## Is Corn Ethanol a Low-Carbon Fuel?

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Reports of disappearing glaciers, shrinking arctic ice, rising sea levels, stronger hurricanes, and unprecedented European heat waves combined with an inexorable buildup in atmospheric carbon dioxide levels is increasing pressure on governments to respond with new greenhouse gas initiatives. California and other states are providing policy leadership in the United States.

Of particular interest to the biofuels industry is Governor Arnold Schwarzenegger's January 2007 executive order that requires a 10 percent reduction in the carbon content of California's transportation fuels by 2020. In contrast to federal renewable fuel standards, which mandate levels of use of biofuels, California's fuel standard does not tell fuel suppliers (oil companies) how they should meet the new requirements. Alternative fuels will have to compete in terms of cost and carbon content. Only those fuels that can reduce carbon content at reasonable cost will be included in California fuel blends. Given that ethanol from corn comprises more than 90 percent of U.S. alternative fuels, a key determinant of the feasibility of meeting California's ambitious goals is the extent to which corn ethanol reduces greenhouse gas emissions.
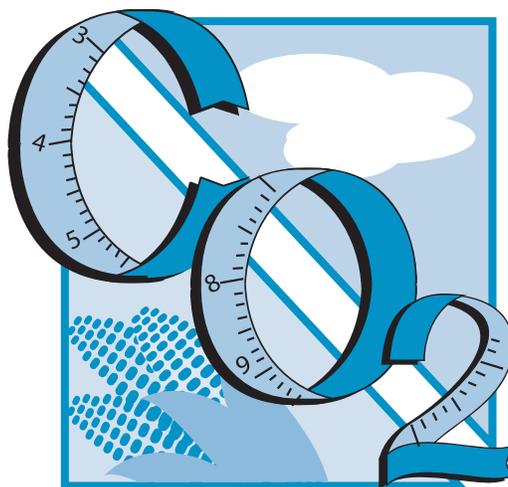


### Accounting for Corn Ethanol's Greenhouse Gas Emissions

Whether corn ethanol reduces net greenhouse gas emissions has been studied by many, and many different answers have been found. Sometimes the difference in answers rests on assumptions. For example, Professor David Pimental from Cornell University attributes all greenhouse gas emissions from ethanol plants to ethanol rather than attributing a portion to distillers grains, which displace feed (more about this later). But sometimes the differences in answers are caused by researchers answering different questions. To illustrate the process that researchers follow to calculate greenhouse gas emissions we answer the following question: Does expansion of Iowa corn production to produce ethanol help reduce the buildup of greenhouse gases? If the answer is yes, then corn-based ethanol produced from Iowa corn may qualify as a low-carbon fuel. If not, then the future of the current ethanol industry may be threatened because it may not help California meet its fuel composition target.

To answer this question requires careful accounting of the differences in production and consumption that lead to changes in greenhouse gas emissions. The method commonly used to estimate greenhouse gas emissions is to conduct a life cycle analysis of the feedstock used to make biofuels. We present results of a life cycle analysis for Iowa corn from planting to refining to burning as fuel. In addition, we also consider changes in emissions caused by land use changes that are attributable to expansion of corn production. These land use changes can occur both domestically and overseas.

### Fuel Consumption

Energy content is typically measured by megajoules (MJ). Gasoline contains approximately 121 MJ per gallon. A gallon of ethanol contains 67.4 percent of the energy content of gasoline so it takes 1.48 gallons of ethanol to replace the energy content of a gallon of gasoline. Greenhouse gas emissions, whether from methane, nitrous oxide, or carbon dioxide, are all measured in units of carbon dioxide equivalent ($CO_2$eq). Life cycle analyses of gasoline suggest that transportation of oil, refining oils into gasoline, and burning the gasoline in cars releases 94 grams of $CO_2$eq per megajoule. This is the carbon content of gasoline. If corn growth required only photosynthesis, if ethanol were produced using solar power, if corn were instantly transported to ethanol plants, and if no land use changes were needed to grow the corn, then displacing a gallon of gasoline with ethanol would reduce greenhouse gas emissions by approximately 11.2 kilograms (kg) of $CO_2$eq.

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However, fossil fuels are used to grow corn and produce ethanol. In addition, using corn to produce ethanol means that fewer acres will be devoted to competing crops, more land will be brought into cultivation, and other uses of corn will decline. The greenhouse gas implications of all these factors need to be considered before we can determine if corn ethanol is a low-carbon fuel.

### Biorefinery Phase

Corn ethanol is produced in either a dry mill or a wet mill plant. Most new ethanol plants are dry mills, so that is what we focus on here. Converting corn to ethanol in a dry mill plant requires energy to transport corn to the plant, prepare the corn for fermentation, ferment the corn, and distill the ethanol from the fermented product. The two key factors that determine the greenhouse gas emissions from a dry mill plant are whether the plant dries the distillers grains or sells them wet and whether the plant's energy source is coal or natural gas.

A dry mill plant that dries distillers grains requires about 38 MJ to produce a gallon of ethanol. If distillers grains are not dried, the energy is reduced to about 26 MJ per gallon. Coal-powered plants emit 62 percent more $CO_2$eq than plants that use natural gas.

The contribution of ethanol to reducing greenhouse gas buildup is reduced by biorefinery emissions. Not all the greenhouse gas emissions of a dry mill plant should be allocated to ethanol because the plant also produces distillers grains, which displace other sources of animal feed, thereby reducing the green-house gas emissions associate with the displaced feed. Table 1 shows the amount of emissions that occurs depending on the source of energy (coal or natural gas) and on whether distillers grains are dried or not.

### Direct Agricultural Phase

Accounting for the fossil fuel used to produce corn further reduces the net reduction in greenhouse gas emissions. Fossil fuels are used directly in the form of diesel fuel or indirectly to produce fertilizer, pesticides, and other agricultural inputs. The two most important determinants of greenhouse gas emissions per gallon of ethanol in the agricultural phase are the yield per acre of land and the amount of nitrogen fertilizer used. And both of these are influenced by whether corn is grown after soybeans or after corn.

If there were no ethanol demand, it is likely that Iowa farmers would plant most of their corn crop after a crop of soybeans. Yields are higher and nitrogen fertilizer costs are lower. The higher yields and lower nitrogen rates have a direct impact on carbon emissions. If yields of corn planted after corn are 10 percent lower than for corn planted after soybeans, then $CO_2$eq emissions per bushel for corn planted after corn would be 10 percent higher than corn planted after soybeans. But the difference in emission is greater than 10 percent because nitrogen fertilizer application rates are typically 50 pounds per acre higher for corn planted after corn. Each additional pound of applied nitrogen contributes an additional 5 kg in $CO_2$eq emissions. The reason for this high emission

**Table 1. $CO_2$ emitted (kg) per gallon of gasoline displaced at the biorefinery stage**

| | Coal | Natural Gas |
|---|---|---|
| Dried distillers grains | 5.12 | 2.88 |
| Wet distillers grains | 3.53 | 2.08 |

rate is that nitrous oxide has a global warming potential more than 300 times that of $CO_2$. The combination of a lower corn yield and a higher nitrogen rate (and accounting for some other small differences) increases emissions from this phase of ethanol production from 3.5 kg to 4.8 kg $CO_2$eq per gallon of gasoline displaced.

A reasonable presumption is that increased ethanol production in Iowa comes primarily from increased acreage of corn planted after corn. Figure 1 shows the resulting net greenhouse reductions. As shown, it appears that expansion of Iowa corn production for ethanol does indeed reduce net greenhouse gas emissions, even when the ethanol is produced in a coal-fired plant. However, before we can make a final conclusion, we need to consider possible changes in emissions caused by changes in land use.

## Induced Changes in Land Use

Increased production of corn for ethanol production will affect land use both domestically and overseas. Domestically, most of the increase in corn production will come about because farmers will switch their land from an alternative crop to corn. Most of the switching will involve soybean acreage because most of the corn is grown alongside soybeans. We have already accounted for the emissions from growing corn. When the additional corn is grown on what would have been a soybean acre, there is an emission credit equal to the amount of emissions associated with soybean production. Under Iowa conditions the amount of credit equals about 1.5 kg $CO_2$eq per gallon of gasoline displaced.

Some corn grown for expanded ethanol use could also come from conversion of land that would not have been cropped otherwise. Virgin land with a mature forest or grassland contains as much carbon as it is ever going to. In contrast, land that has been previously tilled
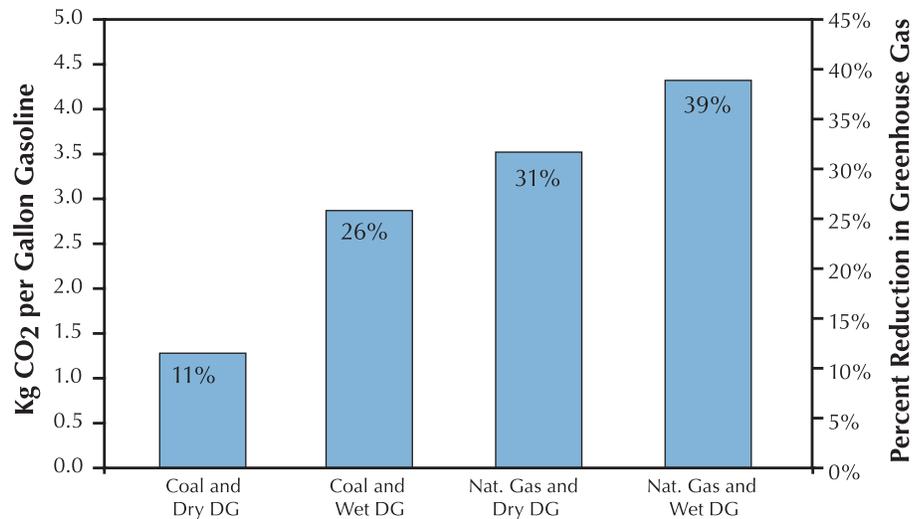


**Figure 1. Life cycle emission reduction for corn ethanol in Iowa**

but is currently not being cropped is gaining carbon in soil or trees. Therefore, tilling virgin land releases more immediate carbon than tilling land that is gaining carbon. But growing crops on previously tilled land results in the loss of the carbon that would have accumulated on the land in future years. The loss of the annual increase in carbon accumulation needs to be accounted for if previously tilled land is cropped.

An example of previously cultivated land is acreage that is enrolled in the Conservation Reserve Program (CRP). The Chicago Climate Exchange assumes that farmers who convert cropland to grassland will sequester 750 kg $CO_2$eq per acre per year. If we use this as the amount of lost sequestration and if we assume also that an equivalent annualized amount of soil carbon stocks will be lost from land conversion, then a debit of 5.3 kg $CO_2$eq per gallon of gasoline displaced needs to be subtracted from the Figure 1 numbers. This debit makes ethanol production from corn a net contributor to greenhouse gas in all cases. Although the actual debit on CRP land may be higher or lower than 5.3 kg, this example illustrates just how sensitive is the measure of ethanol's net greenhouse gas contribution.

To date, expansion of U.S. corn production for ethanol has primarily involved substitution of corn for another crop and not conversion of land. Thus, we conclude that corn-based ethanol reduces greenhouse gas emissions. However, this conclusion may not hold if we extend our accounting boundary to include land use changes in other countries.

As explained earlier, expansion of U.S. corn production for ethanol will reduce U.S. soybean production. But world soybean demand will be unaffected. The result is an increase in world soybean prices and a signal for other countries to expand production. If this production takes place solely through switching from lower-value crops to soybeans, then only the difference in emission rates between the two crops can be attributable to U.S. ethanol production. Because a soybean crop is a low carbon emitter, such a difference would likely result in a credit being added to U.S. ethanol. However, if soybean expansion occurs through conversion of grassland or forestland, then the immediate loss in carbon might be attributable to U.S. ethanol. This latter case presents a potential hurdle that must be overcome before U.S. ethanol can be considered a low-carbon fuel.

# How to Save Billions in Farm Spending

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The most vexing problem facing Congress as it works toward completion of the farm bill is where to find funding to make changes in farm legislation. High commodity prices have drastically reduced available funds that supporters of change can tap to create new programs or expand existing programs. The agricultural committees have found only two significant sources of funds under their control: direct payments and the crop insurance program. Reductions in either program could fund increased nutrition and conservation programs or could be used to redesign commodity programs. The rationale for cutting direct payments is that it is difficult to see why crop farmers should receive subsidy payments when farm income is at record levels. The rationale for cutting crop insurance subsidies is that taxpayer support for the program has ballooned with the higher commodity prices, far outstripping the costs of actually running the program.

The House-passed farm bill kept direct payments in place but reduced crop insurance funding. About half of the House cuts to crop insurance are real and about half are budget sleights of hand that involve moving payments from one fiscal year to the next. At press time, the Senate had yet to act on a farm bill but indications are that the Senate will also choose to reduce crop insurance funding. The final farm bill will be written by a conference committee and the choice for the conference committee will be the same: if changes are to be made in the farm bill, the only two places to fund such changes are reductions in direct payments or funding reductions to crop insurance.

**Table 1. Crop insurance subsidies for program crops**

| Year | Premium Subsidy | A&O Subsidies | Company Underwriting Gains | Total Subsidies for Program Crops | Share of Total Subsidies Accounted For by Program Crops |
|---|---|---|---|---|---|
| | | | million $ | | |
| 2005 | 1,828 | 691 | 783 | 3,302 | 81% |
| 2006 | 2,176 | 789 | 817 | 3,782 | 83% |
| 2007 | 3,218 | 1,126 | 1,105 [a] | 5,448 [a] | 86% |

*Note:* Program crops include barley, corn, cotton, grain sorghum, oats, peanuts, rice, soybeans, and wheat.
[a]Estimated assuming that the 2007 aggregate loss ratio is 0.8.
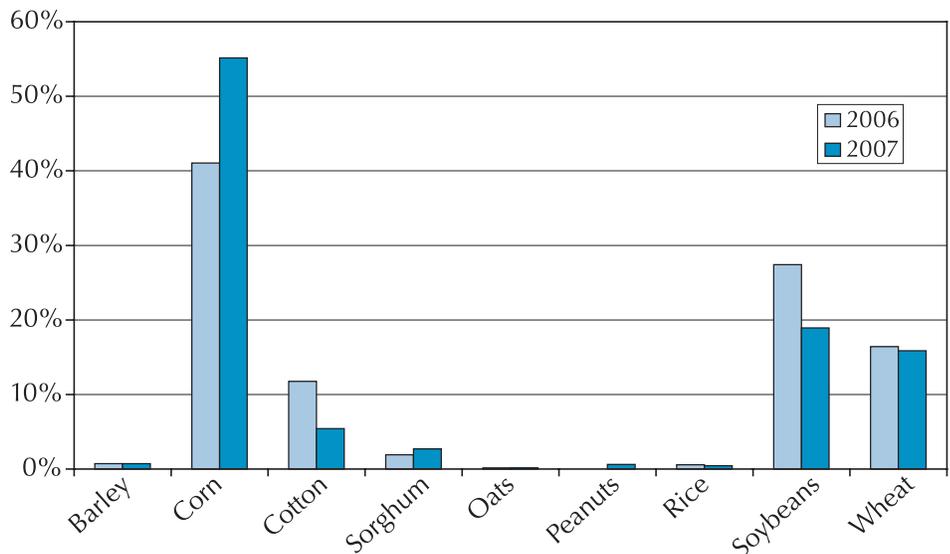


**Figure 1. Share of premium generated by each program crop**

One justification for cutting crop insurance to help fund commodity program reform is that most crop insurance subsidies are targeted at the same crops that receive farm program payments. Table 1 shows a breakdown in crop insurance program costs attributable to program crops from 2005 to 2007. (The 2007 payments are estimated.) Program crops account for more than 80 percent of the costs of the crop insur-ance program, and this share has increased significantly over the last three years. More than $5 billion is now being spent on providing crop insurance to program crop producers, an amount that is about equal to the annual direct payments that the same producers receive.

Figure 1 shows the share of total crop insurance premium for program crops accounted for by each crop. As is readily apparent from the
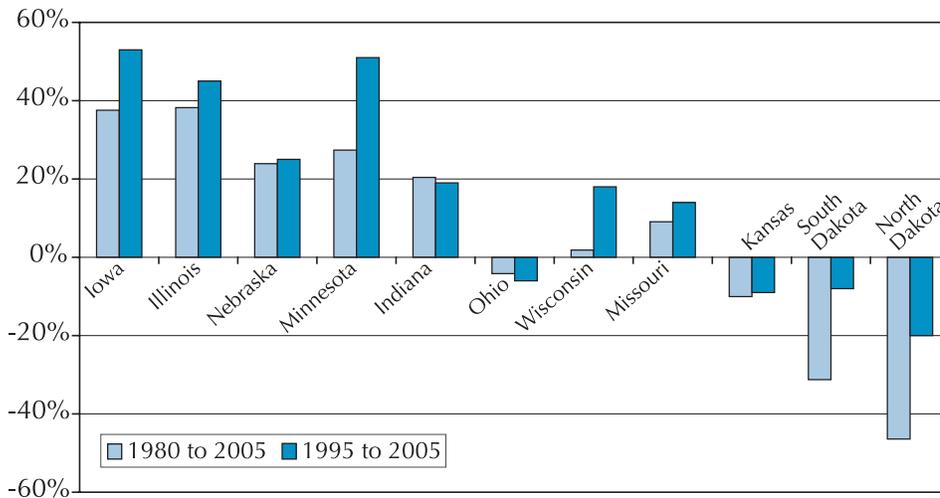
**Figure 2. Premium subsidy required for program crop farmers to break even on crop insurance**

data in Table 1 and Figure 1, when we talk about the crops affected by the crop insurance program, we are really talking about one large crop—corn—and three other crops—soybeans, wheat, and cotton.

The Table 1 data illustrates that significant funds could be obtained from the crop insurance program, either through cuts in premium subsidies, underwriting gains, or A&O (administrative and operating) reimbursements. Defenders of the program, however, argue that it would be counterproductive to cut any of these three items. They say premium subsidies are needed to get farmers to buy insurance, and company profit levels generated by taxpayer-subsidized underwriting gains and A&O are in line with what commercial insurance providers generate from the private market. (See, for example, testimony from Ron Brichler, senior vice president of Great American Insurance Company, before the General Farm Commodities and Risk Management Subcommittee, House Committee on Agriculture, June 7, 2007.) It follows, then, that any cuts from these levels would reduce program participation by both farmers and private companies.

Understanding the implications of cuts in direct payments is simple because they are so transparent. However, the crop insurance program is so complicated that few actually understand how the program works and what would happen if program funding were cut. But by taking a closer look at the program, we can estimate what could be saved and with what impacts. First, let's look at producer premium subsidies.

## Impacts of Reducing Producer Premium Subsidies

Farmers will choose to buy crop insurance if the benefits they derive from it are greater than its price. The first benefit is the standard insurance benefit obtained from knowledge that crop losses in excess of the insurance deductible will be covered. Experience has shown that this insurance benefit alone is insufficient motivation for most farmers to buy crop insurance. It must be, then, that crop insurance is a cost ineffective way for farmers to protect themselves against crop losses. Thus, to boost participation, Congress increased premium subsidies to the point at which most farmers find it difficult to resist. But even with taxpayers paying more than half their premium, many farmers claim that the program still does

not generate enough payments relative to what they are asked to pay.

Figure 2 shows the "break-even" percent subsidy for farmers in major corn- and wheat-producing states. Presented are the levels of premium subsidy that if applied to recent premium rates would equate farmer-paid premiums with expected indemnity payments for producers of corn, soybeans, wheat, rice, and grain sorghum in each state. Expected indemnity payments are calculated for two periods: 1980 to 2005 and 1995 to 2005. The longer period is more indicative of expected indemnities if patterns of crop losses in the 1980s and early 1990s are possible in the future.

The break-even premium subsidy for Iowa is 38 percent if future crop losses follow the 1980 to 2005 pattern or 53 percent if the more recent past is indicative of future losses. This means that Iowa farmers have no profit motivation for buying crop insurance until the premium subsidy gets substantial. The same result holds for Illinois, Nebraska, Minnesota, and Indiana. The negative break-even premium subsidies in Ohio, Kansas, and the Dakotas indicate that farmers in these states do not need a premium subsidy to break even because their premium rates are already low enough.

The Figure 2 data indicate that Corn Belt farmers would not buy crop insurance if it were not heavily subsidized whereas farmers in important wheat states would have a profit motive to buy crop insurance even without premium subsidizes. Given that corn and soybeans together represent about 60 percent of the entire crop insurance program, it is only a bit of an overstatement to say that the crop insurance industry is selling a product with so little demand at its current price that without government price subsidies, there would be no viable market. This conclusion is reinforced by the fact that unlike private insurance products, crop insurance ▫⇨

premiums do not cover the cost of selling, servicing, and reinsuring the insurance policies. Instead, the government provides direct support to insurance providers through A&O reimbursements and reinsurance. If premiums were set to cover these costs, the break-even premium subsidies in Figure 2 would be much greater.

This lack of market for unsubsidized crop insurance means that substantial savings could accrue from a reduction in premium subsidies. Direct savings would come about because farmers would be asked to pay more for their insurance. However, the indirect savings from a reduction in premium subsidies would likely be much greater than the direct savings. Depending on how the cut in premium subsidies was implemented, it is likely that farmers would buy less insurance. This decision would reduce their premium, which would reduce the per-acre premium subsidy and automatically trigger reductions in A&O reimbursements and underwriting gains. Of course, such a move would reverse the policy of trying to maximize participation in the program. The House chose to reduce premium subsidies but only for a subset of crop insurance policies (GRIP and GRP). This choice limits the indirect savings, as many farmers will simply move to products that receive higher subsidies.

### Growth in Administrative and Operating Reimbursements

The best measure of changes in the actual cost of selling and servicing crop insurance policies is changes in the number of policies sold. Although larger farms will tend to involve a bit more work than smaller farms, most of the cost is determined by the number of policies. Table 2 provides data that give insight into A&O reimbursements from 2005 to 2007.

Using 2005 as a base year assumes that company reimburse-

### Table 2. Growth in operating costs and reimbursements since 2005 for program crops

| Year | Number of Policies (thousand) | Number of Acres Insured (million) | A&O Reimbursement per Policy ($) | A&O Reimbursement per Acre ($) |
|------|---|---|---|---|
| 2005 | 1,028 | 190 | 672 | 3.63 |
| 2006 | 996 | 191 | 792 | 4.14 |
| 2007 | 992 | 195 | 1,135 | 5.79 |
| **Percent change from 2005** | | | | |
| 2006 | -3% | 0% | 18% | 14% |
| 2007 | -3% | 2% | 69% | 59% |

ments in that year were enough to allow an adequate level of service to be provided to producers of program crops. As shown, the number of policies sold to producers of program crops has fallen since 2005, yet, as shown in Table 2, total A&O reimbursements have dramatically increased over this period.

To put this growth into context, the House farm bill would reduce A&O reimbursements by about 14.5 percent. However, to hold A&O reimbursements per policy constant at their 2005 levels for program crops would require a 40 percent reduction in A&O reimbursements. An alternative way to provide A&O reimbursements would be to base them on policy count rather than as a percentage of premiums. This change would create an equal incentive for companies and agents to sell crop insurance to small and large farmers and it would not result in dramatic year-to-year changes in taxpayer costs that bear no reflection to actual industry costs. A reduction in A&O would be felt most directly in a reduction in crop insurance agent commissions. If per-policy A&O reimbursements were reduced to 2005 levels, then agent commissions would also be reduced to 2005 levels. If these levels were adequate to sell and service policies in 2005, then they are likely adequate today. If not, then consolidation in the number of agents selling crop insurance would occur.

### Reductions in Underwriting Gains

Another way that Congress could cut crop insurance program costs is through a reduction in net underwriting gains, defined as the difference between premiums collected and indemnities paid after accounting for the subsidized reinsurance that is provided by USDA. The House farm bill cuts program costs by increasing the "net book quota share" from 5 percent to at least 12.5 percent. This quota share is the percentage of net underwriting gains that companies must pay to USDA when their gains are positive and it is the percentage of losses that the companies do not have to cover when net gains are negative.

An increase in this quota share would be cost neutral if the probability and average magnitude of a loss equals the probability and average magnitude of a gain. But, as shown in Figure 2, premiums exceed expected indemnities in the Corn Belt. And because most of the crop insurance program consists of Corn Belt business, the probability of a gain is larger than the probability of a loss. Furthermore, the reinsurance provided by USDA treats losses differently than gains.

A good way to gain insight into the effects of an increase in quota share is by looking at the "value-at-risk" curve facing the crop insurance industry. Value-at-risk curves show the probability that underwrit-
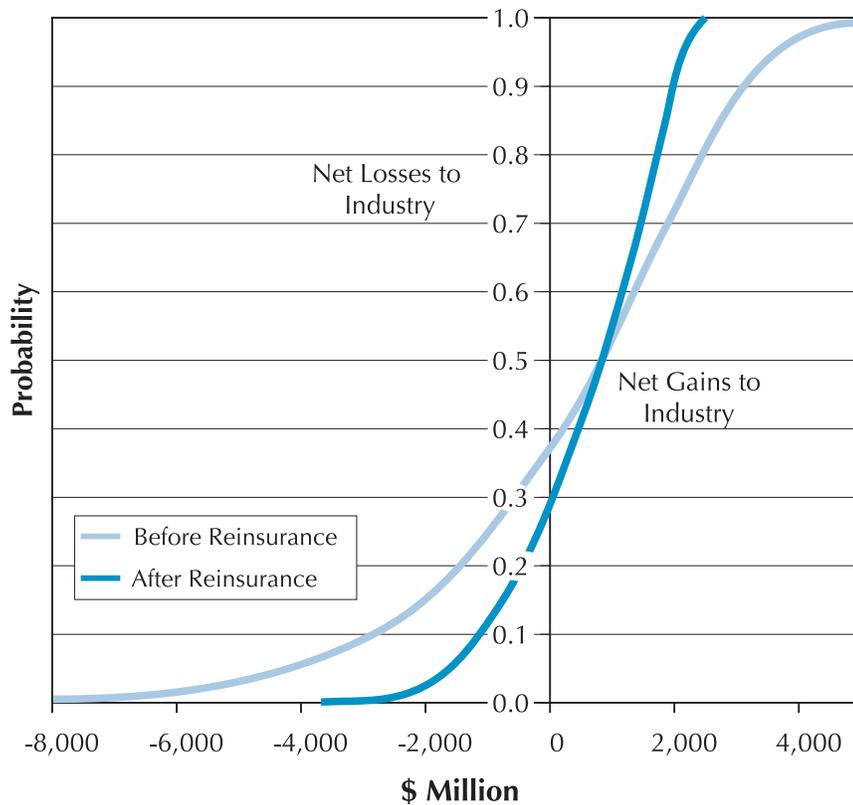
**Figure 3. Value-at-risk curve for crop insurance companies with and without USDA reinsurance**

ing gains will be less than a given level. Figure 3 shows the value-at-risk curve with and without reinsurance for the crop insurance industry from insuring program crops with premiums set at 2007 levels. The 1980 to 2005 level of risk is embodied in these curves. The risk would be much less than that shown if the 1995 to 2005 level of risk were used.

Providing crop insurance to farmers is risky business. Without reinsurance, there is a 1-in-200 chance that losses will exceed $8 billion. The reinsurance provided by USDA reduces the 1-in-200 loss to $2.8 billion with a maximum possible loss of $3.6 billion. This loss was calculated by assuming that companies place all their program crop business in the riskiest/highest-profit reinsurance fund and that USDA reinsurance is based on

industry losses rather than individual company losses. The reinsurance also reduces the probability of a loss from 39 to 30 percent. This means that in 7 years out of 10, crop insurance companies should expect to have positive underwriting gains, which means that an increase in quota share will reduce program costs 70 percent of the time while increasing costs only 30 percent of the time. This asymmetry between gains and losses explains why increasing the net book quota share will reduce taxpayer costs of the program. Every 5 percent increase in quota share reduces program costs by about $27 million.

## Where to Cut?

Congress has the opportunity to offset increased farm bill program costs by targeting cuts to crop

insurance, which has generated tremendous growth in program costs. Significant savings are available through reductions in premium subsidies, A&O reimbursements, and net underwriting gains. Reductions in premium subsidies would likely generate the greatest savings because farmers would likely respond by dramatically reducing the amount of insurance they buy, which would automatically reduce program costs. Because the growth in A&O reimbursements has far outpaced actual increases in program operating delivery costs, significant savings could also be realized by changing the way A&O is calculated. For example, capping per-policy A&O reimbursements at 2005 levels would generate annual savings of almost $450 million. And every 10 percent reduction in the risk exposure of crop insurance companies through expansion of the reinsurance quota share could generate more than $50 million in savings up to a maximum annual savings of more than $500 million.

The choice available to Congress is clear: the only two significant sources of budget offsets to pay for the cost of changing direction with the 2007 farm are crop insurance and direct payments. If Congress chooses to cut crop insurance and it does not want to reduce producers' incentives to buy insurance, then it will need to target A&O and underwriting gains. The impact of such reductions would be small initially because recent growth in both has been substantial. But combined cuts in excess of perhaps $500 million per year would likely begin to change the crop insurance delivery system, with fewer, larger crop insurance agencies. ◆

## Agricultural Situation
## Spotlight

# Blending: Ethanol's New Growth Sector

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The evolution of the ethanol industry continues at a brisk pace. U.S. ethanol production capacity has grown tremendously over the past several years. But recent lower ethanol prices, combined with still strong corn prices, have put a damper on continued expansion. Figure 1 shows the price movements for ethanol in 2007. At the beginning of the year, the ethanol price started out at around $2.50 per gallon. But prices have backed off since then, with recent ethanol prices at between $1.50 and $1.70 per gallon. This price drop has tightened margins at ethanol plants across the nation. But at the same time, the price drop has provided new growth opportunities in ethanol, on the blending side.

## Ethanol Blends
Ethanol is blended with gasoline for a variety of reasons. It is an octane booster; it is an alternative fuel source for use in conventional fuels; and it is an additive that can be used to meet Clean Air Act standards. Ethanol received a boost by means of this last reason when the additive MTBE was removed from the market. Figure 2 shows the percentage of U.S. gasoline that has been blended with ethanol since January 2005. The MTBE removal occurred mostly in May 2006, and the graph shows the jump in ethanol blending, from 35 percent to 45 percent, over the course of that month. Ethanol blending has exceeded 50 percent for a couple of months over the past year at times when ethanol prices have dropped.



**Figure 1. Nearby futures prices for ethanol**
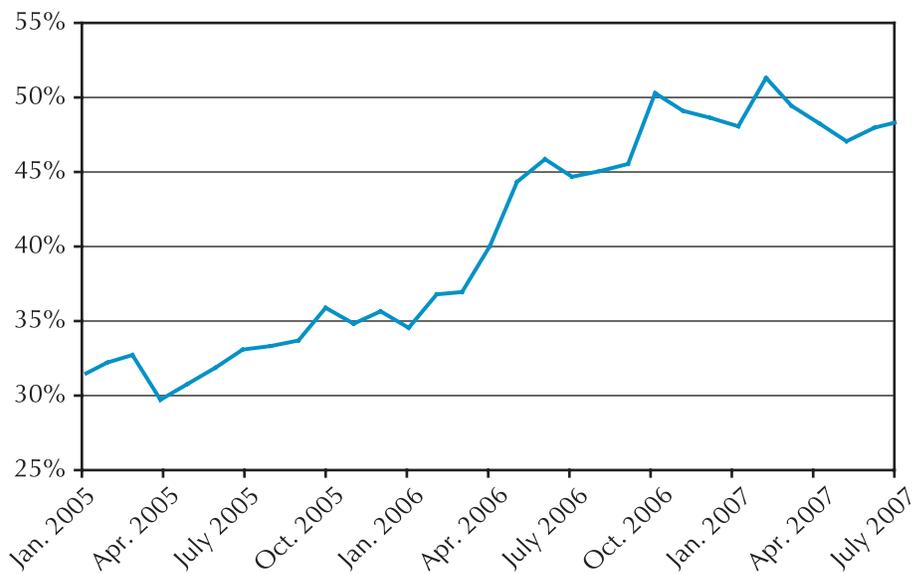


**Figure 2. Percentage of U.S. gasoline blended with ethanol**

These monthly spikes are likely due to ethanol being used as a relatively cheaper alternative fuel source for conventional fuels. And given ethanol's current pricing situation, this type of usage will continue to grow as more ethanol enters the fuel market as part of conventional gasoline.

## Regional Differences
The gasoline market can be broken down into two components: the conventional and the reformulated gaso-

line markets. Reformulated gasoline is gasoline that is manufactured to meet Clean Air Act requirements and is mainly marketed in large urban areas on the East and West Coasts. It was in this reformulated gasoline market that ethanol replaced MTBE. Table 1 outlines U.S. ethanol blending in July 2007. In that month, over 11 billion gallons of gasoline was produced, and nearly half of that total was blended with ethanol. Roughly two-thirds of the ethanol-blended fuel entered the reformulated gasoline market, with the rest entering the conventional gasoline market. But when you look at various regions of the country, the blending story changes. On the coasts and in the southern United States, nearly all of the ethanol-blended fuel is reformulated. But for the Midwest and Northern Plains, most of the ethanol-blended fuel is sold as conventional gasoline. With ethanol-blended fuel already dominating the reformulated gasoline market, the new growth area for ethanol is in the conventional gasoline market.

Figure 3 shows the usage of ethanol-blended fuels across the nation in 2004 (the latest year in which data is available). The map shows three main areas for ethanol usage: California, the upper Midwest, and New York and Connecticut. The California and New York markets are the largest reformulated gasoline markets; even before the phase-out of MTBE, ethanol had captured a sizable portion of those markets. The upper Midwest market was mainly on the conventional gasoline side, with cheaper, locally sourced ethanol and state-level incentives and mandates. But ethanol usage outside of these markets was small to non-existent. In 15 states, no ethanol-blended fuel was sold. In 13 additional states, use of ethanol-blended fuel was below 5 percent. So ethanol has several additional markets it could potentially tap into. And the lower prices we are now seeing for ethanol provide some

### Table 1. Ethanol blending by region, July 2007

| | Finished Motor Gasoline (million gallons) | Blended with Ethanol (%) | Reformulated (%) | Conventional (%) |
|---|---|---|---|---|
| United States | 11,058 | 48.45 | 34.22 | 14.23 |
| East Coast | 2,178 | 72.54 | 68.42 | 4.12 |
| Midwest | 2,187 | 78.41 | 22.93 | 55.48 |
| South Central U.S. | 4,425 | 10.06 | 9.77 | 0.29 |
| Intermountain West | 393 | 33.34 | 0.00 | 33.34 |
| West Coast | 1,874 | 79.29 | 72.53 | 6.75 |



**Blending Percentage**
- 0%
- 1 - 25%
- 25 - 50%
- 50 - 75%
- 75 - 100%
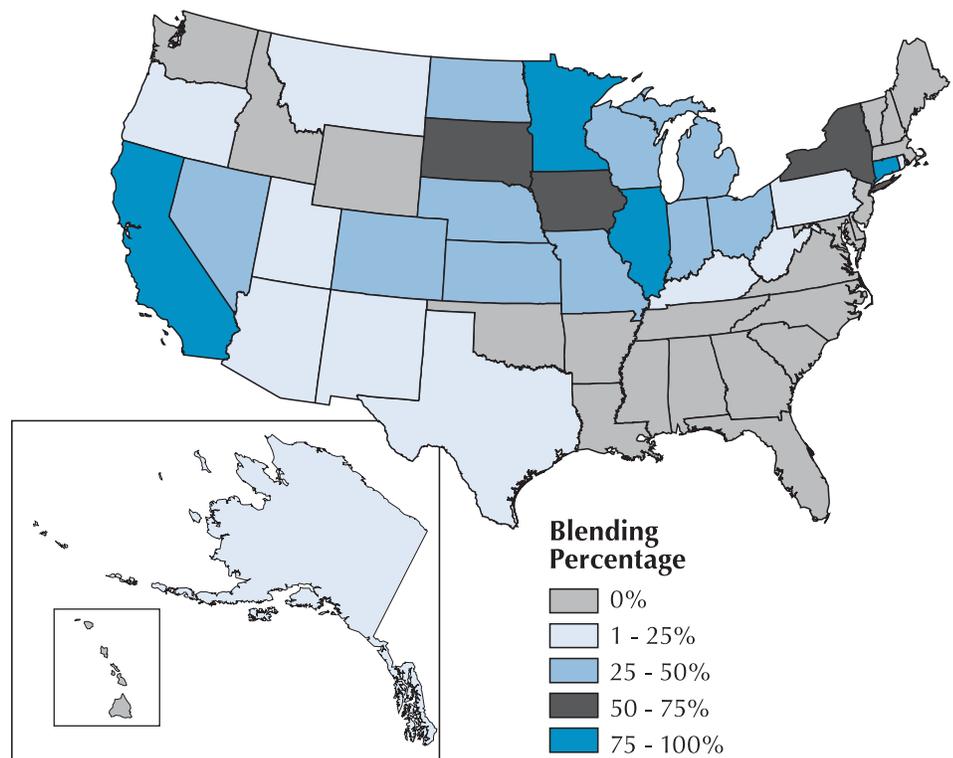
### Figure 3. Usage of ethanol-blended fuel by state in 2004

economic incentives for gasoline blenders to target ethanol-blended fuels in the southern United States, New England, and the Pacific Northwest, where ethanol has not traditionally been sold.

### Pricing Factors

Table 2 displays the price incentives for blending ethanol. To obtain a

consistent series of publically available prices, the calculations shown here use gasoline and ethanol rack prices from the Omaha, Nebraska, market for January and September of 2007. In January, a gallon of gasoline was priced at $1.49 per gallon while a gallon of ethanol was $2.26 per gallon. At these prices, an E-10 blend cost 7.7¢ more per gallon ⇨

## Table 2. Blending economics

| | January 2007 | | September 2007 | |
|---|---|---|---|---|
| | **Regular Unleaded** | **E-10** | **Regular Unleaded** | **E-10** |
| | ($ per gallon) | | ($ per gallon) | |
| Gasoline | 1.490 | 1.341 | 2.300 | 2.070 |
| Ethanol | | 0.226 | | 0.193 |
| Price before taxes | 1.490 | 1.567 | 2.300 | 2.263 |
| | | | | |
| Federal gas tax | 0.184 | 0.184 | 0.184 | 0.184 |
| Ethanol tax credit | | -0.051 | | -0.051 |
| Price after federal taxes | 1.674 | 1.700 | 2.484 | 2.396 |

than regular unleaded before taxes. Even after accounting for the ethanol blender's tax credit, the E-10 blend was still 2.6¢ more. In September, the price of gasoline had risen to $2.30 per gallon, while ethanol had fallen to $1.93 per gallon. With these prices, the E-10 blend is 3.7¢ less expensive before taxes and 8.8¢ less after federal taxes. This large incentive to blend ethanol has only increased with recent further declines in ethanol prices.

### Ethanol Logistics, Demand, and Policy Effects

Several companies are moving to add ethanol-blending capacity and relieve what some have called a blending bottleneck. For example, Gulf Ethanol out of Houston is looking to build the first ethanol blending facility near the port of Houston, taking advantage of existing rail and barge shipping lines. And the market for ethanol through conventional gasoline continues to grow. Florida has recently allowed two E-85 pumps to be operated in the state and will likely have E-10 expansion throughout the state in the near future. Hawaii, Iowa, Louisiana, Missouri, Montana, Oregon, and Washington have all followed Minnesota's move to set renewable fuels standards or ethanol mandates. California will allow blend-

ers to move from 5.7 percent blends to E-10 blends on January 1, 2010.

While most of the economic and political incentives are pointed toward increases in ethanol blending, other policy changes may come down the line in terms of government support. As part of the farm bill debate in Congress, the Senate Finance Committee has approved the "Heartland, Habitat, Harvest, and Horticulture Act of 2007." The bill provides funding and budget offsets for several agricultural programs. One of the provisions of the bill is a 5¢ reduction, to 46¢ per gallon, in the ethanol blender's tax credit once U.S. ethanol production exceeds 7.5 billion gallons per year. However, with ethanol being priced below gasoline, the incentives are still there to blend ethanol, even with the possible reduction in government support. ◆

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### Policy Choices

If, as seems likely, we are entering a future where policy incentives will be skewed toward rewarding production activities that reduce greenhouse gas emissions, then it is important for the U.S. biofuels industry to take steps to ensure that they are providing low-carbon fuels. The key factors determining carbon emissions for corn-based ethanol are (1) whether coal or natural gas is used to power the ethanol plant, (2) whether distillers grains are dried or

sold wet, and (3) whether expansion of corn acreage comes mainly from reduced acreage of lower-value crops or if idled land is brought into production.

The first of these factors is largely under the control of ethanol plant owners. Not drying distillers grains is feasible only if large beef feedlots or dairies are located near the ethanol plants. State and local policies that encourage strategic siting of cattle operations can greatly enhance ethanol's low-carbon credentials. The last factor is beyond the control of industry. Conversion rates

of idled U.S. cropland can be reduced by increasing domestic conservation incentives, such as CRP rental rates. But this policy decision creates a dilemma: if U.S. land is kept idle through higher conservation payments, there will be a larger impact on crop prices and a greater incentive for farmers in other countries to expand production. If this overseas production were to involve conversion of substantial amounts of idle land that would otherwise never be brought into production, then U.S. corn ethanol likely would not be able to lay claim to the title of low-carbon fuel. ◆

# Exchange Rates and Agricultural Commodity Prices

Recent increases in retail food prices have consumer groups looking for culprits. One contributor is the cost of raw agricultural commodities. Figure 1 shows a time series of nominal price indexes (1997 = 100) for corn, soybeans, hogs, cattle, and milk dating back to 1996. As shown, the prices of all commodities except hogs are currently up about 40 percent with almost all of the growth occurring in the last year. A variety of reasons have been offered for this increase, including increased ethanol production, income-led increases in food demand in Asia, supply disruptions in Europe and Australia, and a weak dollar.

There are two separate mechanisms by which a weak dollar leads to higher U.S. prices. First, when the currencies of buyers of U.S. exports appreciate relative to the dollar, then buyers find that the price they have to pay for U.S. goods has fallen when prices are expressed in their now stronger domestic currencies. Lower foreign-denominated prices boost demand for U.S. products and result in higher dollar-denominated prices. This is the usual explanation for why U.S. prices rise with a weak dollar.

But, there is an additional mechanism that comes into play that involves the value of the dollar relative to the currencies of U.S competitors in export markets. If the currency of a major export competitor strengthens relative to the dollar, then the demand for U.S. exports rises even if the currency of the buyer does not change relative to the dollar.

To measure the influence of the dollar's value on commodity prices requires a measurement of the
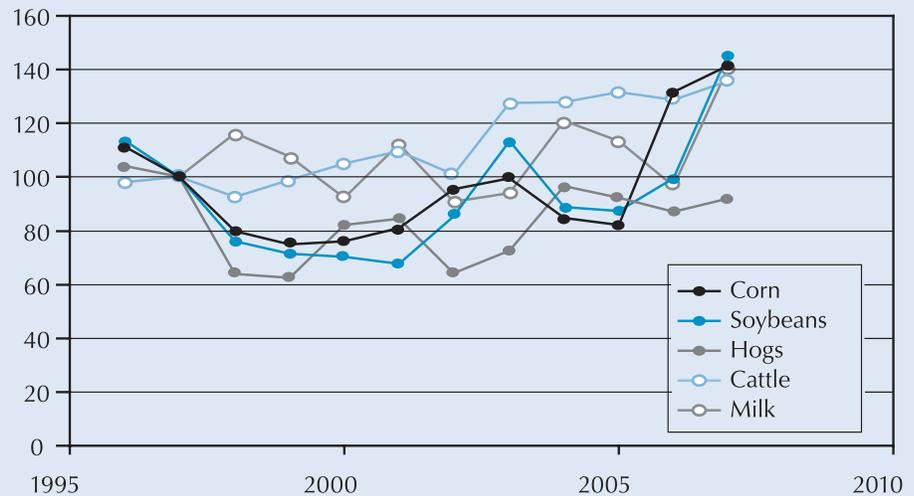


**Figure 1. Nominal price indexes of selected commodities (1997=100)**
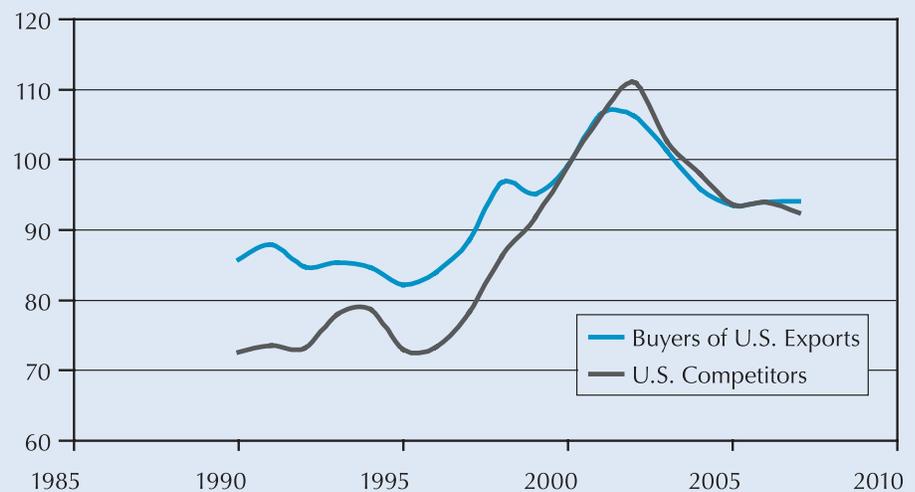


*Source:* USDA-ERS

**Figure 2. Currency indexes (inflation adjusted) of U.S. dollar value against that of competitors and buyers of U.S. exports**

value of the dollar relative to the currencies of both buyers of U.S. exports and competitors. Figure 2 presents inflation-adjusted currency indexes compiled by USDA's Economic Research Service. From its peak value in 2001 and 2002, the dollar value has fallen substantially.

But most of the decrease happened before the run-up in agricultural commodity prices. Either there is a long lag in the response of U.S. prices to a change in the value of the dollar or recent commodity price increases are caused primarily by other factors. ◆

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