Crop Production Management

in Volatile Times

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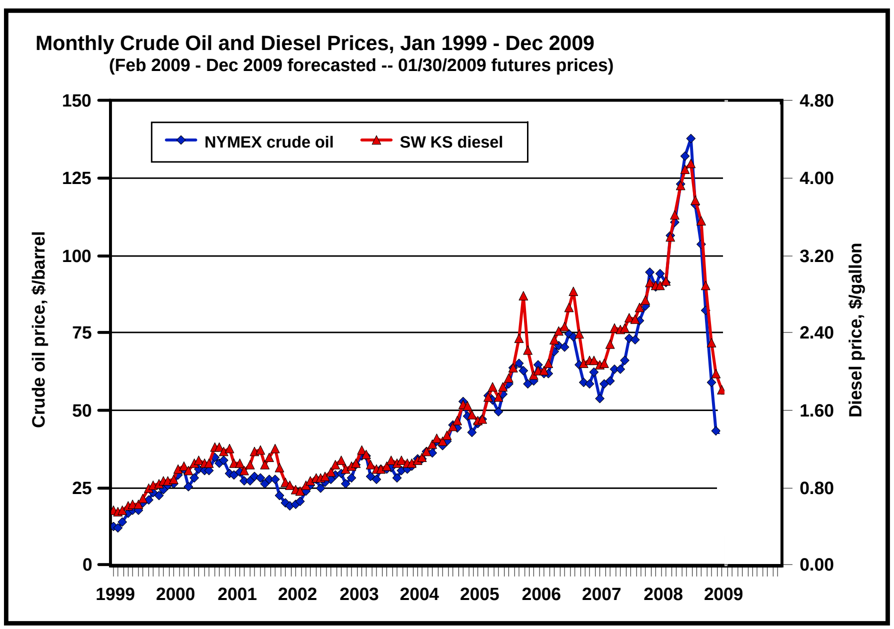
Historical and forecasted oil and diesel fuel prices



Historical relationship suggests that NYMEX crude oil market can be used to forecast diesel prices.

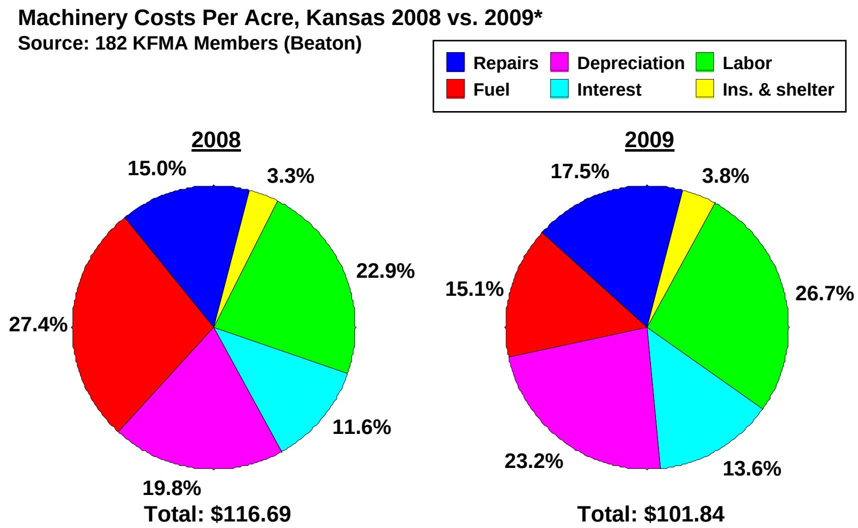
Historical and forecasted crude oil and farm diesel fuel average Mar-Oct prices…

Crude Oil and Off-road Diesel Fuel Prices

Year	Crude oil /1	Year-to-year change $/barrel	Year-to-year change percent	Diesel fuel /2	Year-to-year change $/gal	Year-to-year change percent
2004	$41.84	$11.31	37.0%	$1.37	$0.32	30.0%
2005	$57.98	$16.14	38.6%	$2.04	$0.67	48.5%
2006	$68.07	$10.09	17.4%	$2.41	$0.38	18.6%
2007	$70.09	$2.02	3.0%	$2.52	$0.11	4.4%
2008	$114.19	$44.10	62.9%	$3.68	$1.16	46.0%
2004-08 avg /3	$70.44	$43.54	161.9%	$2.40	$1.43	146.4%
2009 (F)	$51.05	($63.14)	-55.3%	$1.77	($1.91)	-51.8%
2009 less 04-08 avg	($19.39)	xxx	-27.5%	($0.63)	xxx	-26.3%

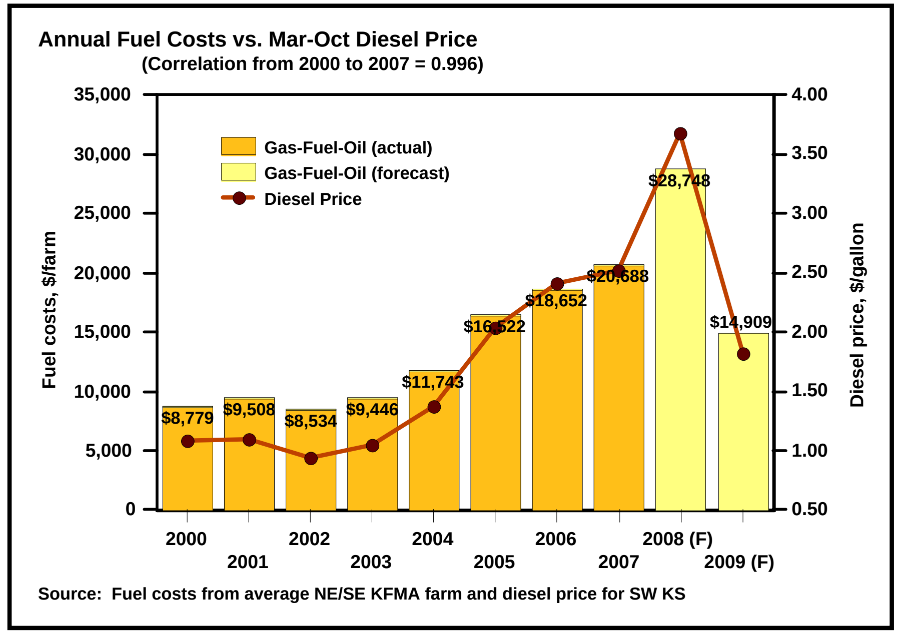
/1 Mar-Oct average of NYMEX futures
/2 Mar-Oct average for Southwest Kansas
/3 Year-to-year and percent changes are calculated from the previous 5-year average (i.e., 1999-2003)
F = forecast based on 01/30/2009 futures prices

Fuel prices were an important driver of machinery cost in 2008



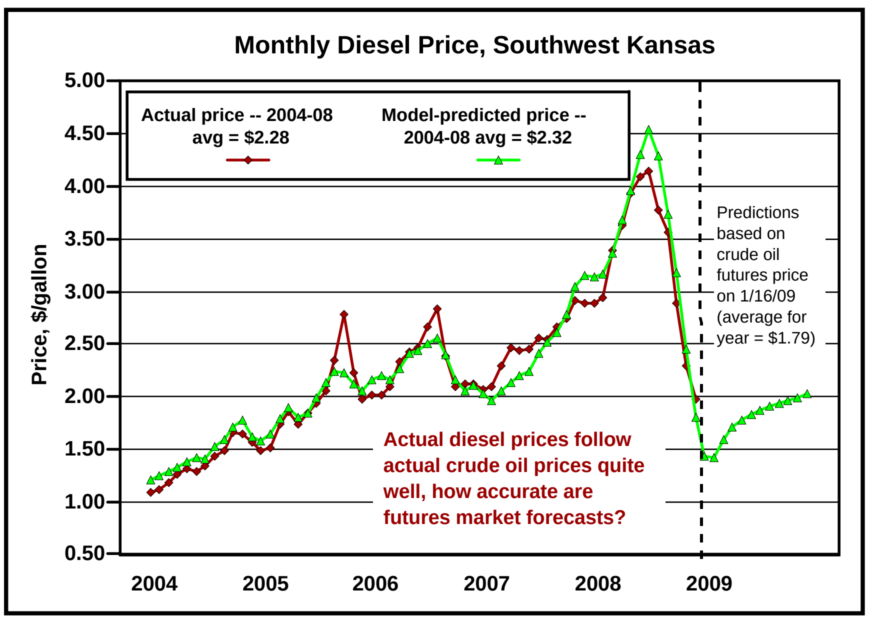
* 2009 values are calculated based on fuel price changes and inflation adjustments for other categories. Fuel price forecasts are based on 1/30/09 crude oil futures prices.

Impact of fuel prices on farm-level costs…

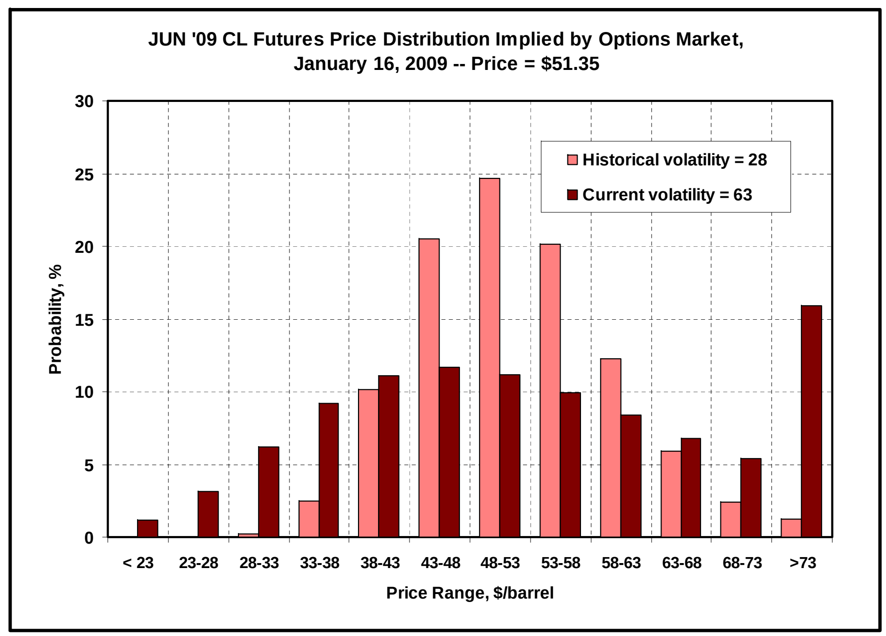


Cannot manage around unless you can predict fuel prices

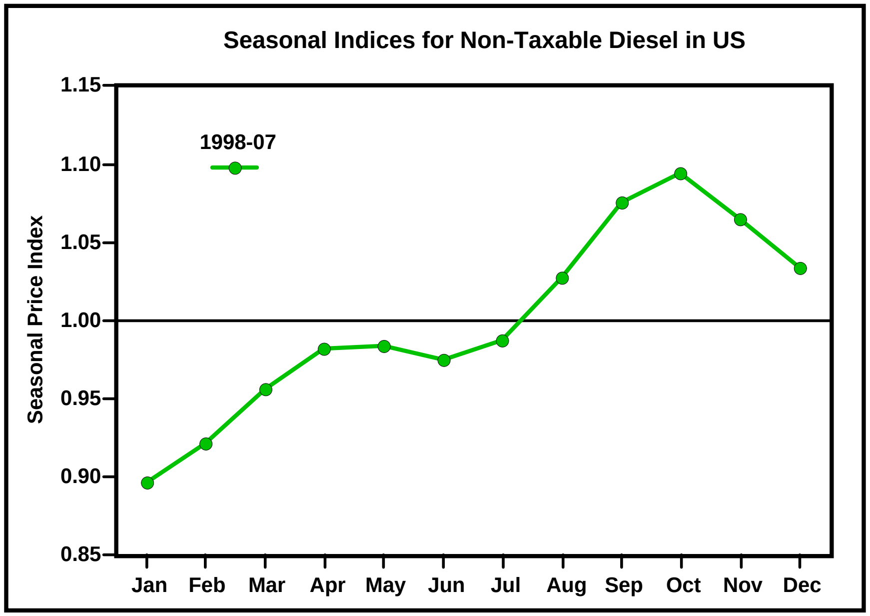
But, how well can prices be predicted?



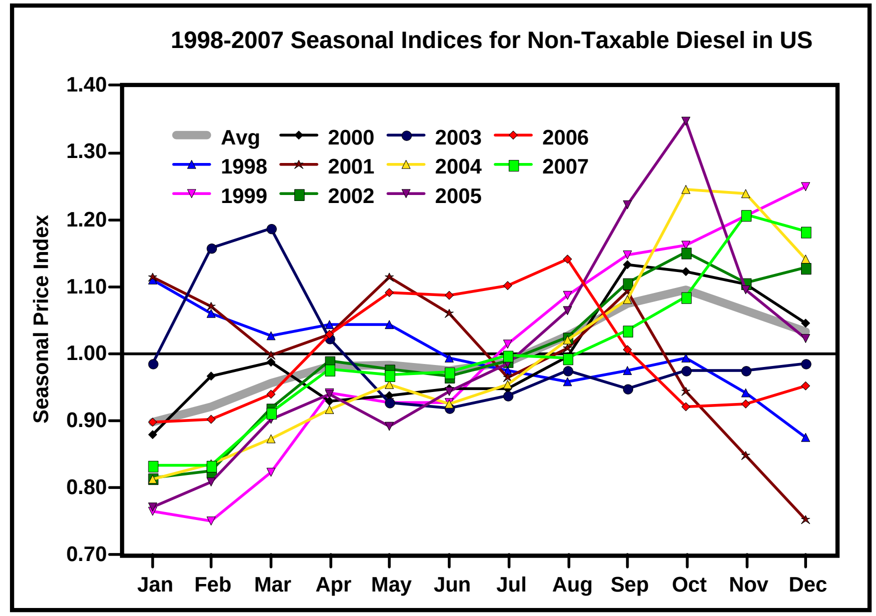
Do we need to "lock in" current price forecasts?



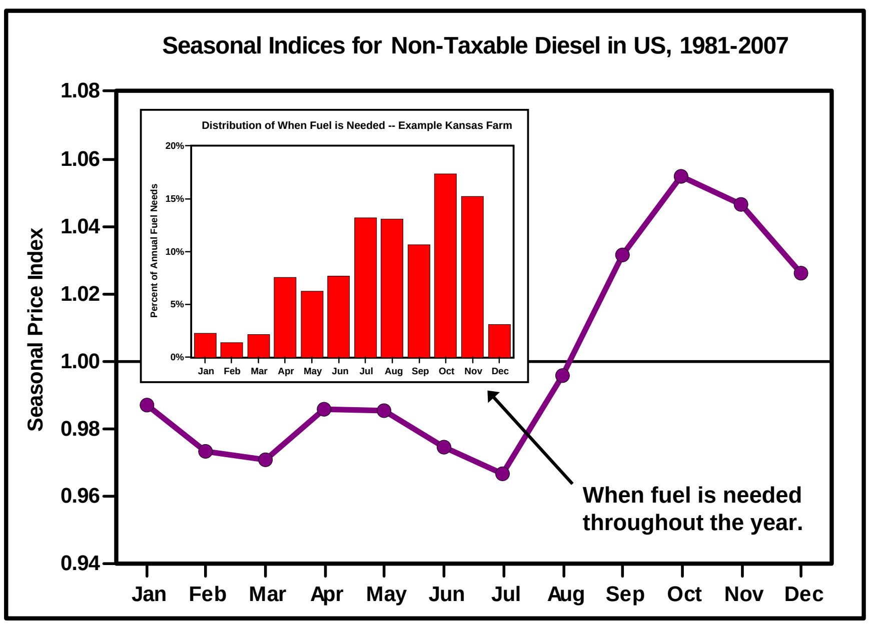
Purchasing fuel based on seasonal patterns?

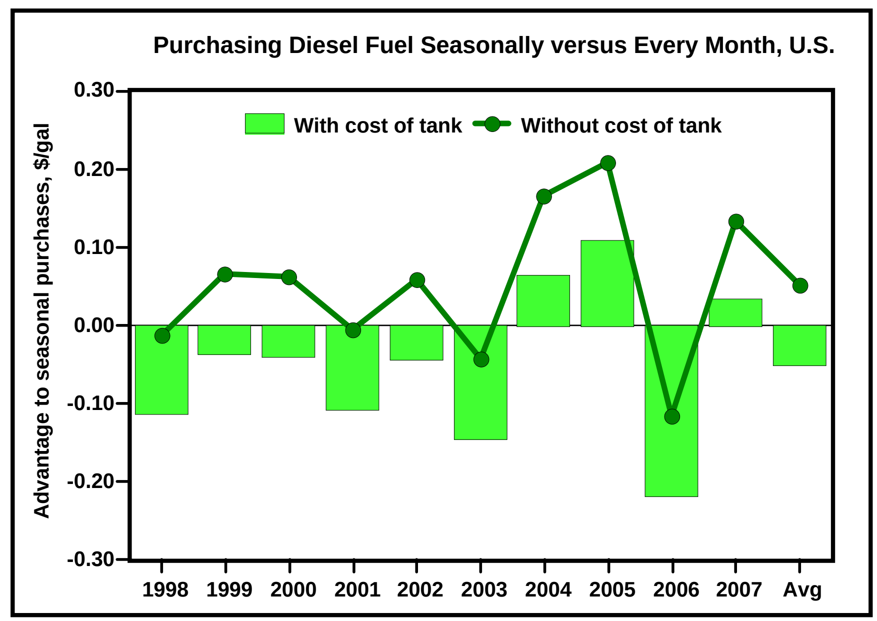


Seasonal pattern is not particularly predictable…



Seasonal pattern used for analysis…



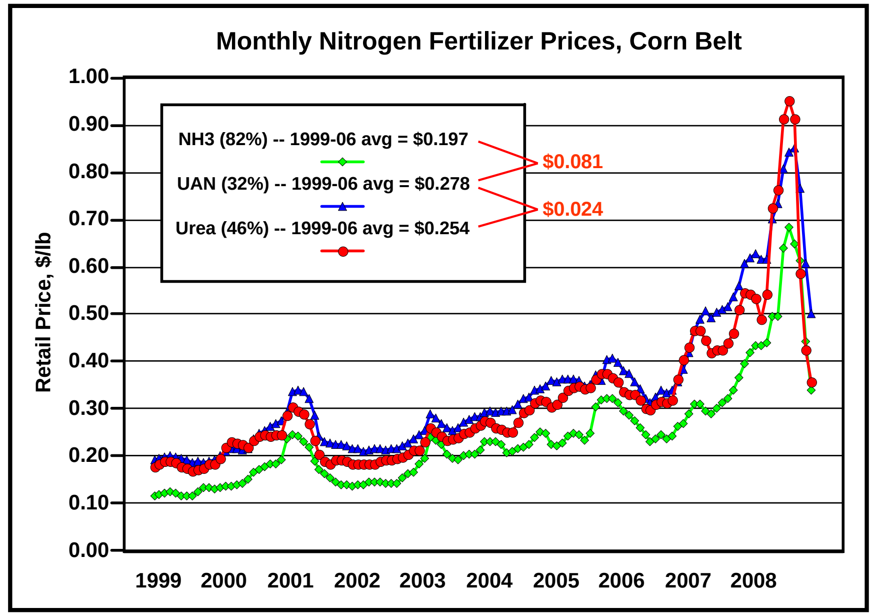


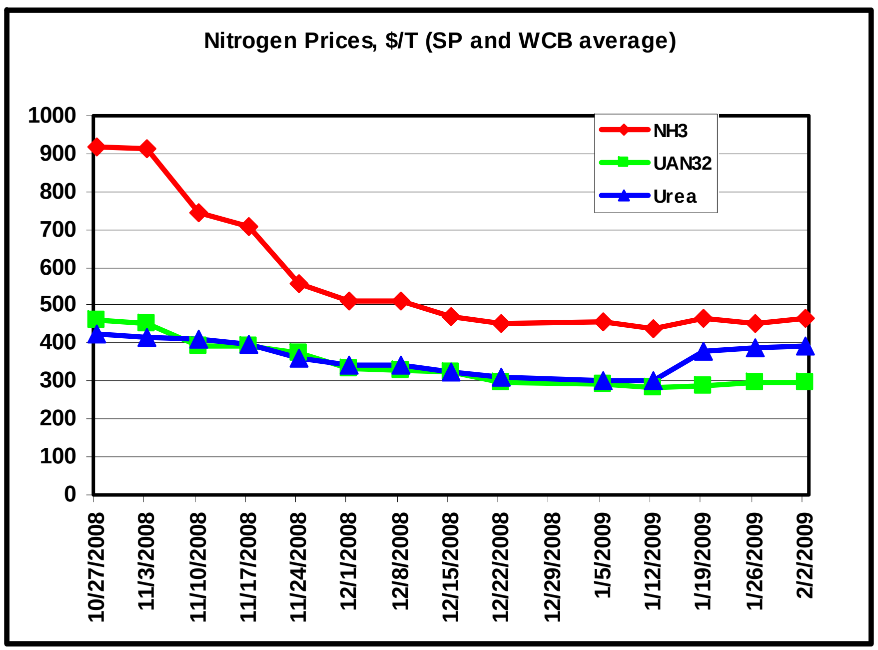
IF the only storage costs that existed were interest, then a strategy of buying in the months of Jan, Feb, Mar, Jun and Jul (based on 27-year seasonal pattern) would have resulted in a $0.05/gallon advantage compared to buying as needed (i.e., every month). Purchasing fuel tanks turns gain into loss.

Fertilizer prices

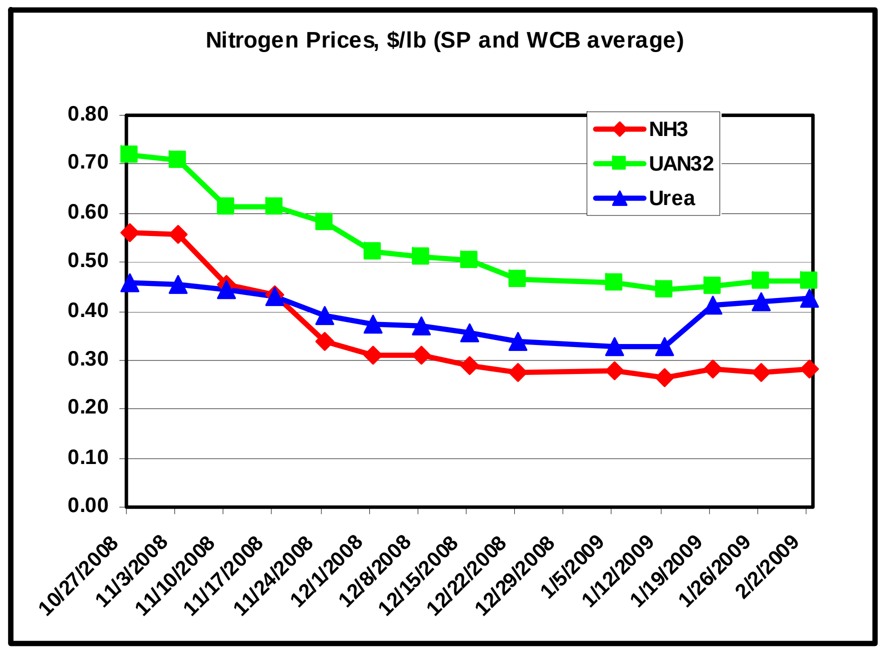
(should you be cutting back on fertilizer rates?)

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



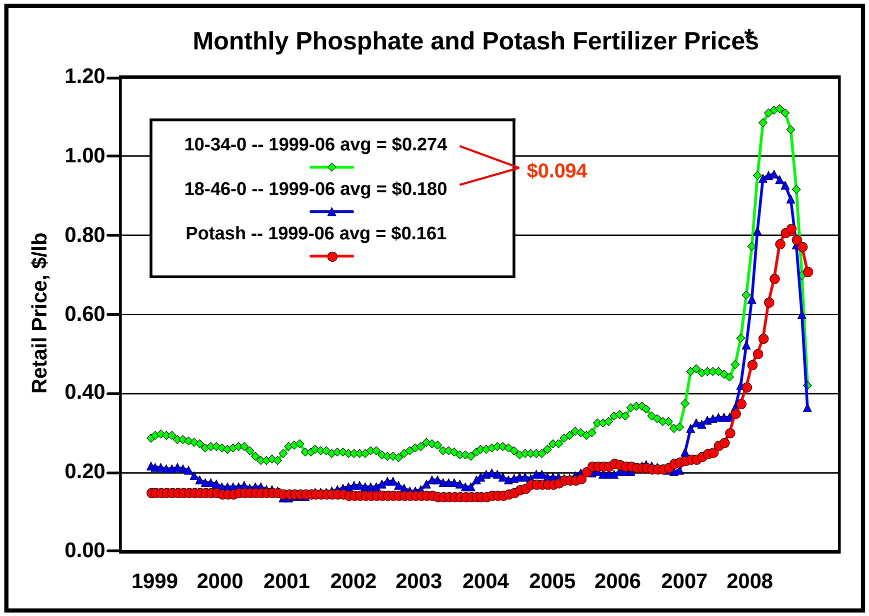


Prices fell off their highs, especially NH3 (big drops in a short time span)

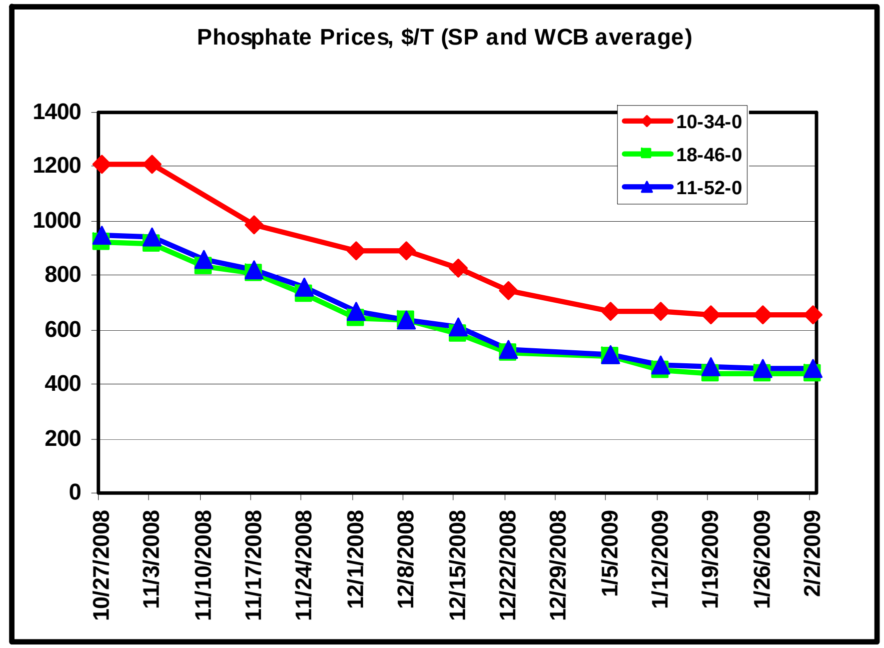


Big differences in prices of N products – urea adjusting to more what we expect?

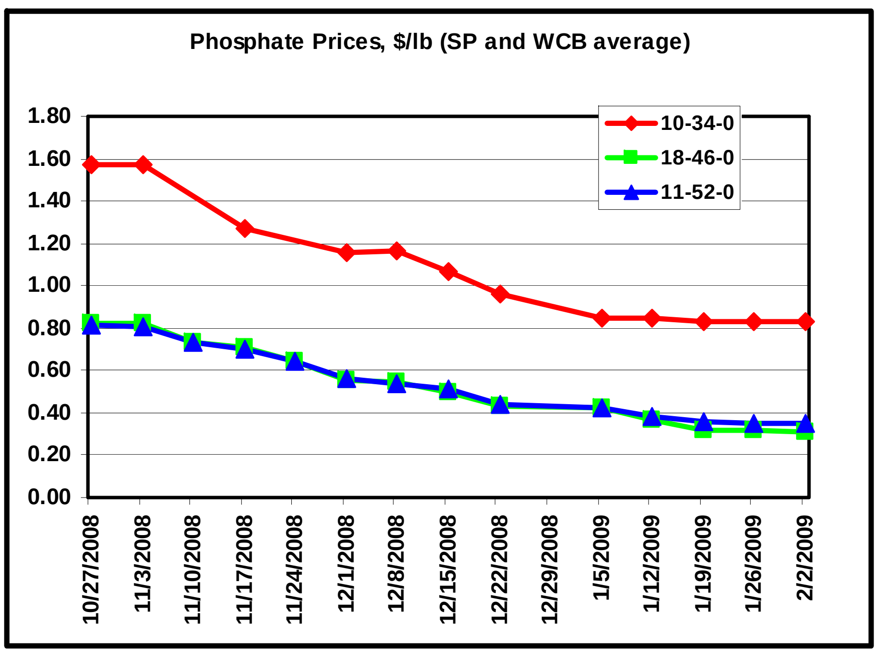
P and K prices have fallen recently, but are still significantly above historical averages…



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



Big price drops in a short time span – now leveling off?

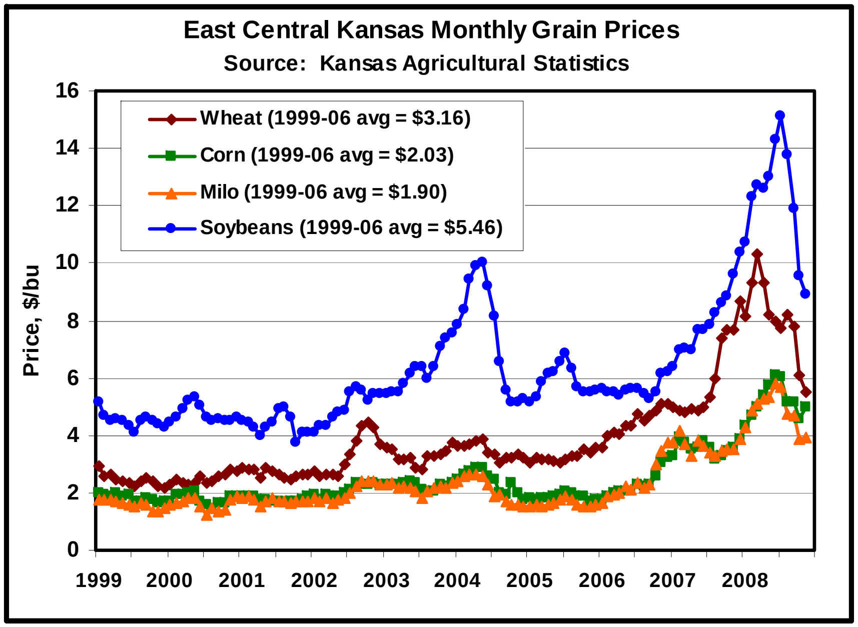


Big differences in prices of P products – how fast will the adjustment be?

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
Soil Test Interpretations and Fertilizer Recommendations
Department of Agronomy 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 . . .

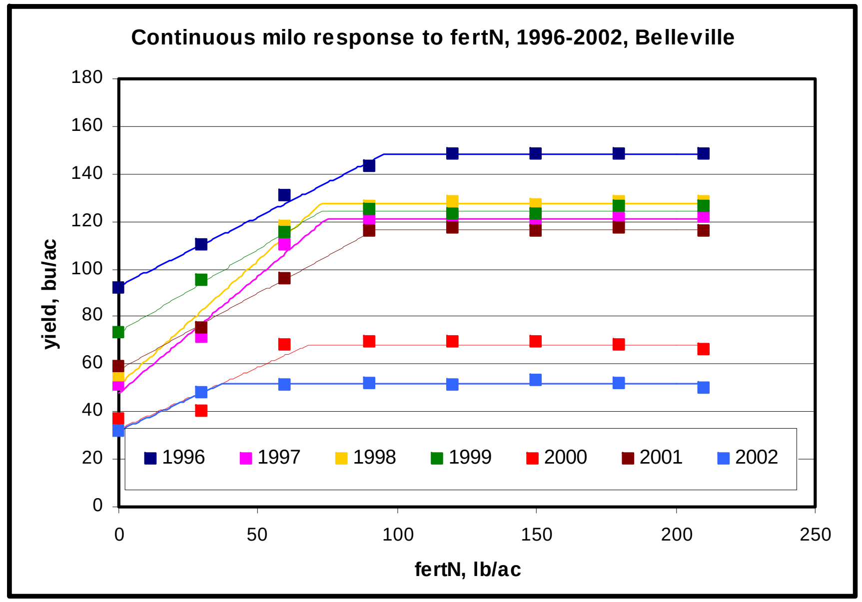
KSU nitrogen recommendations vs. N price

- 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 P2O5)

Nitrogen production function…

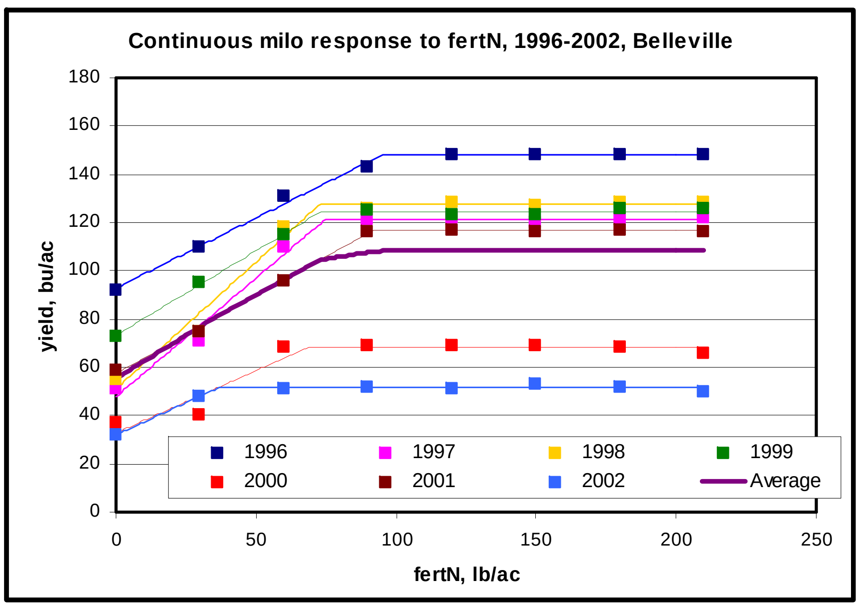
- In a limiting factor framework, it is generally believed that relationship between N and yield is linear for any given year and location (implies linear plateau production function)
- Linear plateau production function implies that optimal N will either be 0 or level where yield plateaus
- Average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

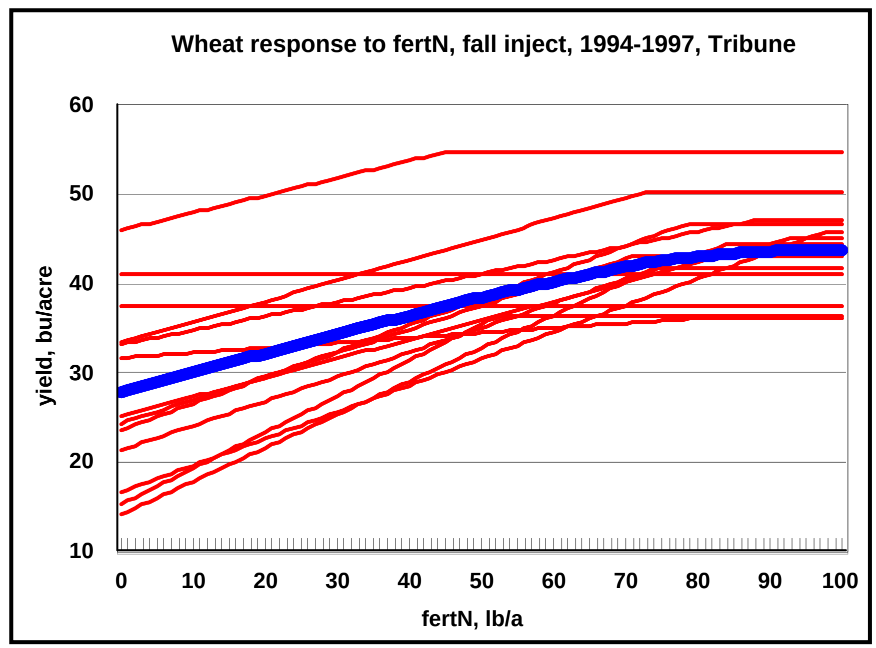


What would yield be for given fertN next year?

Average of linear plateaus can become non-linear…



Average of linear plateaus can become non-linear…



Blue line is NOT based on a mathematical function

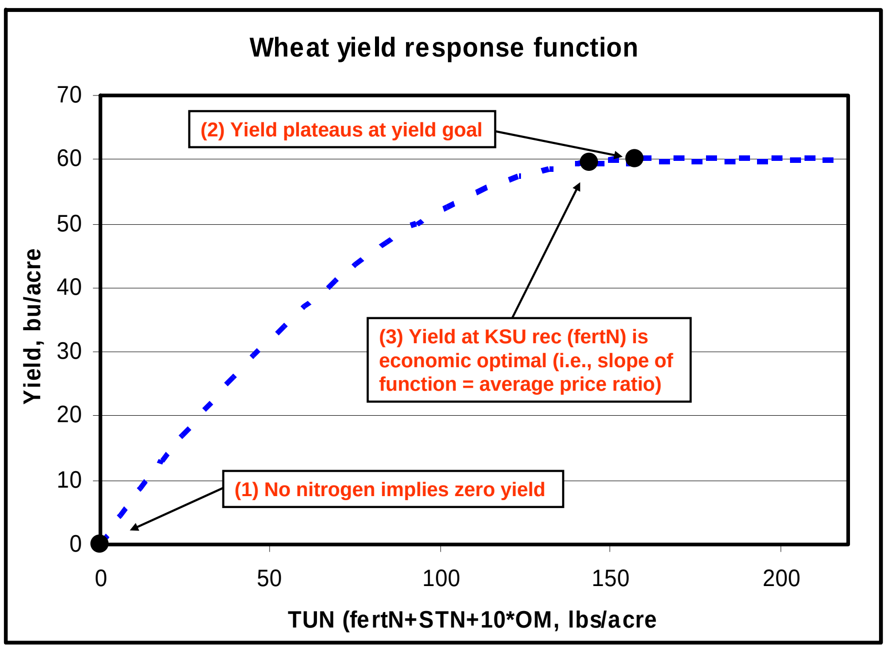
Functional form…

- **Numerous functional forms could be used that would meet objectives. We considered:**
  - Linear plateau, along with four different curvilinear forms
- **Most non-linear models "look" very similar, but results (i.e., optimal N versus N price) do vary**

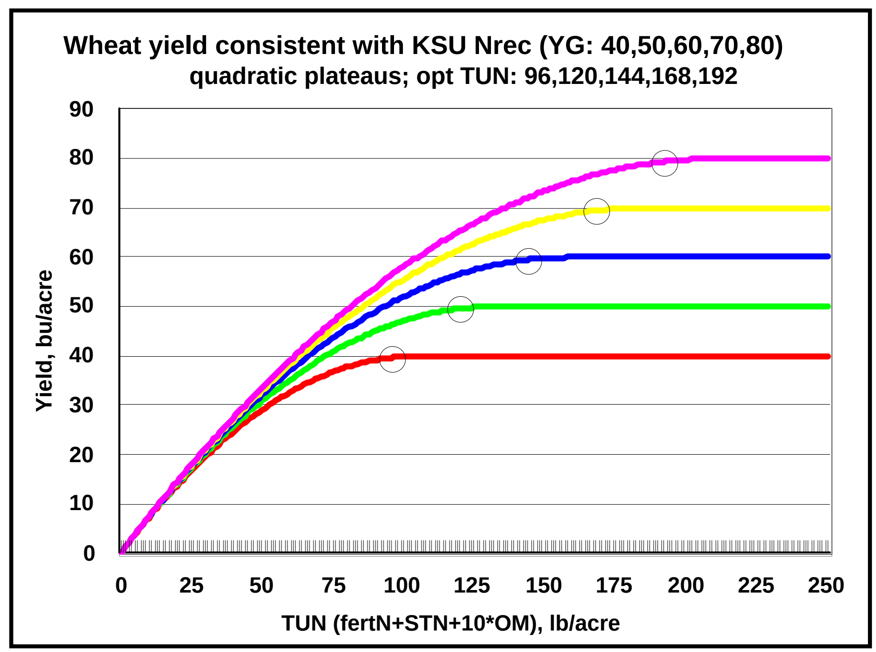
Nitrogen production function…

- **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)

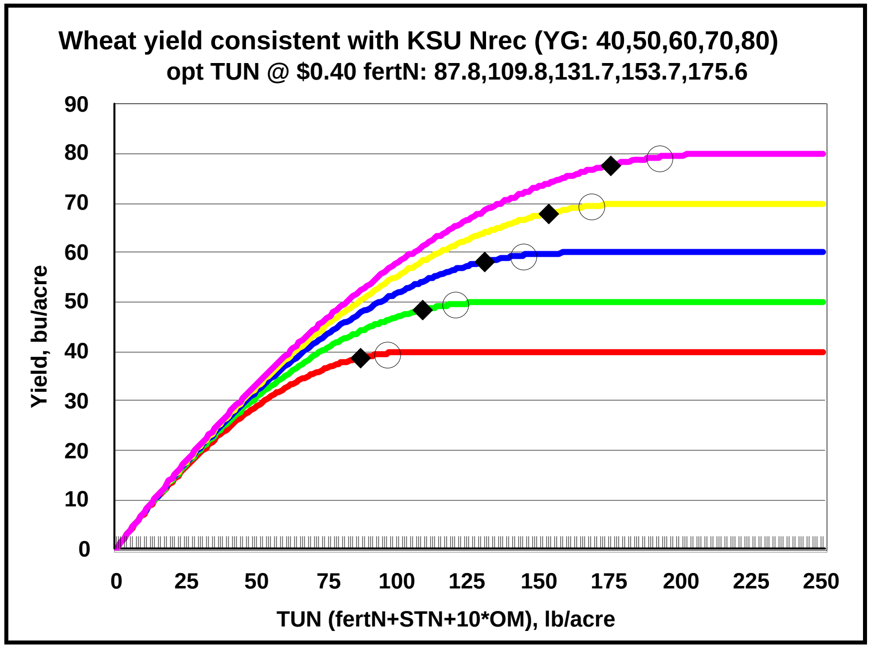
Defined points that allowed quadratic-plateau function to be defined…



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



Slope at diamonds is 0.40/3.22



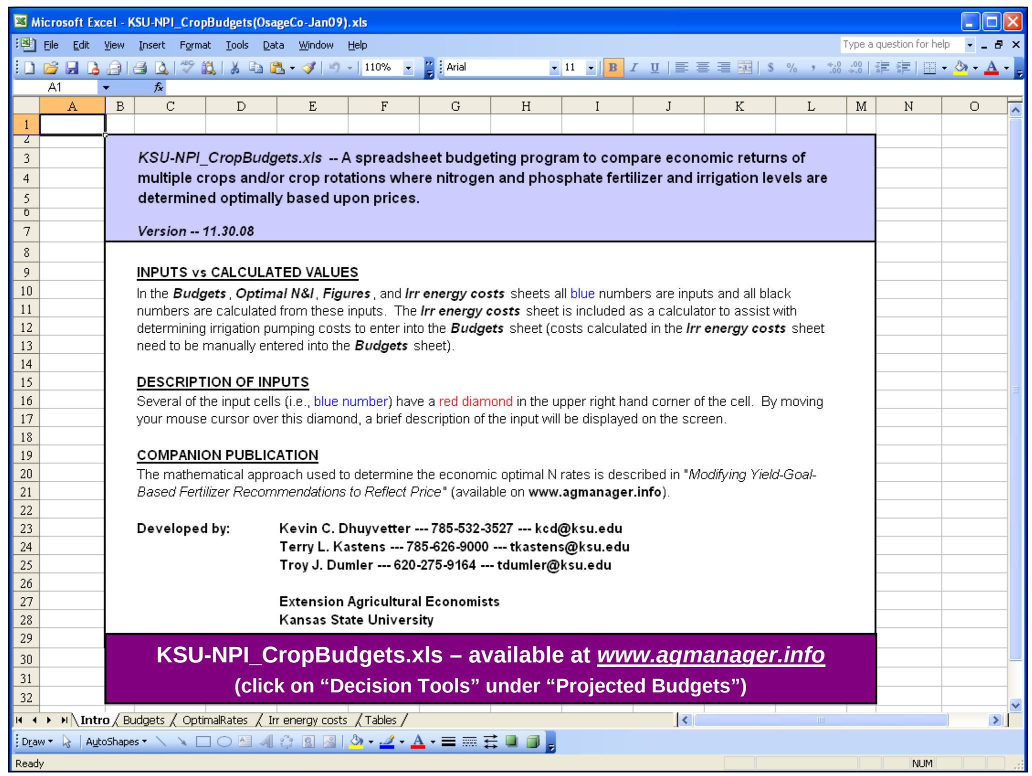
With more expensive N, you make more money by applying less

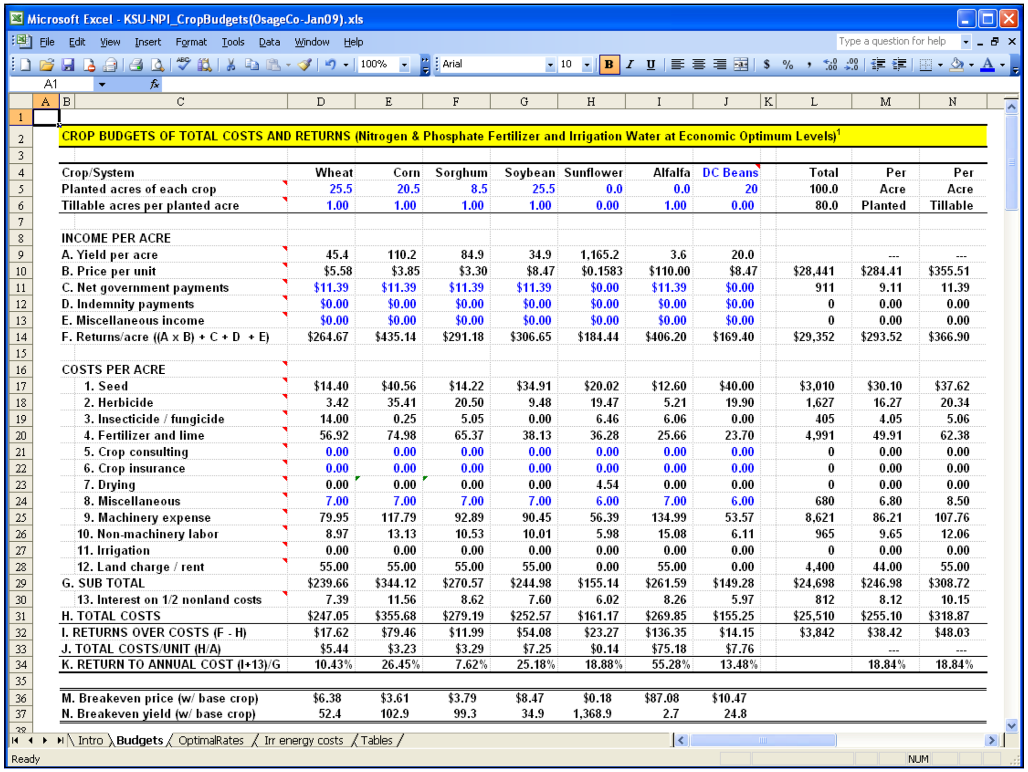
Operationalizing production function…

- We believe we got to the point of "if you believe KSU's fertilizer recommendations you have to believe our price-dependent profit-maximizing rates"
- 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

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



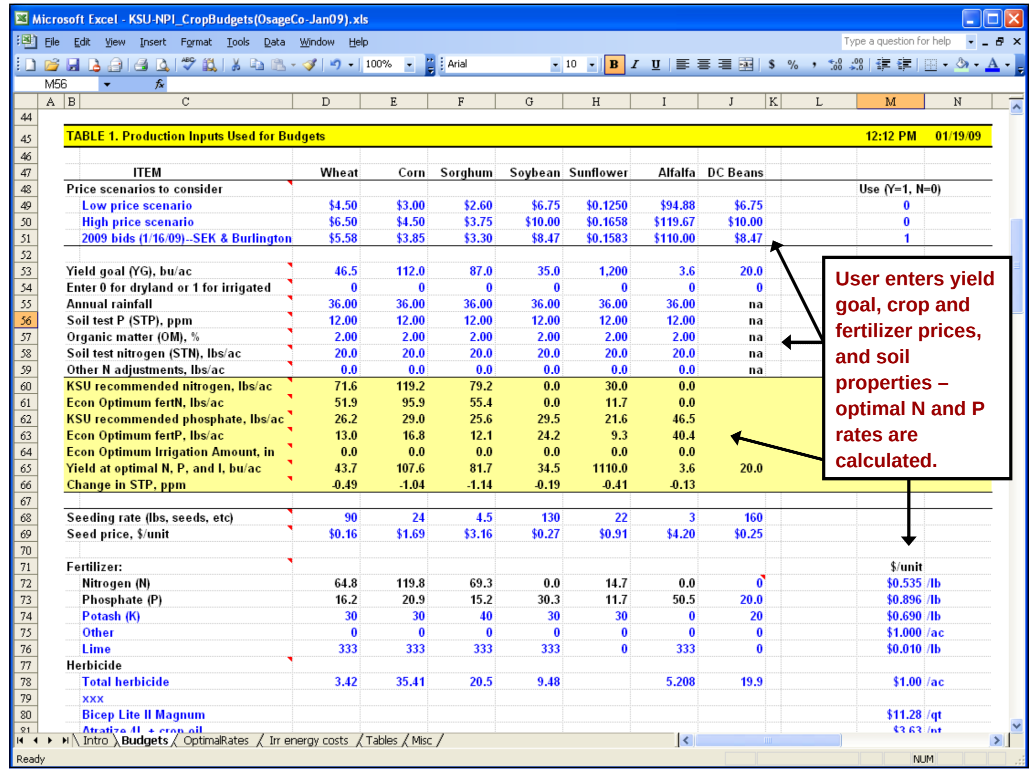


Microsoft Excel - KSU-NPI_CropBudgets(OsageCo-Jan09).xls

CROP BUDGETS OF TOTAL COSTS AND RETURNS (Nitrogen & Phosphate Fertilizer and Irrigation Water at Economic Optimum Levels)[1]

Crop/System	Wheat	Corn	Sorghum	Soybean	Sunflower	Alfalfa	DC Beans	Total	Per	Per
Planted acres of each crop	25.5	20.5	8.5	25.5	0.0	0.0	20	100.0	Acre	Acre
Tillable acres per planted acre	1.00	1.00	1.00	1.00	0.00	1.00	0.00	80.0	Planted	Tillable
INCOME PER ACRE										
A. Yield per acre	45.4	110.2	84.9	34.9	1,165.2	3.6	20.0		---	---
B. Price per unit	$5.58	$3.85	$3.30	$8.47	$0.1583	$110.00	$8.47	$28,441	$284.41	$355.51
C. Net government payments	$11.39	$11.39	$11.39	$11.39	$0.00	$11.39	$0.00	911	9.11	11.39
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)	$264.67	$435.14	$291.18	$306.65	$184.44	$406.20	$169.40	$29,352	$293.52	$366.90
COSTS PER ACRE										
1. Seed	$14.40	$40.56	$14.22	$34.91	$20.02	$12.60	$40.00	$3,010	$30.10	$37.62
2. Herbicide	3.42	35.41	20.50	9.48	19.47	5.21	19.90	1,627	16.27	20.34
3. Insecticide / fungicide	14.00	0.25	5.05	0.00	6.46	6.06	0.00	405	4.05	5.06
4. Fertilizer and lime	56.92	74.98	65.37	38.13	36.28	25.66	23.70	4,991	49.91	62.38
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	4.54	0.00	0.00	0	0.00	0.00
8. Miscellaneous	7.00	7.00	7.00	7.00	6.00	7.00	6.00	680	6.80	8.50
9. Machinery expense	79.95	117.79	92.89	90.45	56.39	134.99	53.57	8,621	86.21	107.76
10. Non-machinery labor	8.97	13.13	10.53	10.01	5.98	15.08	6.11	965	9.65	12.06
11. Irrigation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00	0.00
12. Land charge / rent	55.00	55.00	55.00	55.00	0.00	55.00	0.00	4,400	44.00	55.00
G. SUB TOTAL	$239.66	$344.12	$270.57	$244.98	$155.14	$261.59	$149.28	$24,698	$246.98	$308.72
13. Interest on 1/2 nonland costs	7.39	11.56	8.62	7.60	6.02	8.26	5.97	812	8.12	10.15
H. TOTAL COSTS	$247.05	$355.68	$279.19	$252.57	$161.17	$269.85	$155.25	$25,510	$255.10	$318.87
I. RETURNS OVER COSTS (F - H)	$17.62	$79.46	$11.99	$54.08	$23.27	$136.35	$14.15	$3,842	$38.42	$48.03
J. TOTAL COSTS/UNIT (H/A)	$5.44	$3.23	$3.29	$7.25	$0.14	$75.18	$7.76		---	---
K. RETURN TO ANNUAL COST (I+13)/G	10.43%	26.45%	7.62%	25.18%	18.88%	55.28%	13.48%		18.84%	18.84%
M. Breakeven price (w/ base crop)	$6.38	$3.61	$3.79	$8.47	$0.18	$87.08	$10.47			
N. Breakeven yield (w/ base crop)	52.4	102.9	99.3	34.9	1,368.9	2.7	24.8			

Intro | Budgets | OptimalRates | Irr energy costs | Tables



Microsoft Excel - KSU-NPI_CropBudgets(OsageCo-Jan09).xls

TABLE 1. Production Inputs Used for Budgets 12:12 PM 01/19/09

ITEM	Wheat	Corn	Sorghum	Soybean	Sunflower	Alfalfa	DC Beans	
Price scenarios to consider								Use (Y=1, N=0)
Low price scenario	$4.50	$3.00	$2.60	$6.75	$0.1250	$94.88	$6.75	0
High price scenario	$6.50	$4.50	$3.75	$10.00	$0.1658	$119.67	$10.00	0
2009 bids (1/16/09)--SEK & Burlington	$5.58	$3.85	$3.30	$8.47	$0.1583	$110.00	$8.47	1
Yield goal (YG), bu/ac	46.5	112.0	87.0	35.0	1,200	3.6	20.0	
Enter 0 for dryland or 1 for irrigated	0	0	0	0	0	0	0	
Annual rainfall	36.00	36.00	36.00	36.00	36.00	36.00	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	119.2	79.2	0.0	30.0	0.0		
Econ Optimum fertN, lbs/ac	51.9	95.9	55.4	0.0	11.7	0.0		
KSU recommended phosphate, lbs/ac	26.2	29.0	25.6	29.5	21.6	46.5		
Econ Optimum fertP, lbs/ac	13.0	16.8	12.1	24.2	9.3	40.4		
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	43.7	107.6	81.7	34.5	1110.0	3.6	20.0	
Change in STP, ppm	-0.49	-1.04	-1.14	-0.19	-0.41	-0.13		
Seeding rate (lbs, seeds, etc)	90	24	4.5	130	22	3	160	
Seed price, $/unit	$0.16	$1.69	$3.16	$0.27	$0.91	$4.20	$0.25	
Fertilizer:								$/unit
Nitrogen (N)	64.8	119.8	69.3	0.0	14.7	0.0	0	$0.535 /lb
Phosphate (P)	16.2	20.9	15.2	30.3	11.7	50.5	20.0	$0.896 /lb
Potash (K)	30	30	40	30	30	0	20	$0.690 /lb
Other	0	0	0	0	0	0	0	$1.000 /ac
Lime	333	333	333	333	0	333	0	$0.010 /lb
Herbicide								
Total herbicide	3.42	35.41	20.5	9.48		5.208	19.9	$1.00 /ac
xxx								
Bicep Lite II Magnum								$11.28 /qt

Scenarios considered…

- **Dry versus liquid N & P fertilizer prices**
  - Dry: N = $0.365 and P = $0.495
  - Liquid: N = $0.535 and P = $0.896
- **Three crop price scenarios**

	Wheat	Corn	Sorghum	Soybean
Price scenarios to consider				
Low price scenario	$4.50	$3.00	$2.60	$6.75
High price scenario	$6.50	$4.50	$3.75	$10.00
2009 bids (1/16/09)--SEK & Burlington	$5.58	$3.85	$3.30	$8.47

- **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	DC Beans	Total	Average
Acres	25.5	20.5	8.5	25.5	20.0	100.0	
Dry N & P Prices (N=$0.365 and P=$0.495)							
A. Economic optimal rates							
	45.4	110.2	84.9	34.9			
B. 75% of economic optimal rates (under fertilize)							
	42.8	104.0	80.7	34.2			
C. 125% of economic optimal rates (over fertilize)							
	46.2	111.7	86.3	35.0			
Liquid N & P Prices (N=$0.535 and P=$0.896)							
D. Economic optimal rates							
	43.7	107.6	81.7	34.5			
E. 75% of economic optimal rates (under fertilize)							
	40.7	100.5	77.1	33.7			
F. 125% of economic optimal rates (over fertilize)							
	44.6	109.8	83.5	34.9		xxx	xxx

1) Economic optimal yields are 1-4% higher at lower priced fertilizer (dry).

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

3) Under-fertilizing results in yields about 5% lower 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	DC Beans	Total	Average
Acres	25.5	20.5	8.5	25.5	20.0	100.0	
Dry N & P Prices (N=$0.365 and P=$0.495)							KSU rates $36.75
A. Economic optimal rates							
	$17.62	$79.46	$11.99	$54.08		$3,842	$38.42
B. 75% of economic optimal rates (under fertilize)							
	$12.53	$71.03	$8.73	$52.07		$3,461	$34.61
C. 125% of economic optimal rates (over fertilize)							
	$13.04	$71.36	$7.23	$51.32		$3,448	$34.48
Liquid N & P Prices (N=$0.535 and P=$0.896)							KSU rates $17.03
D. Economic optimal rates							
	$1.66	$54.53	-$3.76	$43.34		$2,350	$23.50
E. 75% of economic optimal rates (under fertilize)							
	-$3.53	$46.85	-$6.65	$42.03		$2,002	$20.02
F. 125% of economic optimal rates (over fertilize)							
	-$3.53	$44.68	-$9.13	$41.21		$1,915	$19.15

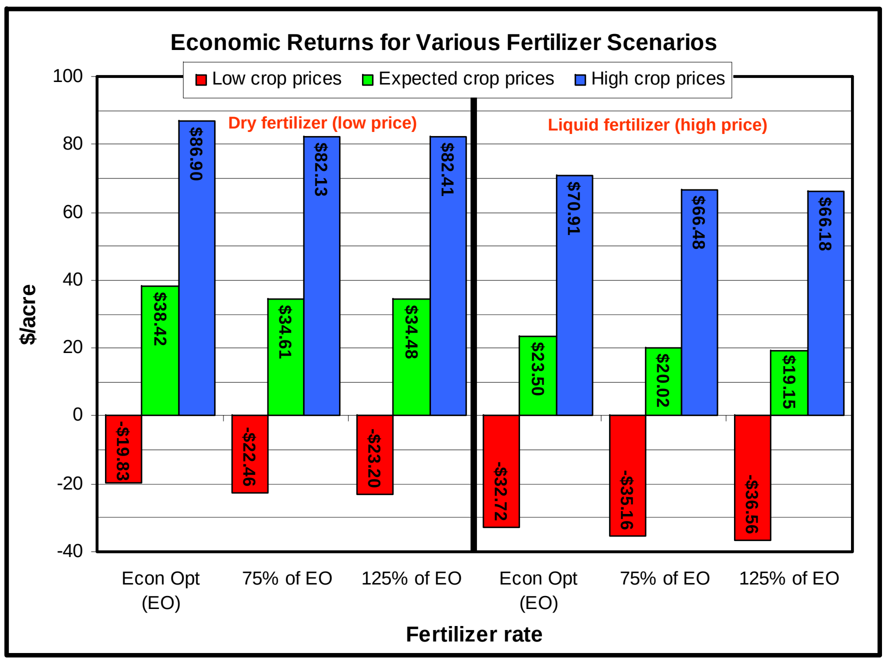
Return over costs at expected 2009 crop prices and various fertilizer scenarios…

Return Over Costs vs Fertilizer Price and Rate (% of economic optimal)							
	Wheat	Corn	Milo	Soybean	DC Beans	Total	Average
Acres	25.5	20.5	8.5	25.5	20.0	100.0	
Dry N & P Prices (N=$0.365 and P=$0.495)							KSU rates $36.75
A. Economic optimal rates							
	$17.62	$79.46	$11.99	$54.08		$3,842	$38.42
B. 75% of economic optimal rates (under fertilize)							
	$12.53	$71.03	$8.73	$52.07		$3,461	$34.61
C. 125% of economic optimal rates (over fertilize)							
	$13.04	$71.36	$7.23	$51.32		$3,448	$34.48
Liquid N & P Prices (N=$0.535 and P=$0.896)							KSU rates $17.03
D.							
						$2,350	$23.50
E.							
						$2,002	$20.02
F.							
						$1,915	$19.15

1) Economic impact of over- or under-fertilizing is about the same at lower priced fertilizer (dry).

2) At higher fertilizer prices (liquid), over-fertilizing starts becoming worse than under-fertilizing.

3) Fertilizer price (dry vs. liquid) has bigger impact on returns than deviations from the optimal rate.



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

Side issues with P

- Depending upon crop and rotation, following MF-2586 N and Precs 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

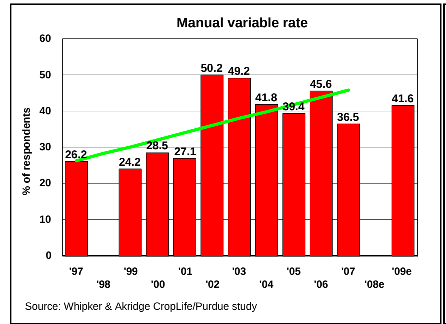
- We're seeing local fertilizer prices vary as much as 2x to 3x from location to location
- Liquid vs. dry – hire custom applicator?
- What will fertilizer prices do this spring?
- What about availability?
- Do I trust my provider's finances?

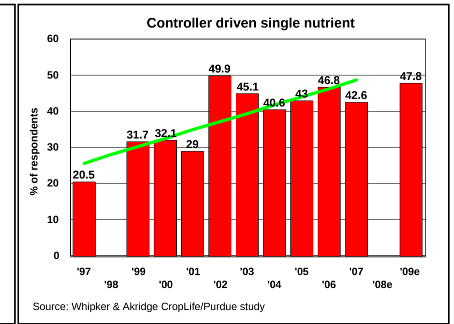
Keep things in perspective

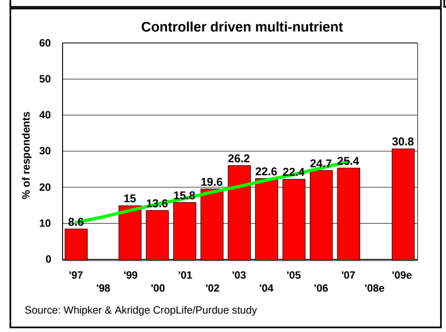
- Over time, differences in farm profitability are driven mostly by:
  - Cost management, principally machinery costs
  - Scale of operation (farm size)
  - Technology adoption
  - Rarely by crop price and crop yield (revenue)
- The fertilizer rate decision matters, but isn't all that important in a relative sense
- That hasn't stopped us from focusing a great deal on fertilizer rates, especially on variable rate application of fertilizer

A couple of slides that capped a recent discussion on the last 10-15 years of variable rate fertilizer (VRA)

Percent of service providers offering services







VRA is not dead, but growing very slowly.

VRA Economics

- Yield response function
  - In a 1-year story, problem is pretty much licked
- VRA equipment cost – no big deal any more
- So, a couple of hurdles are gone
- Soil test thinking
  - Soil tests generally pay at some spatial scale
  - Soil tests are still expensive at a small scale
  - Infrequent small-scale tests sort of work for some nutrients
  - Basing N rates on soil tests a big problem, let alone VRA
  - So, at best small profit if depend upon small-scale soil tests
  - No cheap (and accurate) soil test proxies
- Will we be able to get past soil test thinking?
  - Can we charge ahead, chasing some new idea, relegating analysis to a monitoring role rather than a determining one?

The Time Dimension

- Soils are alive and change over time
- Does fertilizer impact yield or does it impact soil fertility, which in turn impacts yield?
- We've thought some about P and soil pH over time, but have only daydreamed about N in this context
- Continuous no-till: many time-dimension facets
  - Changes in soil structure that can modify yield goals?
  - Increases in soil organic matter, which might greatly buffer the impact of annual decisions around fertilizer
    - Quantity and timing of fertilizer becomes less important?
  - With no-till, can we simply use grain-removal based fertilizer rates, ensuring "correct" rates only when averaged across time? Might that work for N, as well as P?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