14. Relative Efficiency of Kansas Wheat Farms

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Abstract/Summary

This presentation will document changes in wheat acreage in Kansas over the last 35 years, will compare trends in wheat yields to trends in feed grain yields, and will examine the technical and cost efficiency of farms with particular emphasis on how this efficiency relates to the proportion of farm income derived from wheat. Differences in wheat enterprise profitability and the importance of economies of size will also be discussed.

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Introduction

Planted wheat acres in Kansas have declined over the last 35 years. The average planted wheat acres from 1973 to 1979 was 12,157,000 while the average planted wheat acres from 2000 to 2009 was 9,890,000. In contrast, planted corn and soybean acres have grown from 1,966,000 and 1,199,000 to 3,470,000 and 2,950,000, respectively, over the same time periods. The trend in acres planted from 1973 to 2009 for corn, grain sorghum, soybeans, and wheat were 2.70 percent, -1.19 percent, 3.08 percent, and -0.81 percent, respectively.

The average number of planted non-irrigated wheat acres for farms participating in the Kansas Farm Management Association (KFMA) program increased from an average of 310 acres during 1973 to 1979 period to an average of 397 acres during the 2000 to 2008 period. However, this increase is due to increases in average farm size. Wheat as a proportion of total non-irrigated crop acres (this figure includes fallow acres) has declined from approximately 41 percent during 1973 to 1979 period to approximately 36 percent during the 2000 to 2008 period on these farms. Non-irrigated corn and soybean acres, on the other hand, have increased from 3 percent and 5 percent during the 1973 to 1979 period to 13 percent and 19 percent, respectively, during the 2000 to 2008 period.

There are numerous factors that may have contributed to the reduction in wheat acres. First, a relatively lower trend in wheat yields compared to other major crops such as corn, grain sorghum, and soybeans would contribute to a decline in wheat acreage. Second, if wheat prices in relation to other crop prices declined, acreage would shift away from wheat. Third, technological developments that favored corn, grain sorghum, or soybeans over wheat would

contribute to a decline in wheat acreage. The first point has already mentioned relative yield differences. Besides yield, cropping practices such as reduced tillage, or more drought or heat tolerant hybrids that favored crops other than wheat would contribute to a decline in wheat acreage. For example, no-till producers in central and western Kansas typically have rotations that include feed grains or oilseeds or both. These rotations, made possible because of improved hybrids or better management practices, would contribute to a decline in wheat acreage.

This paper examines the relative growth in yields for the major crops in Kansas, trends in relative prices of the major crops in Kansas, and technical and cost efficiency of farms with particular emphasis on how this efficiency relates to the proportion of farm income derived from wheat. The technical and cost efficiency analysis is used to capture possible changes in cropping practices or technologies that may have favored certain crops over wheat. Differences in wheat enterprise efficiency and profitability will also be discussed.

Data and Methods

Trends in corn, grain sorghum, soybean, and wheat yields per acre were explored using annual Kansas data from 1973 to 2008. Specifically, an exponential trend regression was estimated for each crop using non-irrigated yields for each crop. More information on estimating exponential trend regressions can be found in Allen et al. (2005).

Annual Kansas data from 1973 to 2008 was also used to compare the relative prices for corn, grain sorghum, soybeans, and wheat. Specifically, the following price ratios were computed: wheat/corn, wheat/grain sorghum, and wheat/soybeans. Exponential trend regressions were used to determine whether these price ratios have increased or decreased over the time period.

Technical and cost efficiency indices were computed for each KFMA farm with continuous whole-farm or enterprise data from 2004 to 2008 using linear programming (Fare et al., 1985; Coelli et al., 2005). Farms or ranches that are technically efficient produce on the production frontier. These farms are producing the highest level of output for a given level of inputs. Farms that are technically inefficient could expand output with the same level of inputs by improving their technical efficiency. Farms or ranches that are cost efficient (often referred to as economic or overall efficiency) produce on the cost frontier. These farms are producing at the lowest cost for a given level of outputs. Farms that are cost inefficient could lower cost for a given level of outputs by improving cost efficiency.

Two separate efficiency analyses were conducted. The first analysis used data from KFMA farms that had continuous whole-farm data from 2004 to 2008. There were 806 farms that met these criteria. Approximately 11 percent, 41 percent, and 48 percent of the farms were located in western, central, and eastern Kansas, respectively. Two outputs (crop and livestock) and six inputs (labor, seed, fertilizer, herbicide and insecticide, fuel and utilities, and other) were used to estimate the whole-farm technical and cost efficiency indices for each farm. The "other" input includes feed, repairs, depreciation, interest, and miscellaneous expenses. The second analysis used data from KFMA farms with continuous wheat enterprise data from 2004 to 2008. There were 185 farms that met these criteria. One output (wheat) and six inputs (labor, seed, fertilizer, herbicide and insecticide, fuel and utilities, and other) were used to estimate technical and cost efficiency indices for the wheat enterprise on each of 185 farms. The "other" input includes repairs, depreciation, interest, and miscellaneous expenses.

The whole-farm efficiency analysis was summarized using technical and cost efficiency indices and farm characteristics. Farms were categorized using cost efficiency thirds. Variables

compared across thirds included value of farm production, net farm income, operating profit margin ratio, asset turnover ratio, technical efficiency, cost efficiency, total acres, total crop acres, crop intensity index, crop labor percentage, percent of gross farm income derived from specific crop and livestock enterprises, and cost shares. The crop intensity index was computed by dividing total harvested acres by total crop acres. A farm with an index below one fallows a portion of their ground. Conversely, a farm with an index above one double cropped to at least some extent. Cost shares were computed by dividing individual cost items by gross farm income. If the sum of the cost shares is above one, a portion of the costs are not being covered.

The wheat enterprise efficiency analysis was summarized by categorizing the farms into thirds using net return to management per acre as the sorting variable. In addition, to presenting detailed information pertaining to yield, price, gross income, and cost; total cost per bushel was presented graphically and discussed.

Relative Growth in Crop Yields

Table 1 presents the growth rates of corn, grain sorghum, soybeans, and wheat using data from 1973 to 2008. Soybeans had the highest growth rate in yields over the 1973 to 2008 period followed by corn, grain sorghum, and wheat. The R^2 measure in the table measures the percent of the variation in yields explained by the trend regressions. Interestingly, the growth rate in corn yield had the highest R^2 measure. This indicates that corn yields were the easiest to predict. Having said this, even for corn yields, approximately 50 percent of the variation was not explained by the trend regression. Certainly, the relatively low growth rate in wheat yields contributed to the reduction in wheat acres over the 1973 to 2008 period.

Relative Crop Prices

The growth rates in wheat/corn, wheat/grain sorghum, and wheat/soybean price ratios using data from 1973 to 2008 are presented in Table 2. In all three cases, the trends in prices over this period were favorable to wheat. However, it is important to note that not very much of the variation in price ratios was explained by the trend regressions. The favorable prices for wheat over the 1973 to 2008 period likely prevented more acreage from switching out of wheat production.

Whole-Farm Efficiency Analyses

A separate whole-farm efficiency analysis was conducted for western, central, and eastern Kansas. Table 3 presents the results for western Kansas. The discussion below focuses on the variables that were significantly different between the farms in the top one-third and bottom one-third cost efficiency groups. The farms in the top one-third group were relatively larger, had higher operating profit margin and asset turnover ratios, had higher efficiency indices, had a higher crop intensity index, and devoted less of their time to crop production. The results with respect to the percentage of time devoted to crop production variable suggest that economies of scope may be important. For an examination of economies of scope in Kansas see Langemeier and Jones (2006). Only two of the income shares were significant, feed grains and small grains. The farms in the top one-third group produced significantly more feed grains and significantly less small grains. This result is consistent with the higher crop intensity index for this group. Farms that utilized a wheat/corn/fallow or wheat/grain sorghum/fallow rotation would have a higher crop intensity index and would produce relatively more feed grains than farms that utilized a wheat/fallow rotation. The cost shares for labor and the "other" input category were significantly lower for the top one-third group. These items would be related to

economies of scale so this result is consistent with the farm size comparisons between the two groups of farms. The relatively higher seed cost share for the top one-third group is consistent with the income share results; feed grain seed is typically more expensive than wheat seed.

The whole-farm efficiency results for central Kansas are presented in Table 4. The discussion below focuses on the variables that were significantly different between the farms in the top one-third and bottom one-third cost efficiency groups. The farms in the top one-third group were relatively larger, had higher operating profit margin and asset turnover ratios, had higher efficiency indices, and had a higher crop intensity index. The percentage of time devoted to crop production was similar for the two groups of farms. Three of the income share variables were significant, feed grain income share, small grain income share, and dairy income share. The farms in the top one-third group produced significantly more feed grains and significantly less small grains. Dairy production was also higher for the top one-third group. Though rotation data were not available, it is obvious that the top one-third group is utilizing to a greater extent rotations that include both wheat and feed grains. The cost shares for labor, fertilizer, fuel, and "other" were significantly lower for the top one-third group. The results with respect to labor and "other" are related to economies of scale and are consistent with the farm size comparisons between the two groups of farms.

Table 5 presents the whole-farm efficiency results for eastern Kansas. The discussion below focuses on the variables that were significantly different between the farms in the top one-third and bottom one-third cost efficiency groups. The farms in the top one-third group were relatively larger, had higher operating profit margin and asset turnover ratios, had higher efficiency indices, and had a higher crop intensity index. Both of the crop intensity indices are above one, an indication that double cropping was fairly common. The higher crop intensity

index for the top one-third group is consistent with the analysis conducted by Widmar and Langemeier (2009) who found that farms in eastern that are more cost efficient utilized double cropping to a greater extent. The percentage of time devoted to crop production was similar between the two groups. The feed grain, dairy, and swine income shares for the top one-third group were significantly higher. Conversely, income shares for hay and forage, small grains, and beef were significantly lower for this group. The income share results suggest that the enterprise mix differences between the top one-third and bottom one-third groups for eastern Kansas were more diverse than they were for western and central Kansas. The labor, fertilizer, fuel, and "other" cost shares were significantly lower for the top one-third group. The labor and "other" cost share results are related to economies of scale and are consistent with the farm size comparisons between the two groups of farms.

Wheat Enterprise Efficiency and Profitability

Wheat enterprise data from 2004 to 2008 were used to make cost of production and net return comparisons among farms. Table 6 presents yield, price, gross income, and cost data for the net return to management categories. Figure 1 provides a graphical depiction of gross income per acre, total cost per acre, and price per bushel differences among the net return to management categories. In addition to being more technical and cost efficient, the high profit group had more wheat acres, more crop acres, a higher yield, a higher price per bushel, and significantly lower total costs. Gross income per acre for the high profit group was 14 percent higher than that for the low profit group. More importantly, total cost per acre was 28 percent lower for the high profit group. Fertilizer, machinery, and labor were the three largest cost per acre items. These cost categories were from 23 percent to 33 percent lower for the high profit group. Net return to management for the top one-third group was $34.37 per acre. In contrast,

the low profit group lost $47.68 per acre, on average, over the five-year period. These net returns translate into a difference in net return per management between the two groups of $82.05.

Cost per bushel for each farm with continuous wheat enterprise data from 2004 to 2008 is presented in Figure 2. The average cost per bushel over the five-year period was $4.81. The bottom one-third group has a cost of production that was more than $2.00 per bushel higher ($5.95) than the cost of production for the top one-third group ($3.88). The trend line illustrates the importance of economies of scale with respect to wheat production.

Summary and Conclusions

The objectives of this paper were to examine the relative growth in yields for the major crops in Kansas, examine trends in relative prices of the major crops in Kansas, and compute technical and cost efficiency indices for individual farms with particular emphasis on how this efficiency relates to the proportion of gross farm income derived from wheat. The whole-farm efficiency analysis was used to capture changes in cropping practices or technologies that may have favored certain crops over wheat. Differences in wheat enterprise efficiency and profitability were also discussed.

The trend growth rate in wheat yields was substantially lower than the trend growth rates in corn and soybean yields over the 1973 to 2008 period. In contrast, though relatively small, the growth rates in wheat/corn, wheat/grain sorghum, and wheat/soybean price ratios were positive over the 1973 to 2008 period. More importantly, efficient farms produced less wheat and more feed grains. It is also important to note that farms in the top one-third cost efficiency group tended to be larger, had higher operating profit margin and asset turnover ratios, and had a higher crop intensity index.

To motivate wheat producers to examine their production costs, wheat enterprise efficiency and profitability information was also presented. There was a substantially difference in cost per bushel across producer groups. The difference in cost per bushel for farms in the top one-third and bottom one-third groups was over $2.00. Certainly, there is quite a bit of room for improving wheat enterprise cost efficiency.

What are the implications of the results? First, it is important to note that wheat is going to be an important crop on Kansas farms for years to come. However, with the potential for more drought tolerant corn and soybean varieties looming, the acreage of wheat may continue to decline as producers switch to rotations that involve wheat, feed grains, and oilseeds rather than using rotations that are more oriented towards wheat. Second, given the continued importance of wheat on Kansas farms, it is extremely important for producers to get a handle on the relative production costs and profits of wheat.

References

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Table 1. Trends in Yields of Major Crops, 1973 to 2008 Kansas Data.

Variable	Growth Rate	R^2
Corn	1.09%	0.49
Grain Sorghum	0.97%	0.22
Soybeans	1.49%	0.33
Wheat	0.67%	0.16

Table 2. Trends in Price Ratios, 1973 to 2008 Kansas Data.

Variable	Growth Rate	R^2
Wheat to Corn Price Ratio	0.46%	0.17
Wheat to Grain Sorghum Price Ratio	0.33%	0.11
Wheat to Soybean Price Ratio	0.57%	0.12

Note: Corn, soybean, and wheat prices were expressed in dollars per bushel. Grain sorghum price was expressed in dollars per cwt.

Table 3. Whole-Farm Efficiency Indices and Farm Characteristics for KFMA Farms in Western Kansas.

Variable	Top 1/3	Bottom 1/3	Difference Significant
Number of Farms	31	31	
Farm Characteristics			
Gross Farm Income ($)	730,147	246,077	yes
Value of Farm Production ($)	687,579	238,722	yes
Net Farm Income ($)	161,707	38,011	yes
Operating Profit Margin Ratio	0.2219	0.0151	yes
Asset Turnover Ratio	0.4517	0.1937	yes
Technical Efficiency	0.977	0.881	yes
Cost Efficiency	0.901	0.598	yes
Total Acres	3,198	2,092	yes
Total Crop Acres	2,449	1,676	yes
Crop Intensity Index	0.862	0.624	yes
Percent of Labor Devoted to Crops	86.74%	95.32%	yes
Income Shares			
Feed Grains	0.3598	0.2009	yes
Hay and Forage	0.0302	0.0631	no
Oilseeds	0.0428	0.0507	no
Small Grains	0.1957	0.3255	yes
Beef	0.1358	0.1455	no
Dairy	0.0182	0.0000	no
Swine	0.0000	0.0002	no
Cost Shares			
Labor	0.1127	0.3203	yes
Seed	0.0544	0.0347	yes
Fertilizer	0.0865	0.0963	no
Herbicide and Insecticide	0.0776	0.0735	no
Fuel	0.1148	0.1404	no
Other	0.4957	0.7921	yes

Table 4. Whole-Farm Efficiency Indices and Farm Characteristics for KFMA Farms in Central Kansas.

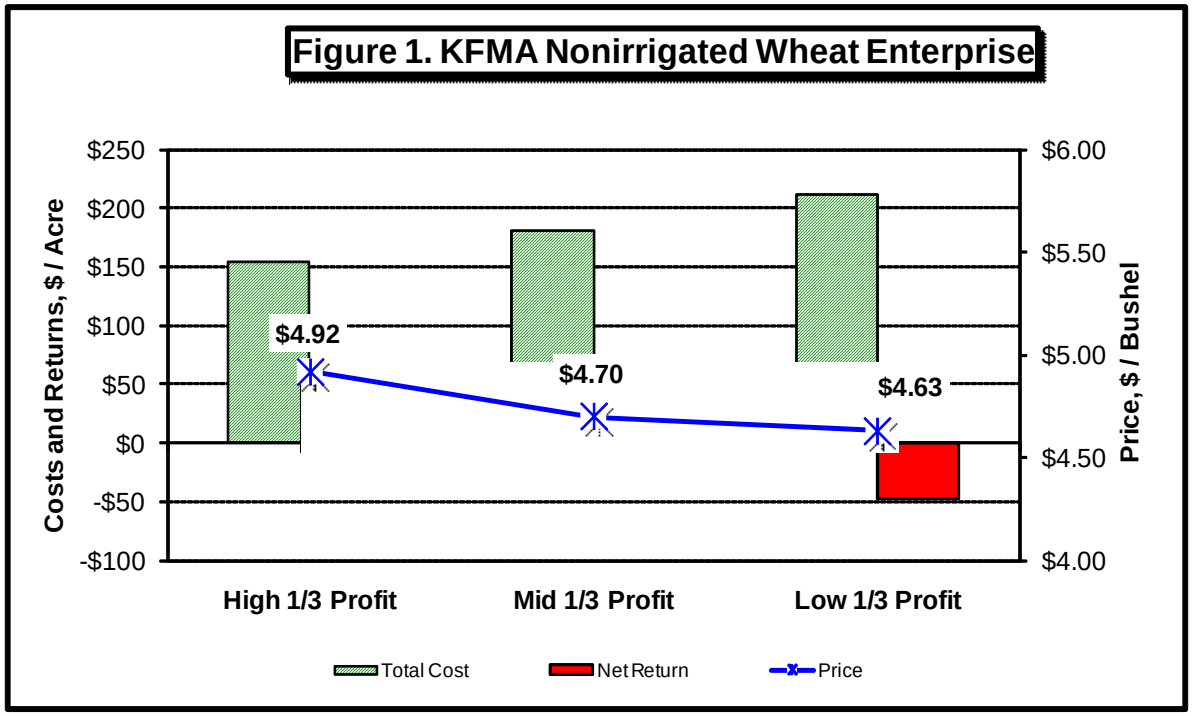
Variable	Top 1/3	Bottom 1/3	Difference Significant
Number of Farms	109	109	
Farm Characteristics			
Gross Farm Income ($)	563,449	198,098	yes
Value of Farm Production ($)	532,171	191,134	yes
Net Farm Income ($)	141,571	28,161	yes
Operating Profit Margin Ratio	0.2074	-0.0282	yes
Asset Turnover Ratio	0.4719	0.2035	yes
Technical Efficiency	0.933	0.733	yes
Cost Efficiency	0.757	0.487	yes
Total Acres	2,449	1,248	yes
Total Crop Acres	1,953	882	yes
Crop Intensity Index	1.041	0.972	yes
Percent of Labor Devoted to Crops	82.17%	85.54%	no
Income Shares			
Feed Grains	0.2243	0.1602	yes
Hay and Forage	0.0315	0.0457	no
Oilseeds	0.1238	0.1163	no
Small Grains	0.2423	0.3337	yes
Beef	0.1347	0.1646	no
Dairy	0.0694	0.0006	yes
Swine	0.0073	0.0057	no
Cost Shares			
Labor	0.1525	0.3091	yes
Seed	0.0549	0.0590	no
Fertilizer	0.1232	0.1480	yes
Herbicide and Insecticide	0.0572	0.0612	no
Fuel	0.0730	0.1071	yes
Other	0.4968	0.7764	yes

Table 5. Whole-Farm Efficiency Indices and Farm Characteristics for KFMA Farms in Eastern Kansas.

Variable	Top 1/3	Bottom 1/3	Difference Significant
Number of Farms	129	129	
Farm Characteristics			
Gross Farm Income ($)	710,408	219,198	yes
Value of Farm Production ($)	620,140	189,391	yes
Net Farm Income ($)	196,375	33,955	yes
Operating Profit Margin Ratio	0.2592	0.0169	yes
Asset Turnover Ratio	0.3823	0.1778	yes
Technical Efficiency	0.927	0.672	yes
Cost Efficiency	0.813	0.510	yes
Total Acres	2,137	1,312	yes
Total Crop Acres	1,597	712	yes
Crop Intensity Index	1.121	1.051	yes
Percent of Labor Devoted to Crops	76.37%	77.45%	no
Income Shares			
Feed Grains	0.2611	0.1698	yes
Hay and Forage	0.0139	0.0399	yes
Oilseeds	0.2651	0.2871	no
Small Grains	0.0608	0.1012	yes
Beef	0.1341	0.2345	yes
Dairy	0.1030	0.0121	yes
Swine	0.0409	0.0101	yes
Cost Shares			
Labor	0.1441	0.3016	yes
Seed	0.0787	0.0869	no
Fertilizer	0.0953	0.1203	yes
Herbicide and Insecticide	0.0464	0.0523	no
Fuel	0.0656	0.0995	yes
Other	0.5198	0.8907	yes

Table 6. Kansas Farm Management Association: State Average
2004-2008 Nonirrigated Wheat Enterprise Sorted by Net Return to Management per Acre

	Profit Category			Difference between High 1/3 and Low 1/3	
	High 1/3 Per Acre	Mid 1/3 Per Acre	Low 1/3 Per Acre	Acres / $	%
Number of Farms	61	62	62		
Enterprise Acres	939	636	422	517	123%
Crop Acres	1,997	1,507	1,059	938	89%
Bushels Produced	28,772	19,185	11,624	17,148	148%
Yield per Acre	39.2	38.4	35.3	3.9	11%
Price per Bushel	$4.92	$4.70	$4.63	$0.29	6%
Technical Efficiency	0.915	0.797	0.699	0.216	31%
Cost Efficiency	0.683	0.573	0.452	0.231	51%
INCOME:					
Crop Income	$149.60	$142.18	$127.01	$22.58	18%
Government Payments	$17.86	$17.89	$18.07	($0.21)	-1%
Other Income	$20.66	$21.87	$19.35	$1.31	7%
Gross Income	**$188.12**	**$181.93**	**$164.43**	**$23.69**	**14%**
COSTS:					
Seed	$7.43	$9.45	$8.88	($1.45)	-16%
Fertilizer	$27.06	$33.07	$35.35	($8.29)	-23%
Herbicide-Insecticide	$6.68	$8.04	$7.90	($1.22)	-15%
Crop Insurance	$5.48	$6.31	$6.26	($0.78)	-12%
Machinery	$42.79	$47.72	$59.53	($16.74)	-28%
Labor	$24.57	$27.65	$36.86	($12.29)	-33%
Other	$6.94	$9.02	$11.99	($5.05)	-42%
Land	$20.92	$25.19	$27.54	($6.62)	-24%
Interest	$11.88	$14.10	$17.80	($5.92)	-33%
Total Cost	**$153.75**	**$180.55**	**$212.11**	**($58.36)**	**-28%**
Net Return to Management	**$34.37**	**$1.38**	**($47.68)**	**$82.05**	



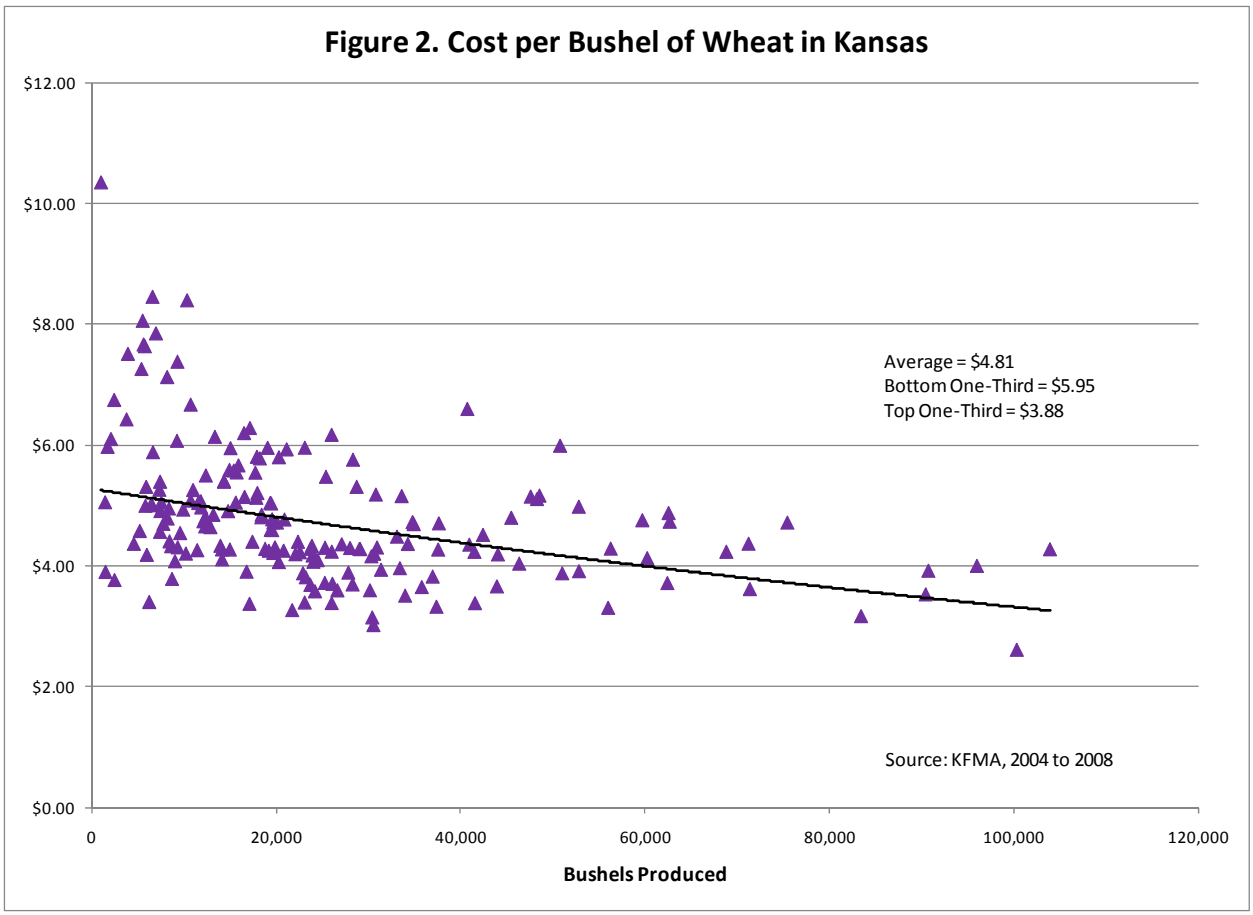


Figure 2. Cost per Bushel of Wheat in Kansas
$12.00
$10.00
$8.00
$6.00
$4.00
$2.00
$0.00
0
20,000
40,000
60,000
80,000
100,000
120,000
Bushels Produced
Average = $4.81
Bottom One-Third = $5.95
Top One-Third = $3.88
Source: KFMA, 2004 to 2008