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THE IMPACT OF HIGHER ENERGY PRICES ON GREAT PLAINS CROP FARM EXPENDITURES

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ABSTRACT—Use of energy-intensive inputs in agriculture is generally considered to be unresponsive to price increases in the short run. An increase in diesel and natural gas prices directly increases costs of energy used on farms for irrigation, machinery operation, and heating. Energy-intensive production inputs such as fertilizer prices also increase due to higher energy costs. This study assesses the impact of substantially higher energy prices in 2000 and 2001 on whole-farm production costs on 983 Kansas farms using actual whole-farm data. It is hypothesized that the impact on fuel, irrigation energy, and fertilizer costs will be significantly more than the impact on seed and chemical costs. Higher prices for fuel, irrigation energy, and fertilizer in 2000 and 2001 raised production costs and lowered net farm income, depending upon farm type and location by an average of $2,697 to $51,685 below what it would have been without these energy price increases. Dryland farms and irrigated farms are impacted most by increasing fertilizer and irrigation energy costs, respectively, and both kinds of cost increases are due to higher natural gas prices.

Key Words: energy prices, farm production costs

Introduction

Prices for diesel fuel and natural gas were substantially higher in the Great Plains during 2000 and 2001 than in 1999, but declined below 2000 levels in 2002. The annual average diesel fuel price in Kansas was $.37/gallon greater in 2000 than in 1999 (Fig. 1). In 2001 it was $.31/gallon higher on average than in 1999 (U.S. Department of Energy [USDOE] 2004). The natural gas price for commercial consumers in Kansas was on average 41%, or $2.10/1,000 ft^3 (MCF), greater in 2000 than in 1999 (Fig. 2). In 2001 it was 13%, or $.95/MCF, greater than in 2000, making it 60%, or $3.05/MCF, greater than in 1999 (USDOE 2004). Although natural gas prices for the Kansas industrial consumers that produce nitrogen fertilizers were not available before 2001, U.S. industrial gas prices were 43% greater in 2000 than in 1999 and 18% higher in 2001 than in 2000, making them 68% greater than in 1999. Electricity prices in Kansas averaged 7.6¢/kWh each year from 1999 through 2001 (USDOE 2004).

The increase in diesel and natural gas prices directly increases costs of energy used on farms, such as fuels for irrigation, machinery operation, and heating. The prices of inputs such as fertilizer, seed, and chemicals are also influenced indirectly by energy costs. Energy-intensive inputs increase in price because higher energy input costs increase the cost of producing production inputs, such as fertilizer, resulting in reduced supply and higher prices. Energy-intensive inputs are inputs that require a relatively large amount of energy to produce. Thus, when the price of energy increases, the cost of producing that input increases, resulting in reduced supply and higher prices for that input.

Three previous studies have examined the impact of energy costs and taxes on irrigation and farm production costs in the Great Plains using either mathematical programming models or energy content-based budgeting approaches (Buller and Williams 1990; Williams et al. 1994; Williams et al. 2001). However, there are no previous studies that examine the effects of higher energy prices using actual farm expenditure data.

Objectives

The general objective of this study is to evaluate the impact of a rapid increase in energy prices on farms over a relatively short period of time by comparing actual on-farm expenditures for energy and energy-intensive inputs for the years 1999, 2000, and 2001. These production costs are

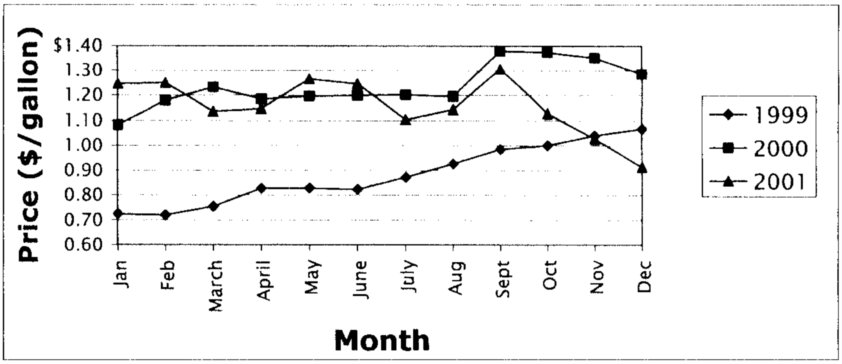

Figure 1. Diesel fuel prices in Kansas, 1999-2001.

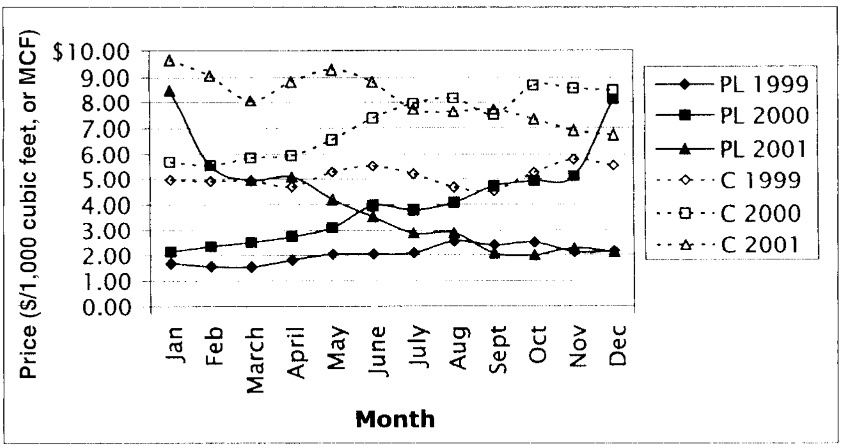

Figure 2. Natural gas prices in Kansas, 1999-2001 (PL = pipeline and C = commercial).

reported in dollars per crop acre for irrigated and dryland farms in six areas of the state. The impact of these cost increases on whole-farm net income is also reported.

Data and Procedures

The extent that production costs increase for the average crop farm in each Kansas farm management association (KFMA) is determined by comparing actual expenditures for energy and energy-intensive inputs classified

as variable inputs for the years 1999, 2000, and 2001 obtained from the Kansas Farm Management Association Data Bank (Kansas Cooperative Extension Service 2002). The input costs examined in this analysis are fuel, fertilizer, irrigation energy, seed, chemicals, and utilities. Because these inputs are mainly used on crop farms, we omitted all farms not classified as nonirrigated crop and irrigated crop farms for 1999, 2000, and 2001. Classification as a crop farm requires that at least 70% of the labor used is for crop production. The data set includes the same farms each year. There are 907 dryland and 76 irrigated farms. Classification as an irrigated farm requires that at least 70% of the labor be used for irrigated crops. Total energy costs are converted to costs per acre by dividing total expenditures for each category by crop acres for each farm. The analysis examines the change in costs over two years using the average for all farms across the state and by each of the six existing KFMAs as defined by geographic region.

Although this data is for Kansas, many other farms in the Great Plains follow similar dryland and irrigated production practices. More or less energy may be required to pump irrigation water, depending on the region, but the relative magnitude of the changes in costs due to increasing energy prices is similar.

Energy Prices and Energy Content of Production Inputs

Farm-level diesel prices for Kansas for the period 1999 through 2001 are reported in Figure 1. These prices are calculated by subtracting Kansas fuel taxes that are exempt from off-road diesel fuel from the Midwest (PADD District 2) diesel price reported by the Energy Information Agency (USDOE 2004). Diesel prices were \$.23 to \$.49 higher per gallon during each month in 2000 than in 1999. During the major-cropping-season months of April through September 2000, diesel prices were on average \$.35/gallon higher than in 1999, which is equivalent to a 40% increase. The annual average diesel fuel price in Kansas was \$.37/gallon higher in 2000 than in 1999 (Fig. 1). The 2000 average price was statistically different from the 1999 price at a 95% confidence level. Diesel prices ranged from \$.13 to \$.52 per gallon higher in 2001 than in 1999, with the exception of November and December, when they fell below the 1999 level. From April through September they averaged \$.32/gallon more than in 1999. The average annual increase in 2001 over 1999 was 32%. The average price in 2001 was statistically different from the 1999 average price. These prices were not only

higher compared to 1999, but were also higher relative to the previous five years. The average annual price of diesel fuel for the Midwest in 2000 was \$.34/gallon greater and \$.26/gallon greater in 2001 than the 1995-1999 average. In 2002 diesel prices fell below the average 2000 level by \$.16/gallon.

Natural gas is the predominant fuel used for irrigation in western Kansas, accounting for 72% of total use (Rogers 2003 personal communication). Natural gas prices at a pipeline in Grant County, KS, in a part of the state that has substantial irrigated acreage, were 95% higher in 2000 than in 1999 and 89% higher in 2001 than in 1999. The Grant County pipeline prices are from the Southwest Kansas Irrigation Association (2003 personal communication). Figure 2 reports the pipeline (PL) and commercial (C) prices by month for 1999 through 2001. The average 2000 and 2001 prices were statistically different from the 1999 price. During the major part of the irrigation season (June through September), prices were 83% higher in 2000 than in 1999 and 25% higher in 2001 than in 1999.

There was no statistical difference in electricity prices during the years 1999 through 2001. There was also no change in the pattern of electricity prices during that period.

Increases in the price of diesel fuel and natural gas led to increased fuel and irrigation energy expenditures on farms in 2000 and 2001 relative to 1999. We expected some expenditures for energy-intensive inputs such as fertilizer, seed, and chemicals to increase as well, but their impact on production costs is less clear because of the indirect nature and quantity of the energy used in producing these inputs.

Many agricultural production inputs are energy intensive. However, there is considerable variation in the energy content that goes into producing various inputs (Pimentel 1980; Bowers 1992). The amount of energy, or Btus, used to produce seeds, chemicals, and fertilizer has a large range. A British thermal unit (Btu) is a unit measurement of energy required to raise the temperature of 1 pound of water 1°F (from 59.5° to 60.5°F). The average energy content of wheat, soybean, grain sorghum, and corn seed is 5,404, 13,651, 25,596, and 44,651 Btus/lb, respectively. The majority of the Btu content is from the combustion of diesel fuel.

Total energy content of herbicides and insecticides averages 174,250 Btus/lb. In herbicide and insecticide production, electricity provides 56% of the energy; naphtha, a derivative of petroleum, provides 17%; fuel oil and steam provide 16%; and natural gas provides 11% (Nelson and Schrock 2002). Therefore, we expect that increased costs of petroleum, diesel fuel,

and natural gas have some impact on herbicide production costs, supply, and price.

Producing nitrogen fertilizers is also energy intensive. Natural gas is the major input used to produce ammonia, and ammonia is the main input in producing nitrogen fertilizers. Anhydrous ammonia requires 21,600 Btus/lb, of which 97% of the energy consumed is natural gas. Ammonia nitrate requires 26,460 Btus/lb, and 91% of this energy comes from natural gas (Pimentel 1980). An increase in natural gas prices causes an increase in ammonia production costs, which decreases the supply of ammonia and results in increased ammonia and nitrogen fertilizer prices. According to the U.S. Geological Survey (USGS) (2002), the quantity of domestic ammonia was 4.3% less in 2000 and 14.7% less in 2001 than in 1999. Nationwide fertilizer prices were 4.7% higher in 2000 and 20.0% higher in 2001 than in 1999 (U.S. Department of Agriculture [USDA] 2002). The increased cost of natural gas feedstock caused production costs at some ammonia plants to rise above the market price of ammonia in 2000. As a result, some production facilities were closed during parts of the year, which reduced supply and raised prices (USGS 2001). The USGS (2002) also reports that high natural gas prices at the beginning of 2001 caused about 40% of the U.S. production capacity to shut down. As natural gas prices fell during 2001, the production capacity came back on line.

Figure 2 shows the pattern of natural gas prices for Kansas commercial users. Although gas prices for Kansas industrial users are not available before 2001, U.S. industrial gas prices were 43% greater in 2000 than in 2001 and 18% higher in 2001 than in 2000, making it 68% greater than in 1999. The average price in 2000 and 2001 were statistically different from the average price in 1999. There is a correlation of .91 between Kansas and U.S. commercial prices and a correlation of .86 between U.S. commercial prices and the Grant County pipeline prices. Therefore, any national price trend carries over to Kansas.

By calculating the increased cost of the Btu content of these energy-intensive inputs, a rough approximation of the general magnitude of the increase in input costs due to energy price increases can be obtained. The general procedure involves determining the price per pound of typical seed, herbicide, and fertilizer inputs in the base year 1999. The next step is to determine the amount and source of the Btus by energy type for each input. Once this is done, the increased cost of the Btus is calculated based upon a price change for each energy type. This amount is then added to the base

price of the input to calculate the "expected" percentage change in input cost due to the energy price increase.

The above procedure is used to approximate the "expected" percentage increase, or relative magnitude of change, in input costs for seeds, herbicides and insecticides, and fertilizer using base prices for 1999 from Kastens and Jones (1999). This provides some information on the expected magnitude of the change in energy-intensive input costs that occurs in the farm data set due to a rapid increase in energy prices.

If all the Btus in seed are attributed to diesel fuel, and the $.37/gallon average price increase in diesel that occurred from 1999 to 2000 is applied, the expected cost increase for wheat, soybean, grain sorghum, and corn seed is, respectively, 8.7%, 8.2%, 4.4%, and 4.4%. The average price increase for natural gas consumers in Kansas for 2000 over 1999 of $2.10/MCF, applied to fertilizer costs, results in an expected input cost increase of 11.7%.

To calculate the expected cost increase for herbicides and insecticides, both of these price increases are applied to the respective energy source. Even though a substantial amount of electricity is consumed in producing these inputs, electricity prices are not statistically significantly different over the study period. The impact results in a small production cost increase of 2.3%.

There are a number of factors other than energy costs that may affect input prices. This analysis indicates that, during a short period of time, such as one or two production seasons when producers have difficulty making major changes such as substituting technologies to reduce the use of energy-intensive inputs, we will expect to see the percentage increase in whole-farm fertilizer costs to be larger than for chemicals and seeds. Because the weight and the resulting Btu content of fertilizer applied per acre substantially exceeds the weight and Btu content of seed and chemicals used per acre, we also expect the total dollar impact on fertilizer costs to be substantial and the impact on seed and chemical costs to be less.

Results

The largest dollar amount and percentage increase in expenditures is for irrigation energy. The increase is $10.17 per irrigated acre, or 110%, for dryland farms with some irrigated acreage and $22.86 per irrigated crop acre, or 120%, for irrigated crop farms (Table 1). Irrigation energy costs were lower in 2001 than in 2000 by 21% for dryland farms and by 9% for irrigated farms. Approximately 72% of irrigation units in Kansas are

TABLE 1
AVERAGE ANNUAL ENERGY-INTENSIVE INPUT EXPENDITURES AND SELECTED FARM CHARACTERISTICS FOR KFMA CROP FARMS, 1999 TO 2001

	Dryland crop farms			Irrigated crop farms		
	1999	2000	2001	1999	2000	2001
Fuels ($/crop acre)	6.78	8.62[a]	8.86[a]	9.79	12.46[b]	12.47[b]
Percentage of total variable costs	5.9	7.5	7.3	5.2	5.7	5.6
Percentage change from prior year		27.1	2.8		27.3	0.1
Fertilizer ($/crop acre)	14.87	15.77[a]	17.93[a]	22.06	24.22	27.13[a]
Percentage of total variable costs	12.6	13.4	14.5	12.1	11.6	12.9
Percentage change from prior year		6.1	13.7		9.8	12.0
Irrigation energy[1] ($/irrigated crop acre)	9.25	19.42[a]	15.31[a]	19.08	41.94[a]	38.05[a]
Percentage of total variable costs	0.3	0.6	0.6	6.4	12.3	11.3
Percentage change from prior year		109.7	-21.1		119.8	-9.3
Seed ($/crop acre)	11.31	11.11	12.45[a]	20.81	23.00	23.05
Percentage of total variable costs	9	8.8	9.3	11.1	10.8	10.4
Percentage change from prior year		-1.8	12.1		10.5	0.2
Chemicals ($/crop acre)	11.95	11.76	11.63	20.29	20.82	21.4
Percentage of total variable costs	10.1	9.9	9.5	10.77	10	9.5
Percentage change from prior year		-1.6	1.1		2.6	2.8
Utilities ($/crop acre)	2.75	2.87	3.04[a]	3.47	3.51	3.54
Percentage of total variable costs	2.3	2.4	2.4	1.8	1.6	1.6
Percentage change from prior year		4.4	5.9		1.2	0.9
Cost impact[2] ($/farm)		4,915	8,059		30,958	32,123
Cost impact[2] ($/acre)		3.72	6.06		18.63	19.39
Crop acres	1,299	1,320	1,330	1,636	1,662	1,657
Dryland	1,218	1,238	1,245	715	715	706
Irrigated	81	82	85	921	946	951
Number of farms	907	907	907	76	76	76

[1] "Irrigation energy" is the amount ($) per irrigated crop acre. Some farms classified as dryland have irrigated acres. Even though the amount per acre appears higher than other per acre costs, the percentage of total cost could be low due to a low number of irrigated acres compared to total acres on dryland farms. The percentage change refers to the change from the previous year cost/acre.

[2] "Cost impact" is the increased cost of fuels, fertilizer, and irrigation energy that reduced net income compared to 1999. It excludes changes in seed, chemicals, utilities, and all other expenditures.

[a] Statistically different from 1999 value at 94% confidence level or greater.

[b] Statistically different from 1999 value at 89% confidence level or greater.

powered by natural gas, and approximately 7% are powered by diesel fuel (D.H. Rogers 2003 personal communication). Therefore, as expected, expenditures for irrigation energy increased significantly. These increases in energy costs for 2000 and 2001 are statistically different from those in 1999. Water use for irrigation was higher in 2000 and 2001 than in 1999 because rainfall in western Kansas was lower in these years. This contributes to the increase in energy costs. The change in water use is accounted for in a later section.

The second-largest percentage increase is in fuel cost. Fuel expenditures on dryland farms increased 27.1% from 1999 to 2000, or $1.84/crop acre (Table 1). Fuel costs not included as part of irrigation energy increased 27.3% from 1999 to 2000, or $2.67/crop acre, for irrigated farms. Fuel costs per acre increased slightly in 2001.

Fertilizer costs increased $.90/acre, or 6.1%, in 2000 and another $2.16/acre, or 13.7%, in 2001 for dryland farms. For irrigated farms these costs rose $2.16/acre, or 9.8%, and $2.91/acre, or 12%, in 2000 and 2001, respectively (Table 1).

Chemical costs decreased by 1.6% and 1.1% for dryland farms in 2000 and 2001. They increased for irrigated farms by 2.6% and 2.8% in 2000 and 2001. This result is also consistent with USDA's Prices Paid by Farmers Index for chemicals, which shows no change from 1999 to 2001 (USDA 2002). The relative magnitude for fertilizer and chemical costs is consistent with previously discussed expectations.

Expenditures on seed increased $1.14/acre, or 10%, for dryland farms and $2.24/acre, or 11%, for irrigated farms over the period encompassing 2000 and 2001. There are many supply and demand factors that influence seed costs, including yields and change in preference for new varieties. Although it is likely that rising energy costs had some influence on the supply and cost of seed, it is difficult to attribute all of the increase in the data set to higher energy prices.

Utility costs were up slightly, although electricity prices were not, but the increase could be due to increases in telephone and cable expenses that are recorded in this category and cannot be separated from electricity costs.

Due to the small change in chemical and utility costs and the uncertain impact on seed costs attributed to higher energy prices, the remainder of the analysis and discussion is limited to fuels, irrigation energy, and fertilizer expenditures.

The average increase in cost per farm due to fuels, irrigation energy, and fertilizer is $4,915 for 2000 and $8,059 for 2001 for dryland farms

(Table 1). The amounts for irrigated farms are $30,958 and $32,123 for 2000 and 2001, respectively. Net farm income decreases by the amount of increase in the costs of fuels, fertilizers, and irrigation energy, with yields, prices, and other cost items remaining constant. Therefore, higher costs of production result in lower net farm incomes in the short run if gross incomes do not increase and other costs do not decline. Some caution is needed in interpreting these results. The impact on income from increased energy price may be understated. Increasing energy prices may also increase some cost categories that may not be accurately reflected in this data. Interest costs incurred because of decreased ability to pay debt, which is the result of lower returns due to higher energy prices, are not reflected in the analysis because they cannot be determined. The impacts of higher energy prices on costs of new equipment and equipment repair, although likely small, cannot be considered. Increased transportation costs due to higher fuel prices can effectively lower commodity prices, below what they will normally be, thus lowering income as well.

Other Factors' Influence on Costs

Could other factors cause the whole-farm expenditures to change for energy and energy-intensive inputs? Although an individual farm makes annual managerial changes such as leasing more or less farmland (which alters crop mix), switching from one tillage system to another, or altering irrigation energy sources and strategies, it is unlikely that widespread change across this large data set occurred over the two-year period of higher energy prices. Use of energy-intensive inputs is generally considered to be inelastic or relatively unresponsive to price increases in the short run. Featherstone et al. (1997) report price elasticities for energy of -.38, and fertilizer and pesticides of -.33, which indicates that for every 1% increase in price there is approximately a .38% to .33% reduction in use. However, over a short period of time these adjustments are likely smaller.

Acreage data at the state level, as shown in Table 2, and data for six regions not reported in the paper all indicate that significant changes in per acre energy expenditures are not likely due to changes in crop enterprise mix, but are due to increased energy prices. Total dryland crop acres on dryland farms remained constant at 95% (Table 2). Although there is a small increase in dryland corn acres and a small decline in dryland sorghum acres at the state level, there are no consistent trends in crop acreage mix across all regions.

TABLE 2
ALLOCATION OF TOTAL CROP ACRES BY CROP FOR 907 DRYLAND AND 76 IRRIGATED CROP FARMS, 1999 TO 2001

	Dryland crop farms (%)			Irrigated crop farms (%)		
	1999	2000	2001	1999	2000	2001
Dryland crops						
Wheat	34.8	36.9	34.6*	16.7	15.9	15.5
Corn	8.3	9.9*	10.9	4.1	3.8	3.5
Sorghum	17.9	16.5*	16.3	3.9	4.5	5.2
Soybean	23.5	21.7	22.0	0.7	1.2	0.9
Alfalfa	2.9	2.8	2.9	0.3	0.1	0.1
Silage	0.6	0.6	0.9	0.2	0.2	0.2
Other grain	0.3	0.1	0.2	0.0	0.0	0.1
Other hay	5.2	5.0	5.4	0.6	0.6	1.7
Other cash crop	1.4	1.3	1.5	2.0	0.7	0.9
Total	94.9	94.8	94.7	28.5	27.0	28.1
Irrigated crops						
Wheat	0.5	0.5	0.7	9.8	8.3	9.3
Corn	2.4	2.4	2.2	46.7	45.8	40.6**
Sorghum	0.3	0.2	0.3	0.7	1.1	2.4**
Soybean	1.3	1.5	1.5	6.9	8.3	9.6
Alfalfa	0.2	0.3	0.3	4.0	4.1	3.8
Silage	0.1	0.1	0.0	0.3	0.8	1.1
Other grain	0.1	0.0	0.0	0.0	0.0	0.0
Other hay	0.1	0.2	0.2	0.9	1.7	2.7
Other cash crop	0.1	0.0	0.1	2.2	2.9	2.4
Total	5.1	5.2	5.3	71.5	73.0	71.9

* Significantly different from previous year at the 90% confidence level or higher.
** Significantly different from 1999 at the 90% confidence level or higher.

The percentage of irrigated crop acres on irrigated farms changed little. On irrigated farms the percentage of corn acres declined while grain sorghum and soybean acres increased slightly (Table 2). In northwest and southwest Kansas soybean acreage increased slightly. This may have been due to irrigators trying to reduce water use on corn acres as irrigation fuel prices increased. Although not reported in detail here, other analysis also indicates it would have been uneconomical for many irrigators to switch

from natural gas to diesel power for operating irrigation systems due to the relative difference in natural gas and diesel prices in 2000 and 2001.

The government commodity program that was in place during 1999, 2000, and 2001 did not directly influence the selection of crop enterprise mix from year to year because government commodity payments were not a function of actual crop production. The program did contain loan rate provisions that provided a price floor for the major commodities. However, during 1999, 2000, and 2001 there were no significant changes in the wheat, corn, sorghum, and soybean loan rates relative to one another that would have altered profitability of the crops. Market prices for wheat increased relative to corn, grain sorghum, and beans, but there was no significant increase in the percentage of wheat acres in the data.

Regional Results

Table 3 provides results for dryland farms located in eastern and central Kansas where the number of irrigated acres is not a significant amount of total crop acres. Table 4 reports the information for dryland and irrigated farms in western Kansas. The largest and most consistent change in expenditures for dryland farms in each region is for fuels (excluding irrigation energy). The increase in cost ranges from a low of 20% in northwest Kansas to a high of 32% in south-central Kansas for 2000. Fuel costs per crop acre and the percentage change in fuel costs for dryland farms in western Kansas are lower than in the rest of the state: 20% for the northwest and 22% for the southwest in 2000. The difference in regional results is likely due to less tillage and, therefore, less diesel fuel being used in the semi-arid western region. Reduced tillage is typically used in this region as a means to conserve soil moisture. Seed expenditures increased little to none for dryland farms in 2000, but increased from 5% to 18% for dryland farms in 2001, depending upon their location. Fertilizer expenditures were higher in 2000 and 2001 than in 1999, but the largest increase occurred from 2000 to 2001.

These cost increases reduce net income on dryland crop farms from a low of $2,697 in northeast Kansas to a high of $11,937 in northwest Kansas in 2000. The reduction ranges from $5,217 in northeast Kansas to $10,654 in northwest Kansas in 2001.

The impact on irrigated farms is greatest in northwest Kansas, with a decline in net farm income of $51,685 and $45,322 in 2000 and 2001, respectively (Table 4). The number of irrigated acres per farm is approximately 35% larger in northwest Kansas than in the southwest. The impact on

TABLE 3
ENERGY AND ENERGY-INTENSIVE INPUT EXPENDITURES AND THEIR IMPACT ON COSTS FOR DRYLAND FARMS IN EASTERN AND CENTRAL KANSAS, 1999 TO 2001

	Northeast Kansas Dryland crop farms			Southeast Kansas Dryland crop farms		
Item	1999	2000	2001	1999	2000	2001
	$/crop acre					
Fuels	8.17	10.05	10.44	7.48	9.64	10.20
Fertilizer	15.24	15.65	17.77	16.89	18.40	21.53
Irrigation energy[1]	2.24	2.84	3.01	3.87	5.10	4.21
Seed	18.46	18.57	19.61	13.95	13.36	15.39
Chemicals	16.51	16.44	14.69	14.71	13.66	13.43
Utilities	3.71	3.65	4.05	3.18	3.37	3.63
Cost impact[2] ($/farm)		2,697	5,217		5,197	10,343
Cost impact[2] ($/acre)		2.84	5.46		4.40	8.58
Crop acres	930	951	956	1,145	1,180	1,205
Dryland	893	912	922	1,134	1,169	1,192
Irrigated	37	39	34	11	11	13
Number of farms	163	163	163	221	221	221

	North-central Kansas Dryland crop farms			South-central Kansas Dryland crop farms		
Item	1999	2000	2001	1999	2000	2001
	$/crop acre					
Fuels	6.57	8.40	7.95	6.79	8.93	8.90
Fertilizer	17.04	18.16	19.8	15.33	15.68	17.85
Irrigation energy[1]	3.88	13.20	11.62	7.12	13.26	11.28
Seed	8.94	8.91	10.51	9.05	9.08	10.18
Chemicals	11.65	11.65	11.73	8.87	9.29	9.55
Utilities	2.72	2.97	2.91	2.34	2.59	2.64
Cost impact[2] ($/farm)		3,811	5,509		4,367	8,033
Cost impact[2] ($/acre)		3.48	4.95		3.21	5.76
Crop acres	1,084	1,099	1,113	1,354	1,360	1,395
Dryland	1,068	1,078	1,089	1,218	1,223	1,250
Irrigated	16	21	24	136	137	145
Number of farms	164	164	164	212	212	212

[1] "Irrigation energy" is the amount per irrigated crop acre. Some farms classified as dryland have irrigated acres.
[2] This is the increased cost of fuels, fertilizer, and irrigation energy that reduced net income compared to 1999, in $/farm.

TABLE 4
ENERGY AND ENERGY-INTENSIVE INPUT EXPENDITURES AND THEIR IMPACT ON COSTS FOR DRYLAND AND IRRIGATED FARMS IN WESTERN KANSAS, 1999 TO 2001

	Northwest Kansas Dryland crop farms			Northwest Kansas Irrigated crop farms		
Item	1999	2000	2001	1999	2000	2001
	$/crop acre					
Fuels	4.17	5.02	5.57	9.75	14.52	11.95
Fertilizer	9.91	11.74	12.08	19.76	23.67	24.43
Irrigation energy[1]	17.81	51.55	38.25	22.50	56.69	48.12
Water use adjusted		44.99	34.98		48.40	43.99
Seed	5.41	5.39	6.10	19.46	21.07	20.01
Chemicals	7.71	7.64	8.84	20.00	21.02	23.20
Utilities	1.55	1.34	1.53	2.73	2.87	2.53
Cost impact[2] ($/farm)		11,937	10,654		51,685	45,322
Cost impact[2] ($/acre)		5.85	5.45		22.27	19.37
Crop acres	1,978	2,039	1,956	2,295	2,321	2,340
Dryland	1,793	1,841	1,748	1,219	1,185	1,155
Irrigated	185	198	208	1,076	1,136	1,185
Number of farms	68	68	68	27	27	27

	Southwest Kansas Dryland crop farms			Southwest Kansas Irrigated crop farms		
Item	1999	2000	2001	1999	2000	2001
	$/crop acre					
Fuels	4.58	5.58	6.39	8.11	8.96	10.29
Fertilizer	6.97	7.46	9.62	23.82	23.53	27.39
Irrigation energy[1]	13.80	20.13	17.38	21.03	40.43	39.82
Water use adjusted		17.57	16.40		36.23	38.33
Seed	5.22	4.30	4.97	21.62	24.20	23.13
Chemicals	7.39	7.20	8.09	21.01	21.29	21.64
Utilities	1.77	1.74	1.95	3.63	3.63	3.87
Cost impact[2] ($/farm)		4,188	10,241		14,817	22,299
Cost impact[2] ($/acre)		1.90	4.68		11.11	17.00
Crop acres	2,203	2,207	2,192	1,294	1,334	1,311
Dryland	1,944	1,955	1,938	450	491	477
Irrigated	259	252	254	844	843	834
Number of farms	79	79	79	38	38	38

[1] "Irrigation energy" is the amount per irrigated crop acre. Some farms classified as dryland have irrigated acres.
[2] "Cost impact" is the increased cost of fuels, fertilizer, and irrigation energy that reduced net income compared to 1999 in $/farm. Includes an adjustment for water use changes due to decreased precipitation.

southwest Kansas irrigated farms is $14,817 and $22,299 in 2000 and 2001, respectively.

Substantial irrigation is used on farms located in western Kansas. Therefore, the largest increase in any given cost category is irrigation energy (Table 4). Agriculture in western Kansas is heavily dependent on natural gas to run irrigation pumps. Utility companies have a percentage of natural gas purchases covered by longer-term contracts for natural gas. This partially buffers utilities (and residential consumers) from short-term price increases or at least delays their onset. Agricultural interests generally do not have such contracts, buying gas on the spot market (Kansas Geological Survey 2001).

As previously mentioned, part of the irrigation energy cost increase was caused by an increase in water use due to less precipitation during the 2000 and 2001 irrigation periods (March through September) compared to 1999. As a result, energy costs were adjusted for water use differences so they could be compared to 1999. For northwest Kansas counties, growing season precipitation in 2000 was 60% of 1999 precipitation. Precipitation in 2001 was 79% of the 1999 amount. Water used for irrigation in these northwestern counties was 37% higher in 2000 and 18% higher in 2001 compared to 1999 (Kansas Water Office 2003). Southwestern-area precipitation during the growing seasons of 2000 and 2001 was 80% and 87% of that in 1999, respectively. Irrigation water use in these southwest Kansas counties was 19% higher in 2000 and 7% higher in 2001 than in 1999 (Kansas Water Office 2003). Irrigation energy expenditures for 2000 and 2001 were adjusted to reflect only the amount associated with an increase in energy costs and not the amount due to an increase in water use in order to make the irrigation energy numbers more comparable for the western Kansas counties. Most irrigation occurs in these two regions, and all but 11 of the farms classified as irrigated farms in the data set are in these two regions. We made this adjustment by multiplying the 1999 irrigation-energy-cost figures by the percentage increase in water use for each of the subsequent years and subtracting the resulting dollar amount from the total cost for irrigation energy that was recorded in raw data for 2000 and 2001. The resulting value reflects the increase in costs due to rising energy prices.

In northwest Kansas, irrigation energy costs increased 152% from 1999 to 2000 and 114% from 1999 to 2001 for irrigated crop farms. As previously stated, some of this increase in cost was likely due to lower precipitation during the growing season in 2000 and 2001 than in 1999. The water-use-adjusted figures provide an estimation of the increase in energy irrigation costs due to rising prices and not an increase in water pumped

(Table 4). For irrigated crop farms, the impact of an increase in energy cost over 1999 is 115% in 2000 and 96% in 2001. In southwest Kansas, irrigated crop farms' energy costs for irrigation increased 92% and 89% in 2000 and 2001, respectively, over 1999. The water-use-adjusted costs increased by 72% and 82%, respectively.

Summary and Implications

The increase in energy prices during 2000 and 2001 had significant implications for agricultural production costs in Kansas and on other areas of the Great Plains. Costs for fuel, irrigation, energy, and fertilizers consumed on the farm increased significantly. These costs were on average \$4,915 higher in 2000 and \$8,059 in 2001 for dryland farms than in 1999. The amount for dryland farms ranges from \$2,697 for an average farm in northeast Kansas to \$11,937 in northwest Kansas in 2000. For 2001 the amount ranges from a low in northeast Kansas of \$5,217 to a high of \$10,654 in northwest Kansas. For all irrigated farms, the increase in costs is \$22,197 in 2000 and \$26,887 in 2001 compared to 1999. The impact relative to 1999 is greater in northwest Kansas—\$51,685 in 2000 and \$45,322 in 2001—than in southwest Kansas—\$14,817 in 2000 and \$22,299 in 2001. These values represent the approximate amount of lost income due to higher energy prices.

These results show that the economic impact of energy price spikes can be significant. However, numerous adjustments might occur in response to higher prices of energy and energy-intensive inputs over a longer time period. Farm managers may attempt to conserve energy, substitute less energy-intensive inputs for higher energy-intensive inputs, conserve energy-intensive inputs, or alter crop rotations and cultural practices to reduce use of energy and energy-intensive inputs while maintaining profitability. Irrigation is expected to become more efficient. Because herbicide cost did not appear to be affected by rising energy prices, increased adoption of reduced tillage may occur. This may also reduce the use of machinery services of some types and the labor to operate the machinery. However, a widespread shift to less tillage may increase the demand for, and therefore price of, herbicides and associated equipment.

Reduced whole-farm profitability as a result of higher energy prices may result in an effort to extend the useful life of machinery and equipment by delaying new purchases. Farm managers also may try to offset the reduced profitability by increasing the number of crop acres to gain cost

efficiency or to maintain whole-farm income. Input adjustments and changes in technology to conserve energy will occur, making the impact of higher energy prices on farm income in the long run smaller than might be expected, if only the impact of increases in production costs are considered in the short run. To the extent that the decrease in profitability from the higher energy prices is not offset by input substitution, input conservation, or changes in crop rotation and cultural practices, it will hasten the exit of marginally profitable farms. If profitability per acre cannot be maintained by energy conservation, then the average size of farms will generally increase, while the number of farms will decline.

References

Bowers, W. 1992. Agricultural field equipment. In *Energy in World Agricultural*, vol. 6*: Energy in Farm Production*, ed. R.C. Fluck, 117-29. Amsterdam: Elsevier Science Publishers.

Buller, O.H., and J.R. Williams. 1990. *Effects of Energy and Commodity Prices on Irrigation in the High Plains*. Kansas State University, Agricultural Experiment Station, Report of Progress no. 611.

Featherstone, A.M., C.B. Moss, and J.L. Hsu. 1997. Imposing curvature in estimating a cost function for Kansas farmers: Does it matter? Selected Paper, American Agricultural Economics Association Meetings, Toronto.

Kansas Cooperative Extension Service. 2002. *The Annual Report: 2002 Management Information*. Kansas Farm Management Association. Department of Agricultural Economics, Kansas State University, Manhattan.

Kansas Geological Survey. 2001. *Natural Gas*. Oil and Gas Open File Reports. Lawrence: Kansas Geological Survey.

Kansas Water Office. 2003. *2001 Kansas Irrigation Water Use Tables*. Kansas Water Office, Topeka.

Kastens, T.L., and R.D. Jones. 1999. *Prices for Crop and Livestock Cost-Return Budgets*. Kansas State University, Manhattan.

Nelson, R.G., and M.D. Schrock. n.d. Direct and embodied energy and CO_2 emission analysis of selected agricultural cropping rotations. Unpublished data. Kansas State University, Manhattan.

Pimentel, D., ed. 1980. *Handbook of Energy Utilization in Agriculture*. Boca Raton, FL: CRC Press.

U.S. Department of Agriculture (USDA). 2002. *Agricultural Outlook*. Washington, DC: Economic Research Service.

U.S. Department of Energy (USDOE). 2004. Energy Information Administration, Washington, DC. http://tonto.eia.doe.gov/oog/ftparea/wogirs/xls/ngm22vmall.xls (accessed February 10, 2004).

U.S. Geological Survey (USGS). 2001. *Nitrogen (Fixed)-Ammonia*. Mineral Commodity Summaries. Washington, DC: U.S. Geological Survey.

USGS. 2002. *Nitrogen (Fixed)-Ammonia*. Mineral Commodity Summaries. Washington, DC: U.S. Geological Survey.

Williams, J.R., F.D. DeLano, and L.N. Langemeier. 1994. Economic impact of a BTU tax on farm production costs in Kansas. *Journal of the American Society of Farm Managers and Rural Appraisers* 58:95-101.

Williams, J.R., F.D. DeLano, and T.D. Aller. 2001. The economic impact of higher oil prices on farm production costs in Kansas. *Journal of American Society of Farm Managers and Rural Appraisers* 64:32-38.