

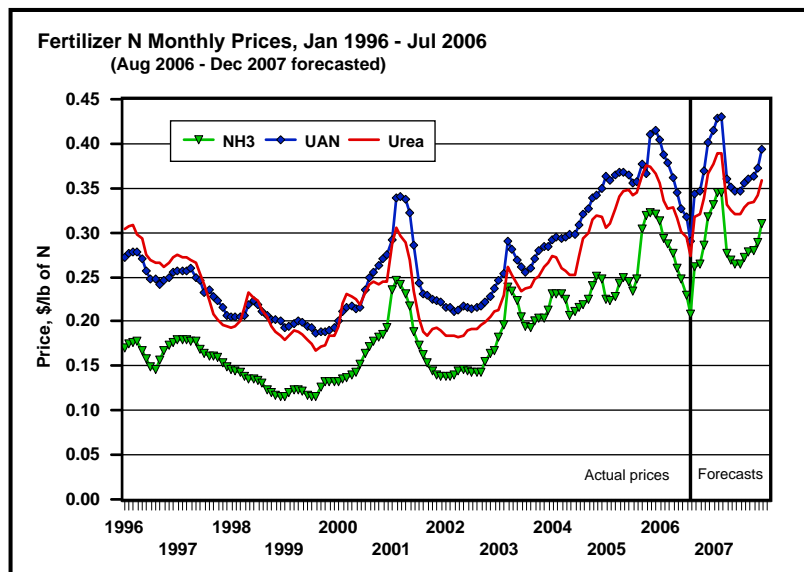
Adjusting Irrigation and N Rates for High Energy and Fertilizer Costs

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Department of Agricultural Economics and SWREC
Kansas State University
2006 Limited Irrigation Field Day
August 16, 2006. Tribune, KS



Historical and forecasted nitrogen prices, Corn Belt



Prices have been falling throughout 2006, unfortunately forecasts suggest prices could increase back to previous highs.

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

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

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

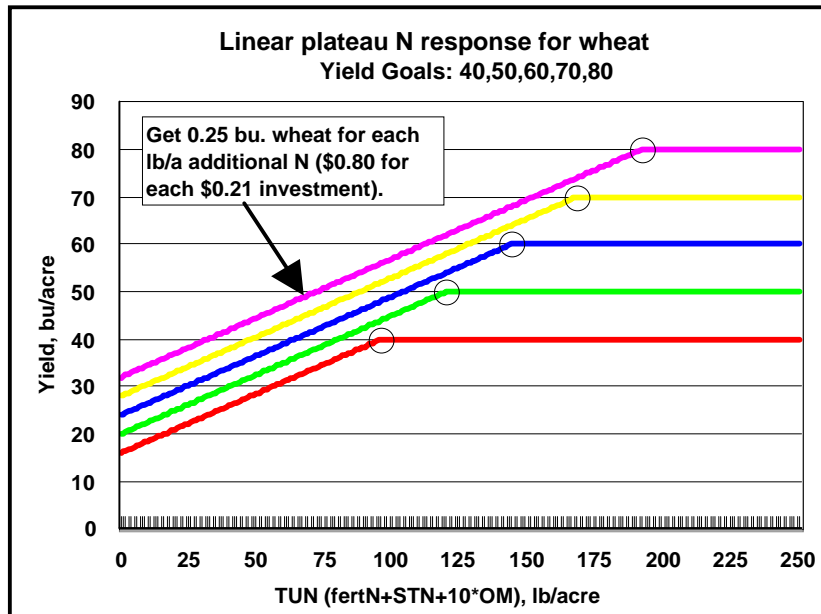
$N \text{ rec} = (\text{Yield Goal} \times 0.075) - (\%SOM \times 20) - \text{Profile N} - \text{Manure N} - \text{Other N Adjustments}$
+ Previous Crop Adjustments

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

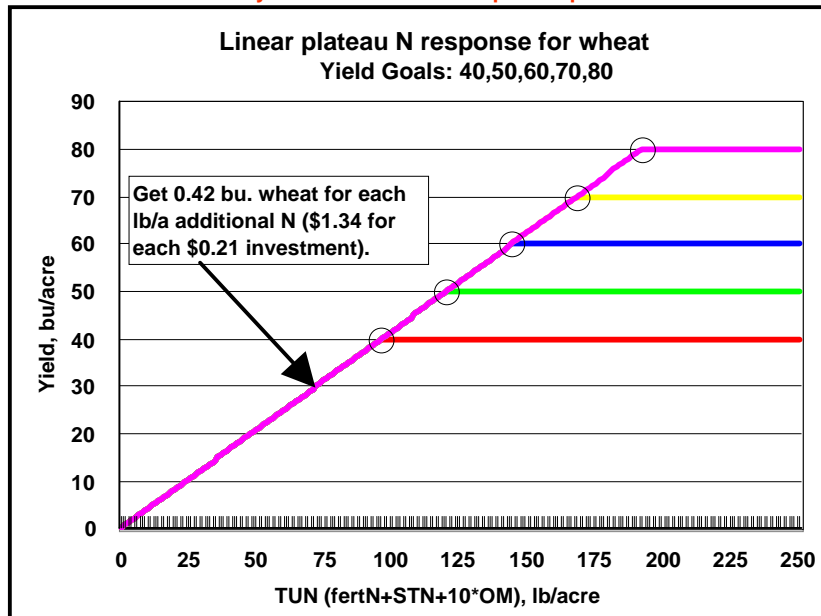
Nitrogen production function...

- 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



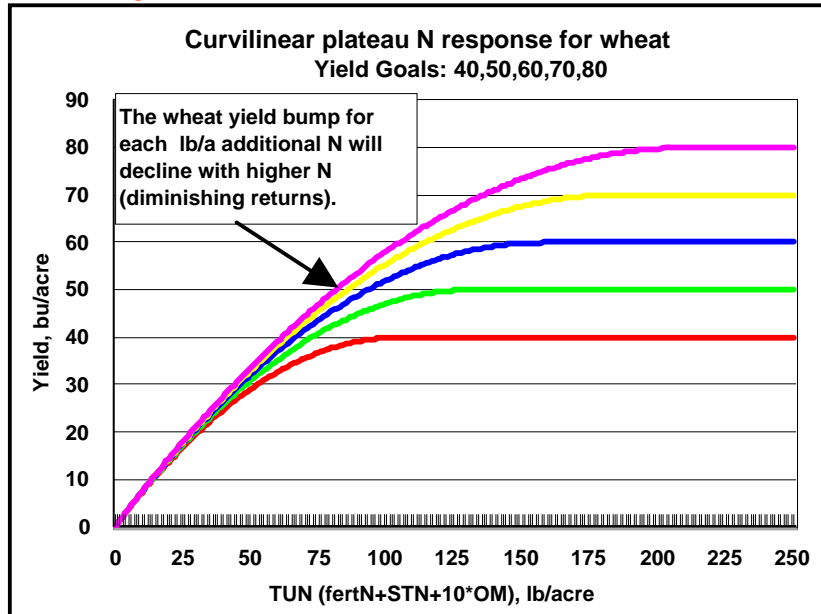
Price won't matter until fertN = \$0.80/lb, then optimal is 0 lb/acre

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

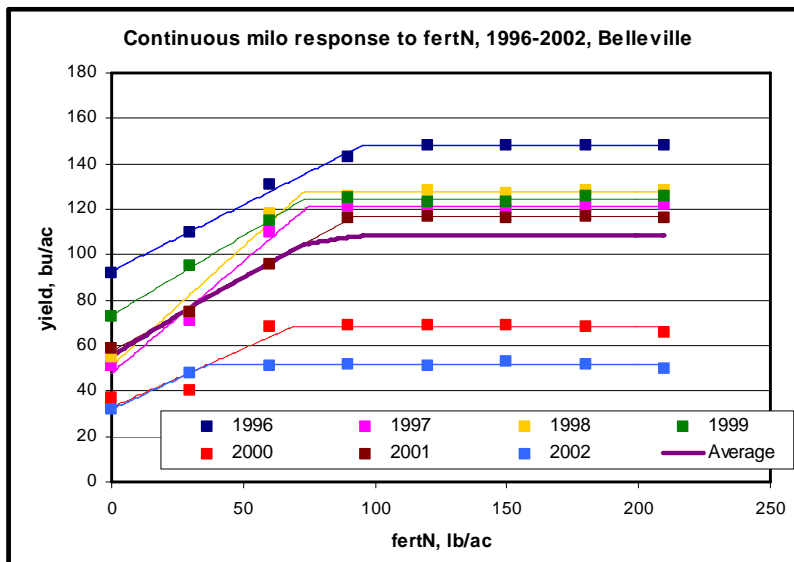
Functions might be curvilinear



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

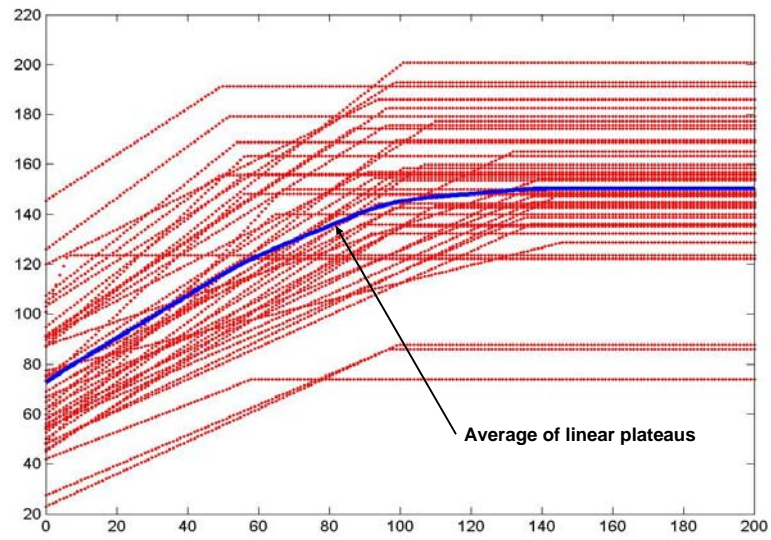


Yield response by year – linear plateau “fits” data quite well...



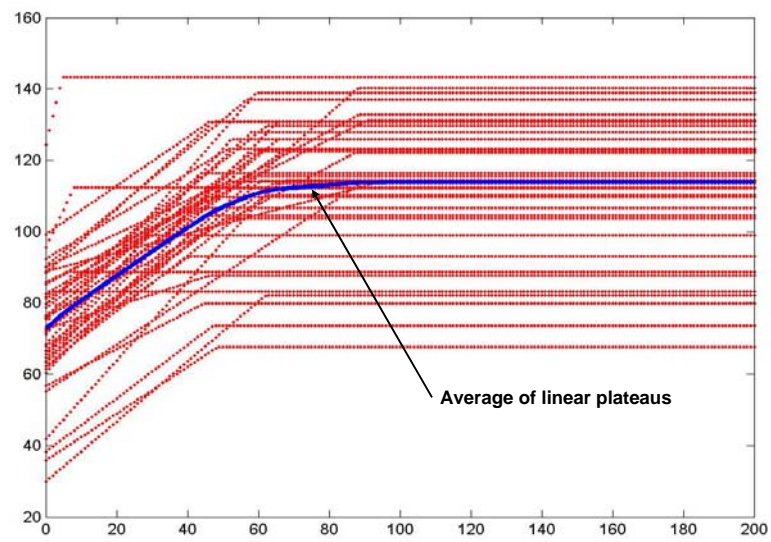
... average (expectation) of linear plateaus can become non-linear.

Tribune corn (1961-2004)



The more years included, the "smoother" the average of the linear plateaus becomes...

Tribune milo (1961-2004)



The more years included, the "smoother" the average of the linear plateaus becomes...

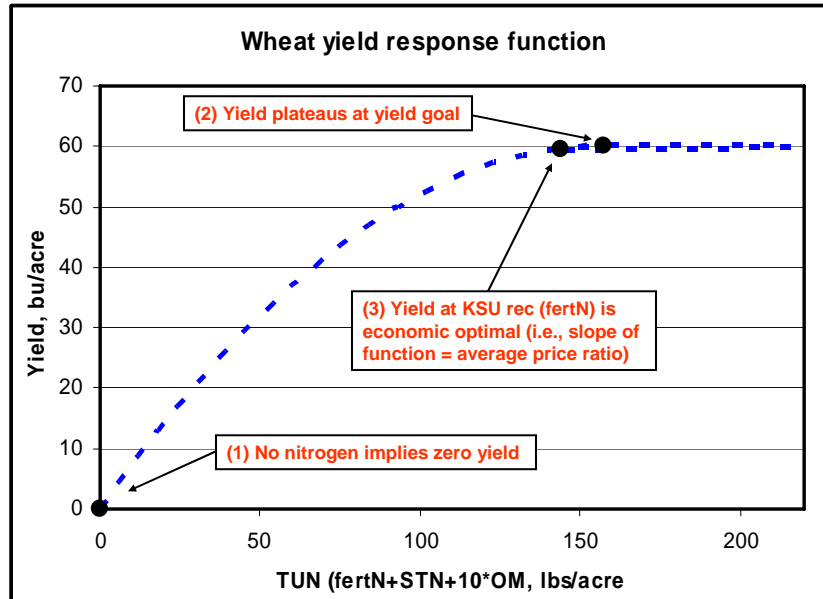
Functional form...

- 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

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...



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).

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Estimated production functions have been imbedded in Excel spreadsheet

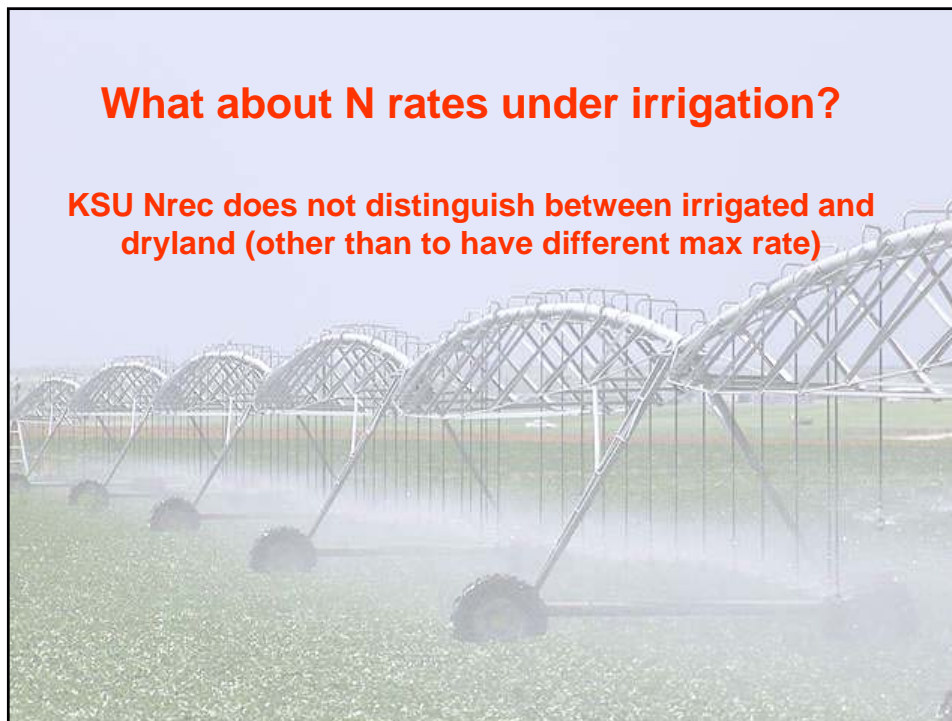
Microsoft Excel - KSU-CropBudgets2006(2006R6P).xls

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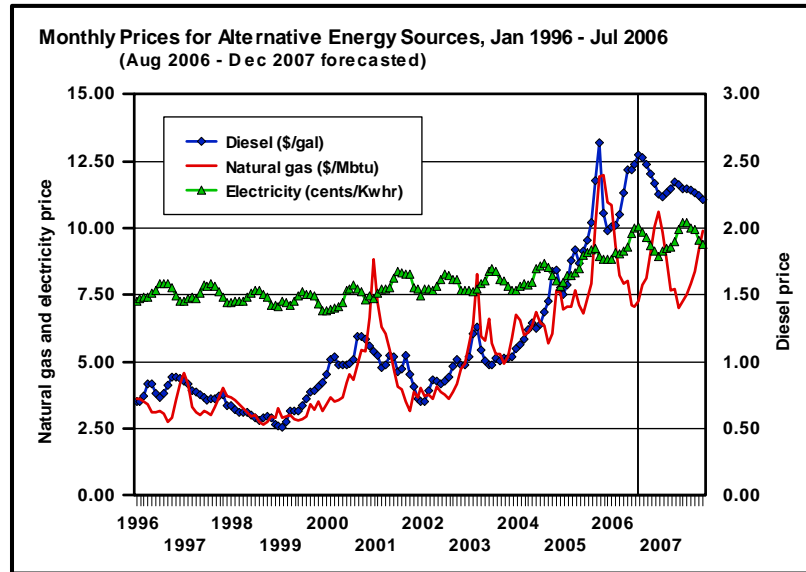
Reply with Changes... End Revisions

	A	B	C	D	E	F	G	H	I	J	K
2	Comparison of Crop Returns with Nitrogen Fertilizer and Irrigation Water at Economic Optimum Levels										
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	0.0			
18	Yield at optimal N and I, bu/ac		44.5	215.2	79.1	36.0	2776.1	---			
20	INCOME PER ACRE										
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	COSTS PER ACRE										
29	4 Seed		\$7.20	\$20.68	\$10.48	\$24.50	\$10.40	\$11.42			

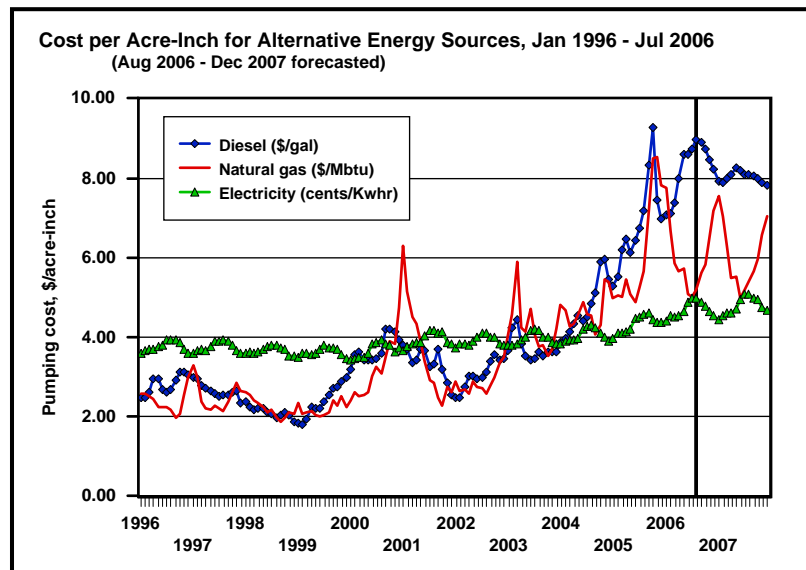
User provided inputs determine N rates.



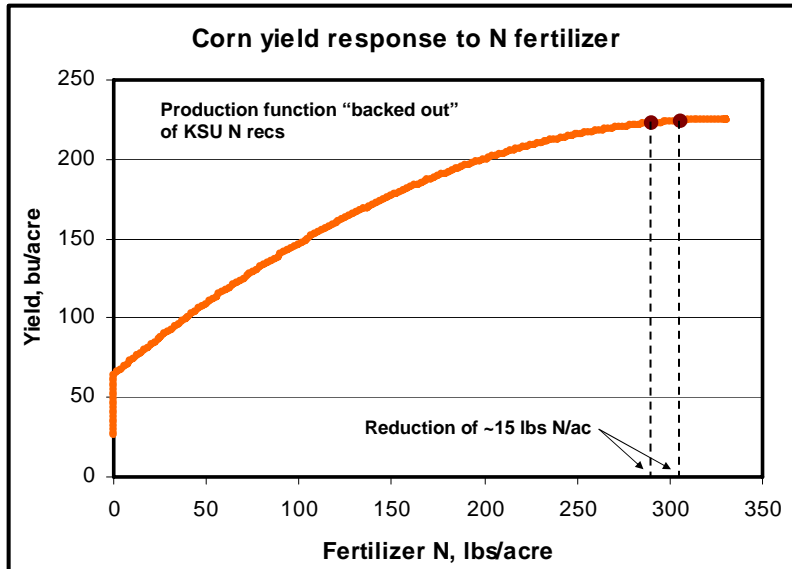
Historical and forecasted energy prices



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

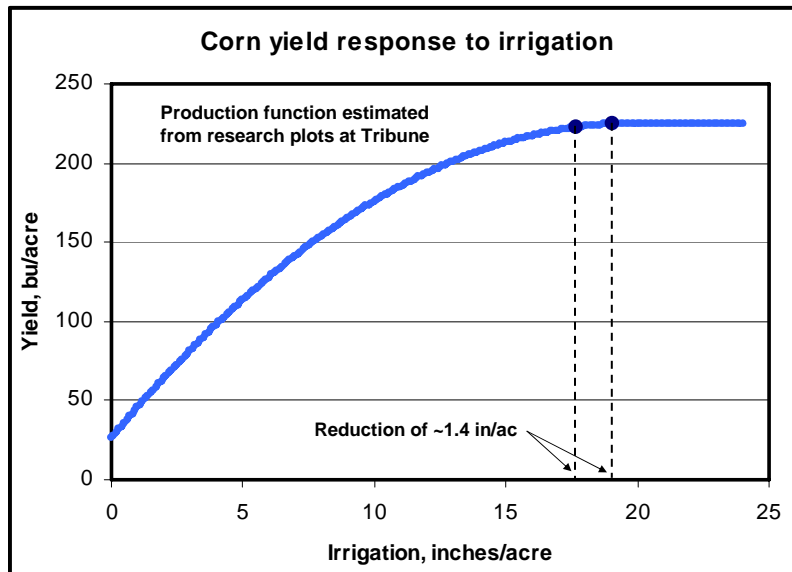


At projected corn prices, change in optimal N is relatively small due to higher N price...



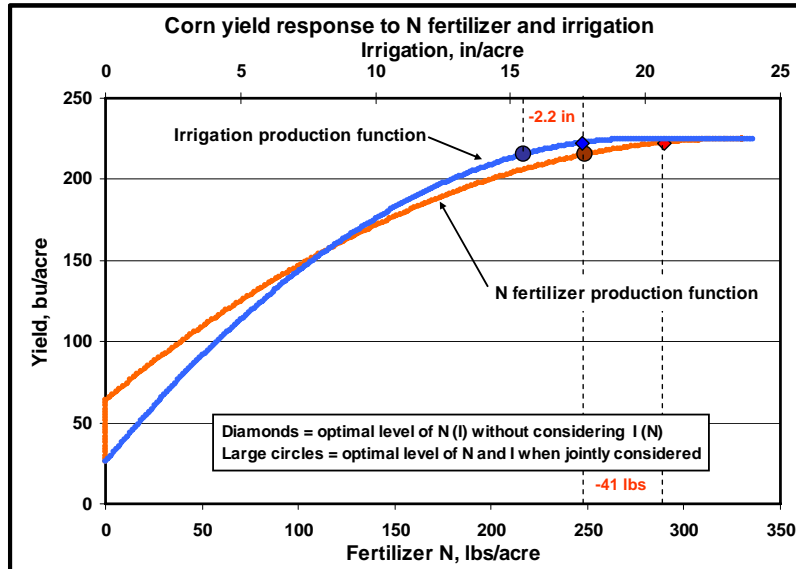
Corn \$2.90/bu; N cost = \$0.21/lb vs. \$0.344/lb

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



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	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*

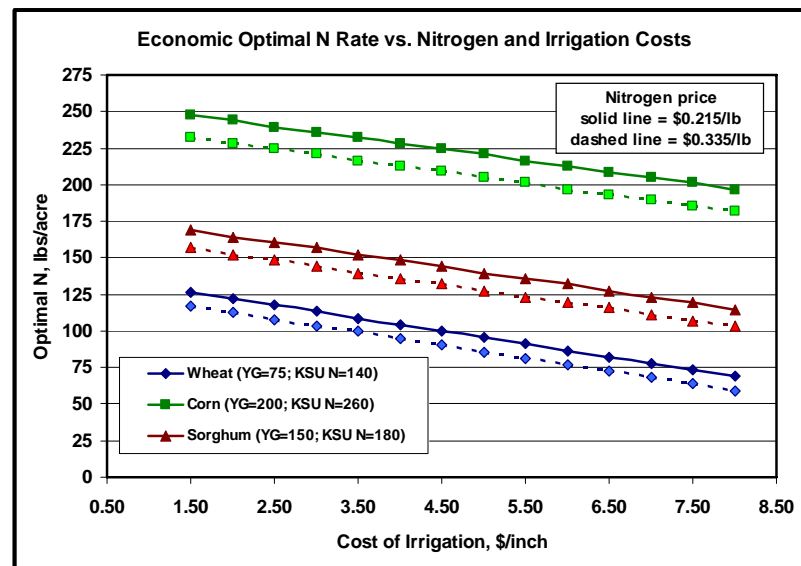
Nitrogen Recommendations for Corn

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)

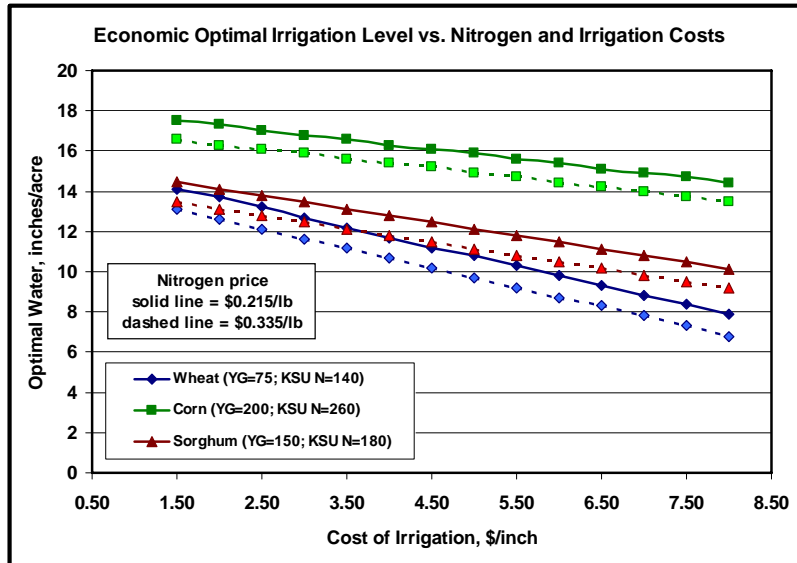
* Optimal rates do not consider irrigation pumping costs

Optimal N rate...



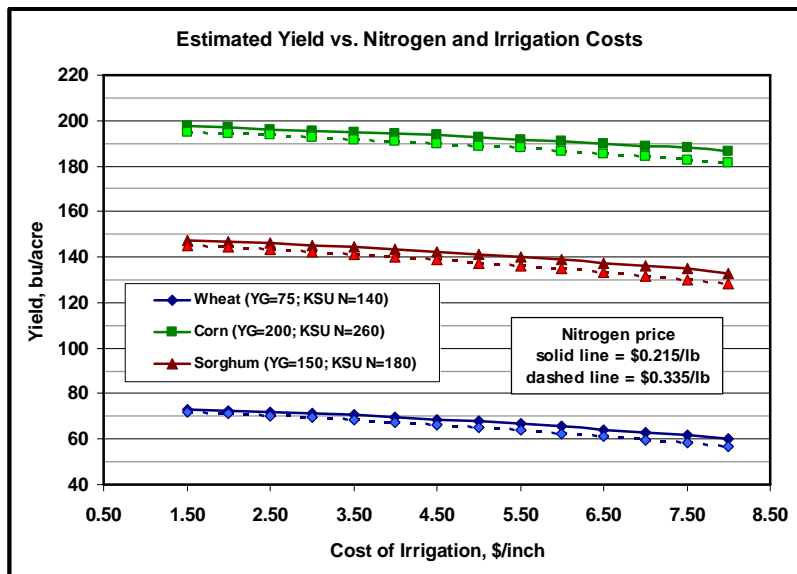
Increase in NUE = 29.6%, 14.3%, 21.7% for wheat, corn, and sorghum, respectively.
 (\$3/ac-in & \$0.215/lb N prices → \$6/ac-in & \$0.335/lb N)

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...



Summary ...

- In order to adjust fertN (irrigation) rates in response to prices, a mathematical relationship between N (water) and yield is needed.
- Quadratic-plateau function allows diminishing returns, but is also consistent with linear plateau within any site-year. A quadratic-plateau function can be “backed out” of KSU N recs.
- 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. However, optimal N rates for irrigated fields are 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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Site Updates

In The Game Markets
August 6, 2006 by Jim Minton,MSU

Livestock Outlook Radio Program
August 7, 2006 by Jim Minton,MSU

Impact of Energy Price Increases on Kansas Non-Irrigated Crop Farms
August 3, 2006 by Langemeier, Park, and Weeden

Updated Crop Basis Tool
August 3, 2006 by Kevin Dwyer

Energy Use in the KS Agricultural Sector
August 3, 2006 by Kasteren et al.

Monthly NH2 and Diesel Price Forecasts
July 27, 2006 by Kevin Dwyer

Dynamics of Change: Must I Grow My Farm?
July 25, 2006 by Kasteren and Dwyer

Crop Basis Maps
July 25, 2006 by Kevin Dwyer

Management Factors: What really matters?
July 29, 2006 by Kasteren and Dwyer

Livestock and Hay Charts
August 6, 2006 by Jim Minton

Excel spreadsheet for estimating animal ID costs
Updated July 6, 2006 by Kevin Dwyer

Seasonality of Futures Prices
July 9, 2006 by Dwyer and Kasteren

Seasonal Prices (Excel spreadsheets) - Crops and Cattle
July 5, 2006 by Kevin Dwyer

Energy Prices and Their Impact on Kansas Irrigated Crop Farms
June 27, 2006 by Park and Langemeier

KSU-Crop Budgets 2006.xls
December 13, 2006 by Dwyer et al.

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Questions ?