Chapter 2
Ethanol Economics at the Sector Level

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The U.S. corn crop is used in a variety of ways. Traditionally, these uses have been classified as: 1) feed for domestic livestock production, 2) input for a variety of food and industrial products produced domestically, and 3) exports, primarily for livestock feed. Domestic feed use has been and is currently the largest market for U.S. corn, with exports traditionally being the second largest market. With the recent growth in ethanol use of corn, however, domestic food and industrial use has eclipsed exports, with the amount of corn used for ethanol production now exceeding annual exports.

As of October 30, 2007, the Renewable Fuels Association (RFA) estimated that 131 plants were currently producing ethanol and that the capacity of those plants was 7.02 billion gallons annually (http://www.ethanolrfa.org/industry/locations/). Assuming that corn is the primary feedstock for those plants and that the average yield is 2.8 gallons of ethanol per bushel of corn, those plants could use a total of 2.51 billion bushels of corn per year. In addition to the existing capacity, RFA indicated that 72 new plants were under construction and 10 existing plants were adding capability. The total new capacity when completed would add an estimated 6.49 billion gallons of ethanol production capacity. Under the same assumptions as above, the new capacity could use an additional 2.32 billion bushels of corn annually, bringing total use of corn for ethanol to 4.83 billion bushels per year by 2008-09. Additional new construction is likely so that a requirement of 5 billion bushels of corn per year is expected in the near future, resulting in production of 14 billion gallons of ethanol per year.

The potential for growth in corn based ethanol production beyond 14 billion gallons depends on the economic and political incentives to add new capacity. These incentives are mostly in the form of the price of ethanol, the subsidy received for blending ethanol, the price of distillers dried grains (a co-product of ethanol production), the price of corn, and the cost of building and operating ethanol plants. Fluctuations in operating costs are mostly influenced by the cost of the energy source for the plant, natural gas in most cases.

Price of Ethanol

As detailed in the subsequent two chapters, the profitability of operating an ethanol plant is most sensitive to the price of ethanol and the price of corn. For example, with ethanol priced at $2.25 per gallon at the plant, a 10 percent change in the price of ethanol, all else equal, changes the operating margin by $.63 per bushel of corn processed ($.225 times 2.8 gallons). In contrast, with corn prices at the plant at $3.75 per bushel, a 10 percent change in the price of corn alters the operating margin by $.375 per bushel. With distillers dried grains (10 percent moisture) priced at $130 per ton, a 10 percent change in price alters the operating margin by $.115 per bushel (assuming a yield of 17.75 pounds per bushel). Finally, with natural gas prices at $7.00 per

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10,000 mm Btu's, a 10 percent change in price alters the operating margin by $.07 per bushel.

The price of ethanol will continue to be influenced by an array of factors, but fundamentally, it is driven by the price of unleaded gasoline. The price of unleaded gasoline will be influenced mostly by the price of crude oil, as exemplified in Table 1.

Table 1. Example of Relationship Between Oil and Gasoline Prices.

Crude Oil Price $/barrel	Wholesale Unleaded Gasoline Price $/gallon
40	1.38
50	1.73
60	2.07
70	2.42
80	2.76

Source: CARD Briefing Paper 06-BP49, November 2006.

The price of ethanol relative to the price of unleaded gasoline will be influenced primarily by the demand for ethanol and the level of subsidies for ethanol. Ethanol demand has been influenced by the level of production mandates, the market determined value of ethanol as an oxygenate and octane enhancer, and the fuel efficiency of ethanol relative to unleaded gasoline. At the current pace of production, ethanol output will exceed mandated levels in 2007. In addition, ethanol production is expected to be sufficiently large by the end of 2007 to completely replace MTBE's to meet mandatory oxygenate requirements.

Quoted prices for ethanol and unleaded gasoline rack prices per gallon in terms of FOB, Omaha, Nebraska, from January 1982 through August 2007 indicate that ethanol prices were consistently higher than unleaded gasoline prices ((http://www.neo.ne.gov/statshtml/66.html). For the calendar year 2006, the premium averaged $.64 per gallon, even though ethanol contains only 67 percent of the btu's of unleaded gasoline. Part of the premium can be attributed to the $.51 per gallon blender tax credit and the remainder can be attributed to the demand for ethanol to meet mandates and as an oxygenate and an octane enhancer. An estimate of the price impact of those factors can be made. In 2006, the price of unleaded gasoline in the price series citied above was $1.94 per gallon. If ethanol has 67 percent of the btu's of unleaded gasoline, the equivalent fuel value of ethanol with unleaded gasoline priced at $1.94 per gallon would be $1.30 per gallon. Adding the $.51 per gallon blender tax credit would bring the value to $1.81 per gallon. The average price was actually $2.58 per gallon. The difference of $.77 per gallon can be attributed to the effects of mandated production and use and the market value of ethanol as an oxygenate and octane enhancer. It is not possible to estimate the premium resulting from the three components individually. However, a significant portion of the premium could erode as mandates are exceeded and MTBE's are completely replaced. Once those goals are accomplished, ethanol prices would presumably have to be competitive with unleaded gasoline prices based on fuel efficiency and environmental qualities. In fact, premiums declined sharply during the summer of 2007 as ethanol production increased. The premium of the ethanol rack price was only $.10 per gallon at Omaha, Nebraska in August 2007 and was at a $.45 discount in October 2007.

As the premium declines, the operating margin of ethanol plants declines accordingly. A decline of $.50 in that premium, for example, would reduce the operating margin of a typical plant by about $1.40 per bushel of corn processed, assuming all other factors unchanged. Under this scenario, the rate of expansion of corn-based ethanol production, or ethanol production from any feedstock, would presumably decline sharply. The following example illustrates the impact of declining ethanol premiums of alternative magnitudes on the operating margin of a typical dry mill ethanol plant, assuming no changes in other factors:

Table 2. Iowa Ethanol Corn and Co-Products Processing Values

	Unit	Actual March 16, 2007 [1]	Reduced Ethanol Premium		
			25 cents	50 cents	75 cents
Ethanol	$/gal	2.25	2.00	1.75	1.50
Ethanol yield (assumed)	gal/bu	2.80	2.80	2.80	2.80
Ethanol Value	$/bu	6.30	5.60	4.90	4.20
DDGS	$/ton	130.00	130.00	130.00	130.00
DDGS Yield (assumed)	lbs/bu	17.75	17.75	17.75	17.75
DDGS Value	$	1.15	1.15	1.15	1.15
Product Value	$/bu	7.45	6.75	6.05	5.35
No. 2 Yellow Corn	$/bu	3.63	3.63	3.63	3.63
Apparent Gross Margin	$/bu	3.82	3.12	2.42	1.72
Operating Cost	$/bu	1.70	1.70	1.70	1.70
Apparent Net Margin	$/bu	2.12	1.42	.72	.02

[1]Source: USDA Market News, Des Moines, Iowa. www.ams.usda.gov/mnreports/nw_gr212.txt
[2]With the premium of ethanol price over unleaded gasoline price reduced by $.25, $.50, and $.75 per gallon.

This example illustrates that if ethanol prices reflected only the equivalent fuel value of unleaded gasoline (plus the effects of subsidy), operating margins would be near zero under conditions that existed on March 16, 2007.

Ethanol and Corn Prices

One way of considering the effect of ethanol demand on corn price is to translate the value of ethanol into a break-even value of corn, as is done later in Chapters 3 and 4. The illustrations in Table 2, for example, suggest that if ethanol can be sold by the manufacturer at $1.50 per gallon, then the manufacturer can pay up to $3.65 per bushel of corn and still break even.

But why is this back-door valuation of ethanol to corn any more meaningful or relevant than, say, hogs to corn or fructose to corn The answer is threefold. First, under recent economic conditions, the value of corn to ethanol manufacturers is much greater than the value of corn to livestock producers or to most other users of corn. However, being the highest-valued user is, by itself, not necessarily meaningful. For example, the implied break even value of corn to pharmaceutical manufacturers, bird-seed suppliers, and many other small users can be many times the value of that implied by more common uses. Yet these users have no perceptible effect on the price of corn because they are such a small part of corn demand.

Thus the second reason that the ethanol to corn valuation is meaningful stems from the magnitude of both current and potential use. The use of corn for ethanol has become a significant part of current U.S. corn demand, representing approximately 20% of the 2006 U.S. crop.

Finally, the importance of the break-even corn price for ethanol is in large part due to the size of the final product (energy) market. After political mandates involving oxygenates and renewable energy are met, ethanol is used as a substitute for gasoline. However, because ethanol represents such a small part of the world's gasoline market, its production has little effect on gasoline price, meaning that large relative increases in ethanol production does not cause the gasoline price to fall significantly. Contrast this, for example, with the use of corn for hog production. As hog production expands or contracts in response to corn prices, the price of hogs is affected. Large relative changes in the production of hogs lead to a change in hog price. However, because of the size of the world oil market, it is presumed that large relative changes in the production of ethanol have only small effects on gasoline price.

In sum, the break-even corn price is particularly meaningful in the case of ethanol because (1) it is considerably higher than traditional corn prices, (2) a relatively large amount of corn production is used for ethanol, and (3) the amount of ethanol produced has very little effect on gasoline price.

But what does this break-even price imply about the potential or future use of corn for ethanol? The answer to this long-run question depends fundamentally on the incentives for ethanol manufactures to enter and exit the industry. Recent, large profits have induced entry of processing plants into the ethanol market at a rapid pace, and the gold rush continues under recent economic and policy conditions.

But where are we headed? Or, what brings us to some sort of equilibrium, causing ethanol manufacturers to expect a normal profit instead of the excessive profit that existed during 2006? Under current technology, the answer is surprisingly simple; that is, a drop in ethanol price and/or an increase in corn price. What and how this happens, however, is not simple.

To understand the how corn price might be determined, consider the scenario where the expected long-run ethanol price makes corn worth $3.50 per bushel to the ethanol manufacturer. If the long-run price of corn is less than $3.50 then the resulting excess profits will cause ethanol-production capacity to increase. If the long-run price of corn is more than $3.50, production capacity will fall.

As the market moves towards a new equilibrium under this high-price scenario, the higher long-run price will cause an increase in the production of corn (quantity supplied response) by increasing the amount of land used for corn production relative to other crops, primarily soybeans.

It is important to recognize that the market is not just seeking the new price for corn, but also the new price relationship between corn and other crops, particularly between corn and soybeans. In other words, the market is trying to find the new price level as well as the new price relative. To illustrate this point, consider the situation during March 2007. At that time, the market was trying to attract an additional 10 million acres (or so) of corn production over the previous year. Given this goal, should the expected price of a bushel of corn that could be received at harvest (the new-crop price) be closer to $3.00, $4.00, or $5.00? The answer is that any of those corn prices can attract the additional acres needed, depending on the price of other crops, particularly soybeans.

During the months preceding planting, farmers consider the relative new-crop prices that the market is offering when making decisions about what to plant. In recent years the expected price of soybeans has been about 2.5 times the price of corn. For example, in March if the market was offering $3.00 for corn that would be harvested in October, it might be offering a new-crop soybean price close to $7.50. However, how many acres would be switched to corn if market offered, say, $6.00 for soybeans instead of $7.50. The question is not IF $3.00 corn can attract 10 million more acres of corn production. The question is: WHAT soybean price makes it happen?

If several levels of corn prices can accomplish the same supply response, depending on other crop prices, what is the equilibrium level? Under this assumed high ethanol price scenario, if the long-term corn price is below $3.50 then the opportunity for excess profits causes entry of additional ethanol plants, increasing the demand for corn and leading to an increase in corn price. If the long-term corn price is above $3.50, then firms will exit the ethanol industry, causing corn demand and consequently corn price to drop.

Production and Consumption Shifts

Assume, for illustration, that oil prices and federal policies lead to a break-even corn price of $3.75. To help illustrate the effects, consider what would happen if there were no substitution between corn and other-crop production. In other words, any increase in the use of corn for ethanol must come entirely at the expense of other uses (e.g., hog production, sweetener manufacturing, corn exports).

Each of these other users must move up its demand curve, using less corn and producing less product. The level of ethanol production in this stylized example depends mostly on the demand characteristics of these other users. If the long run result is a sharp reduction in corn utilization (demand is very elastic) then there will be a corresponding large increase in the use of corn for ethanol. If, however, the demand for corn by other users is relatively inelastic then the shift towards ethanol will be relatively small for a given corn price effect.

What, then, should we expect about this shift away from alternative uses, broadly categorized as U.S. livestock feed, U.S. industrial processing, and foreign consumption. The largest alternative use is U.S. livestock feed, where about one half of U.S. corn production is used mostly for livestock feed in the production of eggs, milk, pork, beef, and poultry, consumed primarily in the U.S. Consequently, the shift effect in this case depends on the elasticity of demand by U.S. consumers for eggs, dairy, and meat.

The dynamics underlying this demand-elasticity question start at the livestock production level, where higher corn prices cause some livestock feeders to go out of business and others to produce less. This decrease in meat/egg/dairy supply will eventually be translated into an increase in retail price. The reaction of the U.S. consumer to the higher prices will play a large role in determining how much corn will be used to produce ethanol. If the consumer exhibits an inelastic demand (higher prices cause little change in consumption) then only a small amount of corn will shift from livestock to ethanol production. The transition effects of getting to such a long-run outcome will, of course, receive much attention, for good reason. But the net effect over time in this scenario is that the consumer will pay for the increased ethanol demand at the meat and dairy counter. If the consumer has an "elastic" demand for meat then consumption (and livestock production) will fall drastically.

The increase in meat price will ultimately reflect the increase in cost of production. Across all meat, egg, and dariy products, assume that feed cost represents 20% of the retail price. (This estimate of 20% is undoubtedly on the high side.) If corn and other feed prices increase by, say, 50% due to ethanol demand, then that translates <u>roughly</u> into a 10% increase in retail price. Estimates for long-run demand for meat/dairy/eggs in the U.S. suggest that the U.S. consumer reaction to this 10% increase in retail price would be a 5% reduction in consumption. Given that approximately 55% of U.S. corn production has typically been used for livestock feed, a 5% reduction in retail consumption translates into about 2.75% of U.S. production (i.e., 55% of 5%).

In our opinion, a large, long-term increase in ethanol demand would ultimately cause higher retail prices at the meat and dairy counter and higher livestock prices, but a relatively small reduction in livestock production. It should be emphasized, however, that this is a long-term outcome and that the path taken to reach this outcome will not be without pain, particularly to livestock producers.

The second broad alternative-use category is foreign consumption, or U.S. exports of corn. Virtually all of the corn exported is used for livestock feed and thus the demand for meat is again the key determinant of quantity effects. Most research has found a higher elasticity of demand for export corn than for domestically-used corn. Assuming that the long-term elasticity is close to one (i.e., a 10% increase in price causes a 10% decrease in exports), then the long-term effect of a 50% increase in corn price is a 50% drop in exports. Given that exports have been about 20% of corn production, then this 50% reduction in exports represents about 10% (20% of 50%) of production.

The third alternative use category is "industrial use," representing starch, fructose, dextrose, other sweeteners, cereal, alcohols, and other food and non-food products. However, the demand for corn for these uses is extremely inelastic, and the cost of corn is a very small share of the retail price. Consequently, large increases in the price of corn will cause very little change in the use of corn for these products, and a very large share of the cost increase will be passed on to the consumer.

Assuming (a) a 50% increase in the corn price (b) a fixed supply of corn, and (c) the above demand elasticities and relationships, then about 3% of U.S. corn production would be reallocated from the feed market to the ethanol market, while about 10% of production would be reallocated from the export market to the ethanol market. In total, in this example (and keep in mind, it is only an example) 13% of a fixed amount of corn production is diverted away from traditional uses to ethanol production.

Corn production, however, is not fixed. A "relief valve" in the short run is provided by the fact that not all land is used for corn production and that large areas can indeed switch from other crops (soybeans in particular) to corn production at a relatively low cost. Conceptually, a fourth "use" of corn in the U.S. can be thought of as soybean production in the sense that the opportunity cost of growing soybeans in most of the U.S. is the profit from growing corn. As ethanol production increases quickly, the least-cost way of using more corn for ethanol in the short run is not through fewer hogs or exports, but through fewer soybeans.

Under this high-price scenario, exit and entry into the ethanol-manufacturing industry causes the long-run corn price to converge towards the expected break-even price. Some of the major impacts are: (1) an increase in both the absolute and relative level of corn price, (2) an increase in the absolute level of soybean price, but a decrease in its relative price, (3) an increase in land prices and rents, (4) an increase in U.S. acres planted to corn, and decline in U.S. acres planted to soybeans, (5) an increase in the cost of producing livestock, (6) an increase in soybean acres in Brazil as well as other adjustments in foreign production, and (7) an increase in price risk under current government support programs.

Adjustments and impacts will depend greatly on corn yield potential, which is discussed in the next section. This is followed by the potential to adjust crop production in other countries, and finally, some price risk implications of increased ethanol production.

Ethanol Yield Per Acre of Corn

One of the factors that will influence the amount of corn acreage required to meet ethanol demand in the immediate future is the yield of ethanol per acre of corn. Ethanol yield per acre, in turn, is a function of ethanol yield per bushel of corn processed and the average corn yield per acre. Ethanol yield per bushel has increased over time primarily as a result of more efficient processing technology. Additional gains are expected as further technological improvements are made, such as seed genetics that produce a higher starch content of the corn grain. The potential for ethanol yield increases is difficult to forecast, but industry sources tend to believe that yield could advance from the current standard of 2.8 gallons per bushel to perhaps 3.1 gallons per bushel in a relatively short period of time. An increase of this magnitude, about 11 percent, would significantly reduce the number of corn acres required to meet a given level of ethanol production.

It is also generally believed that the average yield of corn per acre will continue to increase over time. Average yields have increased significantly over time as new technology and management practices were developed and adopted. The rate of increase in average yield has varied over time as the rate of development and adoption of new technology varied. Average yields increased at a faster rate, for example, after development and adoption of hybrid seed corn in the mid 1930s and after higher rates of nitrogen fertilizer began to be applied in the 1960's.

Since 1960, the linear trend fitted to actual yield data for the U.S. has a slope of 1.85 bushels, meaning that the yield has tended to increase by 1.85 bushels per year. Annual average yields have varied considerably around this upward trend, primarily reflecting variation in annual growing season weather. The variation around the trend has been substantially less since 1996 than in the period 1970 through 1995. Only the average yields of 2002 and 2004 differed substantially from the fitted trend value. Some argue that the trend increase in average yields since 1995 has been larger than the longer term average of 1.85 bushels per acre. That contention has led to the conclusion that technology has been developed and adopted at a faster pace since 1995 and if that continues, average yields will continue to increase at a faster rate than the average since 1960.

There are at least two issues associated with the analysis of the trend in yields since the mid 1990s. The first issue is whether it is appropriate to use the starting date of 1995. That was a year of low yields and it can be argued that starting the trend analysis for a relatively small number of years in a low yield year unfairly biases the calculation of the trend. Starting the trend analysis with 1996, or certainly with 1994, would result in different conclusions about the value of the trend increase in yields since the mid 1990s. Even starting the trend analysis in 1996, however, suggests an accelerating rate of increase in average yields. This leads to the second issue.

The second issue is that fitting a trend value to actual yield data for short periods of time ignores the potential impact of any persistent, abnormal weather patterns during the period. Analysis of state yield data from 1960 through 2006 for Iowa, Illinois and Indiana and correcting for variations from average temperature and precipitation values in individual years, reveals that average yields in those three states have not increased at a faster rate in recent years (Tannura). The apparent increase in the trend value observed in U.S. average yield data since 1996 likely reflects the impact of an extended period of benign weather conditions, rather than a more rapid rate of development and adoption of new technology and/or production practices.

It is premature to conclude that U.S. average corn yields will increase at an increasing rate in the near future. The implication of the trend yield analysis is that a continuation of significant investment in the development of new technology will be required just to maintain the long term rate of increase in average corn yields.

World Response to Increasing Crop Prices

U.S. crop producers increased area devoted to corn production and reduced area planted to other crops in 2007 (Table 3). The switch in acreage was in response to high corn prices relative to the price of other commodities. The switch in acreage in 2007 is indicative of the likely future response of U.S. producers to changing crop price relationships.

Table 3. U.S. Corn Supply and Consumption Balance Sheet, 2002-03 Through 2007-08[1]

	2003-04	2004-05	2005-06	2006-07	2007-08[2]
Area			million acres		
Planted	78.6	80.9	81.8	78.3	92.9
Harvested for Grain	70.9	73.6	75.1	70.6	85.4
			bushels/acre		
Yield	142.2	160.4	148.0	149.1	155.8
			million bushels		
Supply					
Beginning Stocks	1,087	958	2,114	1,967	1,142
Production	10,989	11,807	11,114	10,535	13,308
Imports	14	11	9	10	15
Total	11,190	12,776	13,237	12,512	14,465
Consumption					
Feed	5,795	6,158	6,141	5,750	5,850
Ethanol	1,158	1,323	1,603	2,125	3,300
All food and Ind.	2,537	2,,686	2,981	3,500	4,690
Exports	1,900	1,818	2,147	2,120	2,250
Total	10,232	10,662	11,270	11,370	12,790
Ending Stocks	958	2,114	1,967	1,142	1,675

[1]Marketing year is from September 1 through August 31
[2]Forecast by USDA, September 12, 2007
Source: USDA, WAOB

Assuming that significant crop land acreage is not released from the Conservation Reserve Program (CRP) in 2008, the change in cropping patterns have implications for the domestic supply and price of other commodities. Corn acreage is expected to remain large as long as ethanol production continues to expand. Reduced production of other crops, however, has increased the price of those crops so that corn prices will have to remain high in order to maintain acreage at the higher level or to force a reduction in corn consumption by other users. The unfolding of this potential bidding war for domestic crop acreage, however, will depend to a large degree on 1) the price of ethanol and 2) how the rest of the world responds to a period of higher crop prices, both in terms of consumption and production.

On the production side, it is expected that higher prices will stimulate an increase in crop production in other parts of the world. The most interest will be in the production response for corn, soybeans, and wheat. Much of the focus on the world production response for soybeans and corn will be on Brazil because of a large land base there that can be converted to crop production. As shown in Table 4, Brazil currently has the second largest land base devoted to soybean production. Area devoted to soybeans in Brazil has declined marginally in the past two years, but futures market prices near $10.00 per bushel will likely stimulate a substantial increase in acreage for harvest in 2008 and beyond. Increased production of soybeans in Brazil could substitute directly for U.S. soybean exports, allowing for additional declines in U.S. soybean acreage for several years. Modest expansion in soybean production is also possible in Argentina, Paraguay, and Bolivia. The largest hurdles to expansion in Paraguay and Bolivia will be the development of infrastructure. China currently has the fourth largest area devoted to soybean production, but expansion is not expected there due to limitations of land area and competition from other crops.

Table 4. World Soybean Area (Harvested)

	Year			
Country	2004-05	2005-06	2006-07	Yield (2006-07)
		million hectares		metric tons
U.S.	29.93	28.83	30.19	2.87
Brazil	22.92	22.00	21.00	2.71
Argentina	14.40	15.20	15.80	2.78
China	9.59	9.59	9.30	1.74
India	7.99	7.74	7.70	.95
Paraguay	2.00	2.00	2.00	2.35
Canada	1.17	1.17	1.23	2.86
Bolivia	.92	.95	.99	2.17
Indonesia	.64	.65	.65	1.30
Russia	.56	.66	.85	1.06
World	93.18	92.21	93.49	2.44
Foreign	63.25	63.39	63.30	2.24

Source: USDA, FAS

China currently has the second largest land base devoted to corn production (Table 5). However, potential for expansion in corn area in China is limited, but some gains in productivity are possible. In any case, large increases in production are not expected. Brazil has the third largest area devoted to corn production and area has been increasing modestly (15 percent) in the past two years. Average yields are quite low in Brazil due to high prices and limited availability of fertilizer and new seed hybrids, and the practice of double cropping corn in some areas. To date, most of the Brazilian corn crop has been consumed domestically, with modest exports in years of unusually high yields. With higher corn prices, both the area devoted to corn production and productivity could increase significantly in Brazil. As with soybeans, increased production could substitute for U.S. exports. Opportunities to expand corn production in other countries may be limited, but some potential does exist in Mexico if corn prices are maintained at higher levels. Increased production there would reduce the need for imported U.S. corn.

Table 5. World Corn Area (Harvested)

Country	Year 2004-05	2005-06	2006-07	Yield (2006-07)
		million hectares		metric tons
U.S.	29.80	30.40	28.59	9.36
China	25.24	26.37	27.00	5.30
Brazil	11.56	12.90	13.30	3.61
Mexico	7.69	6.64	7.30	3.01
India	7.50	7.60	8.30	1.81
Nigeria	3.70	4.00	4.20	1.79
Indonesia	3.30	3.31	3.25	2.03
South Africa	3.22	2.03	2.90	2.41
Romania	3.00	2.95	2.60	3.27
Argentina	2.78	2.44	2.85	7.54
Philippines	2.40	2.50	2.50	2.38
Ukraine	2.30	1.66	1.70	3.76
World	144.71	145.44	147.08	4.71
Foreign	114.92	115.04	118.49	3.59

Source: USDA, FAS

Wheat production is more broadly distributed around the world than are corn and soybean production (Table 6). India, Russia, China, Australia, Kazakhstan, and Canada have large areas devoted to wheat production. In addition to traditional exporters such as Australia and Canada, there is likely opportunity to expand wheat production in Russia, Kazakhstan, and the Ukraine. Area devoted to wheat in those areas could be expanded and potential productivity increases exist in Russia and the Ukraine.

Table 6. World Wheat Area (Harvested)

Country	2004-05	2005-06	2006-07	Yield (2006-07)
		Year		
		million hectares		metric tons
India	26.62	26.50	26.40	2.63
Russia	24.20	25.40	23.70	1.89
China	21.63	22.79	23.40	4.42
U.S.	20.23	20.28	18.94	2.60
Australia	13.77	13.00	11.30	.93
Kazakhstan	11.80	11.80	12.40	1.09
Canada	9.86	9.83	10.55	2.59
Turkey	8.60	8.60	8.60	2.09
Pakistan	8.22	8.30	8.30	2.61
Iran	6.80	6.50	6.40	2.19
Argentina	6.10	5.00	5.20	2.73
Ukraine	5.90	6.57	5.50	2.55
France	5.24	5.28	5.26	6.74
Germany	3.11	3.17	3.12	7.20
Morocco	3.06	2.97	3.10	1.97
World	218.76	218.41	212.82	2.79
Foreign	198.52	198.12	193.88	2.80

Source: USDA, FAS

While there are some obvious areas of the world that would likely respond to higher crop prices very quickly, an extended period of high prices would likely lead to productivity gains in a wide range of areas. The extent of such production responses will be important in determining the magnitude of growth in corn based ethanol production in the U.S.

Corn Price Risk

As indicated in the section on ethanol yield per acre, the U.S has experienced generally very favorable growing condition for corn since 1996. As a result, average corn yields have continued to increase in line with the long term trend and no major shortfalls in production have occurred. The recent weather and production history is very different from that of the previous 25 years when significant variation in annual production was experienced and production fell well short of expectations a number of times. From 1970 through 2006, actual U.S. corn production relative to expected production in the spring was as follows:

10 to 20 percent larger---5 years---13.5%

0 to 10 percent larger---17 years---45.9%

0 to 10 percent smaller-- 8 years---21.6%

10 to 20 percent smaller-- 3 years--- 8.1%

20 to 30 percent smaller---1 year-----2.7%

30 to 40 percent smaller---1 year-----2.7%

More than 40 percent smaller----2 years---5.4%

On average, corn production has fallen short of spring expectations by 10 percent or more one time in 5 years since 1970. However, a shortfall exceeding 10 percent has occurred only once in the past 12 years (10.6 percent in 2002). The current situation of rapidly expanding corn consumption and relatively small world grain inventories makes corn prices very sensitive to the level of annual production. Of particular concern is the impact that a major shortfall in U.S. corn production might have on the price and availability of corn for various end users.

Good and Irwin illustrated this issue by examining the potential price and consumption implications of four alternative production scenarios for the 2007 crop. Their analysis is summarized in Table 7. As indicated, a shortfall in production as small as 10 percent would require some reduction in consumption, reduce year-ending inventories to the smallest possible level, and result in an average marketing year farm price at a record high level. The authors conclude the analysis with this statement: "Corn prices are expected to remain generally high and extremely volatile for an extended period of time. The combination of a low level of stocks and an increasing portion of corn consumption occurring in the ethanol sector, where demand is relatively price insensitive, suggests that prices will be extremely responsive to small changes in U.S. and world production prospects or changes in demand for corn in any other sector. Prices of other commodities will also be influenced as the market attempts to allocate production resources, primarily land, among the various crops. Provisions of the new "farm bill" are expected to reflect this changing environment of high and volatile crop prices. In addition, careful consideration of potential market impact should be given to policies encouraging additional bio-fuels production. Other considerations might include provision for a corn reserve in years of large production to provide a buffer for a future shortfall in production."

Table 7. Potential Supply and Consumption Balance Sheets for the 2007-08 U.S. Corn Marketing Year

	2006-07 USDA WASDE	2007-08: Expected Production	2007-08: 10% Larger Production	2007-08: 10% Smaller Production	2007-08: 20% Smaller Production
Supply (million bushels)					
Beginning Stocks	1,967	937	937	937	937
Imports	10	15	10	15	15
Production	10,535	12,290	13,519	11,061	9,832
TOTAL	12,512	13,242	14,466	12,013	10,784
Consumption (million bushels)					
Feed and Residual	5,850	5,750	5,850	5,090	4,450
Exports	2,200	2,000	2,150	1,800	1,600
Ethanol	2,150	3,400	3,500	3,300	3,060
Other	1,375	1,400	1,400	1,360	1,260
TOTAL	11,575	12,550	12,900	11,550	10,370
Ending Stocks	937	692	1,566	463	414
Ending Stocks/Use	8.1%	5.5%	12.1%	4.0%	4.0%
Average Farm Price	$3.10	$3.30	$2.60	$4.25	$5.25

Note: USDA WASDE estimates for 2006-07 were released on May 11, 2007.

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