248	\$0.219	24.1%
2003/04	\$0.207	\$0.228	\$0.282	\$0.294	\$0.259	\$0.263	\$0.251	14.3%
2004/05	\$0.246	\$0.231	\$0.343	\$0.364	\$0.316	\$0.325	\$0.296	18.1%
2005/06	\$0.321	\$0.285	\$0.396	\$0.376	\$0.372	\$0.330	\$0.341	15.0%
2006/07 F	\$0.289	\$0.322	\$0.372	\$0.406	\$0.342	\$0.369	\$0.344	1.0%
06/07 - 05/06	(\$0.032)	\$0.037	(\$0.024)	\$0.030	(\$0.030)	\$0.040	\$0.003	1.0%
06/07 - Avg(99/04)	\$0.123	\$0.128	\$0.190	\$0.198	\$0.126	\$0.126	\$0.128	59.4%

\* Weighted average based on 40% NH3, 25% UAN, and 35% Urea split equally between Oct-Dec and Feb-Apr  
 F = forecast (based on 7/31/06 closing NYMEX natural gas futures prices and KSU model)

## Forecasted crop prices are at recent highs...

### Harvest Crop Prices, Kansas^

Year	Wheat	Corn	Sorghum	Soybeans
2000	\$2.59	\$1.70	\$1.68	\$4.45
2001	\$2.72	\$1.90	\$1.79	\$4.11
2002	\$3.14	\$2.57	\$2.46	\$5.20
2003	\$2.79	\$2.14	\$2.14	\$6.87
2004	\$3.41	\$1.90	\$1.72	\$4.83
2005	\$3.12	\$1.71	\$1.60	\$5.30
2006 F	\$4.75	\$2.35	\$2.40	\$5.45
2007 F	\$4.48	\$2.92	\$2.80	\$6.07
2007 - 2006	(\$0.28)	\$0.57	\$0.39	\$0.62
2007 - Avg(00/04)	\$1.55	\$0.88	\$0.84	\$0.97

^ Average of Colby, Scott City, Beloit, Hutchinson, Emporia, and Topeka  
 F = forecast (w heat in 2006 is an actual price) where 2006 forecasts are based on forward bids and 2007 forecasts are based on futures adjusted for basis).



## Soil Test Interpretations and Fertilizer Recommendations

Department of Agronomy

MF-2586

Nutrient Management

### KSU nitrogen recommendations...

#### Corn and grain sorghum

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

#### Wheat

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

#### Sunflowers

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

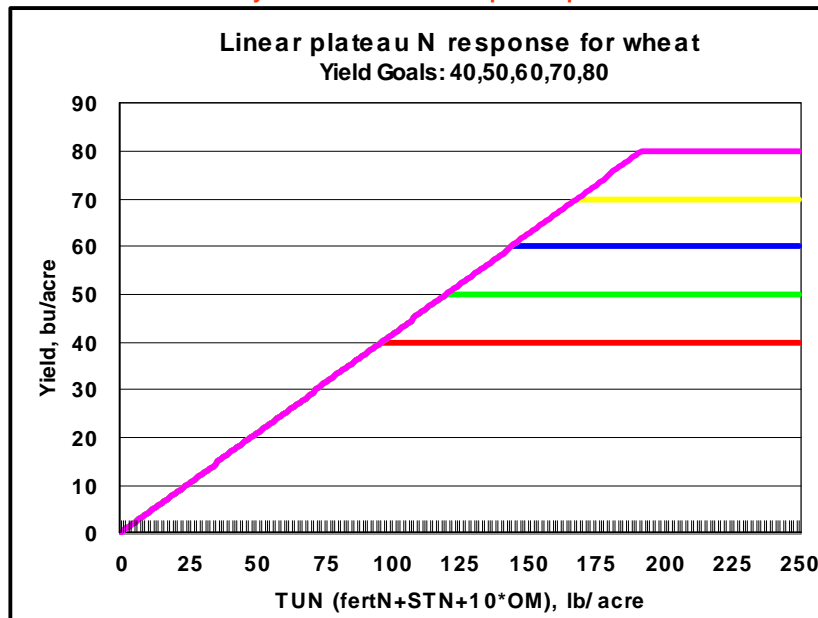
### KSU nitrogen recommendations vs. N price

- 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

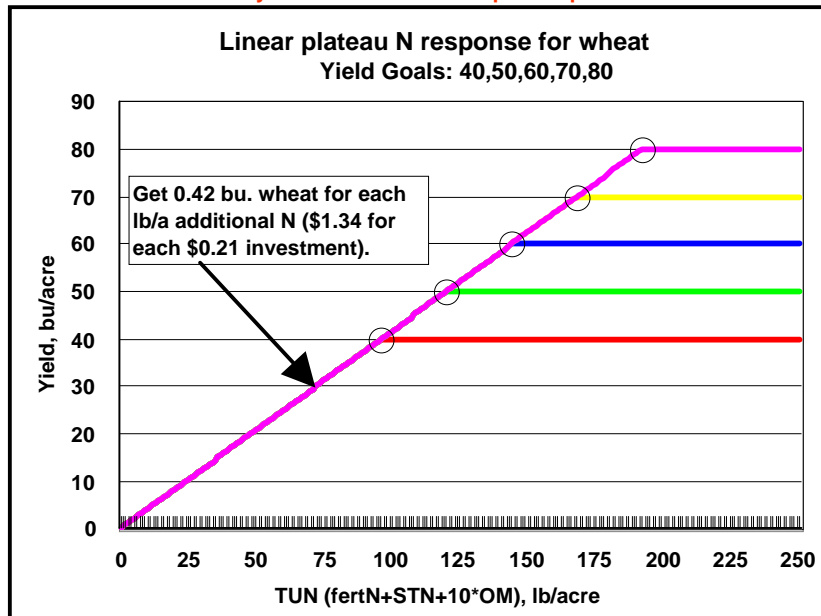
## Nitrogen production function...

- 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
- Average of multiple linear plateau production functions can be non-linear and this represents expectations of future N:yield relationship

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

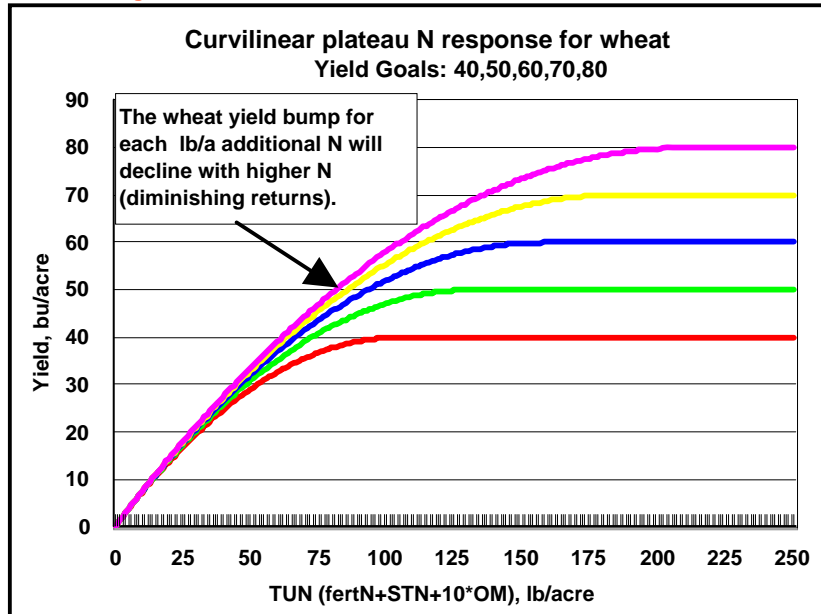


Functions could and likely should have 0-intercept if response is to total N

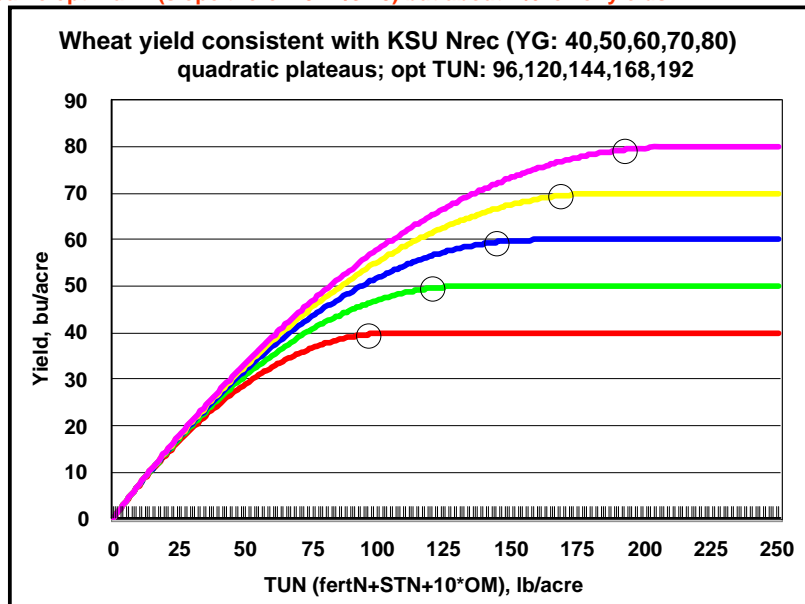


Price won't matter until fertN = \$1.34/lb, then optimal is 0 lb/acre

Functions might be curvilinear



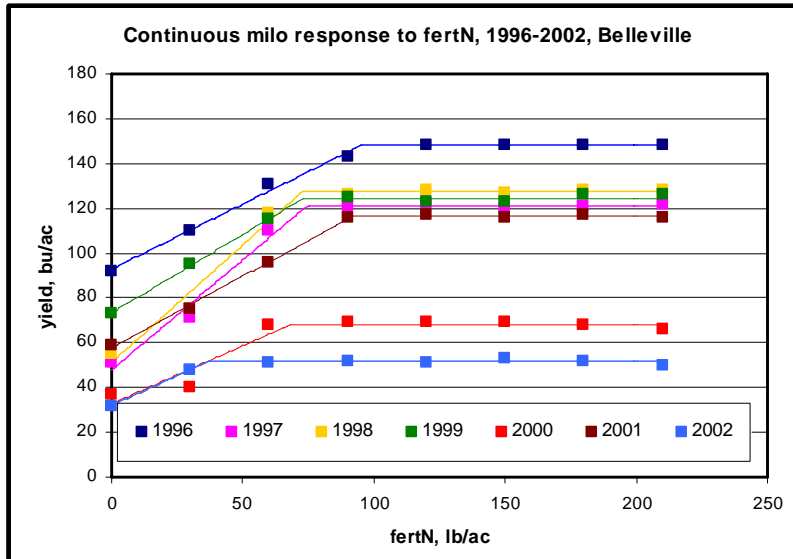
Same optimal N (slope there = 0.21/3.20) but about 1% lower yields



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

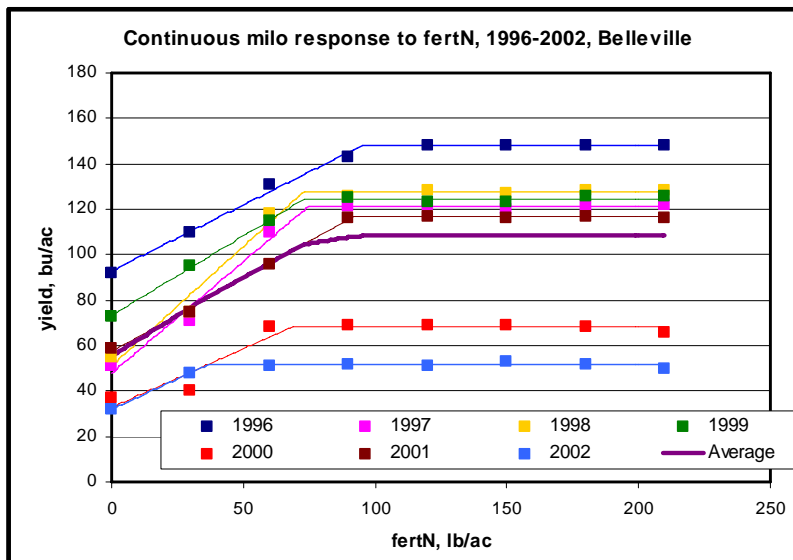


**Yield response by year – linear plateau “fits” data quite well...**

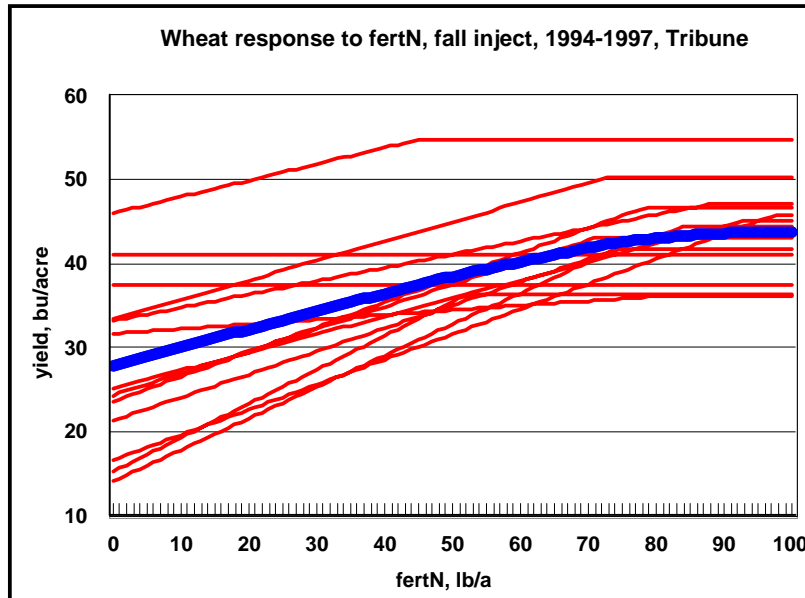


What would yield be for given fertN next year?

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



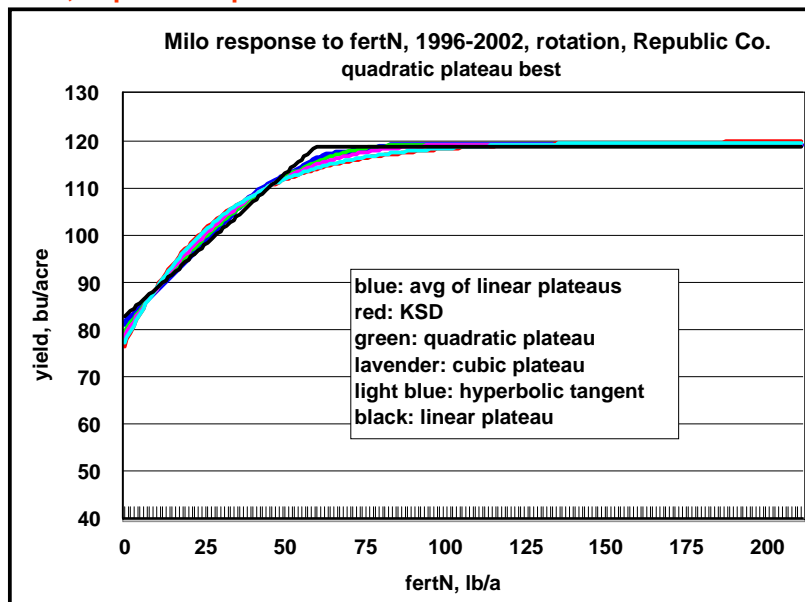
**Average of linear plateaus can become non-linear...**



**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
- Most non-linear models “look” very similar, but results (i.e., optimal N versus N price) do vary

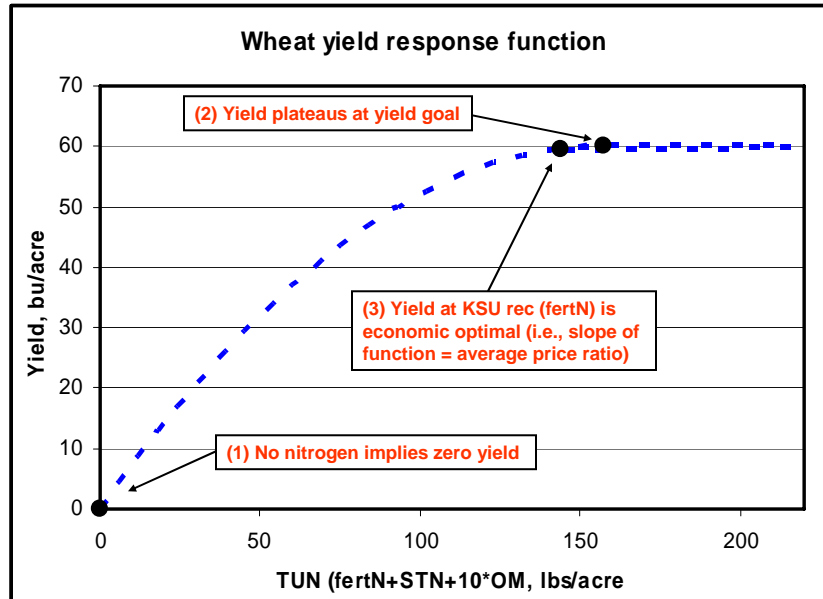
Here, a quadratic plateau fit blue line the best



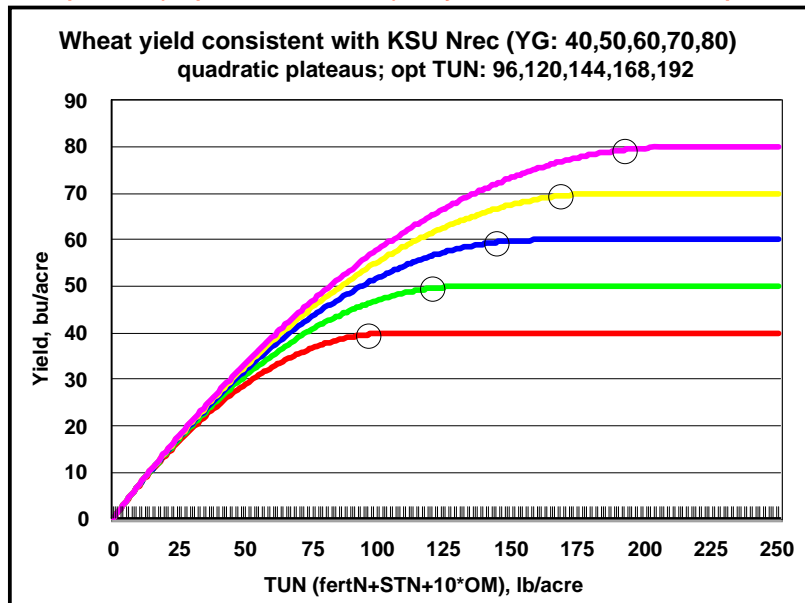
### Nitrogen production function...

- 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)

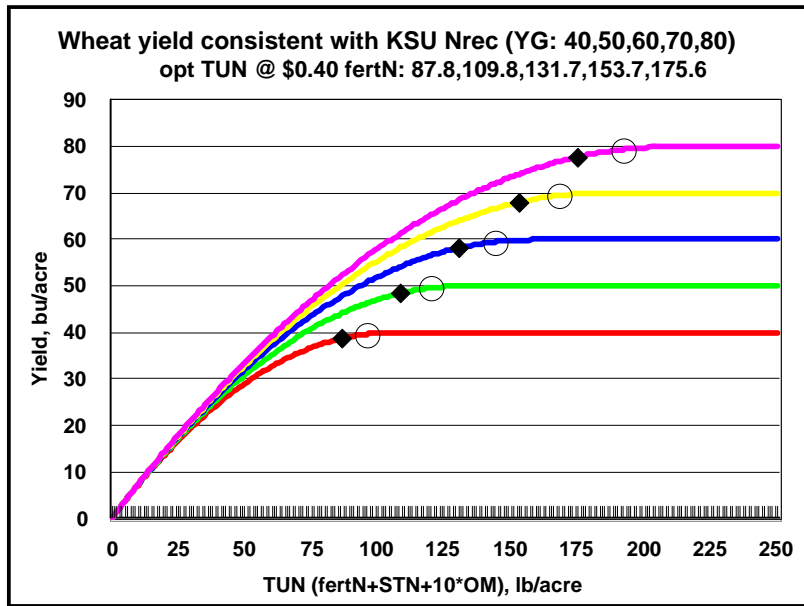
Defined points that allowed quadratic-plateau function to be defined...



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



Slope at diamonds is 0.40/3.20



Microsoft Excel KSU\_CropBudgets2006(2006RBP).xls

File Edit View Insert Format Tools Data Window Help

KSU-CropBudgets2006.xls -- A spreadsheet budgeting program to compare the economic returns of multiple crops and/or crop rotations where nitrogen fertilizer and irrigation levels are determined optimally based upon prices.

Version -- 12.21.05

**INPUTS vs CALCULATED VALUES**  
In the *Budgets*, *Optimal N&I*, *Figures*, and *Irr energy costs* sheets all blue numbers are inputs and all black numbers are calculated from these inputs. The *Irr energy costs* sheet is included as a calculator to assist with determining irrigation pumping costs to enter into the *Budgets* sheet (costs calculated in the *Irr energy costs* sheet need to be manually entered into the *Budgets* sheet).

**DESCRIPTION OF INPUTS**  
Several of the input cells (i.e., blue number) have a red diamond in the upper right hand corner of the cell. By moving your mouse cursor over this diamond, a brief description of the input will be displayed on the screen.

**COMPANION PUBLICATION**  
The mathematical approach used to determine the economic optimal N rates is described in "Modifying Yield-Goal-Based Fertilizer Recommendations to Reflect Price" (available on [www.agmanager.info](http://www.agmanager.info)).

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Extension Agricultural Economists  
Kansas State University

Estimated production functions have been imbedded in Excel spreadsheet

Microsoft Excel - KSU-CropBudgets2006(2006R6P).xls

150%

Reply with Changes...

	A	B	C	D	E	F	G	H	I	J	K
2	<b>Comparison of Crop Returns with Nitrogen Fertilizer and Irrigation Water at Economic Optimum Levels</b>										
3	Crop/System		Wheat	Corn	Sorghum	Soybean	Sunflower	Alfalfa			
4	Rotation (1 or 2, if none enter 0)		1	1	1	1	1	1			
5	Percent of rotation (total - 100%)		24.0%	49.0%	7.5%	6.0%	1.0%	12.5%			
7	Yield goal (YG), bu/ac		45.0	225.0	80.0	40.0	2800.0	7.5			
8	Enter 0 for dryland or 1 for irrigated		0	1	0	0	0	0			
9	Annual rainfall		18.0	18.0	18.0	18.0	18.0	18.0			
10	Organic matter (OM), %		2.00	2.00	2.00	2.00	2.00	2.00			
11	Soil test nitrogen (STN), lbs/ac		20.0	20.0	20.0	20.0	20.0	20.0			
12	Other N adjustments, lbs/ac		0.0	0.0	0.0	0.0	0.0	0.0			
13	Nitrogen fertilizer cost, \$/lb		\$0.344	\$0.344	\$0.344	\$0.344	\$0.344	\$0.344			
14	Irrigation energy cost, \$/inch		\$6.50	\$6.50	\$6.50	\$6.50	\$6.50	\$6.50			
15	KSU recommended nitrogen, lbs/ac		68.0	300.0	68.0	0.0	0.0	0.0			
16	Econ Optimum fertN, lbs/ac		66.4	248.8	65.3	0.0	145.1	---			
17	Econ Optimum Irrigation Amount, in		0.0	15.5	0.0	0.0	0.0	---			
18	Yield at optimal N and I, bu/ac		44.5	215.2	79.1	36.0	2776.1	---			
20	<b>INCOME PER ACRE</b>										
21	A. Yield per acre		44.5	215.2	79.1	36.0	2,776.1	6.8			
22	B. Price per unit		\$4.51	\$2.90	\$2.79	\$6.11	\$0.1502	\$71.36			
23	C. Net government payments		\$36.00	\$36.00	\$36.00	\$36.00	\$36.00	\$36.00			
24	D. Indemnity payments		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00			
25	E. Miscellaneous income		\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00			
26	F. Returns/acre ((A x B) + C + D + E)		\$237.08	\$660.11	\$256.41	\$256.04	\$452.89	\$517.70			
28	<b>COSTS PER ACRE</b>										
29			\$7.20	\$6.66	\$4.48	\$4.50	\$4.40	\$4.42			

N rates based upon user provided inputs

## Adjustments to KSU Nrecs at various wheat and N prices

### Nitrogen Recommendations for Wheat

Yield goal, bu/ac		45				60				
KSU N rec, lbs/ac*		68				104				
N price \$/lb	Wheat price, \$/bu				Wheat price, \$/bu					
	\$2.50	\$3.00	\$3.50	\$4.00	\$4.50	\$2.50	\$3.00	\$3.50	\$4.00	\$4.50
Price adjusted N rec, lbs/ac										
\$0.20	66	68	69	70	71	101	104	106	107	108
\$0.25	63	65	67	68	70	97	100	103	105	106
\$0.30	60	63	65	67	68	93	97	100	102	104
\$0.35	56	60	63	65	66	89	93	97	99	101
\$0.40	53	57	60	63	64	84	90	94	97	99
Price adjusted N rec reduction										
\$0.20	3.3%	0.2%	-1.9%	-3.6%	-4.8%	2.9%	0.2%	-1.7%	-3.1%	-4.2%
\$0.25	7.8%	4.0%	1.3%	-0.7%	-2.3%	6.8%	3.5%	1.2%	-0.6%	-2.0%
\$0.30	12.4%	7.8%	4.6%	2.1%	0.2%	10.8%	6.8%	4.0%	1.9%	0.2%
\$0.35	17.0%	11.6%	7.8%	5.0%	2.8%	14.8%	10.2%	6.8%	4.4%	2.4%
\$0.40	21.5%	15.5%	11.1%	7.8%	5.3%	18.8%	13.5%	9.7%	6.8%	4.6%

Soil organic matter (SOM)=2.0; Soil test nitrogen (STN)=20; Other N adjustment=0

\* Based on formulas reported in *Soil Test Interpretations and Fertilizer Recommendations* (MF-2586)

## Adjustments to KSU Nrecs at various corn and N prices

### Nitrogen Recommendations for Corn

Yield goal, bu/ac		75					125				
KSU N rec, lbs/ac*		60					140				
N price \$/lb	Corn price, \$/bu					Corn price, \$/bu					
	\$2.00	\$2.30	\$2.60	\$2.90	\$3.20	\$2.00	\$2.30	\$2.60	\$2.90	\$3.20	
	Price adjusted N rec, lbs/ac					Price adjusted N rec, lbs/ac					
\$0.20	59	60	61	62	63	138	140	142	144	145	
\$0.25	56	58	59	60	61	133	136	139	141	142	
\$0.30	53	55	57	58	60	129	132	135	137	139	
\$0.35	50	53	55	56	58	124	128	131	134	136	
\$0.40	48	50	53	55	56	119	124	128	131	133	
N price		Price adjusted N rec reduction					Price adjusted N rec reduction				
\$0.20	2.0%	-0.5%	-2.3%	-3.8%	-5.1%	1.4%	-0.3%	-1.7%	-2.7%	-3.6%	
\$0.25	6.7%	3.6%	1.3%	-0.6%	-2.1%	4.8%	2.6%	0.9%	-0.4%	-1.5%	
\$0.30	11.4%	7.7%	4.9%	2.6%	0.8%	8.1%	5.5%	3.5%	1.9%	0.6%	
\$0.35	16.1%	11.8%	8.5%	5.9%	3.8%	11.5%	8.4%	6.1%	4.2%	2.7%	
\$0.40	20.8%	15.9%	12.1%	9.1%	6.7%	14.9%	11.4%	8.7%	6.5%	4.8%	

Soil organic matter (SOM)=2.0; Soil test nitrogen (STN)=20; Other N adjustment=0  
 \* Based on formulas reported in *Soil Test Interpretations and Fertilizer Recommendations* (MF-2586)

## Adjustments to KSU Nrecs at various sorghum and N prices

### Nitrogen Recommendations for Grain Sorghum

Yield goal, bu/ac		60					90				
KSU N rec, lbs/ac*		36					84				
N price \$/lb	Grain sorghum price, \$/bu					Grain sorghum price, \$/bu					
	\$1.90	\$2.20	\$2.50	\$2.80	\$3.10	\$1.90	\$2.20	\$2.50	\$2.80	\$3.10	
	Price adjusted N rec, lbs/ac					Price adjusted N rec, lbs/ac					
\$0.20	36	37	38	39	39	83	85	87	88	89	
\$0.25	33	35	36	37	38	80	82	84	86	87	
\$0.30	31	33	34	35	36	76	79	81	83	85	
\$0.35	28	31	32	34	35	73	76	79	81	82	
\$0.40	26	29	31	32	33	69	73	76	78	80	
N price		Price adjusted N rec reduction					Price adjusted N rec reduction				
\$0.20	1.0%	-2.7%	-5.5%	-7.7%	-9.5%	0.6%	-1.8%	-3.6%	-5.0%	-6.1%	
\$0.25	7.7%	3.1%	-0.4%	-3.2%	-5.4%	5.0%	2.0%	-0.3%	-2.0%	-3.5%	
\$0.30	14.5%	9.0%	4.7%	1.4%	-1.2%	9.3%	5.8%	3.1%	0.9%	-0.8%	
\$0.35	21.3%	14.8%	9.9%	6.0%	2.9%	13.7%	9.5%	6.4%	3.9%	1.9%	
\$0.40	28.0%	20.6%	15.0%	10.6%	7.1%	18.0%	13.3%	9.7%	6.8%	4.5%	

Soil organic matter (SOM)=2.0; Soil test nitrogen (STN)=20; Other N adjustment=0  
 \* Based on formulas reported in *Soil Test Interpretations and Fertilizer Recommendations* (MF-2586)

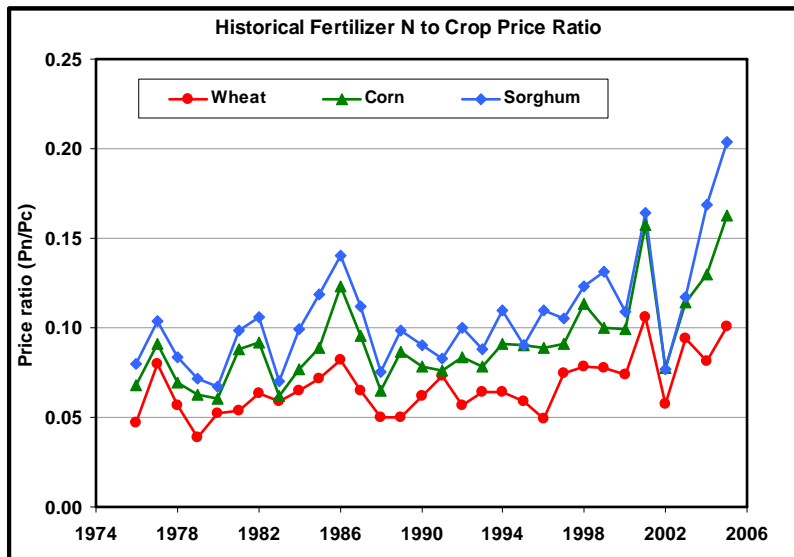
## What are the consequences of ignoring prices when making fertilizer N decisions?

Excess N applied x N price  
– Yield advantage x crop price  
Cost of being “non-optimal”\*

\* Assumes KSU N rec > optimal N rate

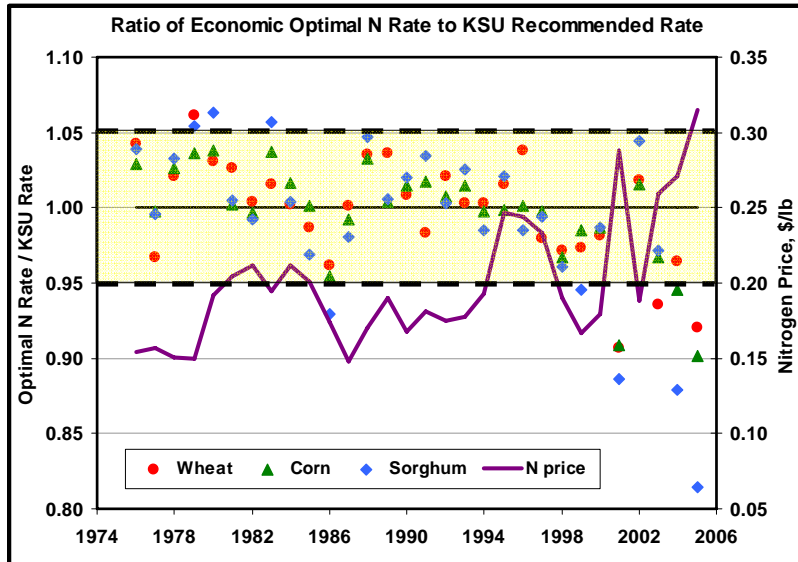


### Fertilizer-to-crop price ratio used to estimate “cost” of being non-optimal



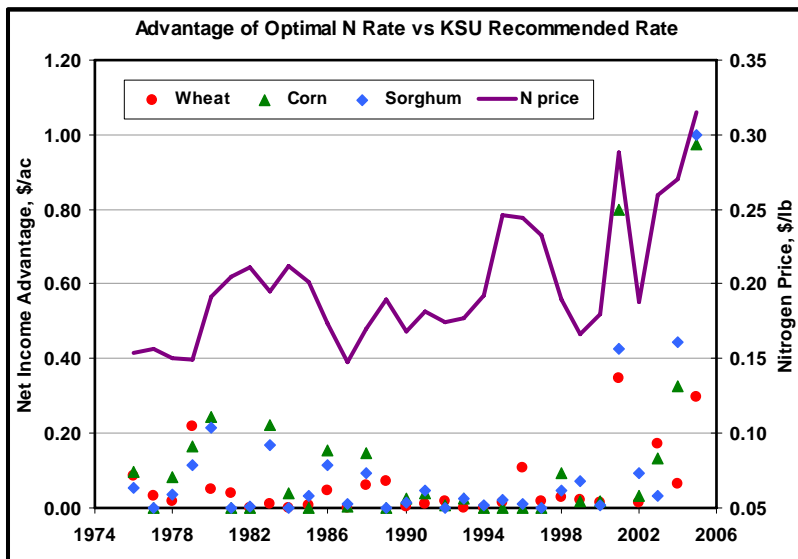
Variability in ratio, which determines optimal N rate, appears to be increasing

Cost of being “non-optimal” has increased in recent years...



KSU Nrec, ignoring prices, is within 5% of optimal N rate most of the time.

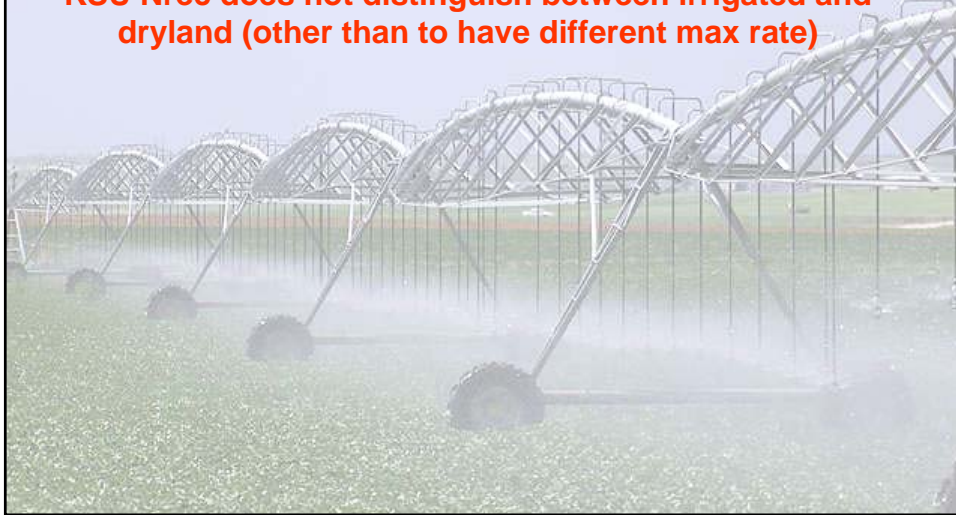
As N prices have increased, cost of being non-optimal has also increased...



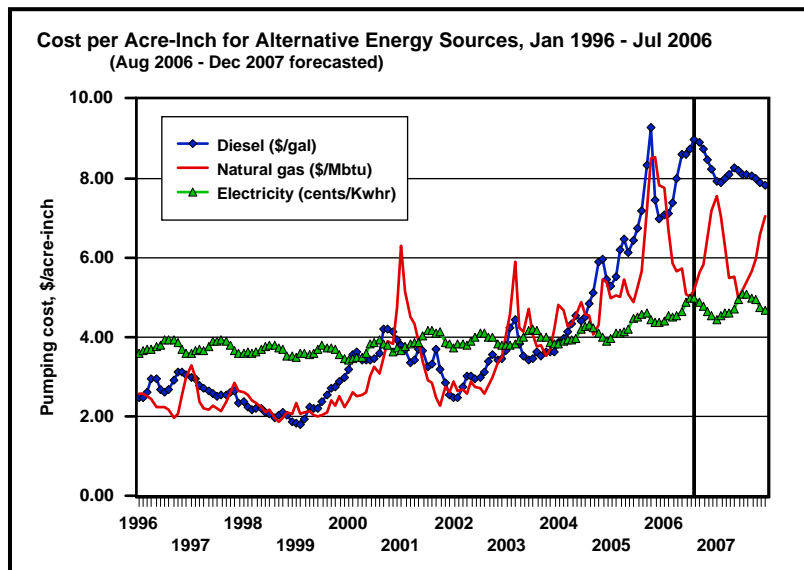
76.7% of observations < \$0.10/ac (86.7% < \$0.20)

## What about N rates under irrigation?

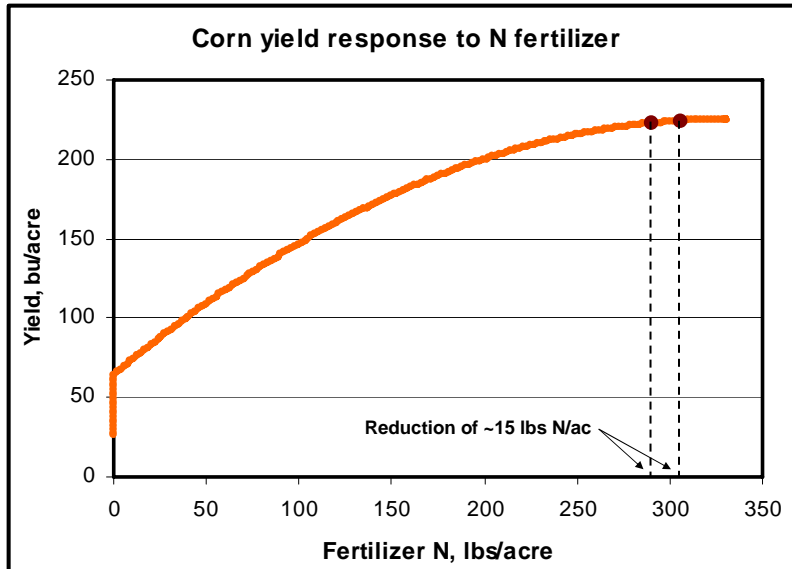
**KSU Nrec does not distinguish between irrigated and dryland (other than to have different max rate)**



**Rising energy prices imply irrigation pumping costs have been increasing significantly...**

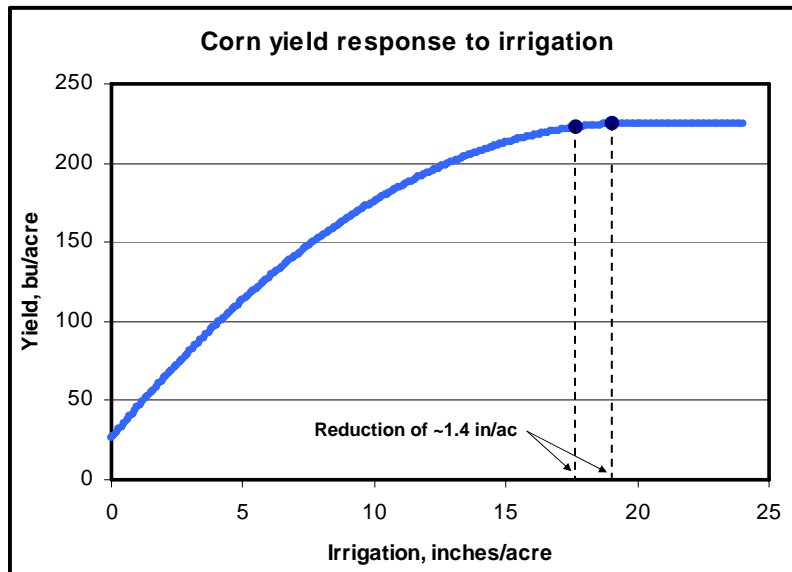


At projected corn prices, change in optimal N is relatively small due to higher N price...



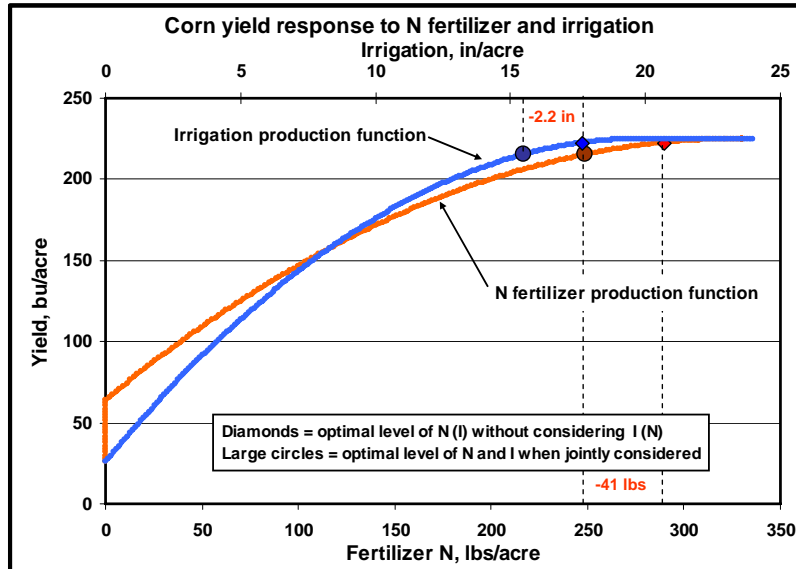
Corn \$2.90/bu; N cost = \$0.21/lb vs. \$0.344/lb

At projected corn prices, change in optimal water is relatively small due to higher pumping costs price...



Corn \$2.90/bu; irrigation cost = \$2.50/in vs. \$6.50/in

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



**Corn \$2.90/bu; N \$0.344/lb, irrigation cost = \$6.50/in**

### Adjustments to KSU Nrecs at various corn and N prices

#### Nitrogen Recommendations for Irrigated Corn

Yield goal, bu/ac		225					225				
KSU N rec, lbs/ac*		300					300				
Irrigation pumping cost, \$/ac-in		\$2.50					\$6.50				
N price \$/lb	Corn price, \$/bu					Corn price, \$/bu					
	\$2.00	\$2.30	\$2.60	\$2.90	\$3.20	\$2.00	\$2.30	\$2.60	\$2.90	\$3.20	
Price adjusted N rec, lbs/ac						Price adjusted N rec, lbs/ac					
\$0.20	273	280	286	291	295	236	249	258	265	271	
\$0.25	265	273	280	286	289	229	241	253	260	267	
\$0.30	256	265	273	280	284	219	234	245	254	262	
\$0.35	249	258	267	273	278	212	227	240	249	256	
\$0.40	240	251	260	267	273	203	219	232	243	251	
N price						N price					
Price adjusted N rec reduction						Price adjusted N rec reduction					
\$0.20	9.1%	6.6%	4.8%	2.9%	1.7%	21.4%	17.1%	14.0%	11.5%	9.7%	
\$0.25	11.5%	9.1%	6.6%	4.8%	3.5%	23.8%	19.5%	15.8%	13.4%	10.9%	
\$0.30	14.6%	11.5%	9.1%	6.6%	5.4%	26.9%	22.0%	18.3%	15.2%	12.8%	
\$0.35	17.1%	14.0%	10.9%	9.1%	7.2%	29.3%	24.4%	20.1%	17.1%	14.6%	
\$0.40	20.1%	16.4%	13.4%	10.9%	9.1%	32.4%	26.9%	22.6%	18.9%	16.4%	

Soil organic matter (SOM)=2.0; Soil test nitrogen (STN)=20; Other N adjustment=0  
 \* Based on formulas reported in *Soil Test Interpretations and Fertilizer Recommendations* (MF-2586)

## Adjustments to KSU Nrecs at various corn and N prices\*

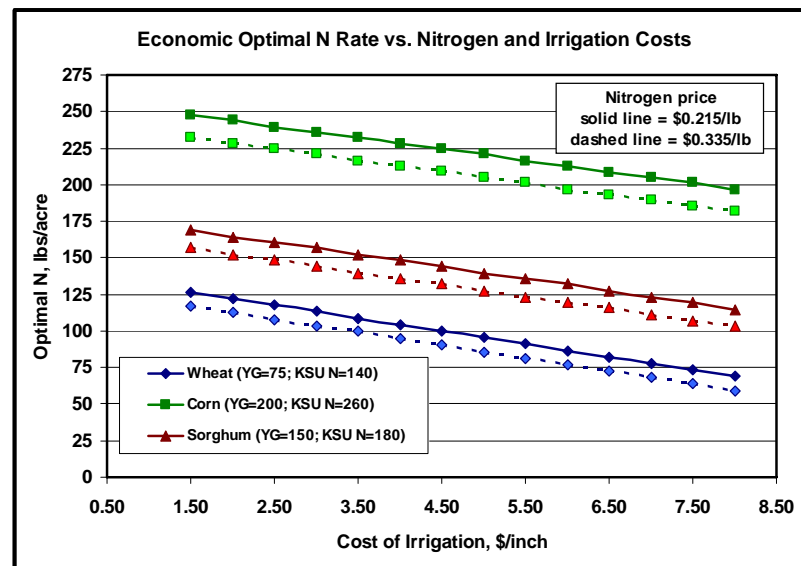
### Nitrogen Recommendations for Corn

Yield goal, bu/ac		175					225				
KSU N rec, lbs/ac*		220					300				
N price \$/lb	Corn price, \$/bu					Corn price, \$/bu					
	\$2.00	\$2.30	\$2.60	\$2.90	\$3.20	\$2.00	\$2.30	\$2.60	\$2.90	\$3.20	
	Price adjusted N rec, lbs/ac					Price adjusted N rec, lbs/ac					
\$0.20	217	221	223	225	227	296	301	304	307	309	
\$0.25	211	215	218	221	223	288	293	298	301	304	
\$0.30	204	209	213	216	219	279	286	291	295	299	
\$0.35	197	203	208	212	215	271	279	285	289	293	
\$0.40	191	198	203	207	211	263	271	278	284	288	
N price	Price adjusted N rec reduction					Price adjusted N rec reduction					
\$0.20	1.3%	-0.3%	-1.5%	-2.4%	-3.2%	1.2%	-0.3%	-1.4%	-2.3%	-3.0%	
\$0.25	4.3%	2.3%	0.8%	-0.4%	-1.3%	4.0%	2.2%	0.8%	-0.4%	-1.3%	
\$0.30	7.3%	4.9%	3.1%	1.7%	0.5%	6.8%	4.6%	2.9%	1.6%	0.5%	
\$0.35	10.2%	7.5%	5.4%	3.7%	2.4%	9.7%	7.1%	5.1%	3.5%	2.3%	
\$0.40	13.2%	10.1%	7.7%	5.8%	4.3%	12.5%	9.5%	7.3%	5.5%	4.0%	

Soil organic matter (SOM)=2.0; Soil test nitrogen (STN)=20; Other N adjustment=0  
 \* Based on formulas reported in *Soil Test Interpretations and Fertilizer Recommendations* (MF-2586)

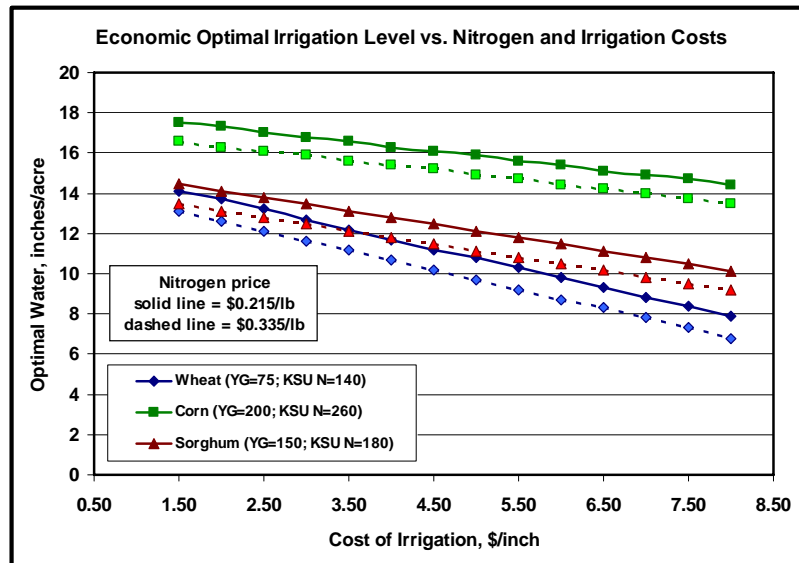
\* Optimal rates do not consider irrigation pumping costs

## Optimal N rate...



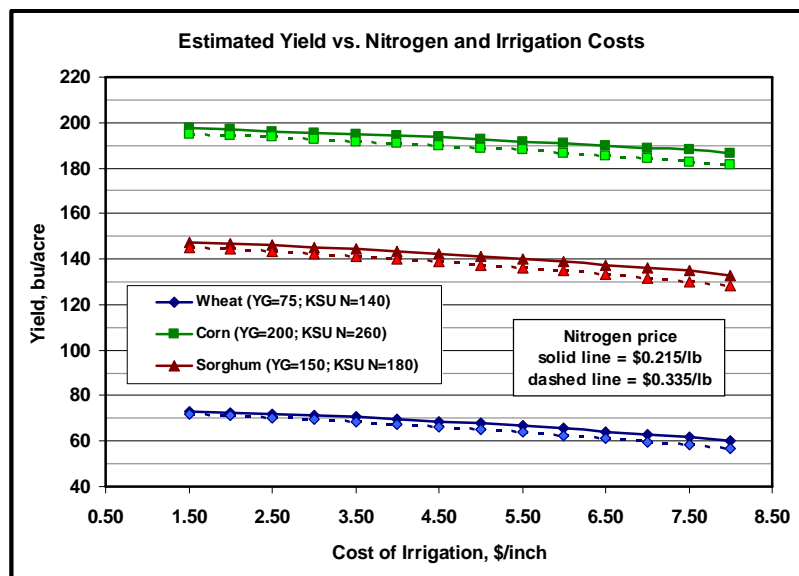
Increase in NUE = 29.6%, 14.3%, 21.7% for wheat, corn, and sorghum, respectively.  
 (\$3/ac-in & \$0.215/lb N prices → \$6/ac-in & \$0.335/lb N)

## Optimal irrigation rate...

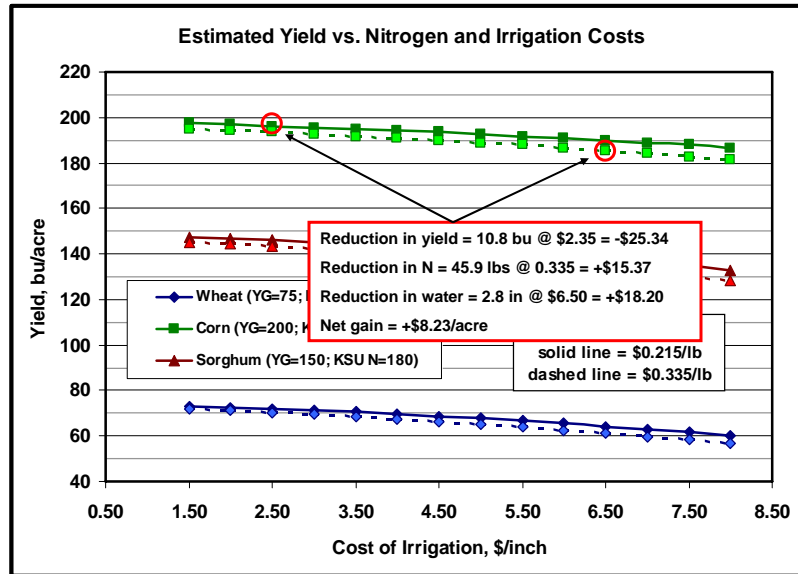


Increase in IWUE = 28.0%, 11.2%, 19.3% for wheat, corn, and sorghum, respectively.  
 (\$3/ac-in & \$0.215/lb N prices → \$6/ac-in & \$0.335/lb N)

## Estimated yield...



## Impact of reduced yield...



## Summary ...

- In order to determine how to adjust fertN rates in response to prices, a mathematical relationship between N and yield is needed
- A quadratic-plateau function can be “backed out” of KSU N recs
- Quadratic-plateau function allows diminishing returns, but is also consistent with linear plateau within any site-year
- Even with N prices at historical highs, economic optimal N rates for 2007 dryland crops are only slightly less (2-5%) than KSU N recs due to strong crop prices

## Summary ...

- Cost of ignoring prices in N recommendations has been low in the past, but with increasing N prices, cost of following non-optimal rate increases
- Optimal N rates for irrigated fields is considerably lower than KSU N recs (10-20%) due to high pumping costs as well as high N prices
- Nitrogen fertilizer and irrigation production functions have been estimated and imbedded within the *KSU-CropBudgets2006.xls* spreadsheet that allow producers to determine optimal N rates for their own farms/fields

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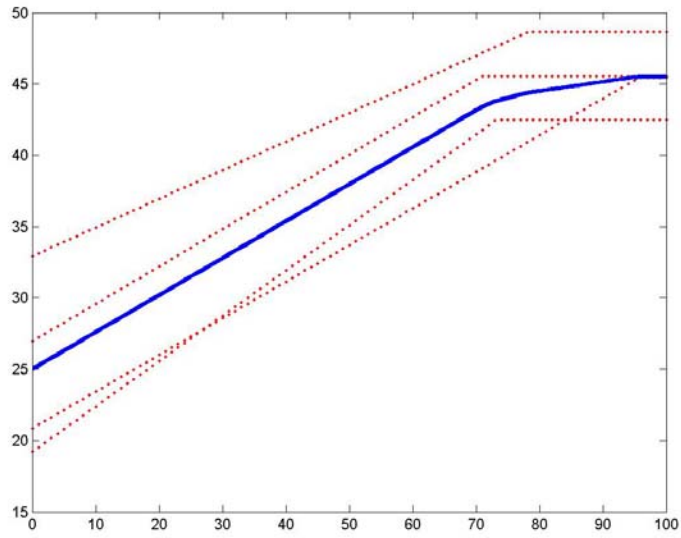
start

2:48 PM

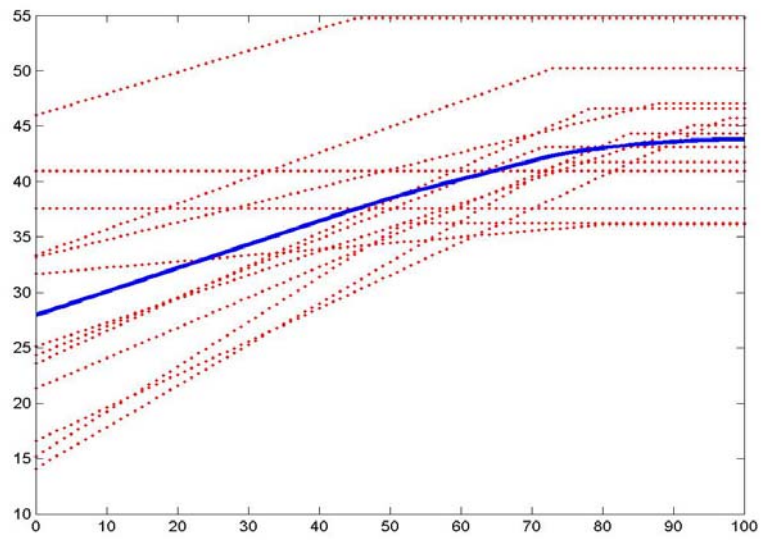
**Site Updates**

- Modifying Fertilizer Recs to Reflect Price**  
December 2, 2005 by *Kashens et al.*
- Impact of Energy Prices on KS Farm Costs**  
December 2, 2005 by *Dhuyvetter et al.*
- Livestock and Hay Charts**  
December 2, 2005 by *Jim Mintz*
- Updated Cattle Databases**  
December 2, 2005 by *Jim Mintz*
- Updated Crop Basis Tool**  
December 1, 2005 by *Kevin Dhuyvetter*
- Monthly NH<sub>3</sub> and Diesel Price Forecasts**  
November 30, 2005 by *Kevin Dhuyvetter*
- In The Cattle Markets**  
November 28, 2005 by *Jim Mintz/LMIC*
- The U.S. Ethanol Industry**  
November 25, 2005 by *Dhuyvetter et al.*
- Livestock Farm Management Update**  
November 18, 2005 by *Rod Jones*
- Crop Basis Maps**  
November 16, 2005, by *Kevin Dhuyvetter*
- Livestock Risk Protection**  
November 17, 2005 by *Dhuyvetter and Mintz*
- Grain Outlook**  
November 17, 2005 by *Mike Woolverton*
- Cost Comparison of Silage Storage Alternatives**  
November 8, 2005 by *Dhuyvetter et al.*

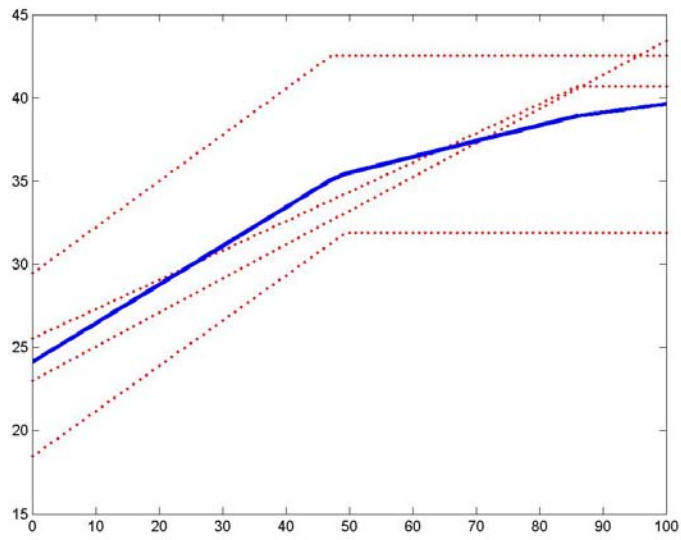
111 Tribune wheat fall inject (1994-1997), year basis



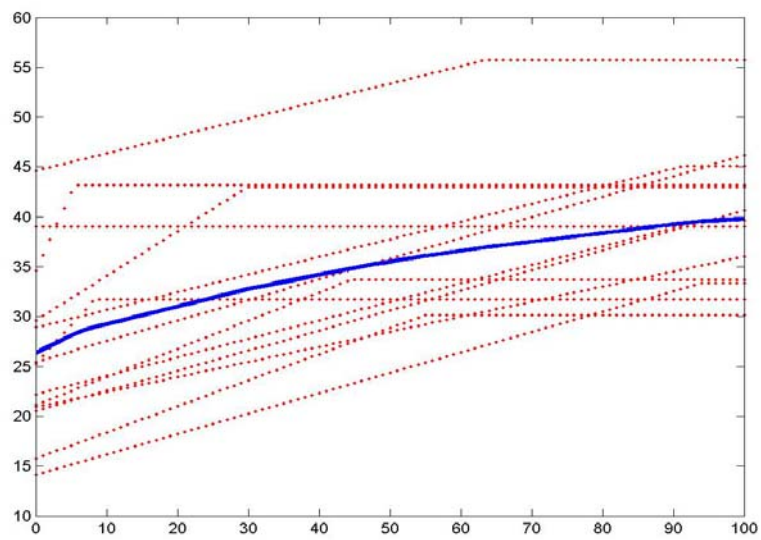
111 Tribune wheat fall inject (1994-1997), site-year basis



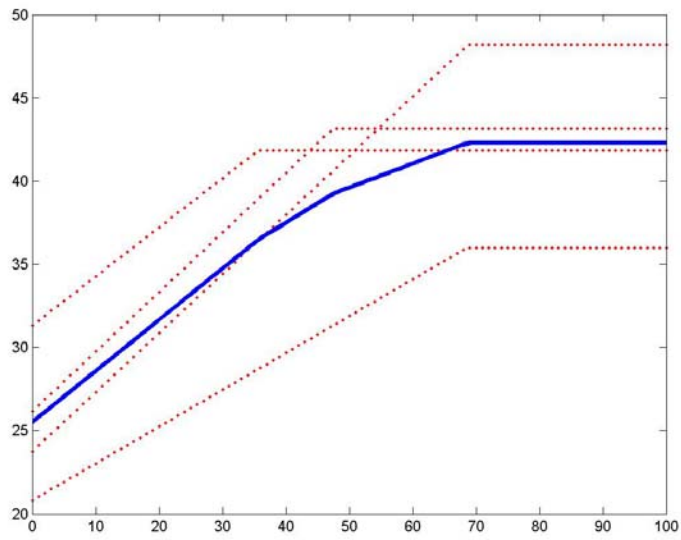
122 Tribune wheat winter broadcast (1994-1997), year basis



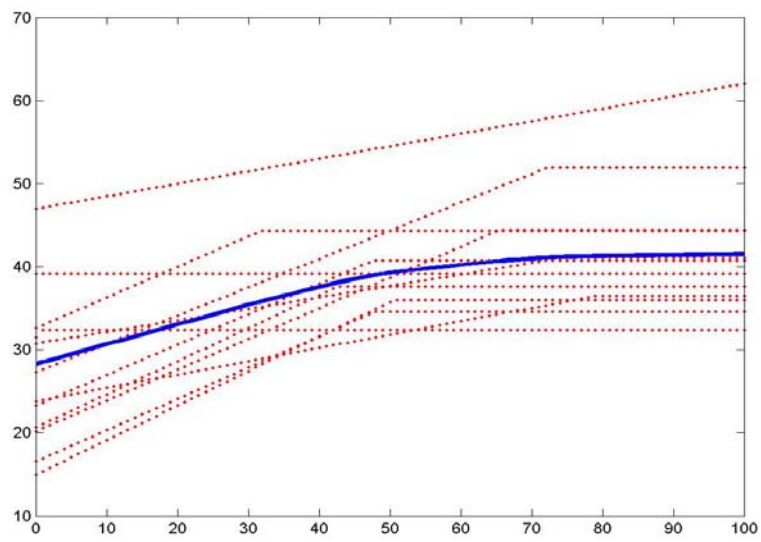
122 Tribune wheat winter broadcast (1994-1997), site-year basis



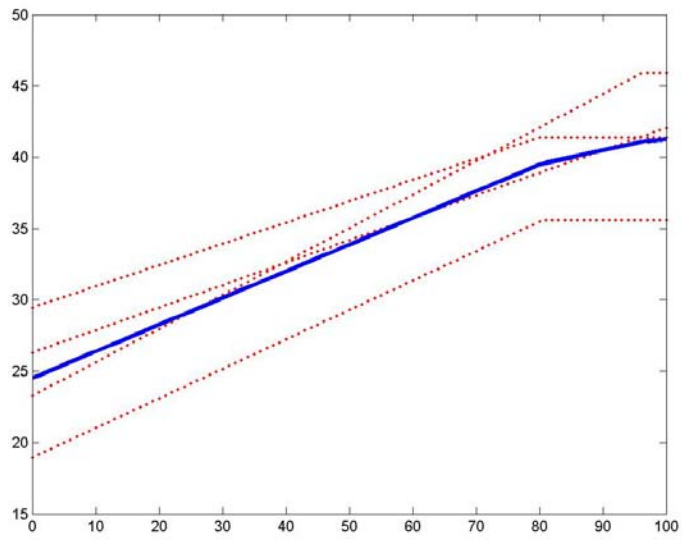
131 Tribune wheat spring inject (1994-1997), year basis



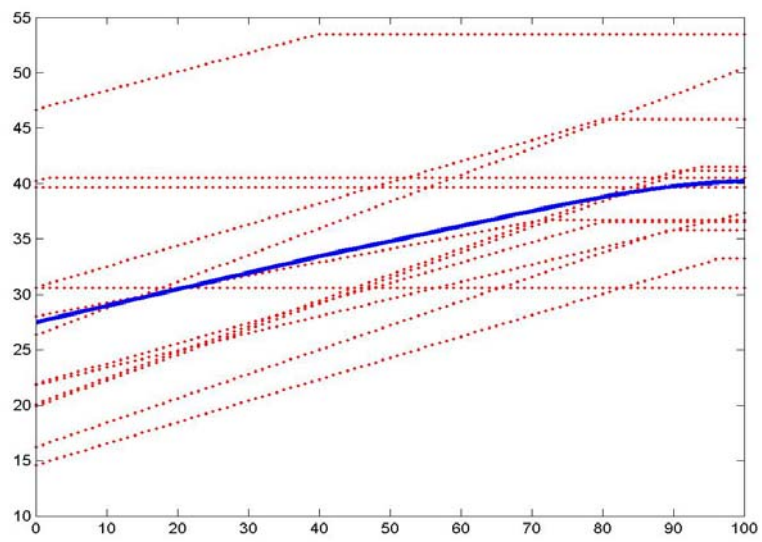
131 Tribune wheat spring inject (1994-1997), site-year basis



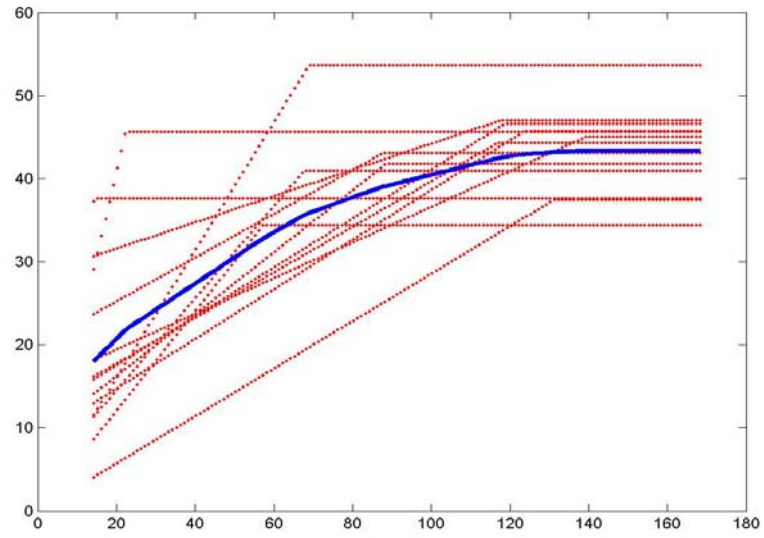
132 Tribune wheat spring broadcast (1994-1997), year basis



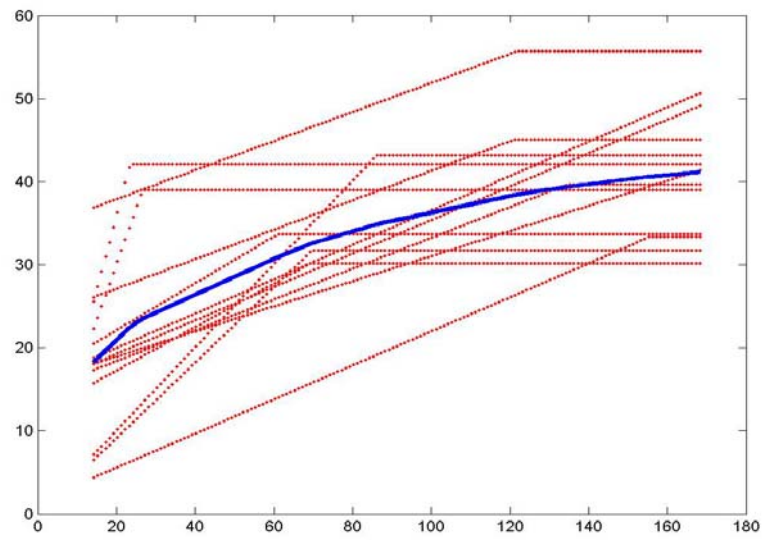
132 Tribune wheat spring broadcast (1994-1997), site-year basis



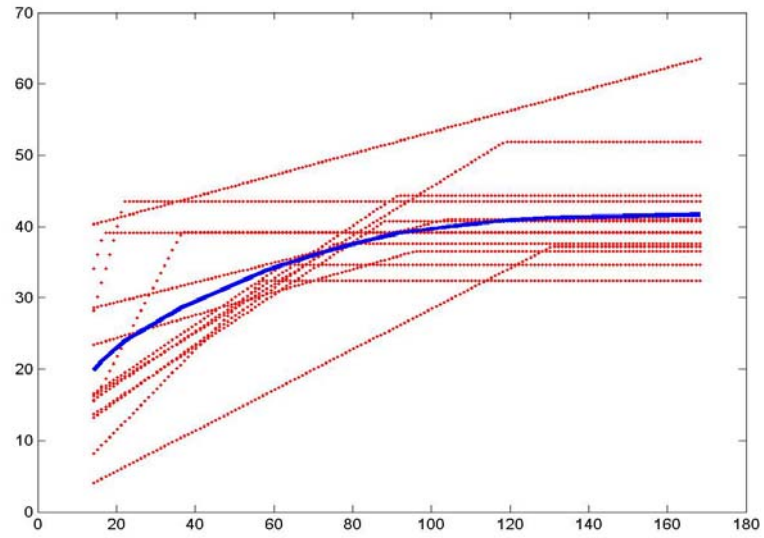
211 Tribune wheat fall inject (1994-1997), site-year basis, totN not fertN



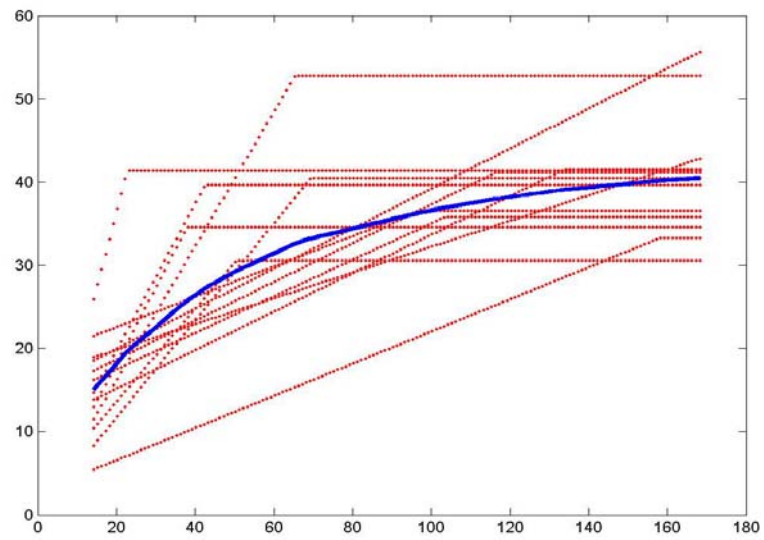
222 Tribune wheat winter broadcast (1994-1997), site-year basis, totN not fertN



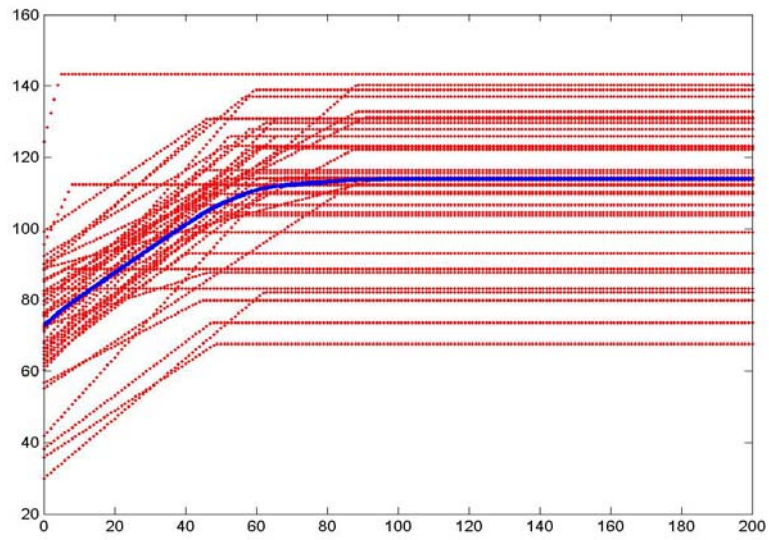
231 Tribune wheat spring inject (1994-1997), site-year basis, totN not fertN



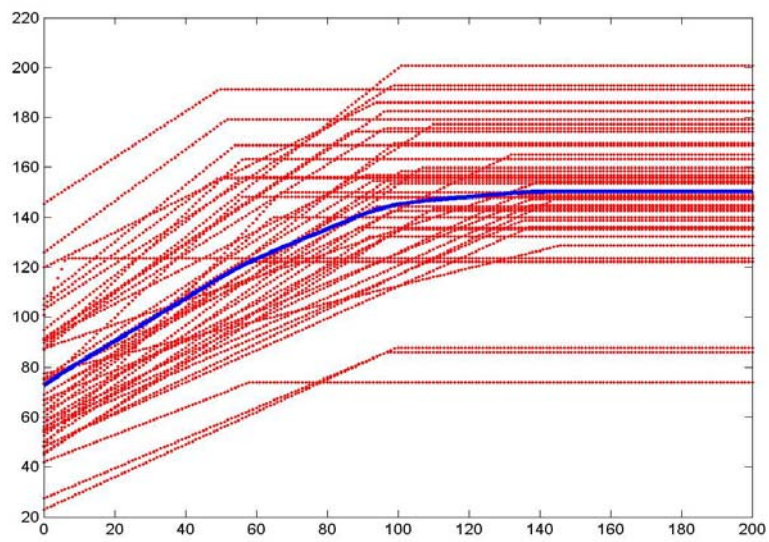
232 Tribune wheat spring broadcast (1994-1997), site-year basis, totN not fertN



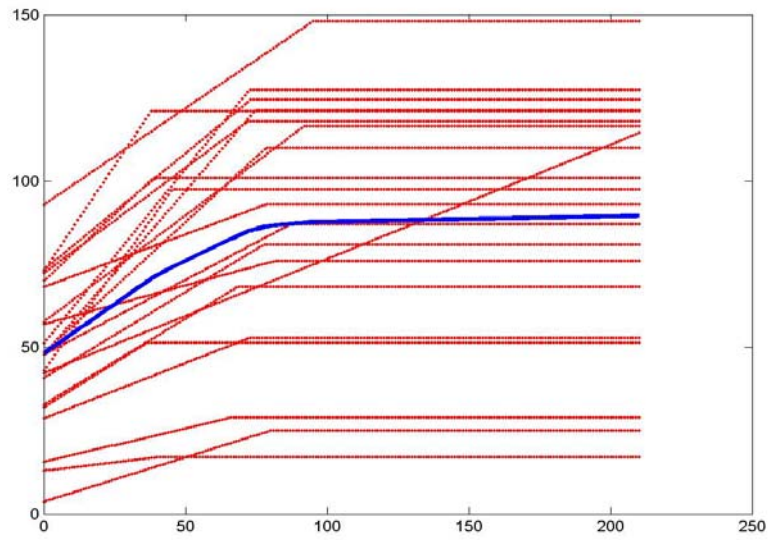
301 Tribune milo (1961-2004)



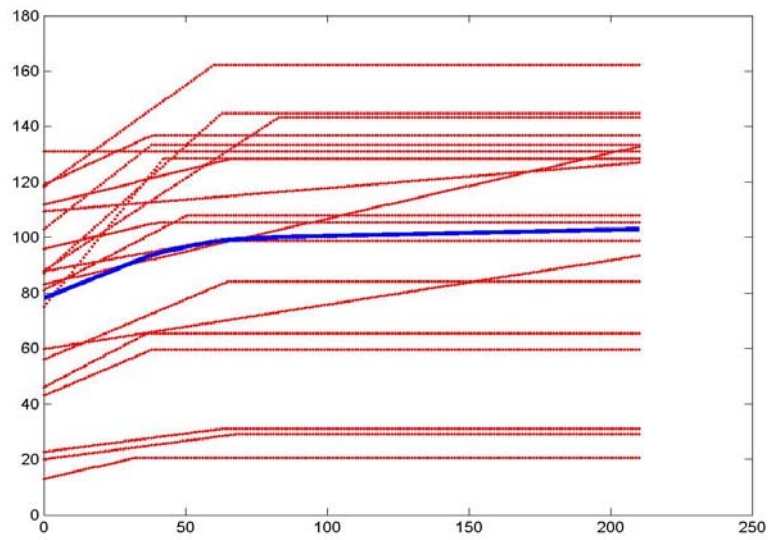
401 Tribune corn (1961-2004)



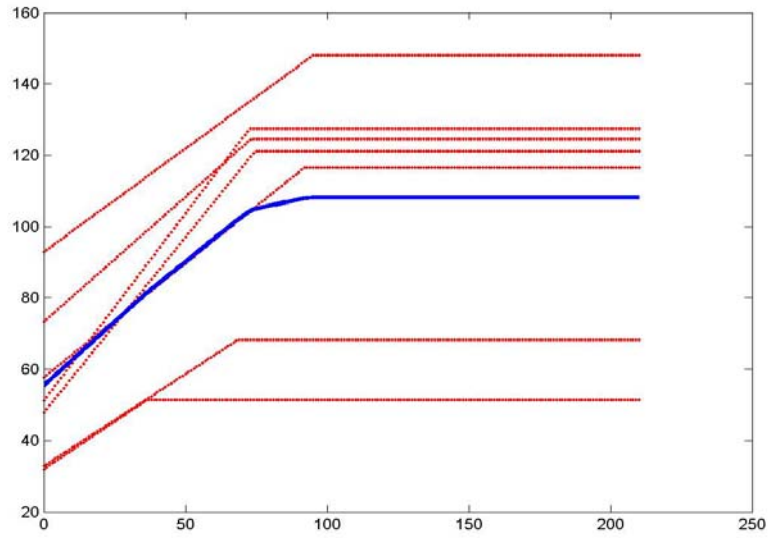
501 Republic milo, continuous (1982-2002)



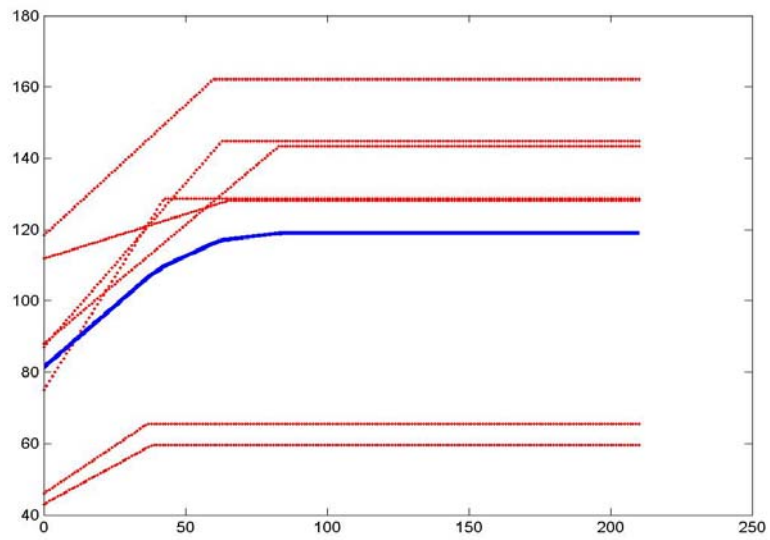
502 Republic milo, rotation (1982-2002)



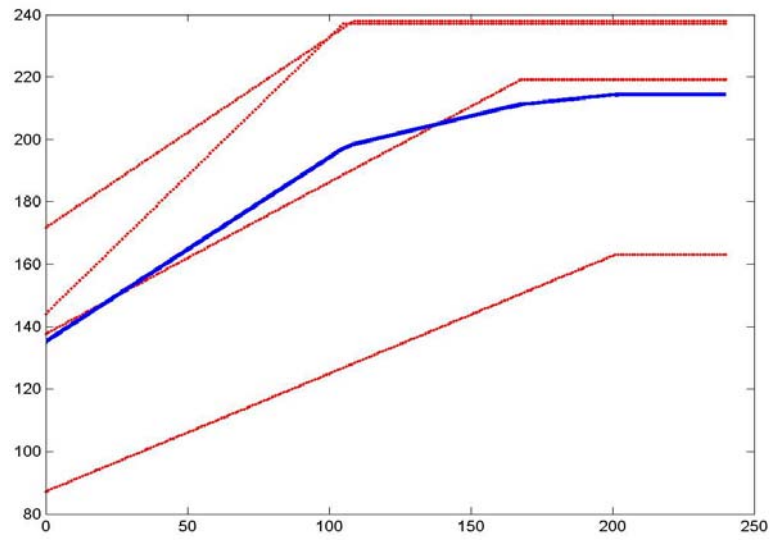
601 Republic milo, continuous (1996-2002)



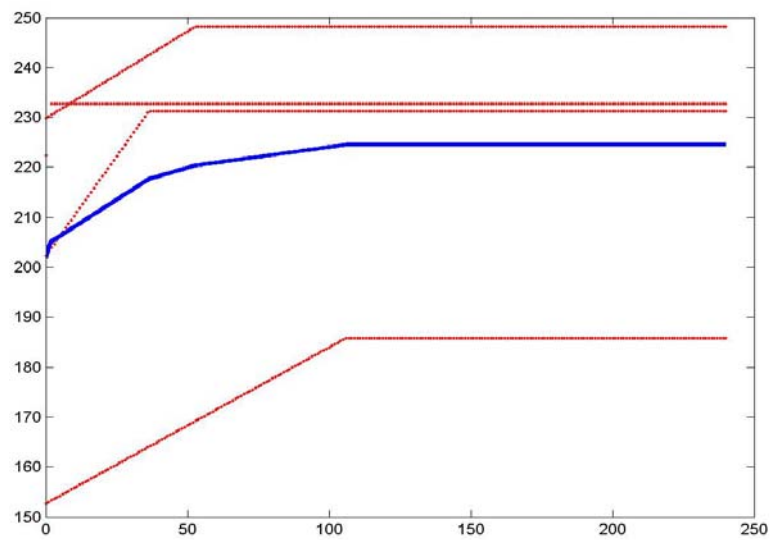
602 Republic milo, rotation (1996-2002)



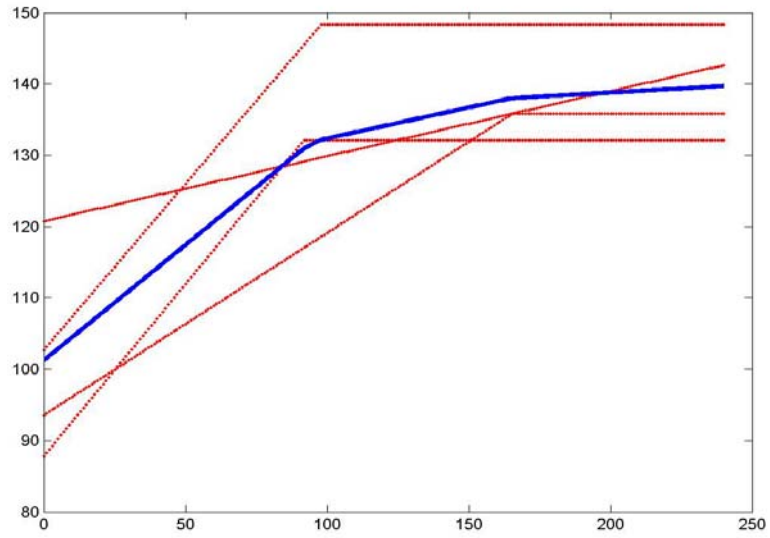
701 Garden City corn after corn (1994-1997)



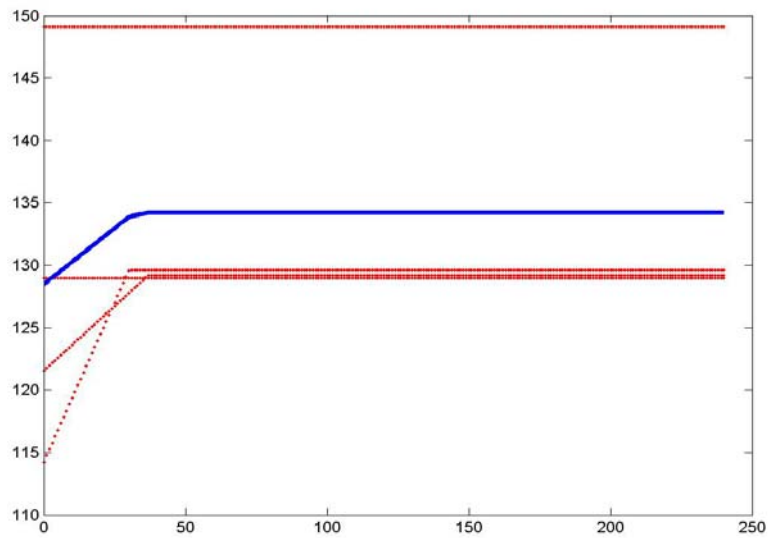
702 Garden City corn after soybeans (1994-1997)



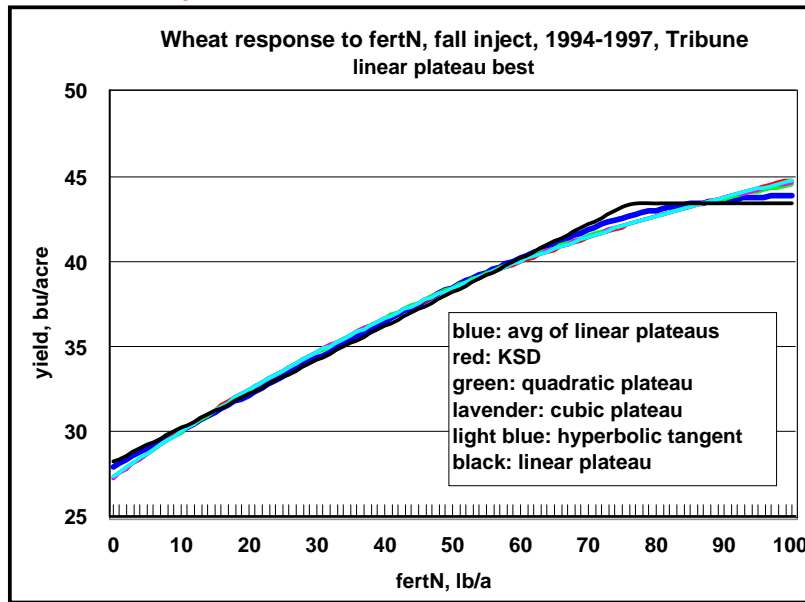
801 Garden City milo after milo (1994-1997)



802 Garden City milo after soybeans (1994-1997)



Here, a linear plateau fit blue line the best



Here, a quadratic plateau fit blue line the best

