

**CARD Policy Brief 12-PB 7**  
**July 2012**

## **Preliminary Assessment of the Drought's Impacts on Crop Prices and Biofuel Production**

**by Bruce Babcock**

*Partial support for this work is based upon work supported by the National Science Foundation under Grant Number EPS-1101284. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.*

Published by the Center for Agricultural and Rural Development, 578 Heady Hall, Iowa State University, Ames, Iowa 50011-1070; Phone: (515) 294-1183; Fax: (515) 294-6336; Web site: [www.card.iastate.edu](http://www.card.iastate.edu).

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## **Executive Summary**

Drought has sharply decreased the size of the US corn and soybean crops this year. While there is no way of knowing for sure how low yields will go, the continuation of hot and dry weather in the major corn and soybean producing areas indicates that yield losses could be of historic proportions. The potential economic impact of low yields—particularly corn yields—is heightened this year because of a low buffer stock of corn, and because 10 percent of our motor fuel supply comes from corn. This briefing paper presents preliminary estimates of the economic impacts of low US corn and soybeans yields. The impacts are estimated for the 2012–13 crop year that begins on September 1st. Because we do not know what future yields will be or what future gasoline prices will be, we make the preliminary estimates using a stochastic partial equilibrium model. This type of model solves for market-clearing prices for a large number of random “draws” of yields and gasoline prices. The model is calibrated to information that is available to us at the current time, including the USDA’s supply and demand projections and the level of futures prices for gasoline, corn, and ethanol.

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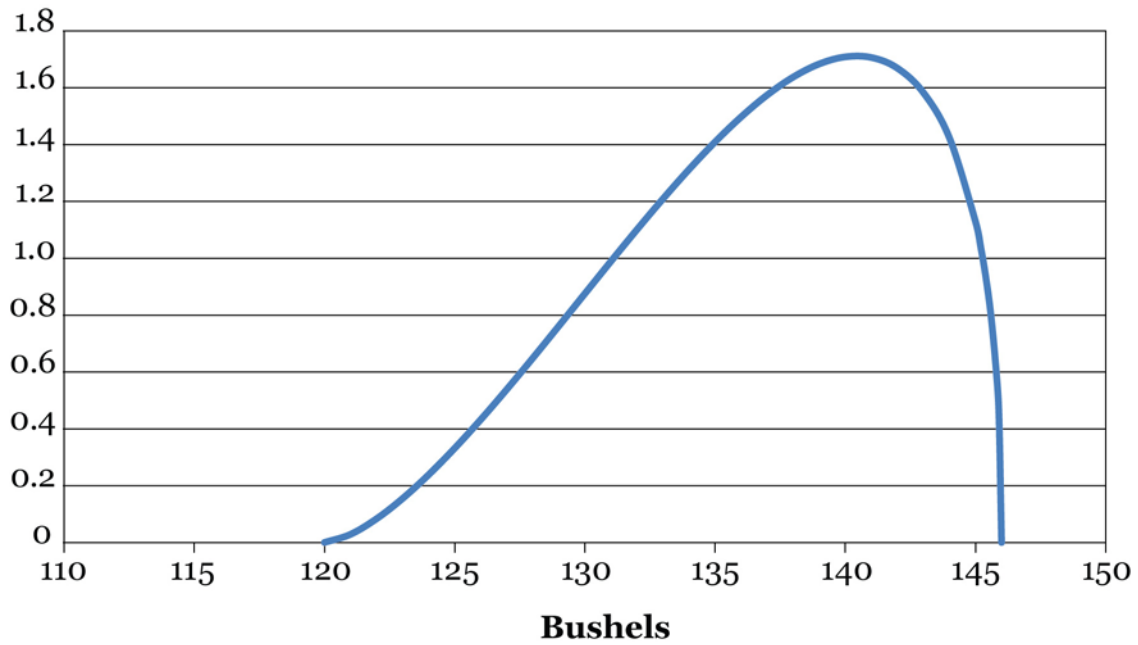
## **Assumptions**

*US Corn Yields:* There is a great deal of uncertainty regarding what US corn and soybean national yields will be. On July 9th, the USDA projected that corn yield per harvested acre will be 146 bu/ac, which surely must be closer to the upper limit on corn yields because of continued hot and dry weather in the primary corn growing regions of Iowa, Illinois, Indiana, and western Nebraska. Maximum corn yield is set at 148 bu/ac in this analysis. Average yield is set at 138 bu/ac, and 120 bu/ac is the lowest possible yield. The 1988 yield loss, expressed as a percent decline from 1988 trend yield, was 25%. Applying this percent yield loss to the 2012 trend yield gives 122 bu/ac. Combining the average yield, the maximum yield, and the minimum yield with an assumed standard deviation of 5 bu/ac is all that is needed to calculate the four parameters of the beta distribution used in this analysis. Figure 1 shows the assumed distribution of corn yields for 2012. Figure 2 shows the corresponding level of US production. Given the continued deterioration of the crop, it may be that we are too optimistic about the size of this year’s crop, but again, there really is no way of knowing at this point in time. Thus, interpret the results presented in this paper as being conditional on the assumed distribution of corn yields.

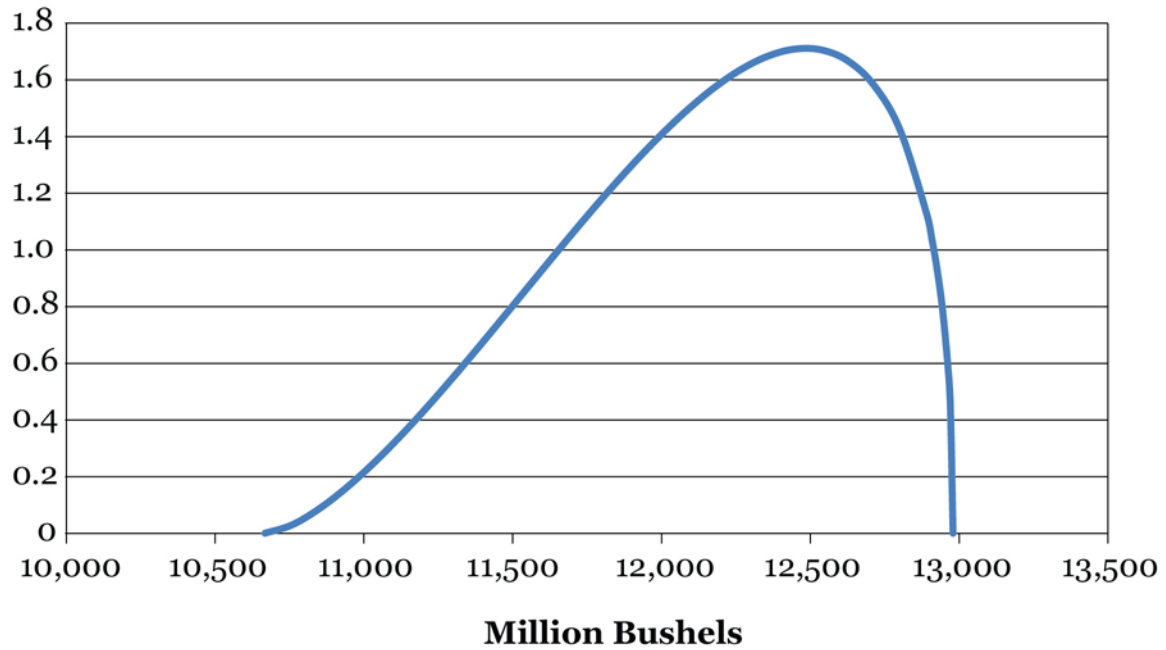
*US Soybean Yields:* Soybean yields are more resilient to drought because soybeans can wait for rain longer than corn. Of course, if rain never comes then that is a problem. The

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<sup>1</sup> For an overview of the model see Babcock, B.A., K.J. Barr, and M. Carriquiry, “Costs and Benefits to Taxpayers, Consumers, and Producers from U.S. Ethanol Policies,” Staff Report 10-SR 106, Center for Agricultural and Rural Development, Iowa State University, July 2010.



**Figure 1. Assumed distribution of US corn yields in 2012**



**Figure 2. Assumed distribution of US corn production in 2012 with 88.9 million acres harvested**

USDA estimated soybean yields at 40.5 bu/ac with 75.3 million acres being harvested. In 1998, soybean yield losses were 17 percent, which would result in a yield of 36 bu/ac this year. For this analysis, the maximum yield is set at 41 bu/ac, the minimum yield is set at 35 bu/ac, and the mean yield is set at 39 bu/ac. An assumed standard deviation of 1.25 results in the distributions of yield and production shown in Figures 3 and 4.

*US Biofuel Mandates:* The conventional biofuel mandate is 13.2 billion gallons in 2012. It rises to 13.8 billion gallons in 2013. Because we base this analysis on a marketing year, we take a weighted average of the two mandates, which is 13.6 billion gallons. While it is not certain how many excess blending credits or RINs are available from 2011 to meet this mandate, Professor Nick Paulson at the University of Illinois at Urbana-Champaign estimates that 2.4 billion gallons are available.<sup>2</sup> Assuming that these gallons are used to meet the 2012–13 mandate implies that 11.2 billion gallons of ethanol must be consumed during this time period. We simulate equilibrium prices for both 11.2 billion gallons and 13.6 billion gallons to show the impacts of the flexibility built into the Renewable Fuels Standards rule. We do not account for the additional flexibility that allows borrowing from next year's obligations to meet this year's mandate, because this would push obligations in 2014 well beyond the ability of the US vehicle fleet to use the ethanol. In addition, we simulate prices assuming a waiver of the mandate during this period in response to a request for a waiver submitted to the EPA. Such a submission occurred in 2008 by Governor Rick Perry. The EPA denied his request for a waiver.

The biodiesel mandate is set at 1.28 billion gallons. We assume that 600 million of these gallons are produced from soybean oil or other close substitute for soybean oil. The other advance biofuel mandate is set at 483 million gallons. Fulfillment of this mandate comes from either imported sugarcane ethanol from Brazil, or by biodiesel made from feedstocks that qualify the fuel to meet the biomass-based diesel mandate.

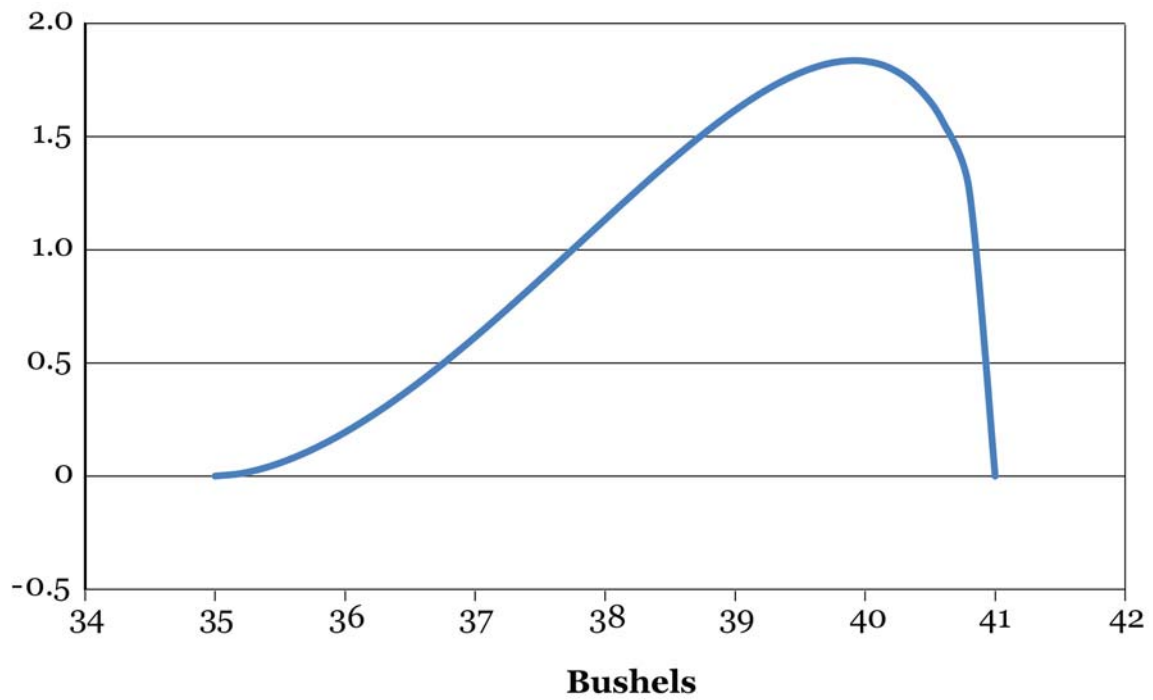
*US Demand for Ethanol:* The voluntary willingness to pay for ethanol by blenders defines the US market demand curve for ethanol. The willingness to pay is assumed to depend on the quantity of ethanol in the market and the price of gasoline—when gasoline prices are high, so too is the value of ethanol as a substitute for gasoline. The value of ethanol falls as ethanol consumption increases because of the difficulty in moving beyond a 10 percent blend in the US vehicle fleet. Figure 5 shows the market demand curve used in this analysis. As shown, if the wholesale price ratio of ethanol to gasoline is 0.9, then the quantity of ethanol demanded is about 12.4 billion gallons. If the price ratio rises to 1.0, the quantity demanded drops to 11 billion gallons. We assume that if the price ratio drops to 0.5, then this will entice the nation's owners of flex fuel vehicles to use E85, or it will entice enough retail outlets to invest in E15 pumps. The average wholesale gasoline price used in this study is \$2.50 per gallon. The volatility of gasoline prices is set at 20 percent.

## **Results**

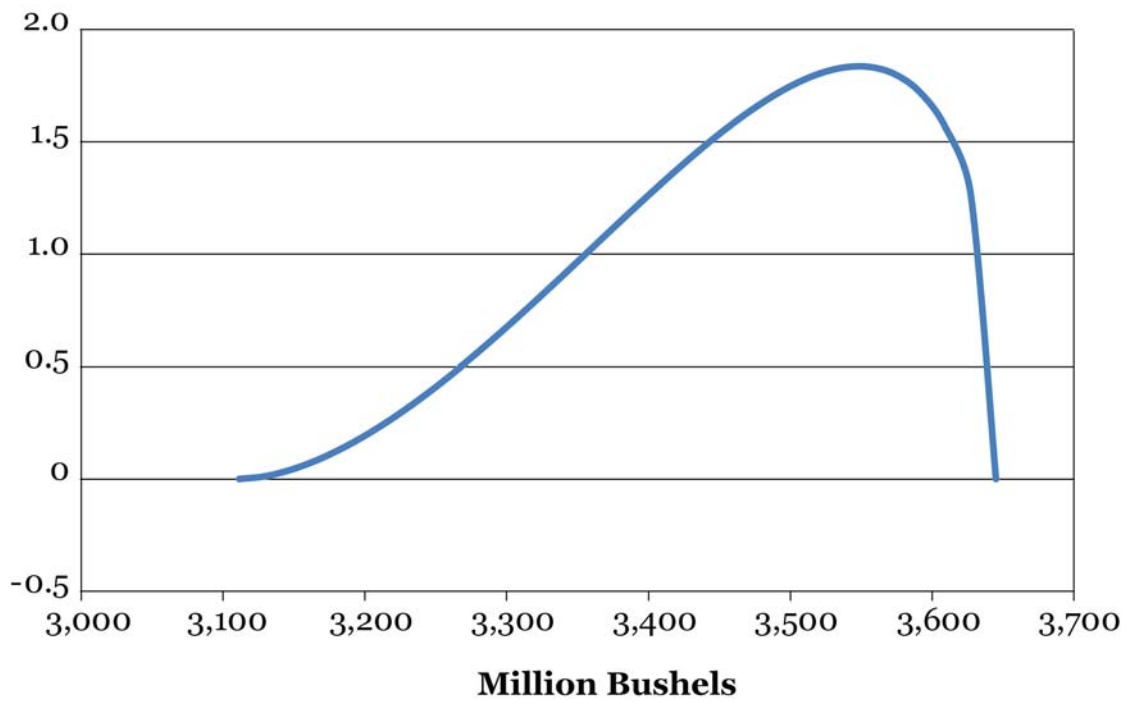
We ran three mandate scenarios through the stochastic simulation model. The first scenario acts as if there is no flexibility in the mandates so that they must be met in full. The second scenario assumes that the effective conventional biofuels mandate met by corn ethanol is reduced by 2.4 billion carry over RINs. The biodiesel mandate and the other advanced biofuel mandate are not reduced because there is no evidence of

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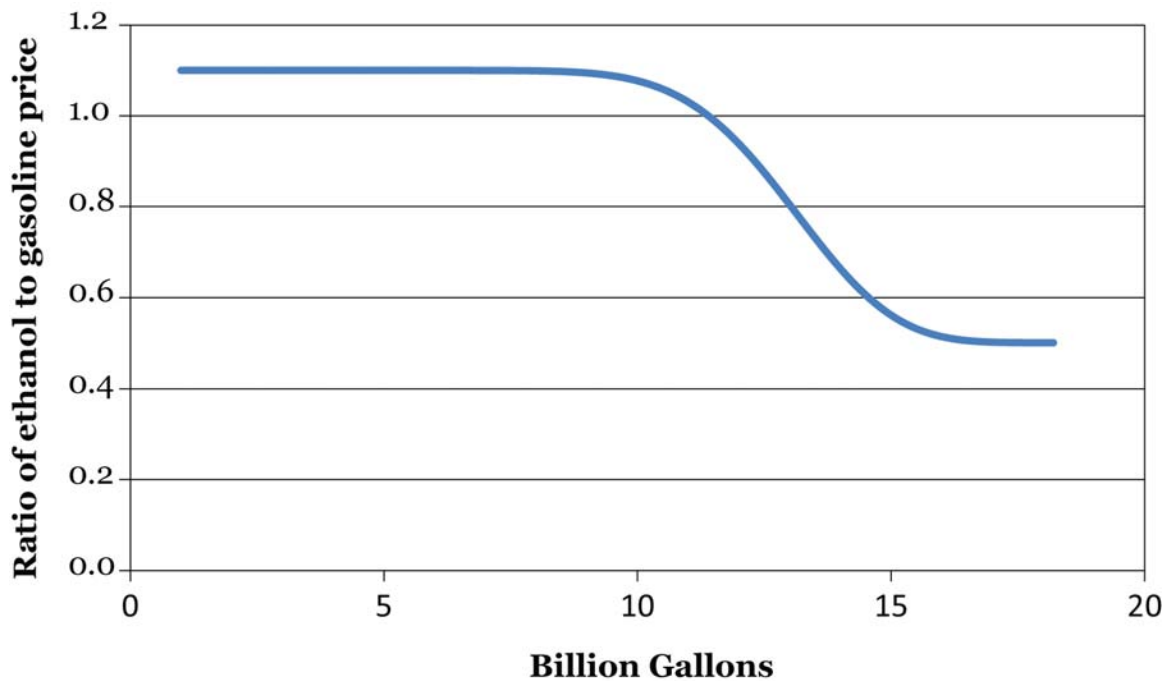
<sup>2</sup> [http://www.farmdocdaily.illinois.edu/2012/03/is\\_the\\_ethanol\\_mandate\\_truly\\_a.html](http://www.farmdocdaily.illinois.edu/2012/03/is_the_ethanol_mandate_truly_a.html)



**Figure 3. Assumed distribution of US soybean yields in 2012**



**Figure 4. Assumed distribution of US soybean production in 2012**



**Figure 5. Assumed Demand Curve for US Ethanol**

carryover RINs for these two fuels. The third scenario does away with all mandates. The focus of this analysis is on the ethanol market and mandate because ethanol will have a larger impact on fuel and feed prices.

Table 1 presents the average results across all 500 simulated market outcomes. The first column of results would be if no flexibility existed in meeting the corn ethanol mandate. An average price of about \$7 per bushel would be needed to meet the mandate and to allocate corn supplies across alternative uses. This average price is higher than the average price projected by USDA on July 9th because the average corn yield used in this analysis is lower than the corn yield assumed by the USDA. Ethanol production is allocated to exports and domestic consumption, which does not drop below 13.6 billion gallons because of the mandate. The average ethanol price of \$2.62 is the price needed to allow ethanol plants to cover their production costs. The United States exports 670 million gallons of ethanol and imports 483 million gallons. Because this model only allows trade between Brazil and the United States, this means that the model shows that the advanced biofuel mandate is met by imported Brazilian sugarcane ethanol. These exports are facilitated by imports from the US, in that the imports lower the domestic ethanol price in Brazil, so they lower the cost of meeting the advanced biofuel mandate. Average RIN prices are high: \$1.01 for conventional ethanol, \$2.35 for biodiesel, and \$1.69 for sugarcane ethanol. Because all RIN prices are expressed in US dollars per gallon of ethanol equivalent, the biodiesel RIN price is equivalent to a gap of \$3.53 per gallon between the cost of producing another gallon of biodiesel and the market value of the fuel.

Accounting for the flexibility in meeting the mandate that exists decreases corn and ethanol prices because average ethanol production decreases by 1.4 billion gallons. The average corn price decreases by \$0.91 per bushel and ethanol prices drop by \$0.25 per



**Table 1. Average Results Across all 500 Yield and Gasoline Price Draws**

	<b>Full Mandate</b>	<b>Flexible Mandate</b>	<b>No Mandate</b>
Corn Price (\$/bu)	6.97	6.06	5.78
Ethanol Price (\$/gal)	2.62	2.37	2.30
Soybean Price (\$/bu)	15.89	15.89	15.15
Soybean Oil Price (cents/lb)	58.5	58.5	47.1
Soybean Meal Price (\$/ton)	431	431	454
Ethanol Production (billion gallons)	14.3	12.9	12.3
Ethanol RIN Price (\$/gal)	1.01	0.16	0
US Ethanol Exports (billion gallons)	0.67	1.16	0.95
US Ethanol Imports (billion gallons)	0.483	0.483	0
Biodiesel RIN Price (\$/gal)	2.35	2.35	0
Advanced Biofuel RIN Price (\$/gal)	1.69	0.90	0

gallon. The RIN price for conventional ethanol drops substantially to an average of only \$0.16 per gallon. The reason for this drop is that the cost of producing ethanol is lower due to lower corn prices, and the willingness to pay for ethanol by blenders is higher because of lower ethanol volumes. Because biodiesel does not have carryover RINs, the flexibility in the mandate has no impact on the biodiesel market. The price of advanced RINs decreases by \$0.79 per gallon. The reason for this drop is the higher willingness to pay for ethanol by US blenders and higher US exports to Brazil, which lowers the price that Brazil needs to send sugarcane ethanol to the United States.

Moving from the flexible mandate to the no mandate scenario has a modest impact on the corn and ethanol markets and a large impact on the biodiesel market. Removing the mandate decreases corn prices by \$0.28 per bushel relative to the flexible-mandate average corn price, which is a decline of 4.6 percent. Ethanol prices only drop by \$0.07 per gallon, and ethanol production only declines by 600 million gallons. The reason for these modest effects is the ethanol demand curve shown in Figure 5. This demand curve measures the value that blenders place on ethanol at different volumes. At an average domestic consumption of 11.4 billion gallons, the value of ethanol in this demand curve is on par with wholesale gasoline. This high valuation of ethanol is consistent with the current price of ethanol relative to gasoline, and perhaps reflects a large value of ethanol in allowing refineries to produce a below-octane gasoline, which when blended with 10 percent ethanol, results in an 87-octane blend. If this demand curve overstates the value of ethanol to blenders, then the effects of removing the mandate would be larger. The impacts of removing the biodiesel mandate is that practically all biodiesel production from vegetable oil would stop. The price of soybean oil would drop by an average of 9.4 cents per pound (16 percent) and the price of soybean meal would rise by \$23 per ton because of decreased supplies of meal. Biodiesel blenders would no longer have to pay a premium of \$3.53 per gallon for biodiesel.

### **Conclusions**

A short corn crop promises to heighten concern about food prices, fuel prices, and the ability of livestock farmers and biofuel producers to stay in business. Results from a

market simulation model provide some preliminary insight into the economic effects of the short crop in 2012. Two findings stand out. The first is that the flexibility built into the Renewable Fuels Standard allowing obligated parties to carry over blending credits (RINs) from previous years significantly lowers the economic impacts of a short crop, because it introduces flexibility into the mandate. The 2.4 billion gallon amount of flexibility assumed in this study lowers the corn price impact of the ethanol mandate in this drought year from \$1.19 per bushel to \$0.28 per bushel. This means that relaxing the mandate further would have modest impacts on corn prices. Of course, this result is conditional on the distribution of corn yields used in this study. If corn yields turn out to be much lower than assumed here, then the impact of the mandate would be far greater. To illustrate this point, the average corn-price impact of relaxing the mandate across the lowest 20 percent of the 500 yield draws used in this study is \$0.44 per gallon. The average yield across the lowest 20 percent of yields is 130.5 bushels per acre. If corn yields turn out to be greater than assumed here then the impacts of relaxing the mandate would be even lower.

The second finding is that if the current price of ethanol relative to gasoline accurately reflects the value of ethanol to blenders, then the price of ethanol will be supported at quite an attractive level as long as ethanol quantities are not pushing up against the blend wall. This implies that ethanol plants will be a strong competitor for corn even without a mandate. In the no mandate scenario simulated here, ethanol production drops by only 600 million gallons when the mandate is waived. This 600 million gallon drop in supply is enough to raise the value of ethanol in the marketplace to support 12.3 billion gallons of production and continue high corn prices. The desire by livestock groups to see additional flexibility in ethanol mandates may not result in as large a drop in feed costs as hoped.

Of course, this high value of ethanol is only high relative to the price of gasoline. If gasoline prices drop, then a waiver of the mandate would have a larger impact. Across the lowest 20 percent of wholesale gasoline prices used in this study, granting a waiver of the corn ethanol mandate would lower corn prices by an average of \$1.13 per bushel from \$5.88 to \$4.75 per bushel. The average price of gasoline in this 20 percent of draws is \$1.87 per gallon.