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Effects of Recent Energy Price Reductions on U.S. Agriculture

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Abstract

Over the last half of 2014, energy prices fell sharply, with crude oil prices down more than 40 percent and natural gas prices down more than 20 percent. Further, energy prices are expected to remain lower than previously projected through at least 2016. The agricultural sector will benefit from lower energy prices primarily because of reduced production and transportation costs. Additionally, biofuel markets are potentially affected by lower energy prices, but the effect on the demand for ethanol is expected to be modest. Effects on individual commodities, therefore, reflect the importance of energy in production costs and whether the commodity is used as a biofuel feedstock, an input in the production of biofuel. Overall effects on acreage and agricultural commodity prices are anticipated to be modest. Farm-sector production expenses are reduced by about $5 billion annually for 2015 and 2016.

Keywords: Energy prices, crude oil, natural gas, costs of production, acreage response, biofuels, ethanol

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Energy Information on the Internet

U.S. Energy Information Administration, *Short-Term Energy Outlook*,
http://www.eia.gov/forecasts/steo/

U.S. Energy Information Administration, *Annual Energy Outlook*,
http://www.eia.gov/forecasts/aeo/

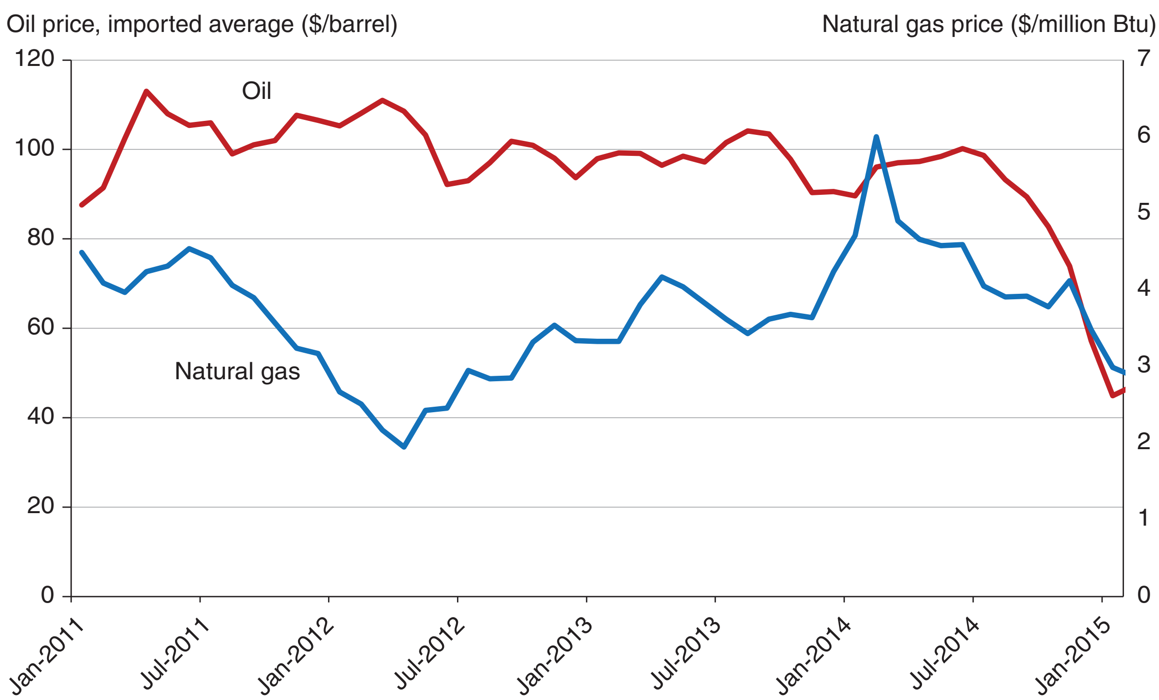
USDA, Economic Research Service, *Bioenergy Topic Page*,
http://www.ers.usda.gov/topics/farm-economy/bioenergy.aspx

Introduction

Energy prices are down sharply since mid-2014, with crude oil leading the decline as it fell from over $100/barrel in June 2014 to an average of less than $50/barrel during the first 3 months of 2015 (fig. 1). This reduction puts oil prices at levels not seen since late 2008 and early 2009 during the depths of the recession. At that time, crude oil prices had collapsed from more than $130/barrel in June 2008 to a low of just under $40/barrel in February 2009, but they recovered quickly as the economy regained strength, climbing above $80/barrel in early 2010 and above $100/barrel by March 2011 (EIA 2015). Although the recent oil price decline since mid-2014 is smaller than the 2008-2009 decline, lower prices are expected to last longer.[1] U.S. crude oil production has dramatically increased as a result of hydraulic fracturing and horizontal drilling (also known as "fracking"), and U.S. oil reserves have continued to rise, surpassing 36 billion barrels in 2013, for the first time since 1975 (EIA, 2014).

Since October 2014, the U.S. Department of Energy's Energy Information Administration (EIA) has lowered its price projections for crude oil and natural gas for 2015 and 2016 (table 1) in their

Figure 1
Monthly oil and natural gas prices



Note: Natural gas prices are Henry Hub spot prices, based on delivery at the Henry Hub natural gas distribution hub in Louisiana.
Source: Energy Information Administration, *Short-Term Energy and Summer Fuels Outlook (STEO)*, April 2015.

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[1]Additionally, the U.S. Energy Information Administration indicated in its April 2015 *Short-Term Energy and Summer Fuels Outlook* that crude oil prices could fall further: "On April 2, Iran and the five permanent members of the United Nations Security Council plus Germany (P5+1) reached a framework agreement that could result in the lifting of oil-related sanctions against Iran. Lifting sanctions could substantially change the *STEO* forecast for oil supply, demand, and prices by allowing a significantly increased volume of Iranian barrels to enter the market. If and when sanctions are lifted, the baseline forecast for world crude oil prices in 2016 could be reduced $5-$15/barrel (bbl) from the level presented in this *STEO*."

monthly *Short-Term Energy Outlook* (*STEO*) report. February 2015 energy price projections for 2015 are sharply lower than earlier projections, with crude oil prices down more than 40 percent and natural gas prices down more than 20 percent. If those projections are realized, the price of crude oil for 2015 would be the lowest since 2006, while the natural gas price would be the second lowest (to 2012's price) since 2000. Although prices for both oil and natural gas are expected to increase in 2016, they would remain much lower than projected a few months earlier.

The price of energy affects agriculture because of the sector's roles as both a user and a producer of energy. Direct energy inputs such as fuel and oil account for a large share of agricultural production expenses. Energy prices—particularly, for natural gas—also strongly influence the cost of fertilizer, which is a major production expense for most crops. Additionally, energy prices influence costs of agricultural chemicals, such as herbicides and insecticides. Developments in the petroleum market affect the markets for biofuels such as ethanol and biodiesel, but the relationship is complex and depends on whether the biofuel competes as an energy source or complements the use of petroleum-based fuels. Changes in the demand for biofuels can, in turn, affect markets for agricultural products such as corn, soybean oil, and other biofuel feedstocks. This report examines how lower energy prices affect the agricultural sector by lowering production costs for major crops and influencing demand for biofuel feedstocks in the ethanol market.

Background

Energy prices affect the production costs of agricultural commodities, as well as the demands for certain agricultural products, particularly biofuel feedstocks. Changes in the cost of production can directly affect the net returns (expected and realized) from producing different crops, and planting decisions at the farm level reflect producers' expectations of those net returns. All else equal, when the cost of producing a commodity declines, the returns to producing that commodity increase, so lower production costs tend to encourage greater production. Since production costs vary by commodity, relative net returns also play a key role in determining acreage allocations among crops. Any changes in acreage allocations and production—based on expected net returns—have implications for the market price of each commodity, reflecting the new equilibrium between supply and demand. Hence, prices for agricultural commodities are tied, at least indirectly, to energy market developments through the link to production decisions.

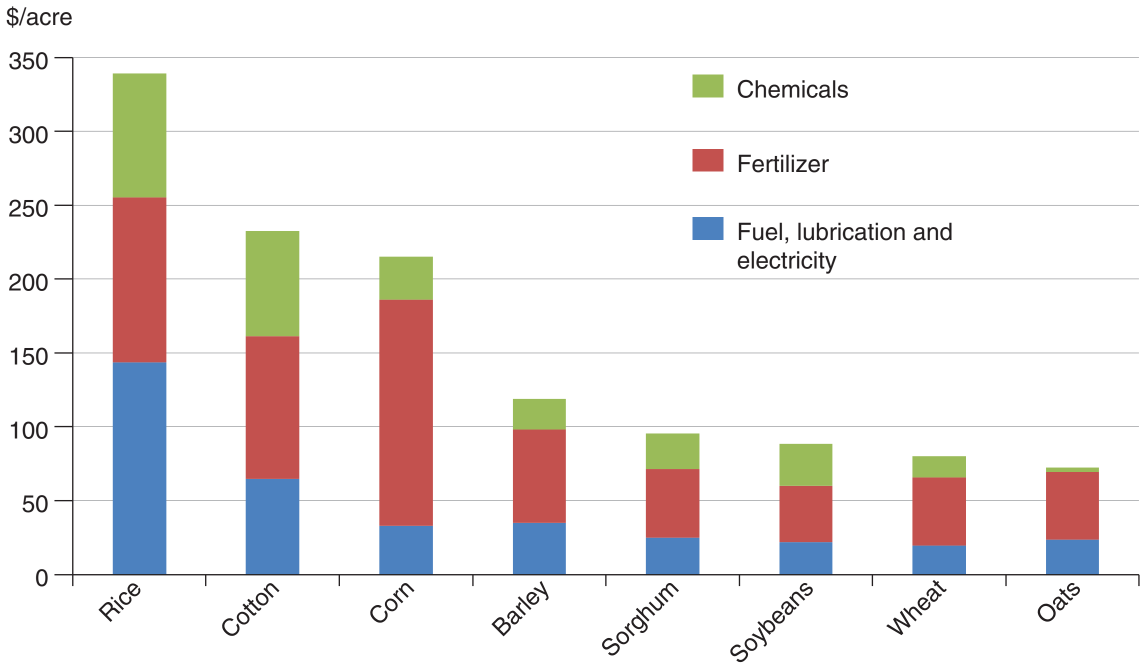
Sands and Westcott (2011) used the Food and Agricultural Policy Simulator (FAPSIM) to analyze the impact of higher energy price scenarios on agricultural markets. They found that on a per-acre basis, corn and rice have the highest energy-related costs among the eight major crops (corn, sorghum, barley, oats, wheat, rice, upland cotton, and soybeans). They found that higher energy prices and, therefore, higher costs of production would cause planted area to decline for seven of the eight crops. The exception was soybeans. Energy-related production costs are lower for soybeans than for most other crops, particularly corn, a crop soybeans compete with in farmers' planting decisions. Energy-related expenses also affect livestock producers. Although livestock producers' direct costs for ERS's cost of production category "fuel, lubrication, and electricity" are relatively lower as a share of operating expenses than those of crop producers, a rise in energy prices would increase livestock producers' feed costs, affecting production of beef and pork more than poultry, because of poultry's lower feed intensity.

This report uses a methodology similar to that of Sands and Westcott (2011) to examine the opposite scenario—the effect of a prolonged period of *lower* than previously expected energy prices on agricultural markets.

Energy-Related Expenses Vary by Crop

The effect of energy prices on the cost of producing particular crops depends on the level and share of production costs for direct energy inputs such as fuel and oil, as well as for indirect energy inputs such as energy-intensive nitrogen fertilizers and agricultural chemicals. Figure 2 shows energy-related production expenses per acre in 2014 for major field crops. Direct energy input expenses are shown for the ERS cost of production category "fuel, lubrication, and electricity," while indirect energy-related inputs are shown for "fertilizer" and for "chemicals." The three most energy-intensive crops are rice, cotton, and corn, with energy expenses almost $340 per acre for rice and exceeding $200 per acre for corn and cotton. Fertilizer costs account for the largest share of total energy-related expenses for major field crops, except for rice, which has extremely high direct energy costs mainly because of extensive irrigation requirements. Oats are the least energy intensive, with expenses for energy-related inputs under $75 per acre, while wheat, soybeans, and sorghum have energy related inputs less than $100 per acre.

Figure 2
Energy-related production expenses per acre for selected crops, 2014



Source: USDA, Economic Research Service, Cost of Production Database, November 2014.

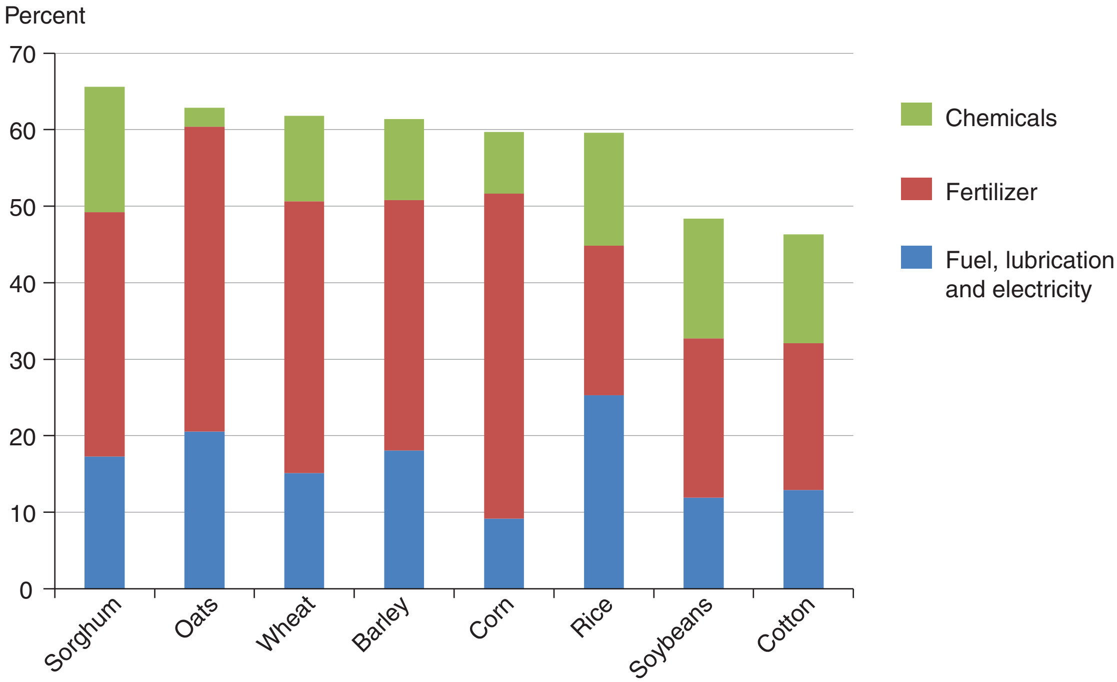
Figure 3 shows energy-related production expenses as a share of each crop's operating expenses. By this measure, sorghum, oats, and wheat have the highest share of costs related to energy inputs, partly because of their low overall operating expenses. Corn and rice remain highly energy-dependent in terms of share of operating expenses, with fertilizer, chemicals, fuel, lubrication, and electricity expenses accounting for about 60 percent of operating expenses. Soybeans remain one of the least energy-dependent crops, with less than half of operating expenses for soybeans tied to these energy-related inputs. However, cotton, a crop with high absolute energy-related expenses per acre, has a lower share of operating expenses related to energy inputs than other crops do, largely reflecting cotton's high overall operating expenses.[2]

The Relationship Between Natural Gas and Fertilizer Prices Has Been Weak in Recent Years

As already noted, fertilizer is one of the largest cost components for most crops. Fertilizer production—particularly nitrogen—is extremely energy intensive, relying on natural gas as the source of hydrogen necessary to produce ammonia through the Haber-Bosch process. Natural gas typically accounts for the largest part of the cost of producing ammonia, the primary source of nitrogen for nitrogen fertilizer (Huang, 2007; Vroomen, 2010). Therefore, the price of natural gas has important implications for agriculture through its effect on fertilizer production costs and ultimately the price of fertilizer.

[2]For livestock producers, energy costs are a smaller part of production costs than feed costs are, so lower energy prices will not greatly affect their costs and margins.

Figure 3
Energy-related production expenses for selected crops relative to total operating expenses, 2014

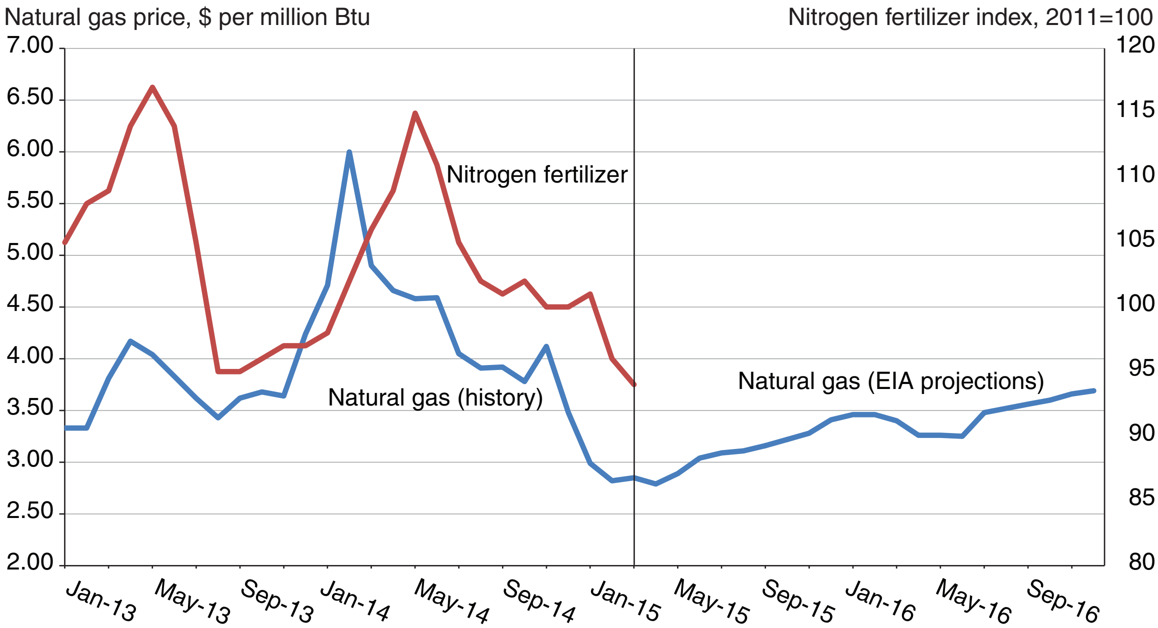


Source: USDA, Economic Research Service, Cost of Production Database, November 2014.

While the largest declines in energy prices since mid-2014 have been in the markets for crude oil and its derivatives such as gasoline and diesel, natural gas prices have also declined significantly over this period, falling from an average of $4.59/million British thermal units (Btu) in June 2014 to $2.83/million Btu in March 2015, a decline of 38 percent (fig. 4).

Lower natural gas prices result in lower fertilizer costs, but the impact is not immediate, and the magnitude of the price effect depends on underlying supply and demand factors. USDA data show that nitrogen prices paid by farmers declined about 13 percent between May 2014 and September 2014, and remained relatively stable through January 2015, before falling further in February and March 2015 (see fig. 4). If natural gas prices remain low as indicated by EIA projections, markets are likely to adapt further, and fertilizer prices will continue to adjust in coming months.

Figure 4
Monthly natural gas and nitrogen fertilizer prices



Notes: No fertilizer projections are available. Natural gas prices are Henry Hub spot prices, based on delivery at the Henry Hub natural gas distribution hub in Louisiana.
Source: Energy Information Administration, *Short-Term Energy Outlook*, February 2015 and USDA, National Agricultural Statistics Service, Quick Stats.

Crop Sector Acreage and Price Adjustments

A U.S. agriculture model (henceforth referred to as "U.S. Model") used in this study is based on prior versions of the FAPSIM model, which USDA developed in the early 1980s (Salathe et al., 1982) and periodically re-specified and re-estimated to reflect structural and policy changes in the U.S. food and agricultural sector. Crops included in the U.S. model are corn, sorghum, barley, oats, wheat, rice, soybeans (including soybean meal and soybean oil), and upland cotton. Livestock sector commodities include hogs, cattle, dairy, broilers, non-broiler chickens, turkeys, and eggs. Each commodity model contains equations to estimate production, prices, and different demand components (including, for example, feed demand for corn and food demand for wheat). The commodity models are then linked through variables that are important to the different commodity prices, such as corn. The model solution computes the market prices that equilibrate supply and demand in all commodity markets simultaneously.

Key for this study are the behavioral relationships for acreage for different field crops. Economic theory for profit maximizing producer behavior indicates that production should be positively related to the price received for the commodity and negatively related to prices of inputs required in the production process. Producer net returns are used in acreage equations to capture these economic effects. Additionally, net returns for other crops that compete with each other for land use are included in the acreage equations. Through these relationships, energy-related input costs influence production in the model, and a new solution is computed across all commodity markets.

To assess the impacts on major field crops in 2015 and 2016, we developed two scenarios. The first scenario is based on higher energy prices that were assumed in fall 2014 and published in *USDA Agricultural Projections to 2024* (USDA, 2015)—this scenario becomes the reference case for the analysis. We then developed an alternative scenario for 2015 and 2016 using EIA's February 2015 *STEO* forecasts for energy prices (see table 1).[3] Changes in agricultural production costs arising from the lower energy prices are used to implement the alternative scenario in the U.S. Model (table 2). The model calculates the impacts of changes in production costs on acreage allocations and production and the resulting adjustments in prices and use (quantities demanded) in major agricultural commodity markets.

Table 1

Recent energy price projections

	Crude oil price imported average			Natural gas Henry Hub spot price		
	2014	2015	2016	2014	2015	2016
	$/barrel			*$/mil Btu*		
October 2014	93.42	91.14	90.09	4.45	3.84	4.07
February 2015	89.39	51.57	67.53	4.39	3.05	3.47
Percent change		-43.4	-25.0		-20.6	-14.7

Note: October 2014 numbers for 2016 are assumptions made in October 2014 from Table 1 of USDA's *Long-Term Agricultural Projections to 2024*. Henry Hub spot prices are based on delivery at the Henry Hub natural gas distribution hub in Louisiana.
Source: Energy Information Administration, October 2014 and February 2015 *Short-Term Energy Outlook* and USDA, Economic Research Service calculations.

[3]Subsequent EIA *STEO* reports have projected lower energy prices than are used in this analysis.

Table 2
Costs of production, operating costs, alternative energy price scenarios

	Reference scenario		Lower energy price scenario		Change in costs		Change in costs	
	2015	2016	2015	2016	2015	2016	2015	2016
	Dollars per planted acre						*Percent*	
Corn	350.31	350.04	337.02	337.58	-13.29	-12.46	-3.8	-3.6
Soybeans	181.08	182.21	174.86	174.75	-6.22	-7.46	-3.4	-4.1
Wheat	126.42	126.81	120.48	121.23	-5.94	-5.58	-4.7	-4.4
Cotton	497.27	500.92	479.72	481.17	-17.55	-19.75	-3.5	-3.9
Sorghum	142.00	142.45	134.87	135.03	-7.14	-7.43	-5.0	-5.2
Barley	188.77	189.47	179.05	180.84	-9.72	-8.63	-5.1	-4.6
Oats	111.41	111.45	104.86	106.98	-6.55	-4.47	-5.9	-4.0
Rice	558.43	561.02	524.86	530.43	-33.57	-30.58	-6.0	-5.5

Source: USDA Economic Research Service (ERS) Cost of Production Projections and ERS calculations.

Effects of Decreasing Energy Prices on Acreage and Production Are Small

Reduced costs of production enhance producer returns and can affect planting decisions in the aggregate, as well as cropping choices between competing crops. Overall, our estimates suggest that the impacts of lower energy prices on 2015 and 2016 planting decisions will be modest.

Tables 2, 3, and 4 present alternative scenarios of costs of production, acreage allocations, and commodity prices, respectively, in response to lower forecast energy prices—namely, crude oil and natural gas prices shown in table 1.

Lower oil and natural gas prices for 2015 and 2016 (see table 1) result in lower projected costs of production for each of the eight crops analyzed (see table 2). The magnitude of the cost reduction for each crop relates to the size of energy-related inputs in its production. In absolute terms, production costs are reduced the most for rice, cotton, and corn, reflecting their high energy-related production expenses. In percentage terms, all changes in production costs from the reference scenario are small relative to the sizes of the energy price reductions. For example, rice has the largest percentage reduction (6 percent) in its production costs among these crops in 2015, much smaller than the 43.4-percent reduction in crude oil prices and the 20.6-percent reduction in natural gas prices that year. The modest changes in production costs relative to changes in energy prices reflect the fact that energy-related input costs represent only a portion of overall operating expenses—as well as the fact that energy-related input prices are projected to decline much less than energy prices. (See box, "Why the Acreage Impacts Are Small.")

With lower energy costs, economic incentives encourage increases in planted acreage in 2015 and 2016. Table 3 shows that, with the lower energy costs analyzed here, overall plantings to eight major field crops increase by about 1.1 million acres in both 2015 and 2016, relatively small gains of 0.4 and 0.5 percent, respectively. Within this aggregate acreage increase, changes in individual

Why the Acreage Impacts Are Small

Despite the large reductions in energy prices, overall changes in acreage are fairly small. Several reasons underlie this result, as follows:

- Even with large reductions in energy prices, price declines for energy-related inputs are considerably smaller. For example, with the 2015 reduction in crude oil prices analyzed here (over 43 percent), fuel prices in the agricultural sector are estimated to fall by only about 20 percent. This lower proportional price change stems from (1) the fact that oil prices are only one input to the production of fuels, and (2) the underlying properties (elasticities) of supply and demand functions in fuels markets.

- Costs for energy-related inputs to agriculture production are only a portion of total input costs. As seen in figure 3, energy-related inputs represent 45-70 percent of operating expenses for crops.

- Crop acreage supply response is inelastic to changes in producer net returns. In other words, changes in net returns lead to acreage changes that are relatively small. Although cross-commodity acreage effects may be more responsive, the aggregate acreage effect for major field crops is estimated to have a price (or price-equivalent) elasticity of less than 0.10. This means that a 10-percent price change for all crops would lead to less than a 1-percent change in total cropped acreage.[1]

[1]For more information regarding crop acreage supply response, see Lin et al. (2000).

Table 3
Planted acreage, selected crops, alternative energy price scenarios

	Reference scenario		Lower energy price scenario		Change		Change	
	2015	2016	2015	2016	2015	2016	2015	2016
	Million acres						*Percent*	
Corn	88.000	90.000	88.522	90.090	0.522	0.090	0.6	0.1
Soybeans	84.000	79.000	83.890	79.277	-0.110	0.277	-0.1	0.4
Wheat	56.000	53.000	56.174	53.529	0.174	0.529	0.3	1.0
Cotton	10.000	10.000	10.173	10.138	0.173	0.138	1.7	1.4
Sorghum	7.500	7.500	7.606	7.509	0.106	0.009	1.4	0.1
Barley	3.500	3.300	3.572	3.340	0.072	0.040	2.0	1.2
Oats	3.000	2.800	3.136	2.838	0.136	0.038	4.5	1.4
Rice	2.935	2.850	2.972	2.875	0.037	0.025	1.3	0.9
Total	254.935	248.450	256.045	249.596	1.110	1.146	0.4	0.5

Source: *USDA Agricultural Projections to 2024* and U.S. Model simulation results. The U.S. Model is based on prior versions of the FAPSIM model, which USDA developed in the early 1980s and periodically re-specified and re-estimated to reflect structural and policy changes in the U.S. food and agricultural sector.

Table 4
Prices, selected crops, alternative energy price scenarios

	Reference scenario		Lower energy price scenario		Change		Change	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
	$ per unit						*Percent*	
Corn	3.40	3.50	3.371	3.469	-0.029	-0.031	-0.8	-0.9
Soybeans	8.50	8.55	8.508	8.530	0.008	-0.020	0.1	-0.2
Wheat	5.00	4.65	4.981	4.606	-0.019	-0.044	-0.4	-1.0
Cotton	0.595	0.605	0.588	0.596	-0.007	-0.009	-1.2	-1.5
Sorghum	3.30	3.40	3.254	3.356	-0.046	-0.044	-1.4	-1.3
Barley	4.80	4.50	4.773	4.475	-0.027	-0.025	-0.6	-0.6
Oats	2.70	2.40	2.674	2.379	-0.026	-0.021	-1.0	-0.9
Rice	14.80	14.70	14.709	14.598	-0.091	-0.102	-0.6	-0.7

Note: $ per unit = dollars per bushel except for rice (which is dollars per hundredweight) and cotton (which is dollars per pound).
Source: *USDA Agricultural Projections to 2024* and U.S. Model simulation results. The U.S. Model is based on prior versions of the FAPSIM model, which USDA developed in the early 1980s and periodically re-specified and re-estimated to reflect structural and policy changes in the U.S. food and agricultural sector.

crop acreages reflect relative changes in producer returns and producer responses to the changes among competing crops (own- and cross-commodity return responses).

The largest cross-commodity influences are between corn and soybeans. Corn has the largest increase in acreage in 2015, reflecting both its gains in expected net returns and those gains relative to increases in returns for soybeans. The 2015 corn acreage increase of more than 0.5 million acres partly reflects some acreage being shifted from soybeans—a primary competing crop with corn. For 2016, corn acreage gains are much less than in 2015, and soybean plantings show the second largest increase among the eight crops, rather than decline. These acreage changes reflect producer responses to (1) lower corn prices and higher soybean prices in 2015 and (2) smaller energy-related cost reductions for corn in 2016 than in 2015, combined with larger energy-related cost reductions for soybeans in 2016 than in 2015.

Expected acreage increases for oats in 2015 are the highest percentage-wise because production cost reductions in the lower energy price scenario are the second largest for oats. Additionally, acreage adjustments for oats have one of the largest percentage responses to changes in its own returns, compared with the other crops, along with small percentage responses to changes in returns for competing crops, compared with the other crops.

The effects of lower energy prices on wheat acreage are only marginal in 2015 because much of the wheat crop (typically 70-75 percent) is winter wheat, which, for 2015, was planted in fall 2014 before the reduction in energy prices. However, because all wheat acreage decisions (including those for winter wheat) will respond to lower costs for 2016, wheat acreage adjustments are larger in 2016 (more than 0.5 million acres) than in 2015. Acreage changes for all other crops are generally small, with each of these crops showing an adjustment of less than 200,000 acres in 2015 and less than 150,000 acres in 2016.

Effects of Decreasing Energy Prices on Commodity Prices Are Also Small

With higher overall acreage and increased plantings for most crops, commodity prices are generally reduced for both years in the lower energy price scenario (see table 4). All price reductions for these crops are small, with none larger than 1.5 percent in 2015/16 and 2016/17. However, with soybean acreage reduced in 2015, soybean prices rise 0.1 percent in 2015/16 compared with the reference scenario price.

Impacts on Farm Income—Lower Farm-Sector Production Costs

Lower energy prices are expected to lead to lower total production expenses by the agricultural sector, largely reflecting the crop-specific reductions in costs of production. For the sector, fuel and oil expenses are reduced by 20.6 percent in 2015, and an additional 11.9 percent in 2016, from the reference scenario (table 5). Fertilizer and electricity expenses also are lower, but by smaller amounts, about 4.5 percent in 2015 and 2.5-3.4 percent in 2016. Because of lags between movements in energy prices and agricultural chemical prices, pesticide expenses fall more in 2016 (almost 13 percent) than in 2015 (slightly more than 1 percent). Overall, total energy-related production expenses in the lower-price scenario are reduced by 7.8 percent ($5.1 billion) in 2015 and 7.7 percent ($4.9 billion) in 2016 from the analogous numbers in the higher priced reference scenario.

Table 5
Selected energy-related production expenses, alternative energy price scenarios

	Reference scenario		Lower energy price scenario		Change		Change	
	2015	2016	2015	2016	2015	2016	2015	2016
	$ billion						*Percent*	
Fertilizer	27.8	26.9	26.6	26.0	-1.2	-0.9	-4.4	-3.4
Fuel and oil	16.5	16.2	13.1	14.3	-3.4	-1.9	-20.6	-11.9
Electricity	5.6	5.7	5.4	5.5	-0.3	-0.1	-4.5	-2.6
Pesticides	14.9	14.9	14.8	13.0	-0.2	-1.9	-1.3	-12.9
Total	64.9	63.6	59.9	58.7	-5.1	-4.9	-7.8	-7.7

Source: *USDA Agricultural Projections to 2024* and USDA, Economic Research Service calculations.

Lower Energy Prices and Biofuel Markets

One of the largest developments in U.S. agricultural markets over the past decade has been a dramatic rise in ethanol production. U.S. ethanol production was about 3.4 billion gallons in 2004, rising to 14.3 billion in 2014. Corn accounts for almost all of the feedstock used to produce ethanol in the United States. Corn used for U.S. ethanol production has grown from about 11 percent of total U.S. corn use in 2003/04 to more than 38 percent of the 2013/14 crop. The surge in demand for corn by the ethanol industry has contributed to higher corn prices over the past decade.[4] In turn, higher prices created an economic incentive for a sharp increase in acreage planted to corn, from about 81 million acres in 2004 to more than 97 million in 2012 and remaining above 90 million through 2014.

While government policies played a role in facilitating the ethanol expansion, market forces also provided incentives to blend ethanol with gasoline to improve its performance and lower its cost. Importantly, the ethanol industry expanded rapidly at the same time energy prices were increasing sharply, with crude oil prices rising from under $40/barrel through most of 2004 to more than $100/barrel over much of the period since 2008, notwithstanding the temporary price collapse (second half of 2008) at the height of the recession and the recent price decline (second half of 2014 and into 2015).

With energy prices now lower and expected to remain low, implications for biofuel markets are of particular interest. Lower fuel oil and natural gas prices have consequences for both supply and demand in the ethanol market.

Effects of lower energy prices on biofuel markets reflect a complex role ethanol plays in the gasoline market. In some markets—particularly for high-ethanol blends such as E85 (85-percent ethanol blend)—ethanol and gasoline compete for use in automobiles based on price and energy content. In these markets, lower gasoline prices would be expected to erode the demand for ethanol, although overall effects would be minimal given the small size of the E85 market. But in markets for conventional gasoline (blends up to 10 percent, or E10), ethanol is a supplement to gasoline that provides important fuel characteristics, including energy content and octane enhancement.[5] In these markets, lower gasoline prices—by leading to greater gasoline use—can raise the demand for ethanol because of the higher volumes of gasoline into which ethanol is blended. At the same time, feedstock prices, predominantly for corn, are key in determining the cost and profitability of producing ethanol.

These multiple factors can affect both the supply and demand for ethanol. On the supply side of the ethanol market, lower input costs for natural gas and corn reduce ethanol production expenses and shift the supply curve to the right.

On the demand side, major factors affecting the ethanol market can be summarized as follows:

- Lower gasoline prices lead to greater gasoline consumption, which expands the market for ethanol blends. The February EIA *STEO* forecast an increase in 2015 gasoline consumption due to lower prices (positive effect).

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[4] Trostle (2008) and Trostle et al. (2011) discuss other factors that contributed to higher prices and price spikes for corn and other commodities.

[5] Although the EPA approved a higher ethanol blend, E15, in 2012 for cars manufactured since 2001, infrastructure challenges and warranty issues have allowed E10 to remain the predominant blend sold in the United States.

- Export demand for corn-based ethanol to date has continued to be strong (positive effect).

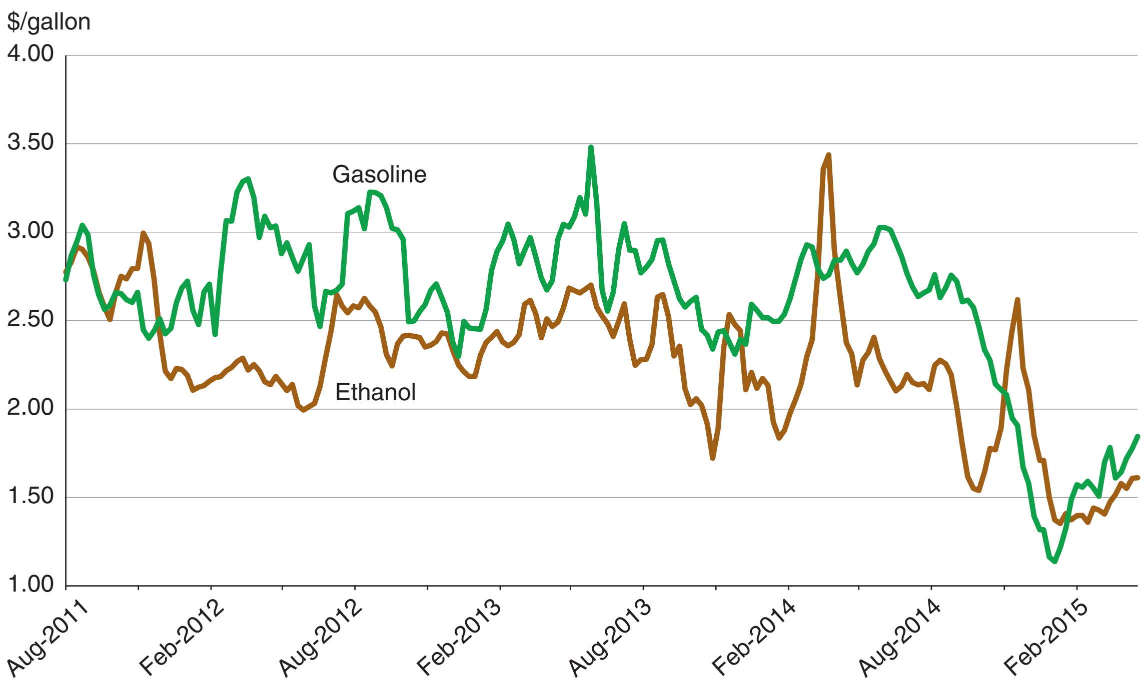
- As the price of gasoline decreases relative to ethanol (fig. 5), the use of ethanol as both an octane enhancer and an energy source becomes relatively more costly, so refiners become reluctant to blend more ethanol than needed to meet the anticipated Renewable Fuel Standard[6] (RFS) (negative effect).

- Higher ethanol prices relative to gasoline prices reduce consumer demand (in the United States and abroad) for high-ethanol blends such as E85 (negative effect).

These multiple forces shift both the supply and demand curves for ethanol. Lower production costs shift the ethanol supply curve to the right. A net increase in the demand for ethanol reflects greater gasoline consumption. Given the decline in ethanol prices from the fall of 2014 to early 2015 (see fig. 5), the shift in supply has been dominant over this period. This outcome is consistent with the continued pattern of high ethanol production (fig. 6) and positive returns over variable costs (fig. 7).

As a result of these developments, the amount of corn used for ethanol production has continued to increase. USDA's April 9, 2015 *World Agricultural Supply and Demand Estimates* (*WASDE*) report forecasts the amount of corn used in ethanol production will increase in 2014/15 a little over 1 percent from that in 2013/14 to 5.2 billion bushels, due in part to projections by EIA of higher gasoline consumption.

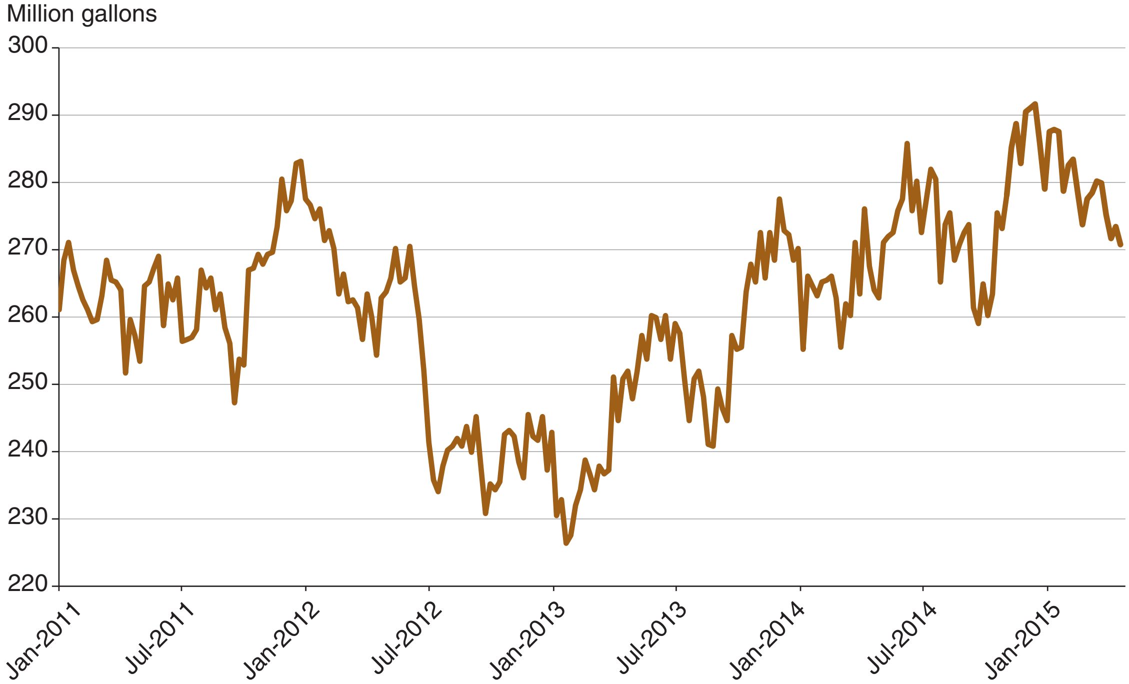
Figure 5
Weekly wholesale Chicago spot prices for gasoline and ethanol



Note: Gasoline is conventional blendstock for oxygenate blending.
Source: Oil Price Information Service, Ethanol & Biodiesel Information Service.

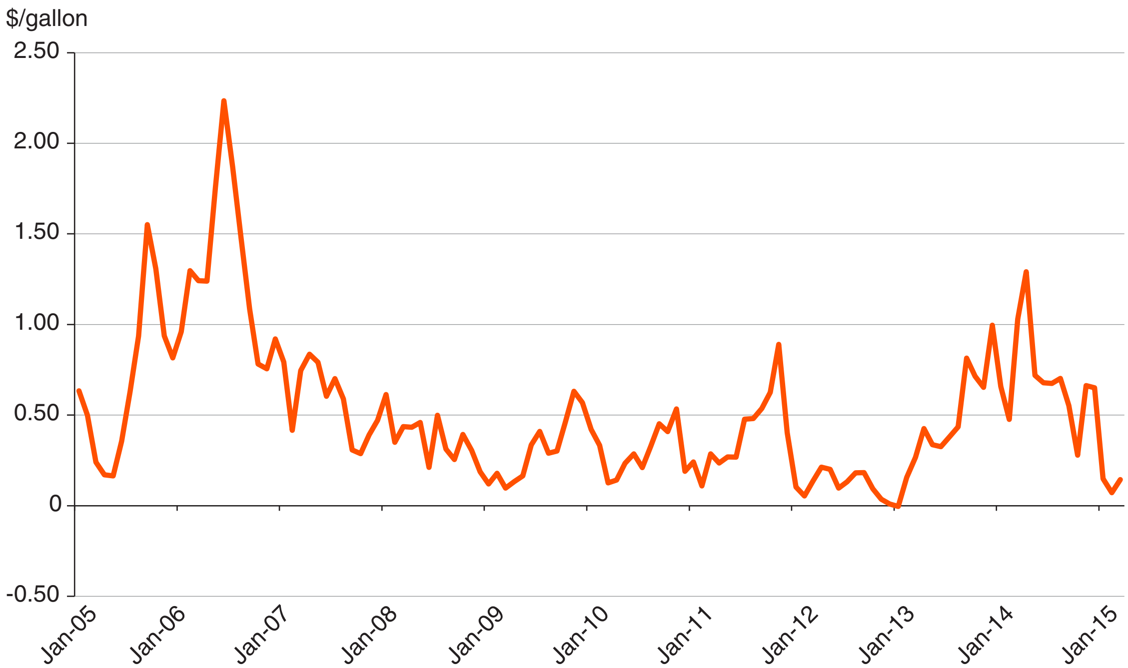
[6]"The Renewable Fuel Standard (RFS) establishes minimum volumes of various types of renewable fuels that must be included in the U.S. supply of fuel for transportation. Those volumes—as defined by the Energy Independence and Security Act of 2007 (EISA)—are intended to grow each year through 2022. In recent years, the requirements of the RFS have been met largely by blending gasoline with ethanol made from cornstarch. In the future, EISA requires the use of increasingly large amounts of "advanced biofuels," which include diesel made from biomass, ethanol made from sugarcane, and cellulosic biofuels." (CBO, June 2014).

Figure 6
Weekly ethanol production



Source: U.S. Energy Information Administration *Weekly Petroleum Status Report*.

Figure 7
Ethanol plant returns over variable costs



Source: Iowa State Ethanol Profitability Model.

Implications for RIN Markets

Changes in biofuel markets can affect the market for Renewable Identification Numbers (RINs). The Environmental Protection Agency (EPA) issues RINs to facilitate compliance with the Renewable Fuel Standard (RFS). Each RIN corresponds to a volume of ethanol (or other renewable fuel) that is produced in or imported into the United States. RINs stay with the ethanol through the distribution system, even as ownership changes. Once the ethanol is blended with gasoline, the RIN may be separated from the fuel and used to report RFS compliance to EPA if the blended fuel is used domestically.

To meet ethanol-related RFS mandates, obligated parties under the RFS must either blend ethanol with gasoline (retaining the RINs) or purchase RINs from other producers to meet their obligations. RINs may be used for compliance in the year they are generated or may be held for the following year's compliance.[1]

Changes in gasoline prices, ethanol prices, and other factors that alter incentives for ethanol blending can affect the ability to meet the RFS and thus the value of the related RINs. The figure shows weekly RIN prices for ethanol. Through 2012, RIN prices were low because the RFS was not binding through this period and RIN supplies exceeded mandates. Over the past 2 years, however, RIN prices have been higher as the RIN supply and demand balance tightened, because of declining gasoline use and the effects of the E10 blend wall.

While ethanol prices have fallen since mid-2014 because of lower costs of natural gas and corn, gasoline prices have fallen more over this period as a result of the decline in crude oil prices. Thus, although ethanol prices are again lower than gasoline prices, ethanol prices in spring 2015 are higher relative to gasoline prices than they were in summer 2014. Such an occurrence reduces the incentive to blend ethanol, absent mandates. Changes in RIN prices reflect this change in relative prices, and thus RIN prices have risen recently, averaging about $0.70 per RIN thus far in 2015, up from about a $0.50 per RIN average for much of 2014.

Current-year U.S. ethanol RIN prices

Source: Oil Price Information Service, Ethanol & Biodiesel Information Service.

[1]See McPhail, L., P. Westcott, and H. Lutman. 2011. *The Renewable Identification Number System and U.S. Biofuel Mandates,* BIO-03, USDA, Economic Research Service.

Summary and Conclusions

The latter half of 2014 showed a sharp reduction in oil and natural gas prices, with expectations that energy prices would remain lower than previously projected, at least through 2016. Energy prices affect a number of markets, including agriculture and biofuels, which also interlink with one another.

This report analyzes effects of lower energy prices in 2015 and 2016, focusing on crop-sector effects. Lower energy prices affect production expenses, which in turn affect total operating costs, acreage allocations, and commodity prices. Additionally, lower energy prices can affect biofuel markets, changing the demand for feedstocks, especially corn for ethanol.

Our analysis suggests that lower energy prices will have a small effect on agriculture in 2015 and 2016. With lower prices of oil and natural gas, costs of production are lower than previously projected—however, this effect is minimal for two reasons. First, prices for energy-related inputs fall by less than the change in energy prices. Second, energy-related costs represent only a portion of total operating expenses. Nonetheless, with lower costs of production, farmers have incentives to adjust planted acreage in 2015 and 2016—a scenario with lower energy prices shows total acreage increases a small amount relative to a reference scenario (with higher energy prices) and the mix of crops planted changes slightly. In addition to the small changes in production costs, another factor causing the small acreage effects is that crop acreage supply response is inelastic to changes in producer net returns, meaning changes in producer net returns lead to relatively small acreage changes.

As a result of the acreage shifts in the lower energy cost scenario, commodity prices generally decrease. However, price effects in the alternative scenario are small compared with a reference scenario with higher energy prices. Overall farm production expenses in the sector are reduced.

Lower energy prices in 2015 and 2016 are also expected to have a variety of effects on the biofuels market. Primarily, lower natural gas prices reduce ethanol production costs, increasing ethanol availability. Furthermore, as lower gasoline prices (in response to lower oil prices) lead to higher gasoline consumption, the market for ethanol blends increases. However, as the price of gasoline decreases relative to ethanol, refiners become reluctant to blend more ethanol with gasoline (for energy and octane) because of ethanol's increased relative cost. Overall, lower energy prices in 2015 and 2016 will minimally increase the demand for ethanol, reflecting the increase in gasoline consumption. At the same time, lower corn prices are expected to combine with reduced natural gas prices to increase ethanol output.

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