ETHANOL INDUSTRY – IMPACT ON CORN AND DGS PRODUCTION

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Introduction

Ethanol has been the buzzword in the U.S. in the last several years. The interest in ethanol has been driven by a number of factors. An important oxygenate for gasoline, methyl tert-butyl ether (MTBE), has been phased out the last couple of years due to concerns of contaminating groundwater. This phaseout has increased the demand for a substitute oxygenate, ethanol. Several states, for various political and environmental reasons, have mandated minimum ethanol inclusion levels in their gasoline, which has further increased the demand for ethanol. Government subsidies at the federal, state, and local levels also have encouraged ethanol production. Finally, high energy prices (e.g., crude oil) have increased the value of ethanol which can be used as a substitute for gasoline. Thus, there have been numerous drivers for expansion of the ethanol industry in recent years, some which have increased demand and others that have encouraged increased supply.

As a result of these factors, ethanol production has increased significantly in the U.S. over the last 20 plus years, with the majority of the increase coming in the last five years (figure 1). Annual ethanol production exceeded one billion gallons for the first time in 1993, then dipped back below a billion gallons in 1996. Current forecasts are for ethanol production to reach about 6.5 billion gallons in 2007, indicating over a six-fold increase in roughly 10 years.[1] The annualized growth rate in ethanol production from 1980 to 2007 is 14.0%, however, production has increased at an annual rate of 24.8% over the last four years (2003 to 2007) and 2007 production is forecasted to be 33.5% above 2006 production. Because ethanol is currently produced principally from corn, these large and rapid increases have huge impacts on the agriculture industry. Corn represents a cash crop to grain farmers and an input expense to livestock producers; thus, corn price directly impacts each of these two large segments of agriculture, but in different ways. The objective of this paper is to determine the implication future ethanol production might have on corn acreage and distillers grain with solubles (DGS) production. More specifically, the corn acres necessary to achieve projected ethanol production levels is examined providing evidence of probable corn price impacts.

Ethanol Production

A bushel of corn produces 2.8 gallons of ethanol and 17-18 pounds of dried distillers by-products. Distillers by-products are a higher protein feed than corn that can be fed either wet or dry. Feeding DGS wet as opposed to dry has the advantage of saving drying costs, but it has some disadvantages as well including shorter shelf life, handling issues, and higher transportation costs. This paper does not consider the wet versus dry issue, but rather assumes 18 pounds of dried distillers are produced per bushel of corn used in ethanol production. While the 2.8 gallons of ethanol per bushel of corn is commonly accepted, historical data from the Energy Information Administration (EIA) on ethanol production and from the National Corn

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[1] At the time of this writing, actual production data through September 2007 were available, October through December were forecasted.

Growers Association (NCGA) on corn used for ethanol suggest that the conversion factor has been lower than 2.8 (Renewable Fuels Association, 2007). For this analysis it was assumed that the conversion rate was 2.75 in 2007 and increases linearly to 2.90 by 2020 as ethanol production technology improves.

Not surprisingly, the majority of U.S. ethanol plants are located in the Midwest where most of the corn is produced (figure 2). As of December 2007, there were 135 ethanol plants operating in the U.S., with a capacity of approximately 7.42 billion gallons per year (bgy). However, there are another 74 plants under construction that would add an estimated 6.06 bgy of capacity when they come on line, giving a total capacity of 13.47 bgy (Renewable Fuels Association, 2007b).

Ethanol Profitability

Figure 3 shows the margin between ethanol price and corn price as a proxy for ethanol profitability. Figure 4 shows the stock prices for several publicly-traded ethanol companies as another proxy for ethanol profitability. Both of these figures reveal similar information. That is, ethanol production was highly profitable in the summer of 2006, but profitability has decreased significantly since that time. Figure 5 reveals why profitability changed so drastically from the summer of 2006 to the fall of 2007. Ethanol prices (output being sold) dropped from over $3.50/gallon to around $2.25/gallon at the same time corn prices (input being purchased) increased over $1/bushel. Figure 5 basically reveals what can happen in a rapidly expanding industry that goes from shortages to surplus production. The key points revealed in figures 3-5 are that the current economic conditions in the ethanol industry are such that rapid expansion going forward is unlikely. Furthermore, current media reports suggest that planned expansion has dampened the last few months.

Given the current economic conditions, policies, and plant capacity, what does the future hold for ethanol production? Although forecasts for future production levels vary, many of the forecasts suggest something in the order of 12 bgy within the next five years. The Energy Bill passed by the U.S. House in December 2007 called for 15 bgy by 2015. While it is difficult to predict what policy makers will do, for several reasons it is likely that such levels of production will be supported by whatever bill is passed. First, 13-15 bgy is consistent with E-10 nationwide (i.e., 10% of all U.S. gasoline consumption) and most consumers would likely accept that as it does not require any change in the cars they are driving. Second, this level basically represents current and planned expansion and would not require a lot of "new" expansion. Thus, the analysis going forward will be based on the assumption of producing nine billion gallons in 2008 (USDA forecast) and then increasing production to 15 bgy by 2015 (figure 6). The "7.5 bgy 2012" values in figure 6 reflect ethanol production levels mandated in the Renewable Fuels Standard passed in 2005. These levels will easily be surpassed and thus are not particularly relevant as this industry moves forward.

Corn Use

Figure 7 shows the different uses of corn in the U.S. going back to the 1990-91 crop year. Over the last five years most uses have been relatively constant with the exception of corn used for ethanol, which has been increasing. As ethanol production increases, corn used for feed likely will decrease as more DGS are included in livestock rations. Information in figure 7 was predicted through the year 2017 based on the following assumptions: corn used for ethanol is based on ethanol production levels depicted in figure 6; exports start at the 5-year historical average and increase 73 million bushels per year (consistent with trend over last 5-10 years); food, seed, and industry (FSI) use excluding ethanol is fixed at its 5-year average; feed and residual use is fixed at its 5-year average, but allowing for DGS to be substituted for corn up to 35% of total corn. Based on these assumptions, figure 8 shows projected U.S. corn use through 2017. Corn used for ethanol production increases to approximately six billion bushels by 2017 and total corn use exceeds 14 billion bushels by 2015. As a point of reference, the largest corn crop ever produced in the U.S. was 13.167 billion bushels in 2007, with 93.6 million acres planted (15% increase in acres from 2006). Information in figure 8 indicates a need for over 13 billion bushels every year from 2011 forward.

Corn Acres

The ability to produce in excess of 13 billion bushels of corn depends on both acres planted to corn and corn yield. Corn yield has increased steadily in the U.S. since about 1940. Though most people recognize that corn yields generally increase over time due to technological improvements, the rate of improvement is less clear. Figure 9 shows historical yields in the U.S., with linear trends for three time periods (1938 to 2007, 1978-2007, and 1993-2007). The 70- and 30-year trends are virtually identical, whereas, the shorter 15-year trend suggests future yields will be much higher. Figure 10 shows the corn planted acres required to meet usage values reported in figure 8 (harvested-to-planted ratio based on historical levels). Based on this analysis, the U.S. does not need to plant as many acres in the next several years as were planted in 2007. However, it does need to plant considerably more acres than the 80 million acres or so that has been planted in the past. This figure also reveals how critical yield is to acres needed. The 93-07 trend (most optimistic yield trend) results in the need for only 83 to 85 million acres over the next seven years. However, if the longer-term trend is more appropriate, we will need to consistently plant over 88 million acres to corn annually within the next several years and that value will increase as ethanol production increases. That is, with high yield trends (i.e., 93-07 trend), the increased demand for corn due to ethanol production essentially can be met merely through higher yields, but that is not the case if future yields are consistent with longer-term trends. In this case, acreage needs to increase each year along with the improved yields to meet corn usage forecasts. The average trend simply reflects an average of the long- and short-term trends and thus acres needed falls in between the other two levels. As a point of reference, the expected yield in 2017 using the average trend yield is 175.0 bushels/acre, which compares to 153.0 in 2007 (second highest yield ever). When looking at the acres needed, it is important to recognize that these are all based on trend yields. If (when?) we experience a short crop, the market will have a significant bidding war for limited bushels.

Crop Prices

Some crop producers have suggested that the recent run up in corn prices will be short lived and that “we’ll be right back where we were before too long just like every other time.” Recognize that the current increase in prices is coming on the heals of some of the largest U.S. corn crops ever observed (2007 is largest corn crop ever and 2006 was the fourth largest). In other words, the current high prices are the result of a strong demand and not a supply shock as often was the case with past price spikes. This implies that if the information displayed in figures 8-10 is correct, we will continue to have a strong demand and the market will need to “buy corn acres” by offering higher prices than long-term averages. Figures 11-13 show futures prices for corn, wheat, and soybeans, respectively, from 1982-2010 (prices for 2008, 2009, and 2010 contracts are based on futures closing prices on 11/30/2007; all other years are actual averages). These figures reveal several important things. First, ethanol does not impact only corn prices. That is, increased ethanol production impacts the prices of all crops (including hay). Second, prices are significantly above long-term averages for as far out as they are being traded. This indicates that these higher prices are likely here to stay for a while.

Distillers Grains

From a livestock producer's perspective, increased ethanol production means feed prices, specifically corn, will increase. Helping to offset this somewhat is the fact that 18 pounds of DGS feed remain for every bushel of corn (56 pounds) that is used for ethanol. However, DGS cannot be fed to all livestock species with the same ease. Beef and dairy animals (ruminants) generally can be fed higher inclusion levels of DGS than can swine or poultry. Also, the ability to feed wet DGS will vary by species and operation type. For example, a large beef feedlot likely can feed wet DGS easier than a cow-calf producer. Dhuyvetter, Kastens, and Boland estimated the potential pounds of dried distillers grains (DDGS) that could be fed by species type on a daily and annual basis (Table 1).

Table 1. Potential dry distillers grains (DDGS) consumption per head, by livestock class[1]

Livestock class	Daily intake of DDGS (lbs/day as fed)[2]	Days fed/year[3]	Lbs of DDGS per animal per year[4]
Beef cows	7.22	90	650.0
Dairy cows	4.17	365	1520.8
Other cattle[5]	2.78	135	375.0
Cattle on feed	5.56	365	2027.8
Breeding swine	1.21	310	374.0
Market swine[6]	0.47	365	171.6
Breeding sheep	0.50	90	45.1
Lambs	0.38	90	34.1
Broilers	0.0207	56	1.1574
Layers	0.0325	365	11.8740
Pullets	0.0099	365	3.6261
Turkeys	0.0421	151	6.3539

[1] Intake values based on DDGS being 90% dry matter (i.e., "as fed" basis).

[2] Daily intake values calculated based on information from Johnson; Noll; and Tokach

[3] Feeding distillers grains to animals during certain periods of the year or for the entire life cycle of the animal is considered highly improbable. Hence, days are not universally 365. For example, feeding distillers grains to beef cows during the pasture season is unlikely.

[4] Values for lambs, broilers, and turkeys represent lbs of DDGS per head over life of animal

[5] Other cattle includes calves and feeder cattle (i.e., cattle that are not cows or cattle on feed)

[6] Market swine include only hogs 60 pounds and above

Combining annual DDGS consumption potential with 2000-2004 national average livestock inventories, Dhuyvetter, Kastens, and Boland estimated a potential total demand for DDGS of about 52 million tons. Calculated in this manner, 52 million tons represents an upper limit as it assumes every animal in the U.S. is consuming the maximum amount possible (based on current nutritionists' recommendations). Figure 14 shows the estimated production of distillers grains given the ethanol production values reported in figure 8. By the year 2016 there would be slightly over 50 million tons available. Given that every animal, of every species, in the country likely will not be consuming at the levels reported in table 1, several things will need to occur given this level of DGS production. The DGS could be exported to other countries, feeding levels could be increased, and/or other uses will need to be identified. Likely it will be a combination of all three of these factors when the time comes. However, prices will have to fall to encourage other uses (i.e., to increase the quantity demanded) to clear the market of this increased supply. That is, if the supply of DGS increases faster than demand, prices will fall.

Figure 15 shows weekly DDGS prices at various locations across the U.S. (Feedstuffs). As would be expected, prices vary both temporally and spatially. Of the locations considered, prices are lowest in Chicago and Minneapolis, which are the two locations closest to the Corn Belt and where the majority of ethanol plants are located. Table 2 reports the summary statistics of the different price series depicted in figure 15. Spatial price differences are large ($30 to $50 per ton), but there also has been considerable variability across time at all locations. The difference between minimum and maximum varies from to $70 to $98 per ton across locations and standard deviations are similar. This suggests that, regardless of location, considerable variability in DDGS prices exists over time. This price risk over time is what many producers are interested in managing. Thus, a logical question is, How well do DDGS prices follow corn prices and can they be effectively hedged using the corn futures market?

Table 2. Summary Statistics of DDGS Prices by Location

		Price, $/ton			
Location	N*	Average	Minimum	Maximum	Std Dev
Atlanta	361	131.16	100.00	188.00	19.25
Chicago	361	97.36	70.00	140.00	17.45
Los Angeles	361	126.97	106.00	187.00	17.99
Minneapolis	361	87.21	60.00	135.00	18.06
Okeechobee	361	130.38	90.00	188.00	18.45
Portland	361	136.12	112.50	189.00	17.74

* Number of observations, weekly data Jan 2001 through Nov 2007.

The relationship between the nearby corn futures price ($/bushel) and the Portland DDGS price ($/ton) is shown in figure 16. The two price series are positively correlated (r = 0.75) implying that as corn prices rise DDGS prices also increase. This positive relationship suggests the possibility of hedging DDGS prices with the corn futures market. However, at any given corn price on the x-axis it can be seen that there is typically about a $40/ton variation in prices, suggesting that the basis risk associated with a cross hedge would be quite high. Given that the purchaser of DGS is only concerned about basis moves one direction (i.e., prices being higher than expected), this implies the relevant basis risk is about +$20/ton. In other words, while hedging the purchase price of DDGS by going long corn futures (i.e., buy corn futures contracts) can help manage price risk, basis risk is quite high, reducing the effectiveness of the hedge.

Take Home Message

Predicting future ethanol production levels is difficult and often seems like hitting a moving target. However, achieving production levels around 13 to 15 billion gallons per year within the next 5-7 years seems reasonable given current information. Given this level of production, we will need to consistently plant 86-90 million acres of corn, which is considerably lower than the 93.6 million planted in 2007, but considerably higher than what was planted from 2002-2006 (79.6 million). This is based on national average yields increasing faster than a 30-year trend, but slower than what the most recent 15 years might suggest. This increased level of ethanol production will continue to support corn and other crop prices at levels significantly higher than long-term historical averages. In addition to higher crop prices, it is likely that we will see increased variability in those prices as the market adjusts to increased corn needs. Livestock producers that are in a position to feed distillers by-products may be able to offset some of the impact of increased corn prices. The benefit of feeding such by-products will vary considerably by animal species and location; so, not all livestock producers will be able take advantage of opportunities to feed distillers that might exist. Furthermore, the price of distillers products are positively correlated with corn prices so input price risk will remain a concern. While the relationship between corn and distillers prices is positive, the ability to effectively hedge distillers prices is limited due to considerable basis risk.

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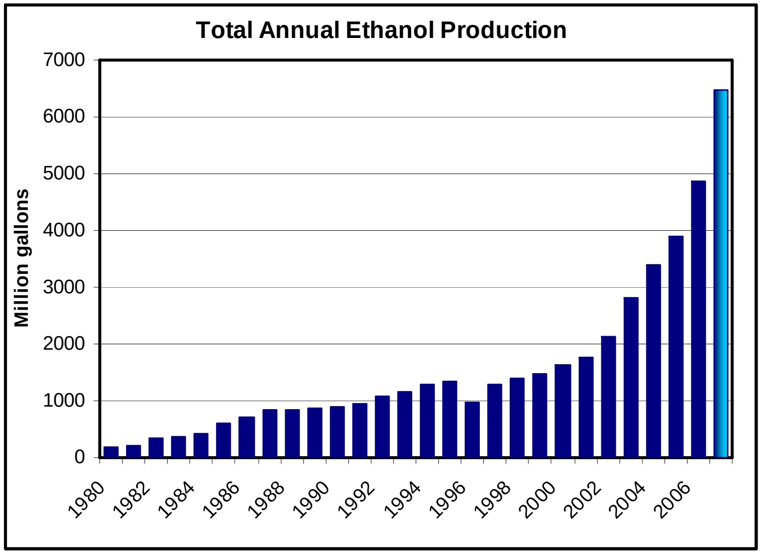

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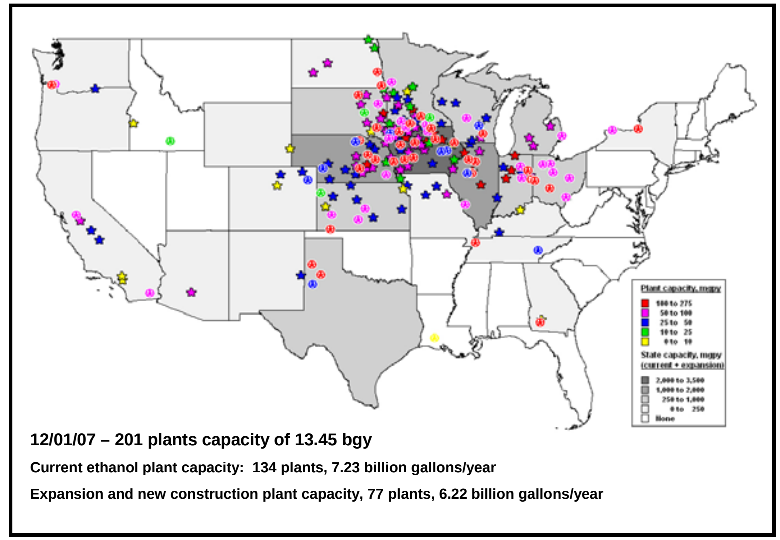

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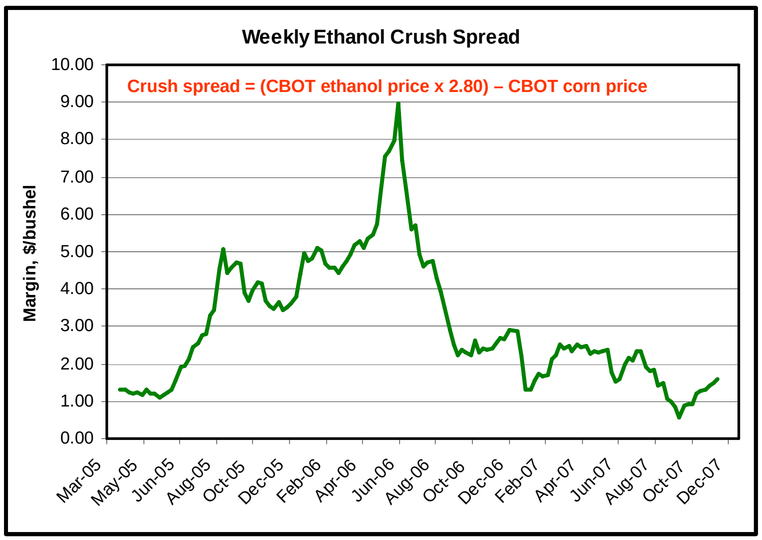

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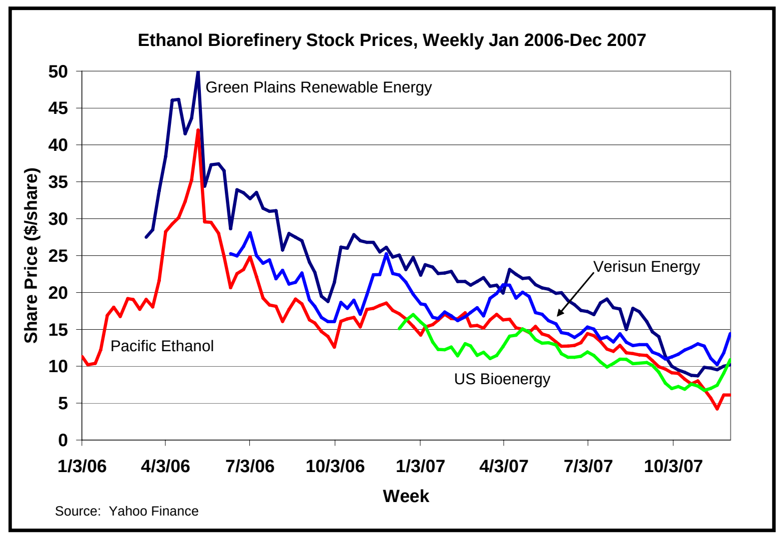

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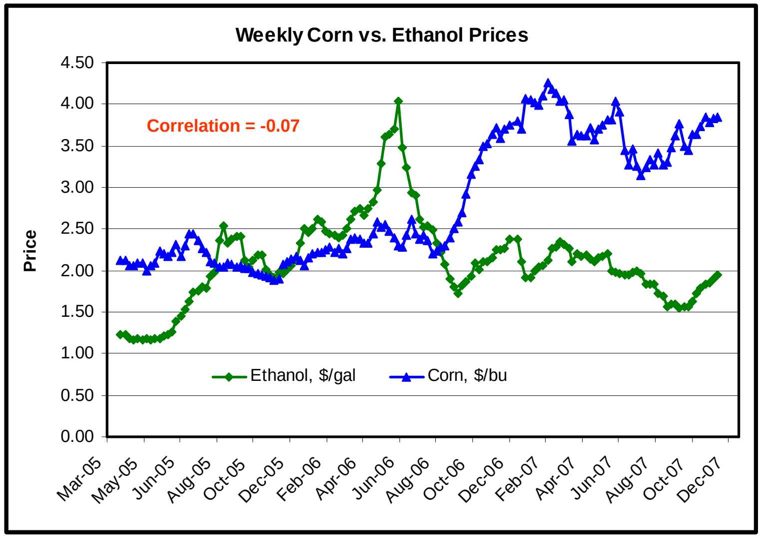

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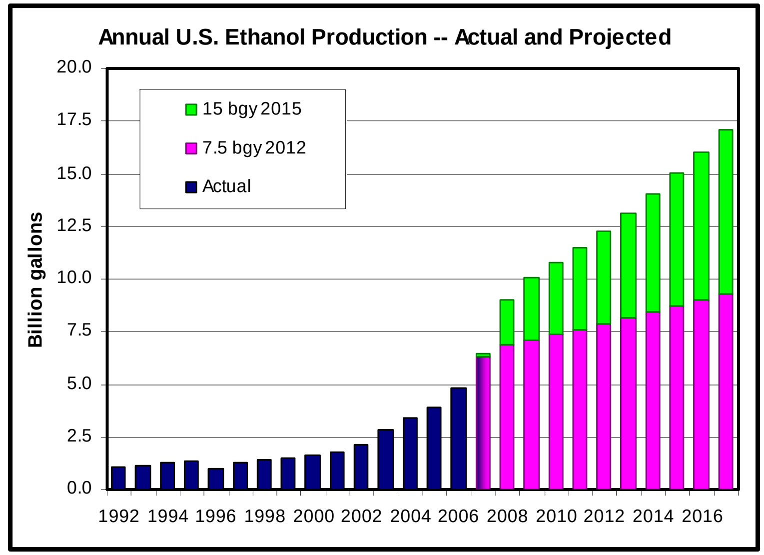

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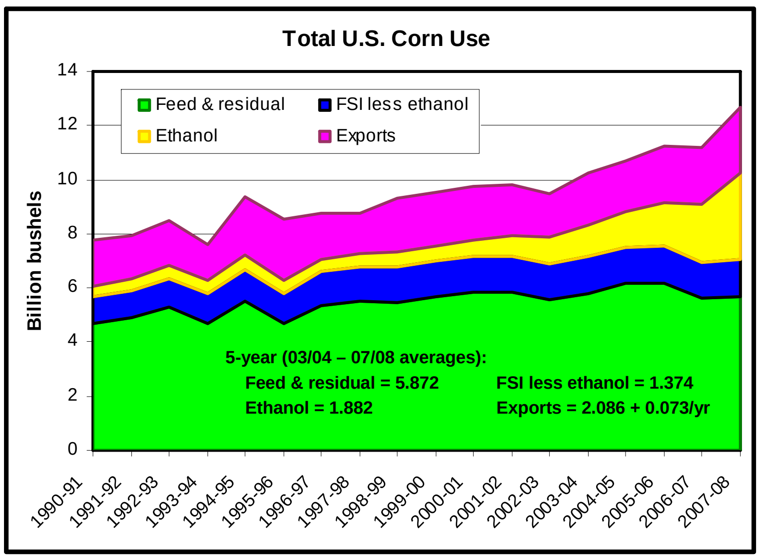

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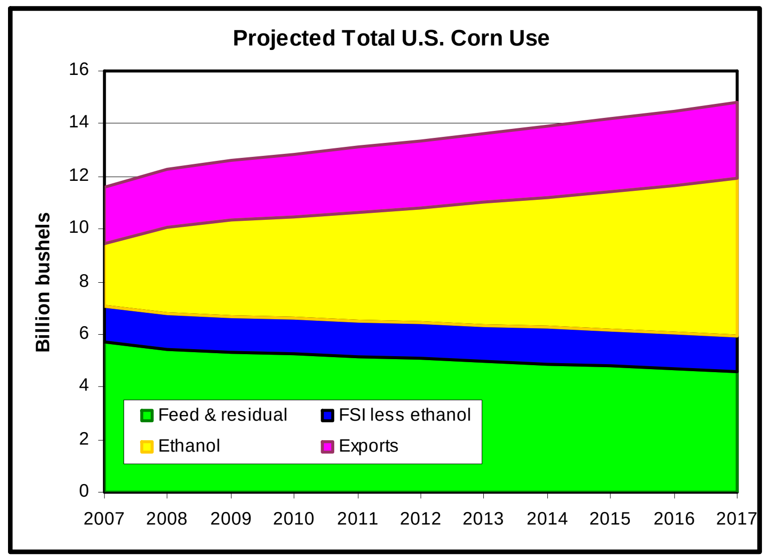

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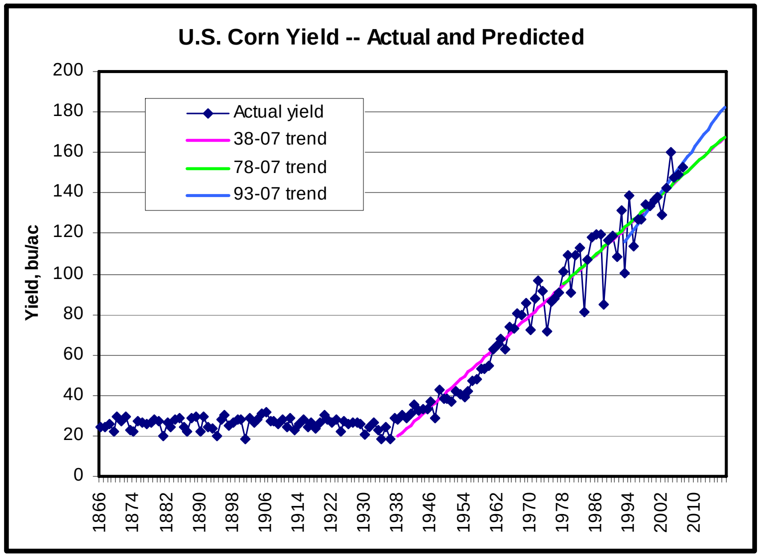

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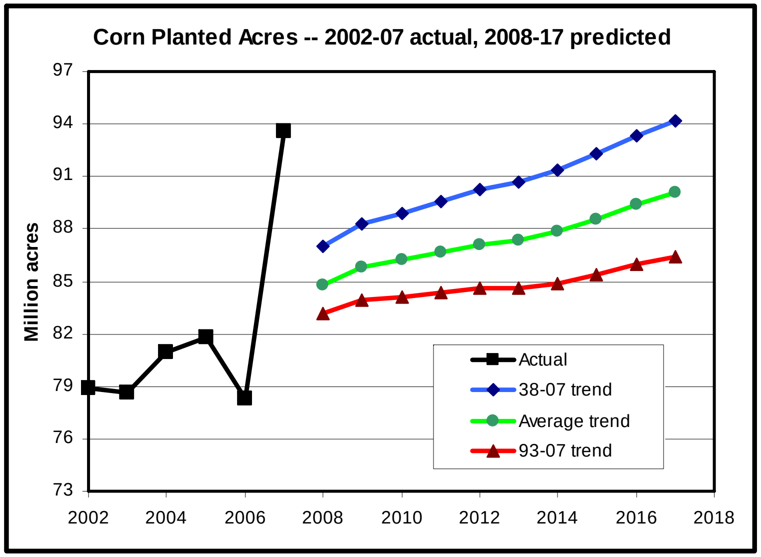

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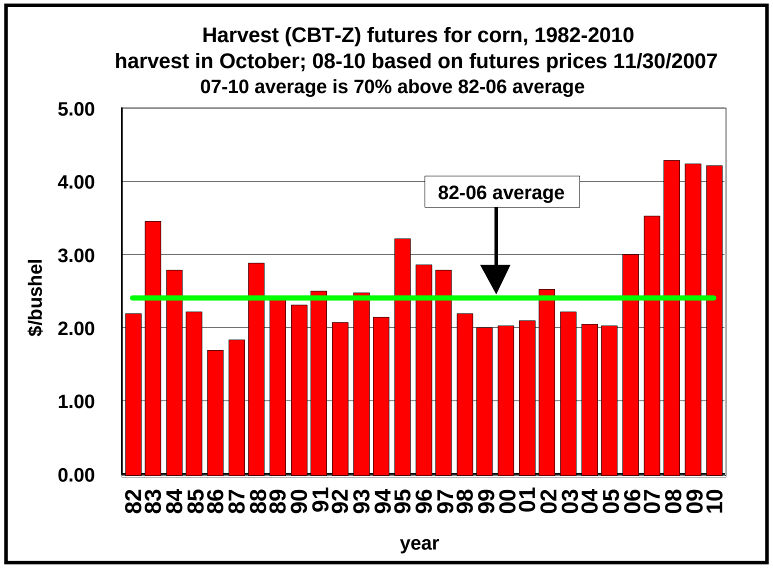

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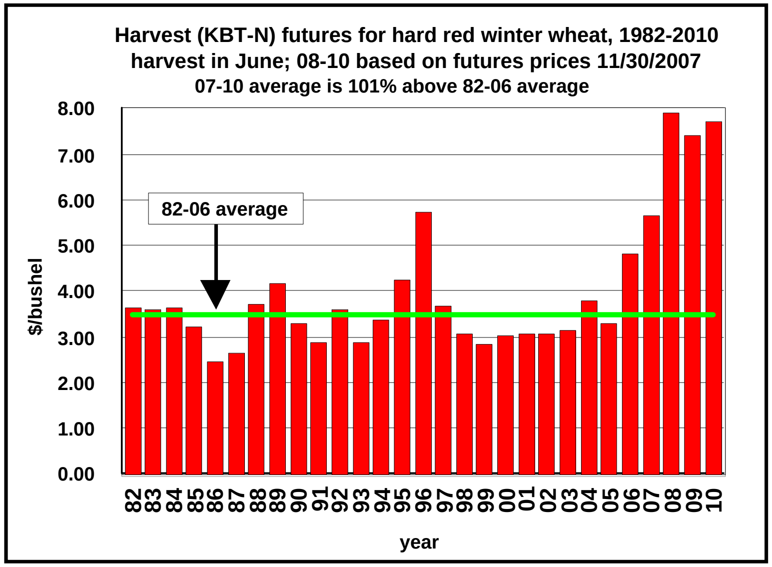

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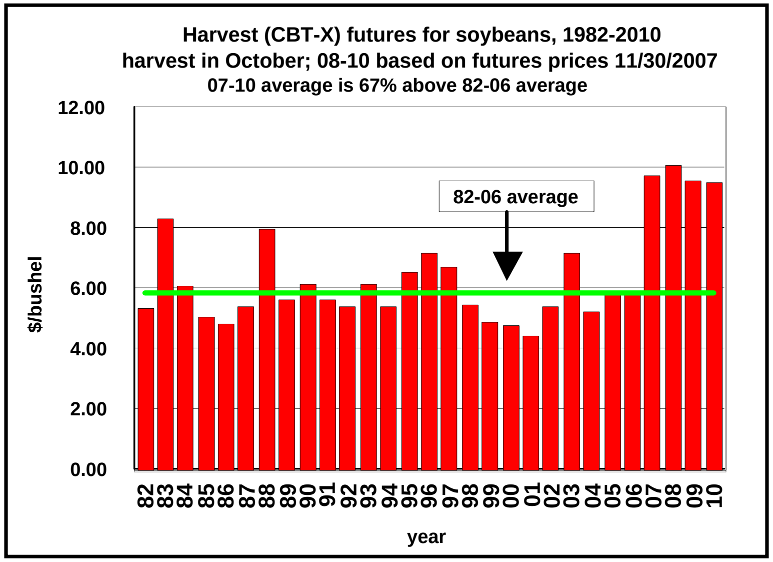

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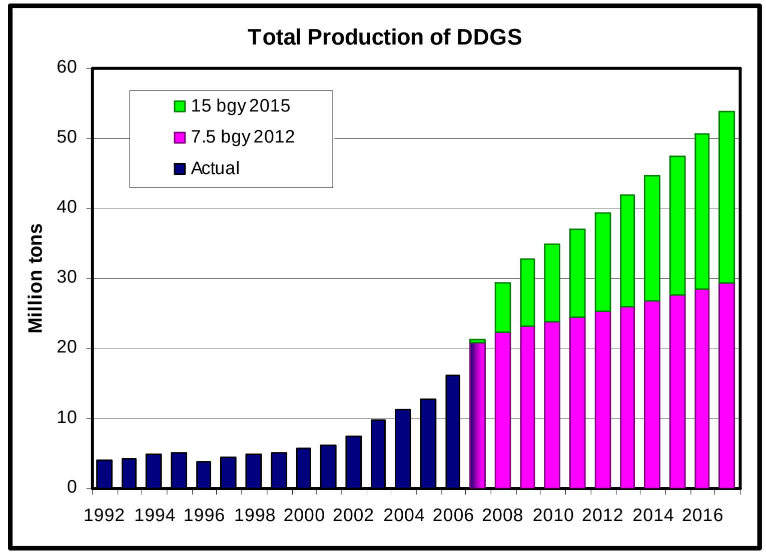

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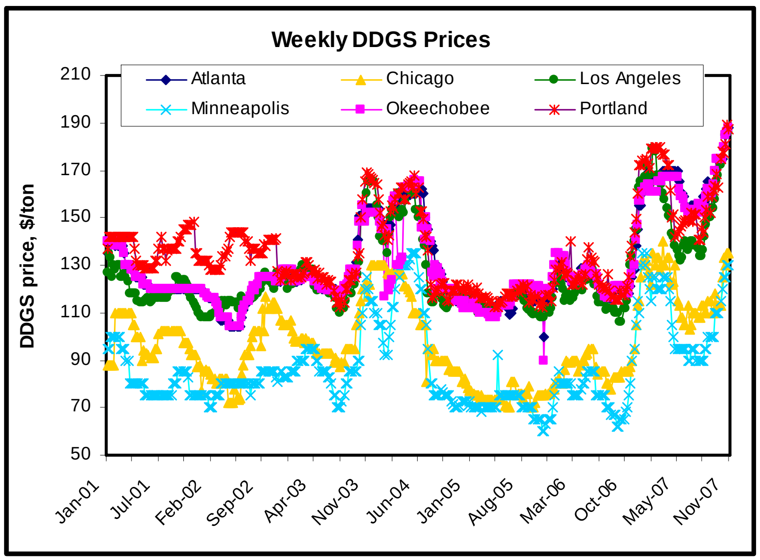

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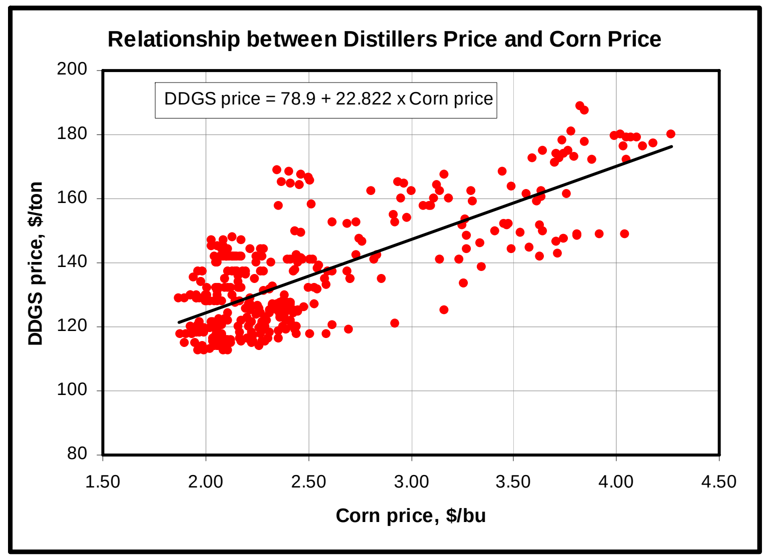

Figure 16.