Crop Profitability – Where Should we Focus our Management Efforts?

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The tremendous volatility that has existed in crop and input (specifically fertilizer) markets the last several years has many people talking about the importance of risk management. While it is hard to argue that risk management is not important, it can mean many different things and thus it is beneficial to know which aspects of risk management we should focus on. For example, when discussing the importance of risk management as it relates to market volatility, most references have to do with buying inputs and selling crops at optimal times. That is, the common "buy low and sell high" thinking prevails (i.e., risk management refers to "price picking"). Given the extreme price movements that are becoming more common, it is easy to see why people are focusing on this and asking "what if I had bought earlier?" or "what if I hadn't sold pre-harvest?" type of questions. While hindsight analyses make it quite easy to see what "should have been done," making these same decisions in real time are much more difficult. It is obvious that if inputs are purchased at a lower price and/or outputs sold at a higher price, all else equal, that profits will increase. However, the question that needs to be answered is, do we have evidence that producers can consistently identify the optimal times to buy inputs and sell their crops in real time?

When trying to identify which management areas producers should focus on, a relevant concept is that of persistence. Persistence simply refers to something that is *consistently* better (or worse) than average, as opposed to being random. If something is random that simply means that one year I might be much better than average and the next year I could just as easily be below average. Thus, it seems logical that producers should focus their management efforts in areas that are more persistent (i.e., less random) because that is likely where they will be successful in improving their profitability. Putting this in the perspective of price "picking," this simply means that producers should focus their management efforts in this area if this is something they can do with persistence (i.e., they can consistently get better prices than average).

Figure 1 shows the persistence of a number of different management traits for 705 Kansas producers continuously enrolled in the Kansas Farm Management Association (KFMA) from 1999-2008 (for a detailed discussion of the methodology of this study see Kastens and Dhuyvetter). The tallest bars in figure 1 represent those traits that are the most persistent across time and likewise the shortest bars represent those traits that are the least persistent over time. If producers follow a normal distribution, half of each bar represents producers that are consistently better than the average and half are consistently worse than the average. For example, roughly 44% of the farms would be consistently larger (Size) than average and 44% would be

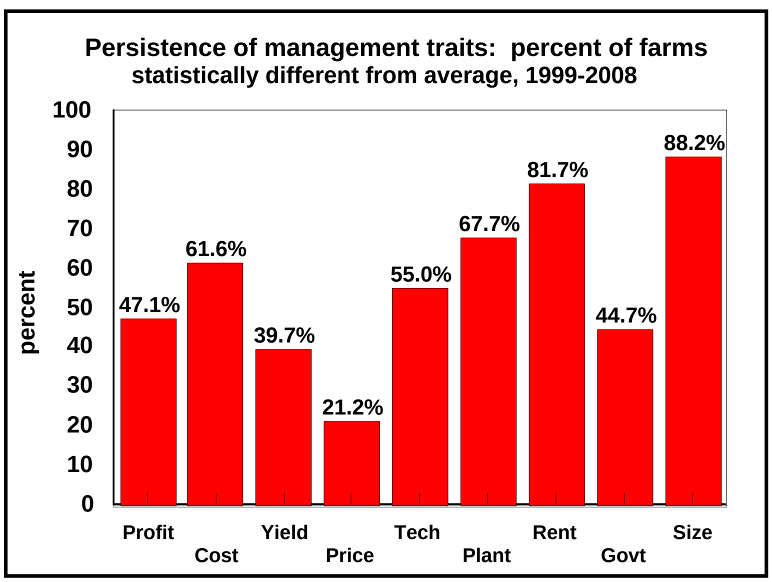

Figure 1

consistently smaller than the average. The other 12% were farms that were possibly growing or contracting in size and thus their farm size was not persistent over this time period. While this result might seem quite obvious as farms tend to be larger (smaller) than average, it is important to recognize this because it might have some implications for management if this is related to profitability. On the other hand, Price is the least persistent indicating that the majority of producers (approximately 79%) were neither consistently better nor consistently worse than the average over this 10-year time period.

In addition to farm size, other management traits that were somewhat persistent were Rent (percent of acres farmed that were rented versus owned), Plant (planting intensity measure indicating less reliance on fallow (western KS) or increased used of double cropping (eastern KS)), Cost (cost per acre after accounting for crop mix), and Tech (relative use of herbicides versus tillage). While figure 1 says nothing about profitability, it does indicate areas where producers can differentiate themselves from others. Assuming these areas are also related to profitability differences, this gives some indication where to focus management efforts.

Figure 2 shows how being in the best 1/3 of farms impacts profitability, relative to being average, for each of the management traits individually. After accounting for all other traits, farm size (Size) has the largest impact on profitability indicating that economies of size exist. That is, after accounting for other management factors, larger farms are more profitable than smaller farms (this impact has been growing over time when results here are compared to results from earlier 10-year periods). The second most important management trait is cost of production (Cost), followed by planting intensity (Plant) and technology adoption (Tech -- substitution of herbicides for tillage). The values in figure 2 are additive and thus a large farm that has low costs, using less tillage, and planting more intensively will have a huge advantage over a farm that is average in all of these categories. While price is significantly different from zero, indicating that producers who get higher prices are more profitable, the magnitude of being in the top 1/3 is much less than many of the other management traits. This is because this trait is much less persistent, i.e., it is very difficult to consistently be better than the average.

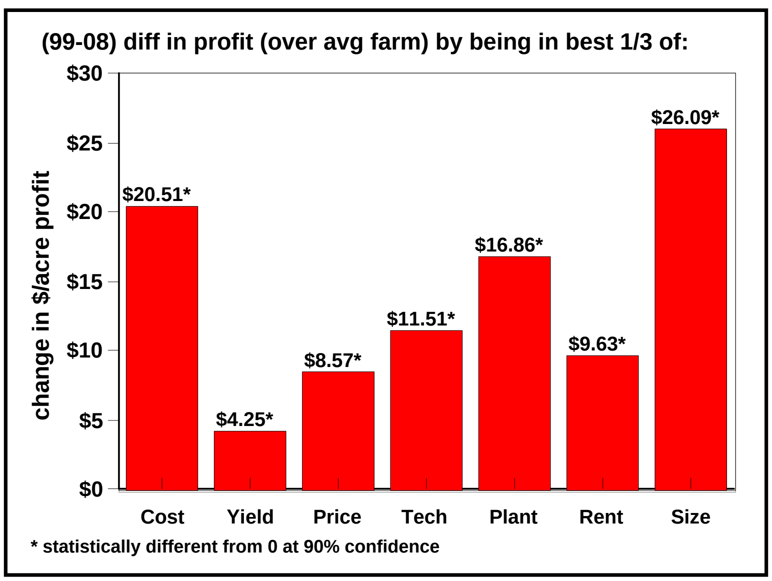

Figure 2

The results in figures 1 and 2 would suggest that managers should focus their efforts on capturing benefits associated with economies of size, controlling costs, and adopting technology as ways to improve profitability more than trying to get higher prices than their neighbors. This is not because the returns to getting higher prices are not significant, but rather because it is very difficult to consistently achieve this and thus spending management time in this area may not be the best use of limited time.

The data used for the analysis presented in figures 1 and 2 were whole-farm data and thus it was not possible to look at specific cost categories. Another way of examining which factors drive profitability differences across producers is to look at enterprise analyses data. KFMA enterprise data allows one to look at profitability in a more detailed manner, but the number of operations with data over longer periods is reduced significantly. Figure 3 shows the differences between the High 1/3 and Low 1/3 farm, ranked on profitability, for various farm characteristics and income and cost categories for the three-year period 2007-2009 (further details of this study can be found in Dhuyvetter and Smith).

DIFFERENCE between the High 1/3 and Low 1/3 farms ranked on return to management
Kansas Farm Management Association Enterprise Analysis, State Averages 2007-09

	Corn	Irr Corn	Sorghum	Wheat	Soybean	Alfalfa
Number of farms	115	50	128	221	139	46
INCOME ($/acre)						
Yield per acre, bu	17.8	16.6	23.2	7.6	7.8	1.2
Price per unit	$0.25	$0.28	$0.12	$0.29	$0.40	$13.12
Crop income	$97.17	$51.95	$72.78	$45.16	$91.51	$167.91
Government payment	-0.04	-5.09	-1.64	1.10	-0.20	-1.61
Gross income	$97.64	$45.16	$68.63	$50.69	$94.12	$166.63
COSTS ($/acre)[1]						
Seed	-$3.83	-$27.93	-$2.53	-$2.14	-$2.30	$1.42
Fertilizer	-7.42	-26.14	-3.81	-15.32	-0.92	2.67
Herbicide-insecticide	-6.10	-17.85	-7.77	-3.42	-2.67	-3.10
Crop insurance	0.72	-15.37	0.24	0.04	0.64	-0.40
Machinery	-19.70	-22.91	-27.75	-30.52	-32.71	-17.79
Other	-5.41	-49.21	-8.76	-11.06	-10.23	-5.83
Land	3.11	-36.25	-3.49	-7.41	6.15	11.26
Interest	-4.46	-16.16	-4.11	-4.75	-5.02	-4.36
Total Cost	-$43.08	-$211.82	-$57.97	-$74.59	-$47.06	-$16.12
Net Return to Management	$140.72	$256.98	$126.60	$125.28	$141.18	$182.75
Enterprise acres	184	-99	201	606	150	-28
Operator percentage	4.2%	-7.3%	-0.6%	-1.6%	3.0%	6.5%
Yield effect	37.9%	19.9%	48.1%	34.3%	45.7%	49.3%
Price effect	18.5%	16.2%	7.5%	9.9%	11.8%	29.0%
Operator % effect	13.0%	-18.5%	-1.4%	-3.8%	9.1%	12.9%
Cost effect	30.6%	82.4%	45.8%	59.5%	33.3%	8.8%

[1] Based on the operator's share of production, and thus includes only production expenses paid by the operator.

Figure 3

There are several key results of the data reported in figure 3. First, there is a tremendous difference between the profitability of the top 1/3 of producers and the bottom 1/3 of producers (consistently $125 to $140 per acre for non-irrigated grain crops). To put return differences of this magnitude into context, the average non-irrigated land rent in Kansas during this time period was less than $50/acre. Producers in the top 1/3 consistently achieved higher yields and received higher prices than producers in the bottom 1/3. Government payments, on a per acre basis, generally were slightly lower for producers in the top 1/3. On average, high profit farms had lower costs than low profit farms in most all categories, with the exception of crop insurance. Thus, the more profitable farms were able to achieve higher yields without necessarily spending more money on crop inputs (i.e., they managed costs without sacrificing yields). Consistent with the results reported in figure 2, high profit farms tended to be larger (exception was irrigated corn and alfalfa) than the low profit farms. While the ability to get higher prices was an important determinant in their higher profitability, the yield and cost effects were generally more important in explaining profitability differences. That is, cost and yield differences were more important in explaining profit differences than price differences were. Furthermore, as additional years are included in an analysis the impact of price in explaining profitability differences tends to decrease (data not shown), once again supporting that price is a less persistent variable. In other words, the shorter the analysis period, the more likely prices will be important in explaining profitability differences. However, this does not suggest price picking is something we should focus our management efforts on if it is not persistent (i.e., if this result is somewhat random and thus not repeatable).

Taken together, the results and information presented in figures 1-3 suggest that farm size, cost management and technology adoption are key drivers of profitability differences between producers. Machinery investment and costs are directly related to these three factors. That is, the particular machinery investment strategy a producer has for their operation is related to and impacts each of these factors and hence will also impact profitability. Figure 4 shows a histogram of average machinery costs of 614 non-irrigated crop farms continuously enrolled in KFMA from 2005 through 2009 (costs exclude labor). The average costs are $66.07, but it can be seen that there is tremendous variability around this value. For example, 10% of the operations had machinery costs that were $40/acre or less, but there also were almost 10% of the operations that had machinery costs in excess of $100/acre.

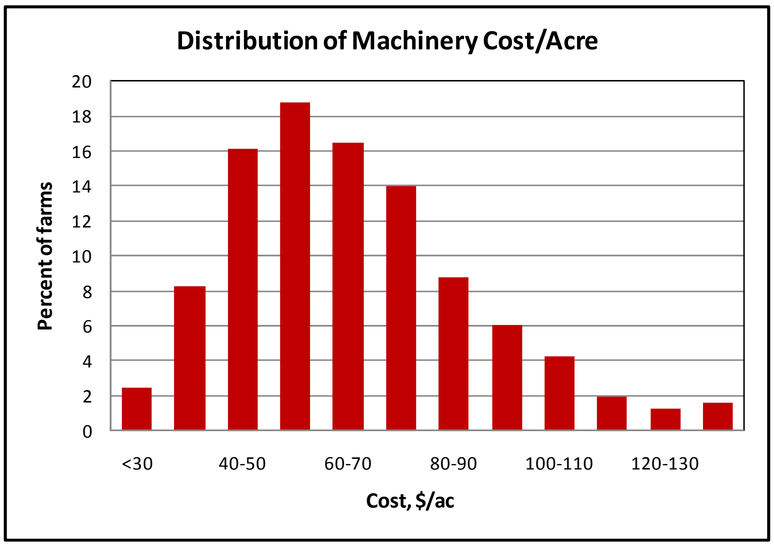

Figure 4

Figure 5 compares the relative ranking of the 614 farms' machinery costs in 2009 compared to their relative ranking in 2008. The correlation between the two year's rankings is 0.80 indicating that producers that tend to have low (high) machinery costs one year also have low (high) machinery costs the next year. While this might seem like a rather intuitive result, it is important when thinking about where to focus management efforts. That is, figures 4 and 5 suggest that machinery costs vary

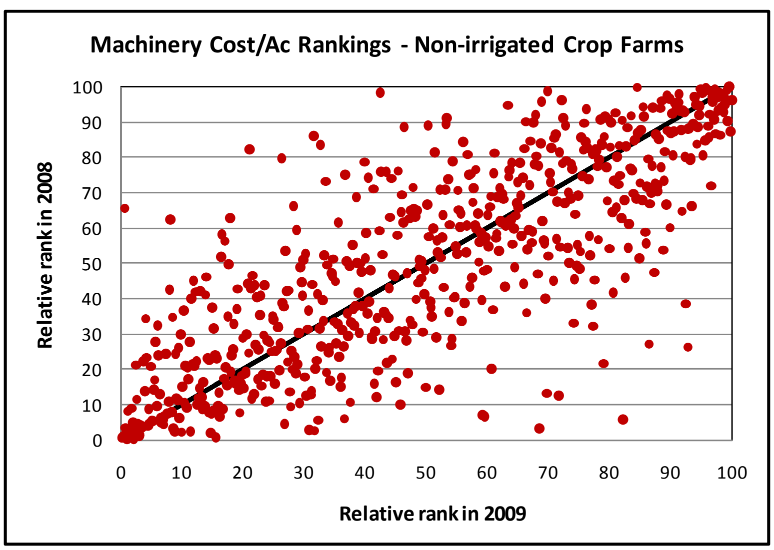

Figure 5

tremendously and they are quite persistent. Thus, this seems like a very logical area for producers to focus their management efforts in.

Many factors impact machinery costs and thus it is important that producers analyze their machinery purchase decisions carefully. Deciding whether to buy new versus used or which size/capacity of machine to buy are important factors to consider. Also, a major decision in the current environment is whether or not to invest in the many precision ag technologies (e.g., auto-steer, section controllers, etc.). In some cases these decisions are quite obvious, but often times they are very farm specific and thus each individual producer needs to analzye what is best for their operation. A number of machinery-related decision making tools have been developed at Kansas State University that can help producers analyze the many choices they have. These tools can be used to estimate the costs of owning various types of equipment (sprayer, combine, tractor) as well as the returns to investing in guidance and section control systems and are available for public download at www.agmanager.info/farmmgt/machinery/.

Another important area that has generated a lot of questions with regard to cost management in recent years is related to fertilizer use. Specifically, as fertilizer prices started increasing in the mid 2000's, producers began asking questions about recommended fertilizer rates and whether they should cut back on fertilizer use. Figures 6 and 7 show annual prices in the U.S. of the major fertilizers (N, P, and K) for the last 30 years. Prices were relatively stable for the first 20 plus years of this time period. However, it appears those days are behind us and the new "normal" might be characterized by much more volatile prices. When fertilizer prices were fairly stable and relatively low, economic optimal rates change very little from year to year. However, beginning in about 2005 prices of nitrogen were much higher prompting questions as to what this meant in terms of nitrogen fertilizer recommendations.

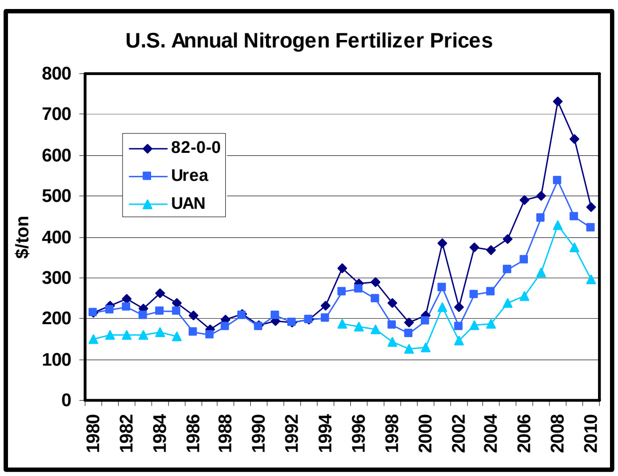

Figure 6

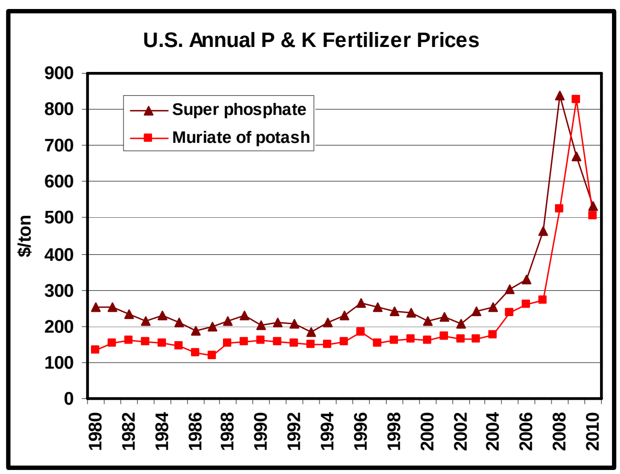

Figure 7

The official K-State fertilizer recommendations as reported in MF-2586 (Leikam, Lamond, and Mengel) do not account for prices of either fertilizer or the crop. Rather, the recommendations are based on soil properties (e.g., soil-test N, organic matter, etc) as well as a producer-provided yield goal. Thus, there is no quantifiable method as to how recommended rates should be modified based on changing prices of either the crop or fertilizer. Because nitrogen prices were increasing significantly at this time and no formal method existed to incorporate prices into recommendations, research in 2005 was initiated to develop a means of modifying the official K-State recommendations to reflect prices (see Kastens et al. (2005) for details). Some of the key aspects of this research were the following:

1) The relationship between yield and nitrogen (production function) was characterized as a quadratic plateau, which implies diminishing returns to additional fertilizer.
2) The quadratic plateau production function is consistent with linear plateau relationship between yield and nitrogen in individual years, which is consistent with the limiting factor framework.
3) The developed models "give back" the same nitrogen recommendations as the official K-State recommendations at long-run average prices (i.e., the models were calibrated to equate with official recommendations, which have many years of history and agronomic research behind them).

The results of this research were incorporated into an Excel spreadsheet decision tool that allowed producers to examine how nitrogen (N) fertilizer recommendation rates varied as the prices of crops and fertilizer N changed. As stated above, the algorithms developed were consistent with K-State official recommendations published in MF-2586 at long-run (10-year average) prices. That is, at long-run price relationships, the "economic model" gave back the exact same recommendations as those published in MF-2586. However, as prices deviated from long-run relationships the economic optimal recommendations deviated from those published in MF-2586.

Beginning in late summer, early fall of 2008 producers began asking questions again because now fertilizer prices were quite high and crop prices were falling. However, unlike in 2005, this time producers were asking about the fact that both N and P prices were very high and what impact this had on optimal fertilizer rates. In response to these questions, the spreadsheet was modified to account for fertilizer P prices as well as N prices (estimated yield-phosphorus relationships were based on the sufficiency P recs published in MF-2586). One additional assumption was made regarding the official K-State recommendations (i.e., those published in MF-2586) and that was that N recommendations are based on P being non-limiting and vice versa. This assumption is consistent with the recommendations themselves (i.e., N recs are not a function of soil test P, nor are P recs a function of soil test N) as well as the fact that most research studies supporting the recommendations focused on one nutrient only with other factors considered to be non-limiting. The details of this revised approach that accounts for both N and P simultaneously (also accounts for pumping costs on irrigated crops) are reported in Kastens et al. (2009). The revised algorithms were once again imbedded into an Excel spreadsheet decision tool (*KSU-NPI_CropBudgets.xls*), which is available at http://www.agmanager.info/crops/prodecon/decision/default.asp. In this version of the spreadsheet, the economic optimal N rate is a function of yield goal, soil-test properties, crop price, N price ***and*** P price. Likewise, the optimal P to apply is a function of both P and N prices.

Tables 1a, 1b, and 1c reflect screen captures from the fertilizer input section of *KSU-NPI_CropBudgets.xls* for three different price scenarios. Blue values are user inputs, which determine the KSU recommended nitrogen and phosphate rates (i.e., those consistent with recommendations published in MF-2586) and the Econ Optimum fertN and fertP rates (i.e., those based on our revised algorithms). Table 1a is based on crop prices producers are currently facing for 2011 and current N and P prices, where the N price is based on the "low cost" N (NH_3). In this price scenario, the economic optimal N rates are appoximately 8% lower than the official KSU recommendations and P rates are approximately 20% lower. Table 1b reflects the same prices, except in this case N price is based on the "high cost" N (UAN). Given this higher price of N, the economic optimal N rates are now approximately 14% lower than the official KSU recommendations and the economic optimal P rates are about 30% lower. Thus, the higher price of N impacted both the optimal N rate as well as the optimal P rate. While this makes sense intuitively (i.e., if I cut back on my N due to a higher price I also should cut back on P because of the lower expected yield), this result is not something that can ever come out of the official K-State fertilizer recommendations because there is nothing linking the two nutrients together. Table 1c shows the impact of the high fertilizer costs and longer-run crop prices (i.e., much lower crop prices). In this case the economic optimal N rates are about 30% below the official KSU recommendation and economic optimal P rates about 50% lower.

TABLE 1a. Production Inputs Used for Budgets 4:04 PM 12/20/10

ITEM	Wheat	Corn	Sorghum	Soybean	Sunflower	
Price scenarios to consider						Use (Y=1, N=0)
Crop prices -- current	$7.13	$4.71	$4.51	$11.27	$0.1950	1
Yield goal (YG), bu/ac	45.0	90.0	80.0	30.0	1,200	
Enter 0 for dryland or 1 for irrigated	0	0	0	0	0	
Soil test P (STP), ppm	12.00	12.00	12.00	12.00	12.00	
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00	
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0	
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0	
KSU recommended nitrogen, lbs/ac	68.0	84.0	68.0	0.0	30.0	
Econ Optimum fertN, lbs/ac	62.2	76.9	62.6	0.0	23.5	
KSU recommended phosphate, lbs/ac	26.0	27.2	25.1	28.5	21.6	
Econ Optimum fertP, lbs/ac	20.7	21.4	19.8	28.0	16.2	
Econ Optimum Irrigation Amount, in	0.0	0.0	0.0	0.0	0.0	
Yield at optimal N, P, and I, bu/ac	44.2	88.7	78.6	29.9	1171.2	
Change in STP, ppm	-0.08	-0.44	-0.65	0.23	-0.08	
Fertilizer:						$/unit
Nitrogen (N)	62.2	76.9	62.6	0.0	23.5	$0.400 /lb
Phosphate (P)	20.7	21.4	19.8	28.0	16.2	$0.580 /lb

TABLE 1b. Production Inputs Used for Budgets 4:06 PM 12/20/10

ITEM	Wheat	Corn	Sorghum	Soybean	Sunflower	
Price scenarios to consider						Use (Y=1, N=0)
Crop prices -- current	$7.13	$4.71	$4.51	$11.27	$0.1950	1
Yield goal (YG), bu/ac	45.0	90.0	80.0	30.0	1,200	
Enter 0 for dryland or 1 for irrigated	0	0	0	0	0	
Soil test P (STP), ppm	12.00	12.00	12.00	12.00	12.00	
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00	
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0	
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0	
KSU recommended nitrogen, lbs/ac	68.0	84.0	68.0	0.0	30.0	
Econ Optimum fertN, lbs/ac	58.7	72.9	58.2	0.0	20.3	
KSU recommended phosphate, lbs/ac	26.0	27.2	25.1	28.5	21.6	
Econ Optimum fertP, lbs/ac	18.6	19.6	17.8	28.0	14.3	
Econ Optimum Irrigation Amount, in	0.0	0.0	0.0	0.0	0.0	
Yield at optimal N, P, and I, bu/ac	43.8	88.0	77.9	29.9	1158.0	
Change in STP, ppm	-0.18	-0.53	-0.74	0.23	-0.17	
Fertilizer:						$/unit
Nitrogen (N)	58.7	72.9	58.2	0.0	20.3	$0.550 /lb
Phosphate (P)	18.6	19.6	17.8	28.0	14.3	$0.580 /lb

TABLE 1c. Production Inputs Used for Budgets						4:08 PM 12/20/10
ITEM	Wheat	Corn	Sorghum	Soybean	Sunflower	
Price scenarios to consider						Use (Y=1, N=0)
Crop prices -- low	$4.50	$3.00	$2.80	$7.50	$0.1250	1
Yield goal (YG), bu/ac	45.0	90.0	80.0	30.0	1,200	
Enter 0 for dryland or 1 for irrigated	0	0	0	0	0	
Soil test P (STP), ppm	12.00	12.00	12.00	12.00	12.00	
Organic matter (OM), %	2.00	2.00	2.00	2.00	2.00	
Soil test nitrogen (STN), lbs/ac	20.0	20.0	20.0	20.0	20.0	
Other N adjustments, lbs/ac	0.0	0.0	0.0	0.0	0.0	
KSU recommended nitrogen, lbs/ac	68.0	84.0	68.0	0.0	30.0	
Econ Optimum fertN, lbs/ac	47.5	59.5	44.5	0.0	10.0	
KSU recommended phosphate, lbs/ac	26.0	27.2	25.1	28.5	21.6	
Econ Optimum fertP, lbs/ac	12.1	13.5	11.3	25.6	8.3	
Econ Optimum Irrigation Amount, in	0.0	0.0	0.0	0.0	0.0	
Yield at optimal N, P, and I, bu/ac	42.0	85.1	74.6	29.7	1098.0	
Change in STP, ppm	-0.49	-0.81	-1.03	0.10	-0.45	
Fertilizer:						$/unit
Nitrogen (N)	47.5	59.5	44.5	0.0	10.0	$0.550 /lb
Phosphate (P)	12.1	13.5	11.3	25.6	8.3	$0.580 /lb

As fertilizer and crop prices continue to exhibit tremendous variability it is important that producers make informed decisions about the rates of fertilizer they apply. That is, likely it is inappropriate not to reduce rates if fertilizer prices are increasing significantly. However, blindly cutting back on rates also may be inappropriate, especially if crop prices have also risen. In order to determine how fertilizer rates should be adjusted in response to prices, a mathematical relationship (i.e., production function) between nutrient and yield is needed. Based on a number of fertilizer trials in central and western Kansas, it was determined that a quadratic plateau production function fit the data better than alternative functional forms in most cases. Given assumptions about what the developers of the official KSU fertilizer recommendations might have been thinking about crop and fertilizer prices (i.e., long run average prices), a quadratic plateau function can be “backed out” of the KSU N and P recommendations. This quadratic plateau function is consistent with KSU recommendations at long-run prices, allows diminishing returns to fertilizer, but is also consistent with linear plateau with any site-year. In other words, the approach used to develop a framework for modifying yield-goal-based fertilizer recommendations based on prices is consistent with properties that both agronomists and economists believe are true. Another important thing to recognize is that when multiple inputs are considered simultaneously (e.g., N and P), economic optimal rates are lower than when other inputs are ignored (or have zero cost).

Summary

Tremendous variability exists in the profitability across producers at any point in time. Prices obviously impact returns and thus can be an important factor in explaining profitability differences between producers in any given year. However, there is little research evidence indicating that producers can consistently get higher prices than the average (i.e., the fact that they get a high price one year is somewhat of a random occurrence). Thus, focusing management efforts on “picking prices” does not seem to be a wise use of limited management time or resources. Rather, producers should focus their efforts on those areas that impact profitability and are persistent (i.e., where my management efforts can have an impact). Over time, differences in profitability are driven principally by cost and yield differences, with cost being the more important of the two. High profit farms tend to be low-cost operators, but they do not cut costs at the expense of production. This suggests that high profit farms make wise input decisions to make sure they adopt appropriate technologies and also apply inputs in a profit-maximizing manner. Numerous tools have been developed that can help producers evaluate the various input decisions they have to make every year (a number of these can be found at www.AgManager.info). While there is no guarantee that using a decision-tool will lead to the best decision, it is believed that making decisions based on a quantified approach (i.e., "crunching the numbers") is better than simply making gut feel decisions. Based on research of Kansas farms, it appears that producers should focus their management efforts on farm size, cost control, technology adoption, and production more so than on picking prices.

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