Fertilizer Prices / Breakeven Points

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Kansas State University
AG PROFITABILITY CONFERENCE

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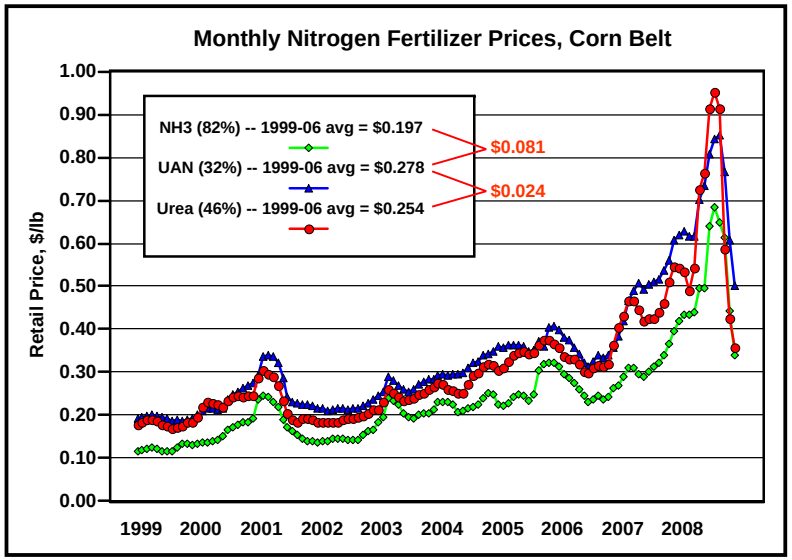
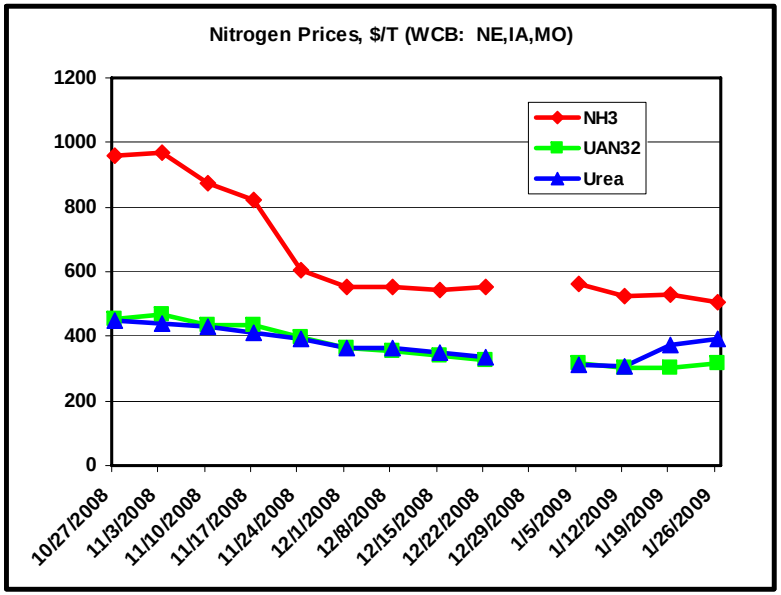
Kansas State University
Department of Agricultural Economics

Fertilizer prices

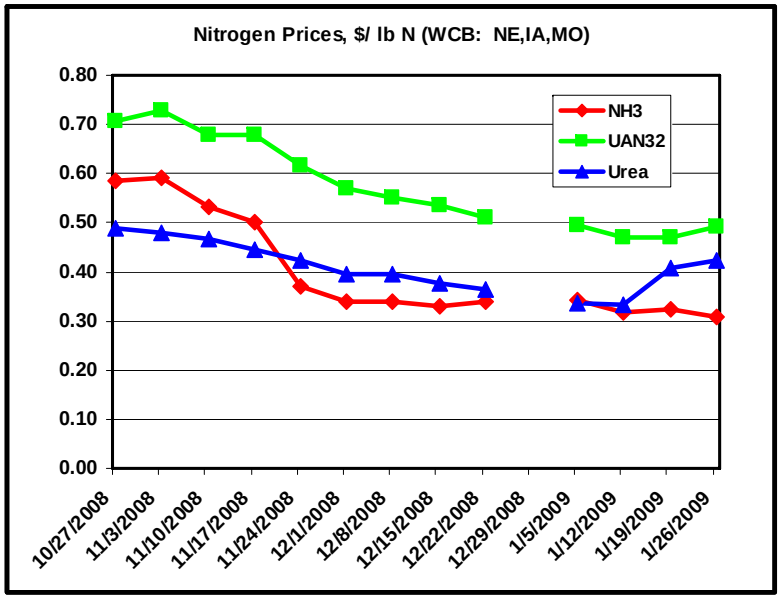
(should you be cutting back on fertilizer rates?)

N prices have fallen recently, but are still significantly above historical averages…



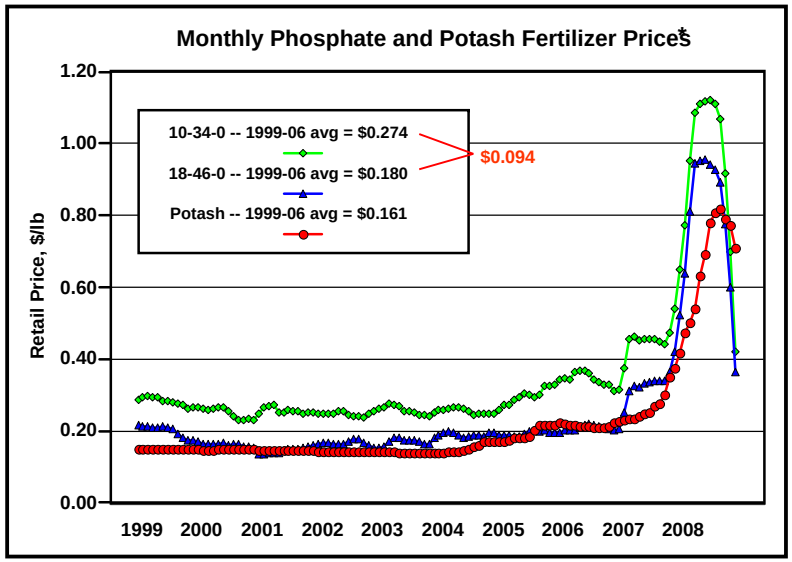


Prices fell off their highs, especially NH3 (big drops in a short time span)

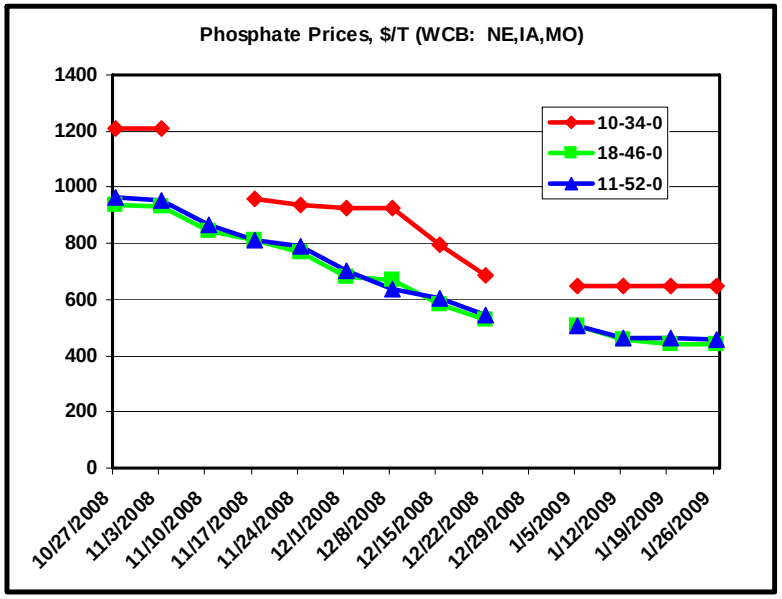


Big differences in prices of N products – urea adjusting to more what we expect?

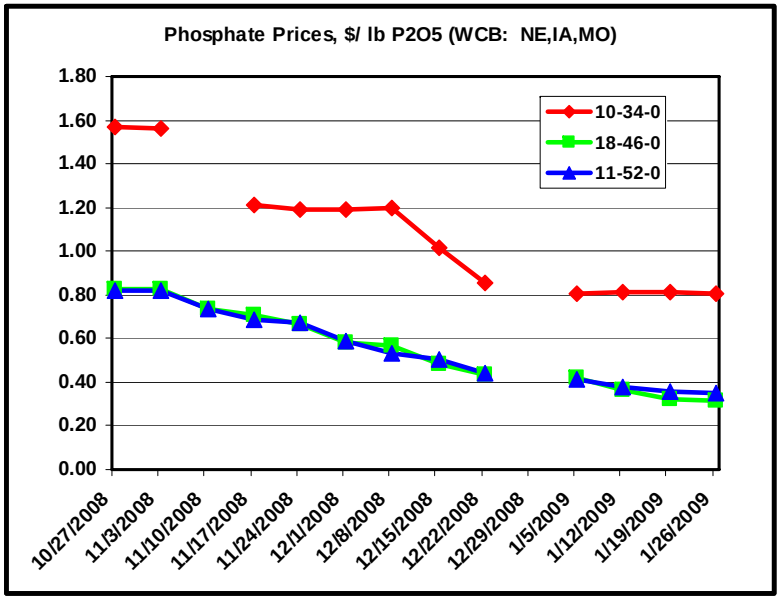
P and K prices have fallen recently, but are still significantly above historical averages…



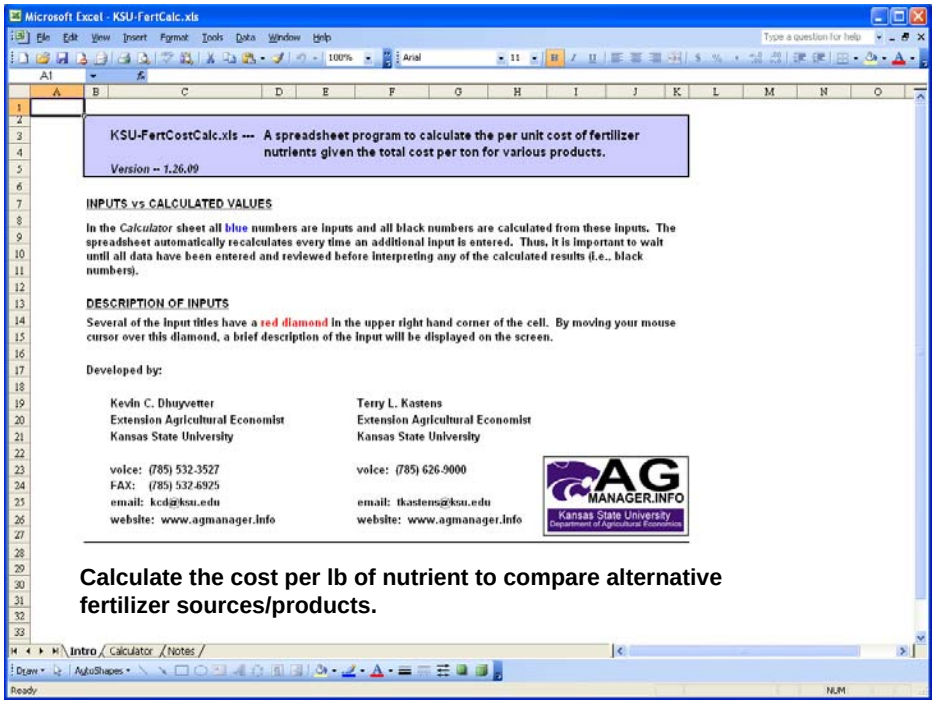
* Price of phosphate is based on blend price less value of N (average of NH3, UAN 32, and Urea prices)



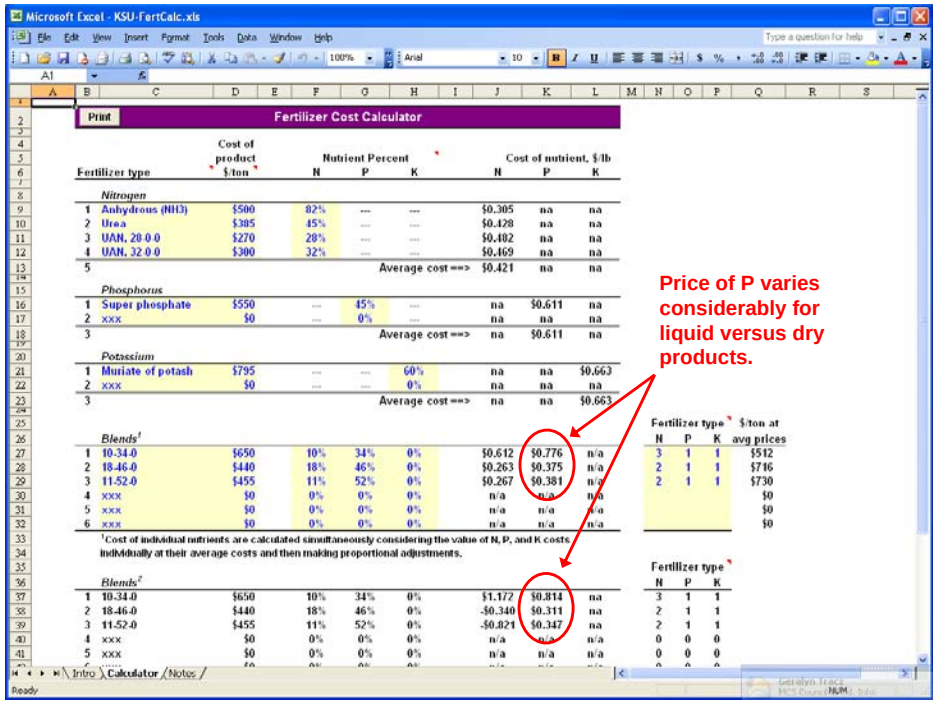
Big differences in prices of P products – how fast will the adjustment be?



Big differences in prices of P products – how fast will the adjustment be?



Calculate the cost per lb of nutrient to compare alternative fertilizer sources/products.

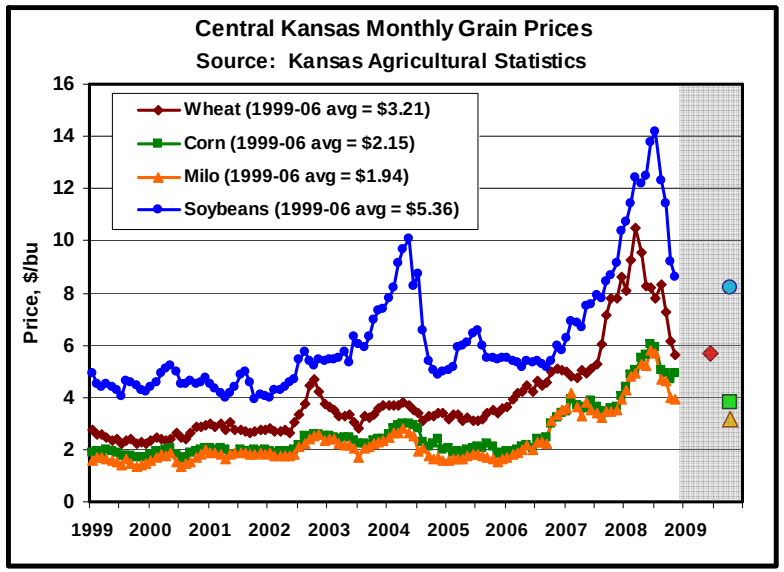


Price of P varies considerably for liquid versus dry products.

What do these high prices imply for fertilizer rates?

. . . perhaps not a great deal if expected crop prices also are really high . . . sort of what we've been preaching the last year and a half

Like fertilizer prices, crop prices have fallen recently, but they are still significantly above historical averages…



So, should we adjust fertilizer rates when fertilizer or crop prices change?

K-STATE Kansas State University
Department of Agronomy
Soil Test Interpretations and Fertilizer Recommendations
MF-2586
Nutrient Management

KSU nitrogen recommendations … no prices

Corn and grain sorghum

N rec = (Yield Goal x 1.6) – (%SOM x 20) – Profile N – Manure N – Other N Adjustments + Previous Crop Adjustments

Wheat

N rec = (Yield Goal x 2.4) – (%SOM x 10) – Profile N – Manure N – Other N Adjustments + Previous Crop Adjustments + Tillage Adjustments + Grazing Adjustments

Sunflowers

N rec = (Yield Goal x 0.075) – (%SOM x 20) – Profile N – Manure N – Other N Adjustments + Previous Crop Adjustments

Kastens, Dhuyvetter, Schlegel, & Dumler started working on this in late 2005 . . .

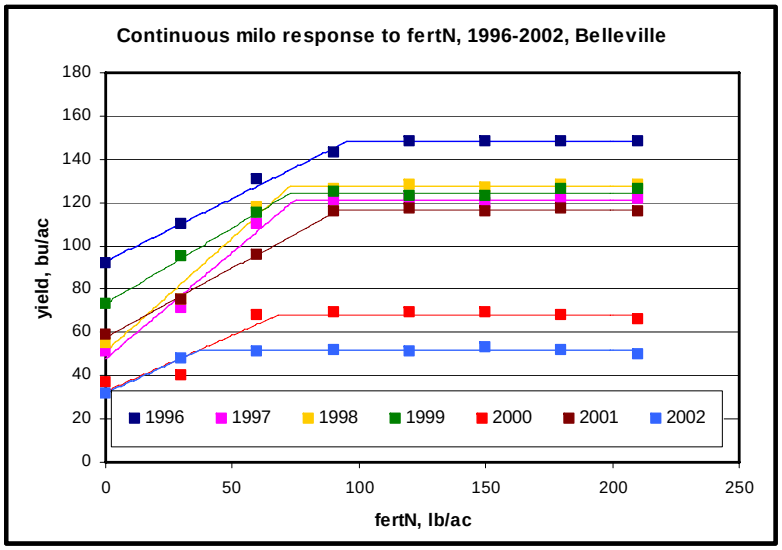
KSU nitrogen recommendations vs. N price

- 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 $3.22/bu
  - Corn $2.35/bu
  - fertN $0.21/lb N (fertP, used later, $0.24/lb P_2O_5)

Nitrogen production function…

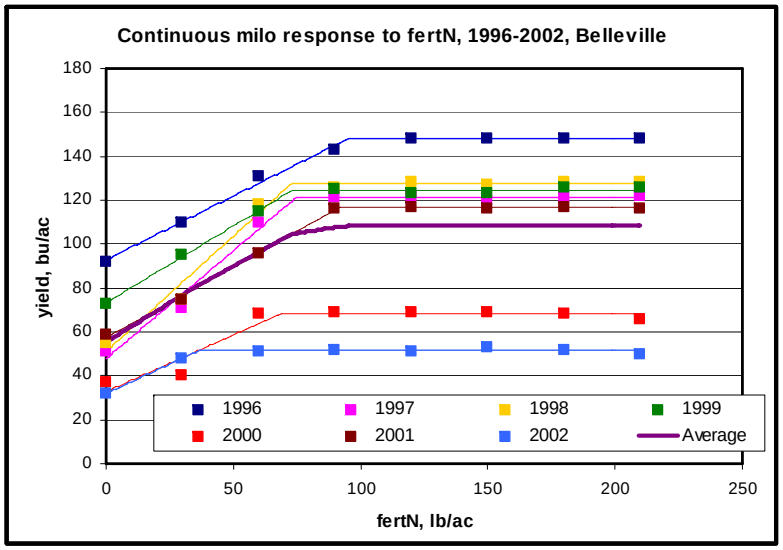
- In a limiting factor framework, it is generally believed that relationship between N and yield is linear for any given year and location (implies linear plateau production function)
- Linear plateau production function implies that optimal N will either be 0 or level where yield plateaus
- Average of multiple linear plateau production functions can be non-linear and this represents expectations of future N:yield relationship

Yield response by year – linear plateau "fits" data quite well…



What would yield be for given fertN next year?

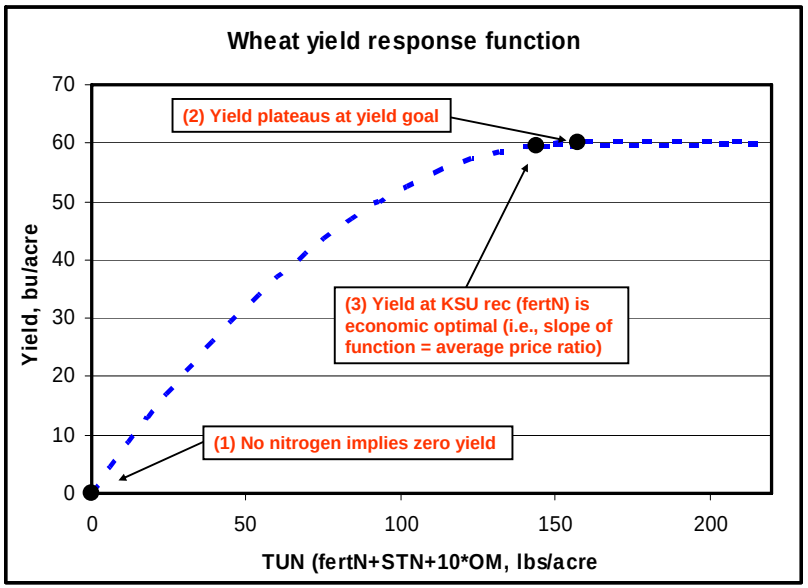
Average of linear plateaus can become non-linear…



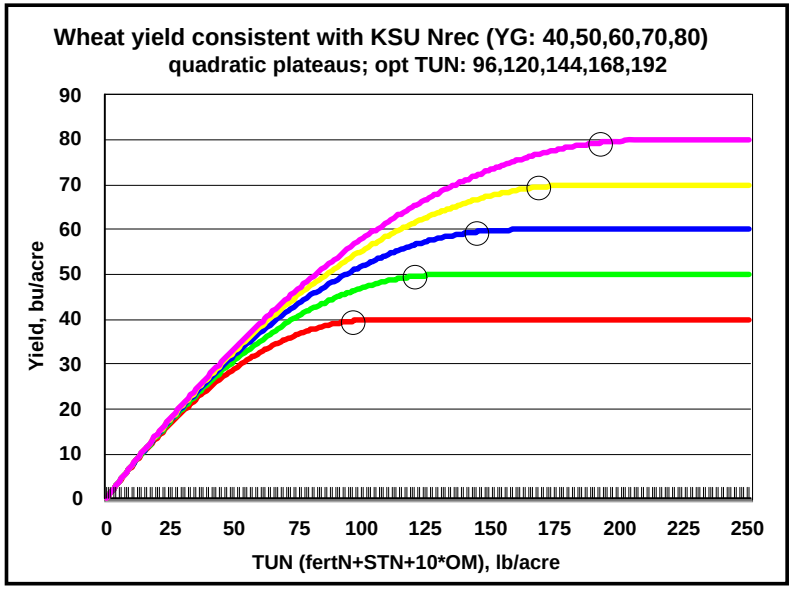
Nitrogen production function…

- 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)

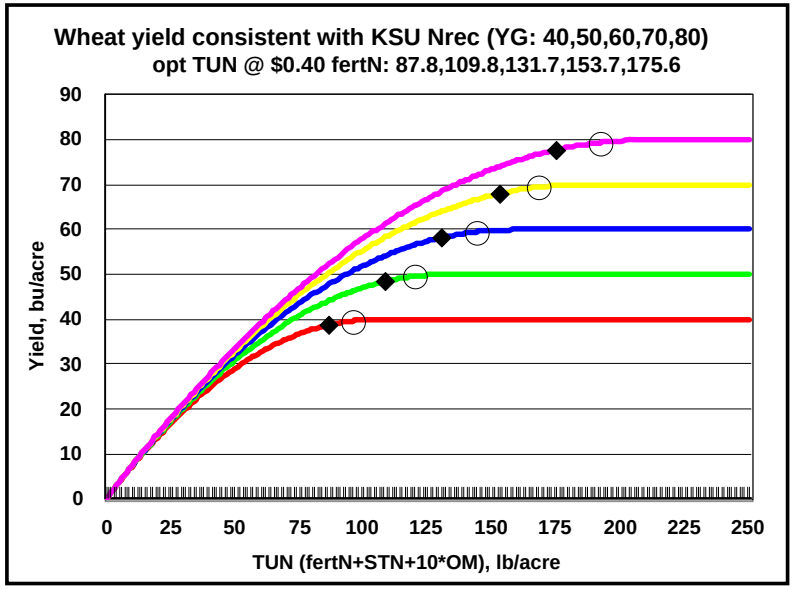
Defined points that allowed quadratic-plateau function to be defined…



Same optimal N (slope there = 0.21/3.22) but yields about 1% lower than plateau



Slope at diamonds is 0.40/3.22



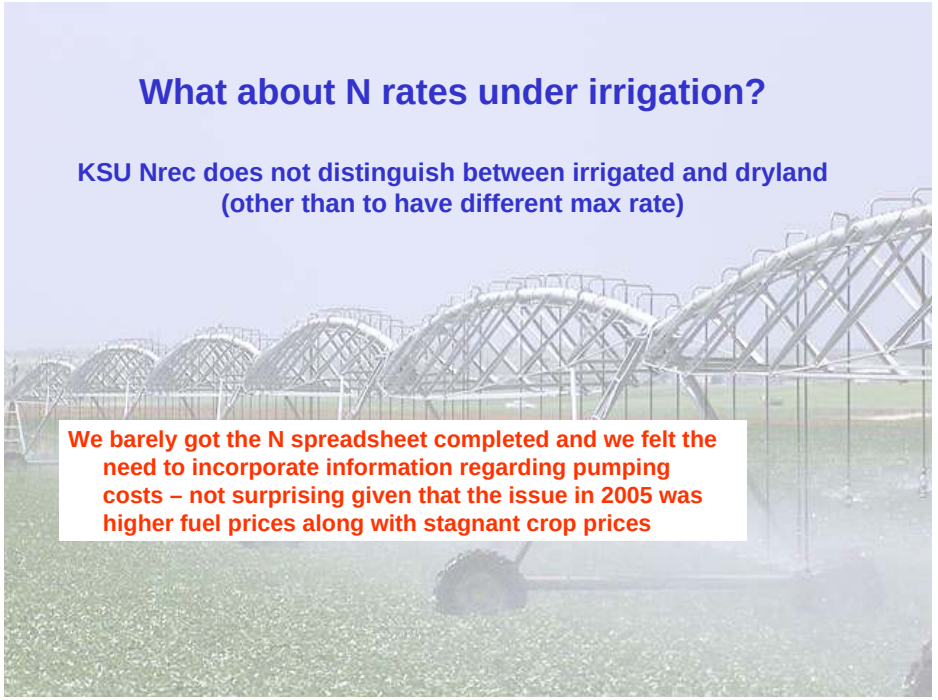
With more expensive N, you make more money by applying less

Operationalizing production function…

- Everything was embedded in an Excel spreadsheet so that users could determine optimal fertilizer N rates based on fertilizer N prices and crop prices
- We could use the spreadsheet to recommend some "typical" percentage cutbacks on fertilizer – dealers had been requesting such info throughout 2005

What about N rates under irrigation?

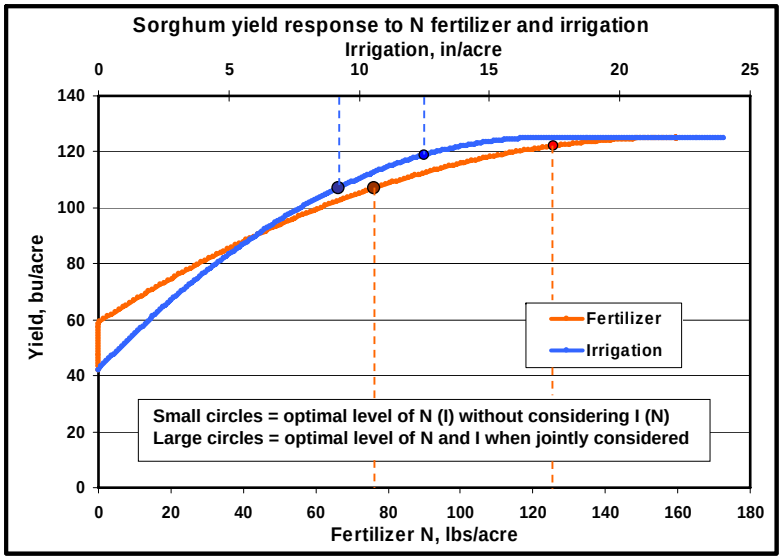
KSU Nrec does not distinguish between irrigated and dryland (other than to have different max rate)



We barely got the N spreadsheet completed and we felt the need to incorporate information regarding pumping costs – not surprising given that the issue in 2005 was higher fuel prices along with stagnant crop prices

- **KSU N recs don't distinguish between irrigators and non-irrigators, which means:**
  - **Recommended N rates assume water is not limiting yield (or that producer picks a reduced yield goal based on water cost)**
- **With high pumping cost and high N prices and low crop prices, our spreadsheet recommended large cutbacks in both N and irrigation water**

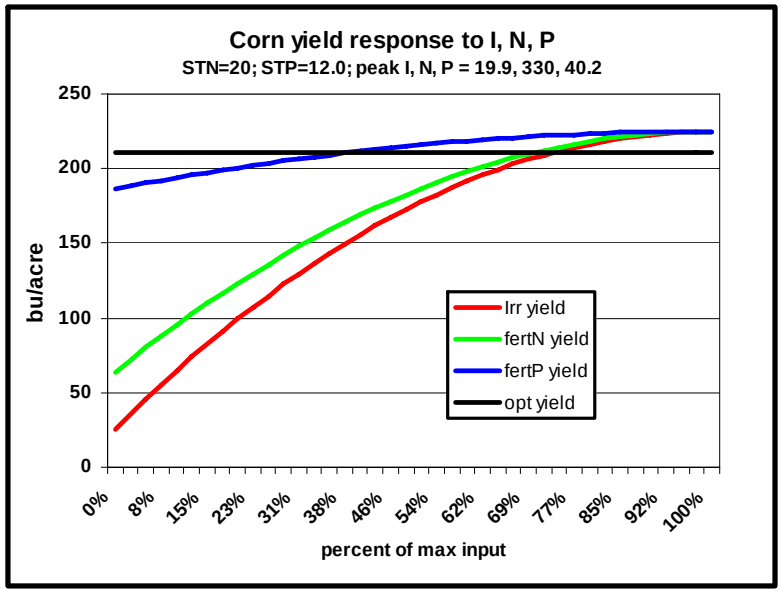
When considering irrigation and N together, optimal values decrease significantly…



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

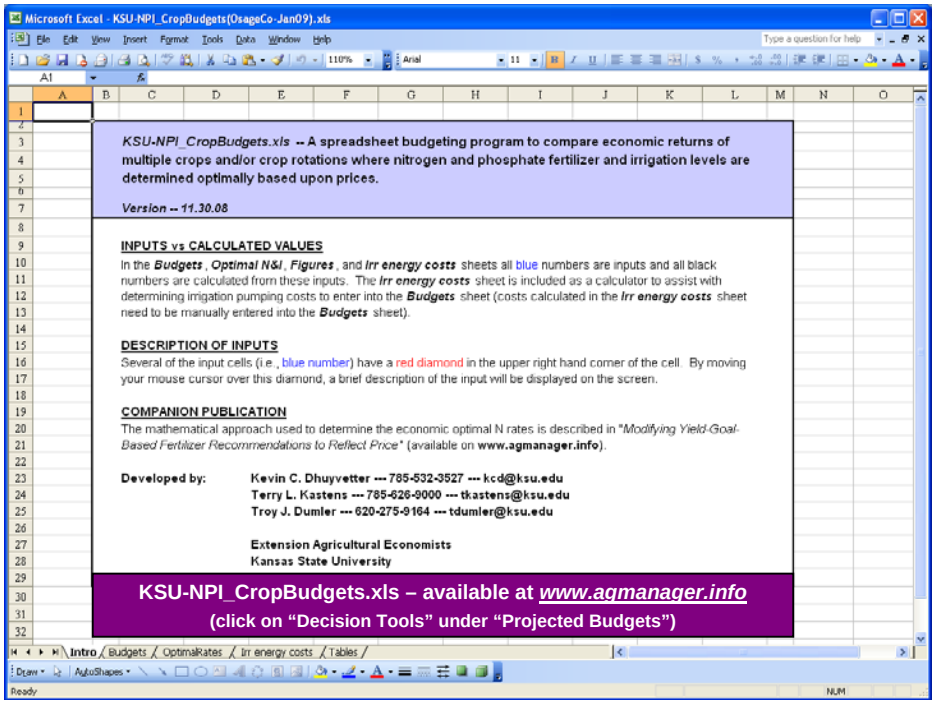
Late summer early Fall 2008 …

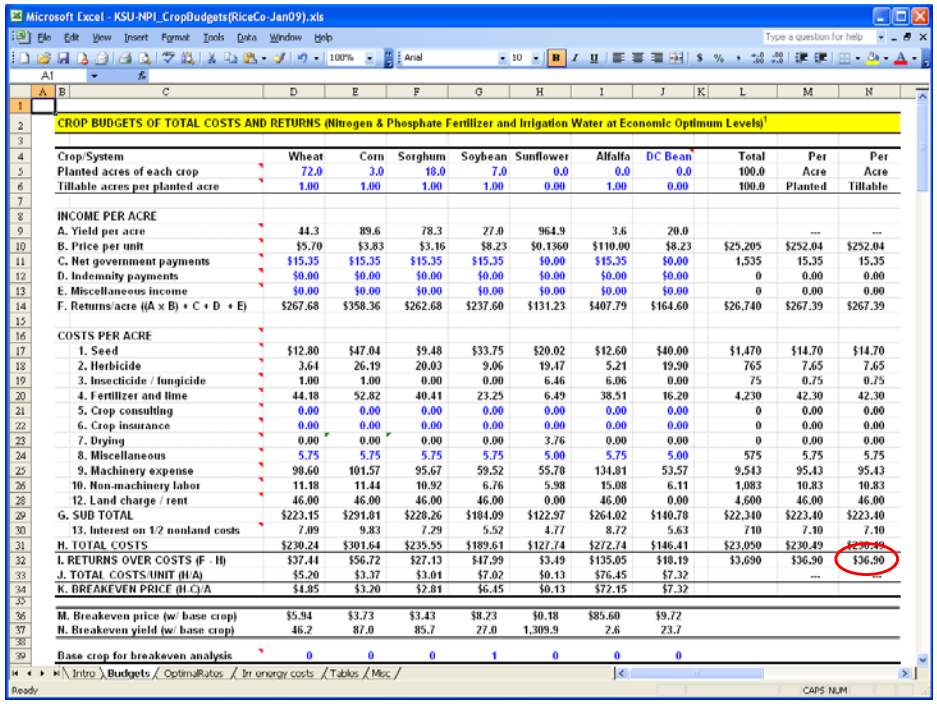
- **Very high fertilizer prices and not just N**
- **Falling crop prices**
- **Producers asking about price-based adjustments again, especially related to high P prices ($1.20/lb P2O5??)**
- **And so we adjust the decision spreadsheet again… …this time incorporating P**
  - **Use MF-2586 sufficiency P recs**



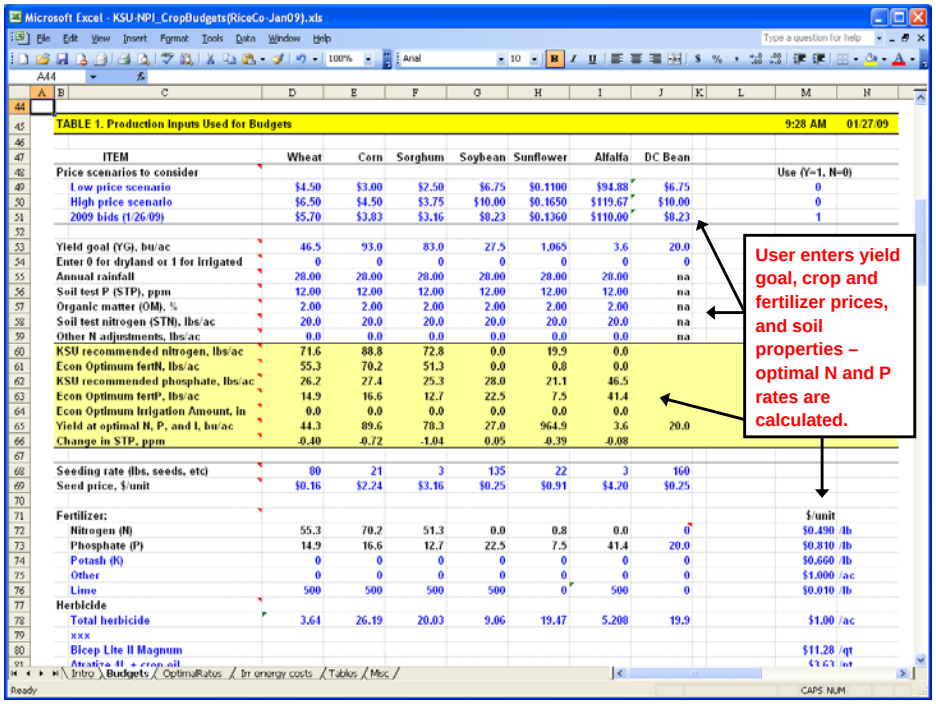
Corn $4.29/bu; N $0.71/lb, P2O5 $1.09/lb, irrigation cost = $6.00/in (20 in rain; YG=225)

MF-2586 recs: 300 lb N, 38.0 P2O5; optimal rates: 13.1 in water, 226.9 lb N, 14.5 lb P2O5

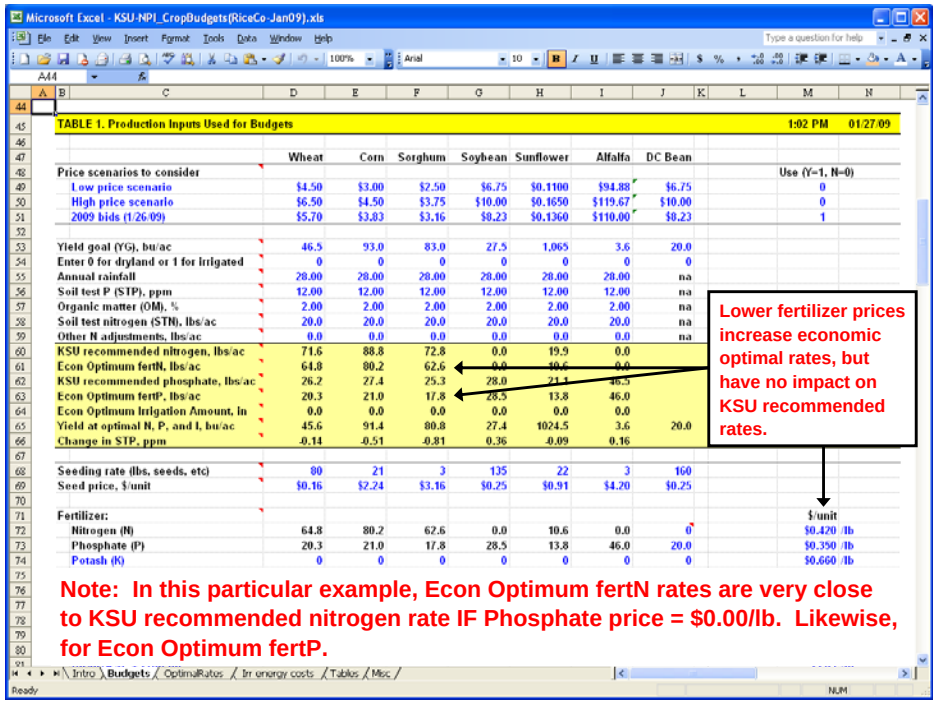




Crop/System	Wheat	Corn	Sorghum	Soybean	Sunflower	Alfalfa	DC Bean	Total	Per Acre Planted	Per Acre Tillable
Planted acres of each crop	72.0	3.0	18.0	7.0	0.0	0.0	0.0	100.0		
Tillable acres per planted acre	1.00	1.00	1.00	1.00	0.00	1.00	0.00	100.0		
INCOME PER ACRE										
A. Yield per acre	44.3	89.6	78.3	27.0	964.9	3.6	20.0		---	---
B. Price per unit	$5.70	$3.83	$3.16	$8.23	$0.1360	$110.00	$8.23	$25,205	$252.04	$252.04
C. Net government payments	$15.35	$15.35	$15.35	$15.35	$0.00	$15.35	$0.00	1,535	15.35	15.35
D. Indemnity payments	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0	0.00	0.00
E. Miscellaneous income	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0	0.00	0.00
F. Returns/acre ((A x B) + C + D + E)	$267.68	$358.36	$262.68	$237.60	$131.23	$407.79	$164.60	$26,740	$267.39	$267.39
COSTS PER ACRE										
1. Seed	$12.80	$47.04	$9.48	$33.75	$20.02	$12.60	$40.00	$1,470	$14.70	$14.70
2. Herbicide	3.61	26.19	20.03	9.06	19.47	5.21	19.90	765	7.65	7.65
3. Insecticide / fungicide	1.00	1.00	0.00	0.00	6.46	6.06	0.00	75	0.75	0.75
4. Fertilizer and lime	44.18	52.82	40.41	23.25	6.49	38.51	16.20	4,230	42.30	42.30
5. Crop consulting	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00
6. Crop insurance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00
7. Drying	0.00	0.00	0.00	0.00	3.76	0.00	0.00	0	0.00	0.00
8. Miscellaneous	5.75	5.75	5.75	5.75	5.00	5.75	5.00	575	5.75	5.75
9. Machinery expense	90.60	101.57	95.67	59.52	55.78	134.81	53.57	9,543	95.43	95.43
10. Non-machinery labor	11.18	11.44	10.92	6.76	5.98	15.08	6.11	1,083	10.83	10.83
12. Land charge / rent	46.00	46.00	46.00	46.00	0.00	46.00	0.00	4,600	46.00	46.00
G. SUB TOTAL	$223.15	$291.81	$228.26	$184.09	$122.97	$264.02	$140.78	$22,340	$223.40	$223.40
13. Interest on 1/2 nonland costs	7.09	9.83	7.29	5.52	4.77	8.72	5.63	710	7.10	7.10
H. TOTAL COSTS	$230.24	$301.64	$235.55	$189.61	$127.74	$272.74	$146.41	$23,050	$230.49	$230.49
I. RETURNS OVER COSTS (F - H)	$37.44	$56.72	$27.13	$47.99	$3.49	$135.05	$18.19	$3,690	$36.90	$36.90
J. TOTAL COSTS/UNIT (H/A)	$5.20	$3.37	$3.01	$7.02	$0.13	$76.45	$7.32		---	---
K. BREAKEVEN PRICE (H-C)/A	$4.85	$3.20	$2.81	$6.45	$0.13	$72.15	$7.32			
M. Breakeven price (w/ base crop)	$5.94	$3.73	$3.43	$8.23	$0.18	$85.60	$9.72			
N. Breakeven yield (w/ base crop)	46.2	87.0	85.7	27.0	1,309.9	2.6	23.7			
Base crop for breakeven analysis	0	0	0	1	0	0	0			



ITEM	Wheat	Corn	Sorghum	Soybean	Sunflower	Alfalfa	DC Bean		
Price scenarios to consider								Use (Y=1, N=0)	
Low price scenario	$4.50	$3.00	$2.50	$6.75	$0.1100	$94.88	$6.75	0	
High price scenario	$6.50	$4.50	$3.75	$10.00	$0.1650	$119.67	$10.00	0	
2009 bids (1/26/09)	$5.70	$3.83	$3.16	$8.23	$0.1360	$110.00	$8.23	1	
Yield goal (YG), bu/ac	46.5	93.0	83.0	27.5	1,065	3.6	20.0		
Enter 0 for dryland or 1 for Irrigated	0	0	0	0	0	0	0		
Annual rainfall	28.00	28.00	28.00	28.00	28.00	28.00	na		
Soil test P (STP), ppm	12.00	12.00	12.00	12.00	12.00	12.00	na		
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00	2.00	na		
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0	20.0	na		
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0	0.0	na		
KSU recommended nitrogen, lbs/ac	71.6	88.8	72.8	0.0	19.9	0.0			
Econ Optimum fertN, lbs/ac	55.3	70.2	51.3	0.0	0.8	0.0			
KSU recommended phosphate, lbs/ac	26.2	27.4	25.3	28.0	21.1	46.5			
Econ Optimum fertP, lbs/ac	14.9	16.6	12.7	22.5	7.5	41.4			
Econ Optimum Irrigation Amount, in	0.0	0.0	0.0	0.0	0.0	0.0			
Yield at optimal N, P, and I, bu/ac	44.3	89.6	78.3	27.0	964.9	3.6	20.0		
Change in STP, ppm	-0.40	-0.72	-1.04	0.05	-0.39	-0.08			
Seeding rate (lbs, seeds, etc)	80	21	3	135	22	3	160		
Seed price, $/unit	$0.16	$2.24	$3.16	$0.25	$0.91	$4.20	$0.25		
Fertilizer:								$/unit	
Nitrogen (N)	55.3	70.2	51.3	0.0	0.8	0.0	0	$0.490	/lb
Phosphate (P)	14.9	16.6	12.7	22.5	7.5	41.4	20.0	$0.810	/lb
Potash (K)	0	0	0	0	0	0	0	$0.660	/lb
Other	0	0	0	0	0	0	0	$1.000	/ac
Lime	500	500	500	500	0	500	0	$0.010	/lb
Herbicide									
Total herbicide	3.64	26.19	20.03	9.06	19.47	5.208	19.9	$1.00	/ac
xxx									
Bicep Lite II Magnum								$11.28	/qt
Atrazine 4L + crop oil								$3.63	/qt



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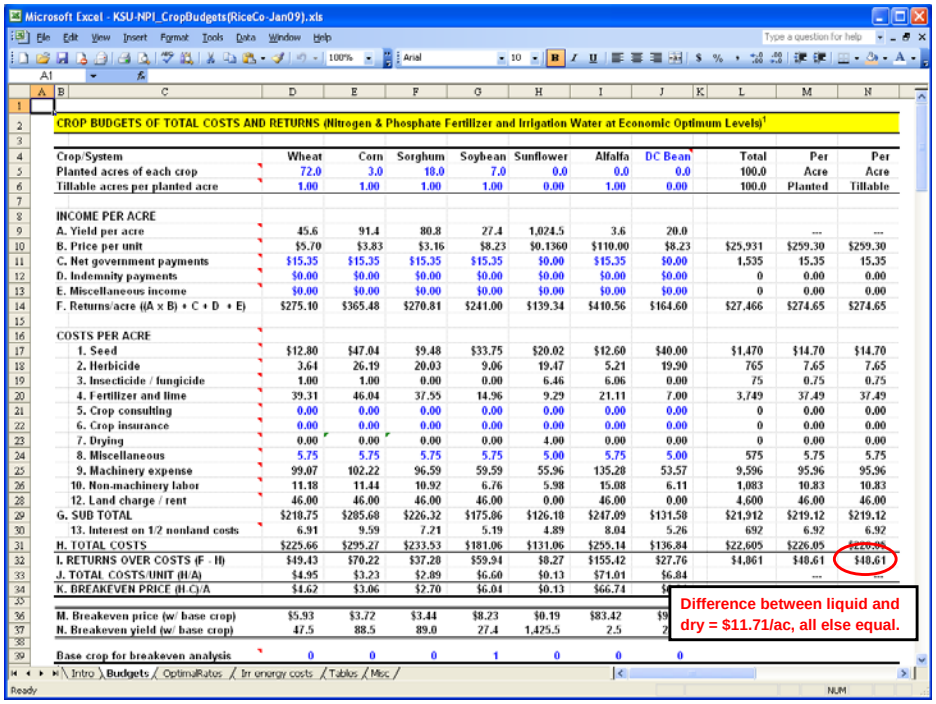
2009 bids (1/26/09)	$5.70	$3.83	$3.16	$8.23	$0.1360	$110.00	$8.23	1	
Yield goal (YG), bu/ac	46.5	93.0	83.0	27.5	1,065	3.6	20.0		
Enter 0 for dryland or 1 for Irrigated	0	0	0	0	0	0	0		
Annual rainfall	28.00	28.00	28.00	28.00	28.00	28.00	na		
Soil test P (STP), ppm	12.00	12.00	12.00	12.00	12.00	12.00	na		
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00	2.00	na		
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0	20.0	na		
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0	0.0	na		
KSU recommended nitrogen, lbs/ac	71.6	88.8	72.8	0.0	19.9	0.0			
Econ Optimum fertN, lbs/ac	64.8	80.2	62.6	0.0	10.6	0.0			
KSU recommended phosphate, lbs/ac	26.2	27.4	25.3	28.0	21.1	46.5			
Econ Optimum fertP, lbs/ac	20.3	21.0	17.8	28.5	13.8	46.0			
Econ Optimum Irrigation Amount, in	0.0	0.0	0.0	0.0	0.0	0.0			
Yield at optimal N, P, and I, bu/ac	45.6	91.4	80.8	27.4	1024.5	3.6	20.0		
Change in STP, ppm	-0.14	-0.51	-0.81	0.36	-0.09	0.16			
Seeding rate (lbs, seeds, etc)	80	21	3	135	22	3	160		
Seed price, $/unit	$0.16	$2.24	$3.16	$0.25	$0.91	$4.20	$0.25		
Fertilizer:								$/unit	
Nitrogen (N)	64.8	80.2	62.6	0.0	10.6	0.0	0	$0.420	/lb
Phosphate (P)	20.3	21.0	17.8	28.5	13.8	46.0	20.0	$0.350	/lb
Potash (K)	0	0	0	0	0	0	0	$0.660	/lb



Scenarios considered…

- **Dry versus liquid N & P fertilizer prices**
  - Dry: N = $0.42 and P = $0.35
  - Liquid: N = $0.49 and P = $0.81
- **Three crop price scenarios**

	Wheat	Corn	Sorghum	Soybean
Price scenarios to consider				
Low price scenario	$4.50	$3.00	$2.50	$6.75
High price scenario	$6.50	$4.50	$3.75	$10.00
2009 bids (1/26/09)	$5.70	$3.83	$3.16	$8.23

- **Fertilizer rates**
  - Economic optimal
  - 75% of economic optimal (under fertilize)
  - 125% of economic optimal (over fertilize)

Crop yield at expected 2009 crop prices and various fertilizer scenarios…

Model-Estimated Yield vs Fertilizer Price and Rate (% of economic optimal)						
	Wheat	Corn	Milo	Soybean	Total	Average
Acres	72.0	3.0	18.0	7.0	100.0	
Dry N & P Prices (N=$0.42 and P=$0.35)						
A. Economic optimal rates	45.6	91.4	80.8	27.4		
B. 75% of economic optimal rates (under fertilize)	43.0	87.0	77.0	2		
C. 125% of economic optimal rates (over fertilize)	46.3	92.7	82.3	2		
Liquid N & P Prices (N=$0.49 and P=$0.81)						
D. Economic optimal rates	44.3	89.6	78.3	2		
E. 75% of economic optimal rates (under fertilize)	41.4	84.6	74.2	2		
F. 125% of economic optimal rates (over fertilize)	45.2	91.3	80.0	27.4	xxx	xxx

1) Economic optimal yields are 1-3% higher at lower priced fertilizer (dry).

2) Under-fertilizing results in yields about 5% lower than optimal rate yields.

3) Over-fertilizing results in yields 1-2% higher than optimal rate yields.

Return over costs at expected 2009 crop prices and various fertilizer scenarios…

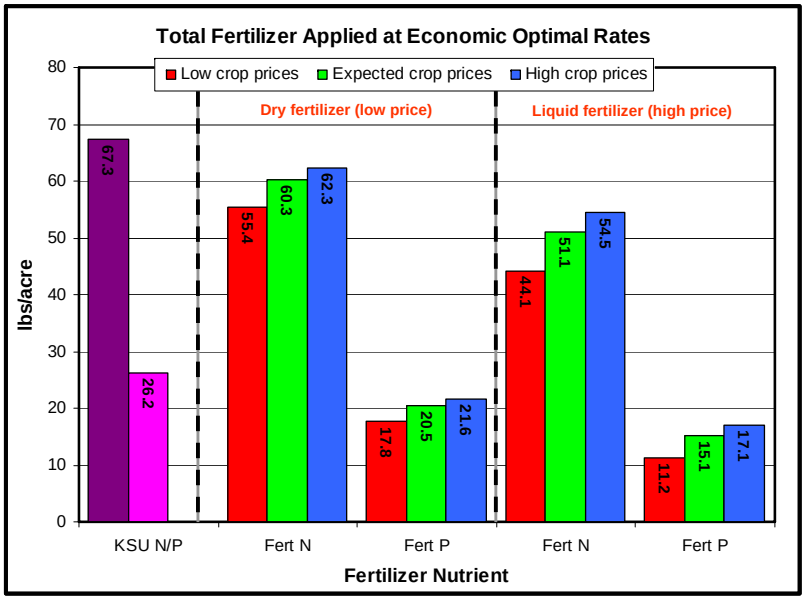
Return Over Costs vs Fertilizer Price and Rate (% of economic optimal)						
	Wheat	Corn	Milo	Soybean	Total	Average
Acres	72.0	3.0	18.0	7.0	100.0	
Dry N & P Prices (N=$0.42 and P=$0.35)						
A. Economic optimal rates	$49.43	$70.22	$37.28	$59.94	$4,861	$48.61
B. 75% of economic optimal rates (under fertilize)	$44.70	$65.45	$35.09	$58.19	$4,454	$44.54
C. 125% of economic optimal rates (over fertilize)	$44.31	$63.98	$32.78	$57.65	$4,376	$43.76
Liquid N & P Prices (N=$0.49 and P=$0.81)						
D. Economic optimal rates	$37.44	$56.72	$27.13	$47.99	$3,690	$36.90
E. 75% of economic optimal rates (under fertilize)	$32.16	$51.84	$24.86	$46.97	$3,247	$32.47
F. 125% of economic optimal rates (over fertilize)	$32.37	$50.38	$22.67	$46.47	$3,215	$32.15

Fertilizer price (dry vs. liquid) has bigger impact on returns than deviations from the optimal rate (over applying is slightly worse than under applying).

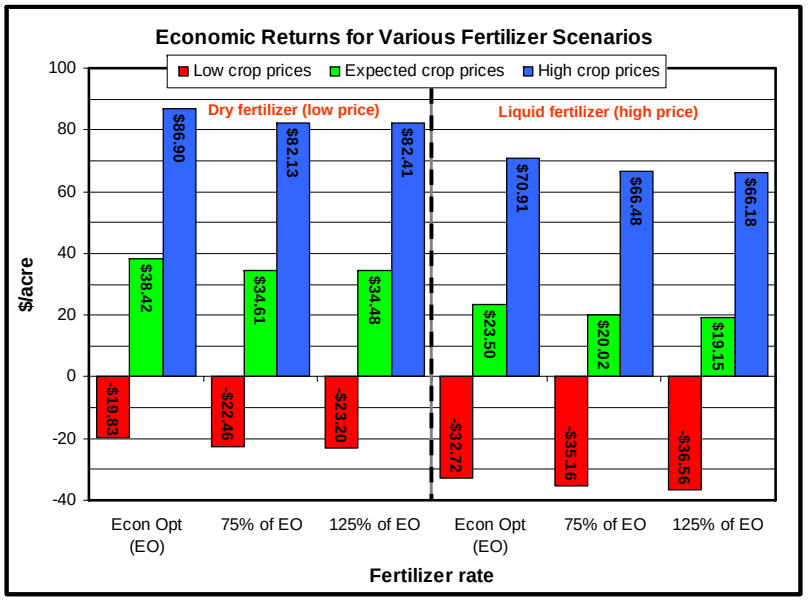
Return over costs at expected 2009 crop prices and various fertilizer scenarios…

Return Over Costs vs Fertilizer Price and Rate (% of economic optimal)						
	Wheat	Corn	Milo	Soybean	Total	Average
Acres	72.0	3.0	18.0	7.0	100.0	
Dry N & P Prices (N=$0.42 and P=$0.35)						KSU rates $46.55
A. Economic optimal rates						
	$49.43	$70.22	$37.28	$59.94	$4,861	$48.61
B. 75% of economic optimal rates (under fertilize)						
	$44.70	$65.45	$35.09	$58.19	$4,454	$44.54
C. 125% of economic optimal rates (over fertilize)						
	$44.31	$63.98	$32.78	$57.65	$4,376	$43.76
Liquid N & P Prices (N=$0.49 and P=$0.81)						KSU rates $29.11
D. Economic optimal rates						
	$37.44	$56.72	$27.13	$47.99	$3,690	$36.90
E. 75% of economic optimal rates (under fertilize)						
	$32.16	$51.84	$24.86	$46.97	$3,247	$32.47
F. 125% of economic optimal rates (over fertilize)						
	$32.37	$50.38	$22.67	$46.47	$3,215	$32.15

Following KSU recommendations is only slightly less profitable at low fertilizer prices, however, much larger difference at high fertilizer prices.



KSU recommended rates are higher in all cases…



Fertilizer prices and rates impact returns, but not near as much as commodity prices…

Side issues with P

- Following MF-2586 N and Precs, depending upon crop and rotation, will end up over time at 11-14 ppm STP
- At crop prices and high fertilizer prices shown (esp P), would end up at much lower STP, perhaps 5-10 ppm
- Seems weird to end up that low but is it wrong?
  - Haven't seen such prices before

Critical issues to think about

- Are MF-2586 rates really predicated on “other factors not limiting?”
- Can we fully compensate for low soil fertility with fertilizer?
- Might application methods and timing modify our results?
- What about using fertilizer P to compensate for low soil pH?

So, what should one do?

- Use the spreadsheet! If your intuition causes you to question the results:
  - Average the results with some other method
  - Use the adjustment factors in the spreadsheet
  - Question your intuition
- Likely, no one would ignore prices forever, i.e., regardless of their levels

There may be bigger issues to consider

- We’re seeing local fertilizer prices vary as much as 2x to 3x from location to location
- Liquid vs. dry – hire custom applicator?
- We expect continued drops in prices but perhaps a spike again next spring since little fertilizer got placed in the fall of 2008
- What about availability?
- Do I trust my provider’s finances?