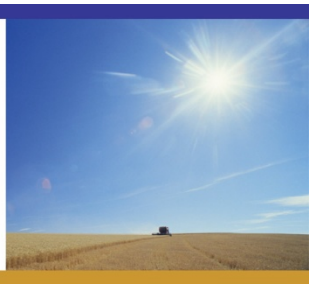
MARKETING & OUTLOOK BRIEFS

Department of Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign



Alternative 2011 Corn Production, Consumption, and Price Scenarios

Darrel Good and Scott Irwin

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At 12.477 billion bushels, the 2010 U.S. corn crop was nearly a billion bushels smaller than early season forecasts. The shortfall reflected a below-trend average yield of 152.8 bushels, 11.9 bushels below the record average yield of 2009.

In addition to a smaller than expected crop, corn consumption during the first half of the 2010-11 marketing year was larger than forecast at the start of the year, reflecting a large increase in the amount of corn used for ethanol production. The USDA projects corn use for ethanol production during the 2010-11 marketing year that started on September 1, 2010 at 4.95 billion bushels, 382 million bushels more than used last year and 250 million bushels above the USDA projection at the beginning of the year. Consumption of U.S. corn for all purposes during the current marketing year is forecast at 13.5 billion bushels, 434 million more than consumed last year and 60 million above the projection at the beginning of the year.

The smaller than expected U.S. corn crop in 2010 and the rapid rate of increase in the use of corn for ethanol has resulted in prospects for very small domestic stocks at the end of the 2010-11 marketing year. The USDA projects those stocks at 675 million bushels, representing only 5 percent of projected marketing year consumption. Corn prices doubled between late June 2010 and late February 2011 as domestic and world events pointed towards very tight supplies of corn and the need to expand domestic production in 2011.

Rising prices of corn and other commodities resulted in some escalation in the rate of increase in food prices and concerns that further troublesome increases would be forthcoming without some moderation in commodity prices. Central to commodity and food prices in 2011 and beyond is the size of the 2011 U. S. corn crop.

The purpose of this brief is to develop supply, consumption, and price scenarios for the 2011-12 marketing year for three alternative U.S. corn yields. These yield alternatives include a trend yield, an average yield resulting from good weather, and an average yield resulting from poor weather. For comparison, the USDA forecast of 2011-12 marketing year production, consumption, and stocks presented at the *Annual Outlook Forum* on February 24 and 25, 2011 is also presented. The paper concludes with a brief discussion of the policy implications of a small corn crop in 2011.

This analysis of alternative corn yield scenarios for 2011 is motivated by what seems to be an under-appreciation for corn yield risk, particularly the risk of low yields. Even after the lower than expected yield of 2010, there still appears to be a general lack of concern about a weather-induced shortfall in U.S. corn yields. We discussed the corn yield debate in some detail last

year (Irwin and Good, 2010). Briefly, lack of widespread concern about low corn yields is motivated by the yield experience since 1995 (Figure 1). Many attribute the lack of a major shortfall in the U.S. average yield since 1995 to the adoption of improved seed genetics and seed traits that have increased yield potential and reduced vulnerability to adverse weather conditions. In contrast, the crop weather models that we have developed attribute much of the unusually good yield performance since 1996 to an extended period of generally better than average weather. The bottom-line is that we believe the risk of weather-induced shortfalls in corn production may be greater than generally perceived, suggesting that market participants and policymakers may be ill-prepared to cope with such a shortfall should it occur.

2011 Yield Scenarios

Average U.S. corn yields from 1960 through 2010 are used to calculate a trend yield for 2011 and to quantify an average 2011 yield under both a "good" weather and a "poor" weather scenario. Many analysts use a shorter time period to conduct this type of analysis, arguing that yields are now increasing at a faster rate than in the period prior to 1990. As described above, we argue that the trend has not changed appreciably, but that adverse weather has been experienced less frequently since the mid-1990s and that the longer-term trend is still relevant. Using a shorter time period for the analysis results in yield estimates about 3 bushels higher than those presented here.

A trend yield for 2011 is calculated by fitting a linear trend to actual U.S. yields from 1960 to 2010 and extending the trend one year (Figure 1). The linear trend for the 51 year period is 1.89, indicating that the U.S. average yield has increased at a rate of 1.89 bushels per year since 1960. The trend yield calculation for 2011 is 158.4 bushels. We use 158 bushels in this analysis.

Next, actual annual yields since 1960 are detrended using a factor of 1.89 bushels per year. For each year, the detrended yield calculation represents yield in terms of 2011 technology (Figure 2). The average of these detrended yields (horizontal line) represents the trend yield. Annual deviations from the average reveal the yield impact of weather. We exclude 1988 and 1993 from further analysis due to the low likelihood that weather events of those two years will be experienced in 2011. In 1988, a widespread severe drought had overspread much of the corn growing area by this time of the year. In the summer of 1993, extreme flooding was experienced in much of the northern and western Corn Belt.

For the remaining 49 years, the detrended yields are ranked from lowest to highest (Figure 3). The average of the 10 highest and 10 lowest yields are calculated and used as the expected 2011 yield under "good" and "poor" growing conditions, respectively. The average of the 10 highest detrended yields is 168.8 bushels and the average of the 10 lowest detrended yields is 146.7 bushels. For this analysis, we use yields of 169 and 147 to represent yield prospects under "good" and "poor" weather scenarios. The "good" and "poor" whether yield scenarios represent the average yield in the upper and lower 20 percent of the yield experience since 1960, representing a 1 in 5 outcome. While we use the average yields in the upper and lower 20 percent of yield distribution, we recognize that there is large variation in yields in those "tails". Yields in the lowest 20 percent of the yield distribution have ranged from 134 to 153 bushels. Yields in the highest 20 percent of the yield distribution have ranged from 166 to 174 bushels

We have also developed a crop weather model, described in some detail last year, (Irwin and Good, 2010) that is used to calculate yield trends after adjusting for variations in annual growing season weather conditions. The trend calculation

and the "good" and "poor" growing condition yield calculations using that model are similar to the ones described above. The crop weather model provides an important validation for the much simpler methodology used here.

Production Scenarios for 2011-12

For all of the 2011-12 scenarios, planted acreage of corn is projected at 92 million acres, 3.8 million more than planted in 2010. That projection is based on the expected response of corn producers to the current high corn prices, but there is substantial uncertainty about the projection. Prices of other crops competing for acreage in 2011 are also high. It is not known how much total crop land acreage can be expanded in 2011 or how producers will respond to the array of high crop prices.

Based on the planted acreage forecast, we project harvested acreage of corn for grain at 84.9 million acres, reflecting typical acreage of corn harvested for silage and abandoned acreage. The USDA will report the results of its annual *Prospective Plantings* survey on March 31, 2011 and its annual *Acreage* survey on June 30, 2011. These reports can be used to update the planted and harvested acreage projections used here.

Based on the acreage assumptions, a trend yield of 158 bushels in 2011 would result in a crop of 13.414 billion bushels and total marketing year supplies of 14.099 billion bushels. The supply of corn would be marginally smaller than the supply for the current year. Under the good weather scenario, the 2011 crop is projected at 14.348 billion bushels and total supplies are projected at 15.033 billion bushels, about 860 million larger than the supply for the current marketing year. Under the poor weather scenario, the 2011 crop is projected at 12.48 billion bushels, with a total marketing year supply of 13.175 billion bushels. That supply would be 1.0 billion bushels smaller than the supply for the current marketing year.

Consumption Projections for 2011-12

Making projections of marketing year corn consumption is complicated by the uncertainty about the strength of demand in each of the consumption categories. In addition, the sensitivity of consumption to the price of corn (price elasticity) varies by category of use Export demand is determined to a large extent by the level of foreign grain production and exports are not very sensitive to the price of corn. The basic assumption in the each yield scenarios is that exports will be at a "typical" or "normal" level over a wide price range. The projection of exports varies only for the poor weather scenario.

Feed demand is influenced by livestock numbers and livestock production profitability, but demand is more price elastic than demand in other categories of use. That is, feed consumption is more responsive to corn prices than consumption in other categories. Because feed demand is more responsive to corn prices than are other uses, it is assumed that the majority of the adjustment to small or large production (high and low prices) will occur in this category. It is also assumed that livestock and livestock product prices will remain generally high in the year ahead, as currently reflected by deferred futures prices. High livestock prices imply strong feed demand. The strong demand scenario implies that it will take higher prices of corn to trigger an adjustment in use than if livestock prices were low.

The demand for corn processing uses other than ethanol (primarily food products) is influenced primarily by the rate of domestic population growth. Consumption in that category is the least sensitive to corn prices. Like the projection of corn exports, the projection of use in this category varies only for the poor weather scenario.

Projecting corn consumption for ethanol production is complicated. For the most part, a minimum level of ethanol production is determined by the level of annual mandates for renewable biofuels production. These mandates increase from 12.6 billion gallons in 2011 to 13.2 billion gallons in 2012 and eventually to 15 billion gallons in 2015. Converting the calendar year mandates to corn marketing year mandates and assuming the entire mandate is met by corn-based ethanol, the minimum level of corn consumption would be 4.65 billion bushels in the 2011-12 marketing year. Ethanol blending and production exceeds the mandate when it is profitable to both blend and produce ethanol. That characterizes the situation for the current year when the minimum amount of corn required to meet the mandate is about 4.4 billion bushels and actual use is projected at 4.95 billion bushels. Conversely, if it becomes uneconomic to blend ethanol, blenders can use credits from excess ethanol blending in the previous year to partially meet the mandate in the current year. We estimate those credits to currently be near 1.5 billion gallons.

Absent subsidies, the profitability of ethanol blending can be broadly represented by the difference between gasoline and ethanol prices (see Irwin, Good, and Mallory (2010) for a more complete discussion of ethanol blending margins). Essentially, ethanol prices below gasoline prices make for profitable blending and vice versa. Blenders are currently subsidized $0.45 per gallon of ethanol blended into the fuel supply, making blending profitable even if ethanol prices exceed gasoline prices (up to $0.45 per gallon). The current tax credit expires at the end of 2011. Assuming the credit is not re-instated, blending profitability after January 1, 2012 will be primarily a function of the difference between ethanol and gasoline prices.

If blending is profitable, blenders presumably want to buy and blend as much ethanol as possible. For ethanol production to be profitable, the price of ethanol has to be high enough to cover the costs of production (adjusted for the revenue from the sale of the co-product, distillers' grain). The largest and most variable component of ethanol production costs is the price of corn.

Absent subsidies, the highest price blenders can pay for ethanol and maintain blending profitability is equal to the wholesale price of gasoline. That price must also be high enough to make ethanol production profitable. The price of gasoline, in turn, is a function of the level of crude oil prices. What emerges, then, is that the amount of corn consumed for ethanol production reflects an intricate combination of mandates, corn prices, crude oil prices, ethanol/gasoline price differences, and subsidies.

One final complicating factor is the ethanol "blend wall," currently a regulatory limit of 10% ethanol in gasoline blends. While the U.S. Environmental Protection Agency (EPA) has announced rules for a higher mid-level blend (15%) for at least some vehicle models, it will likely take some time before those higher blends become available at the retail level. We assume that the 10% blend limit remains in place for the 2011-12 marketing year. The key question then is whether this blend wall will "bind," i.e. place an effective ceiling on domestic ethanol blending and use. There is unfortunately no widely agreed upon number for this effective ceiling. If one starts with a total transportation fuel usage of 150 billion gallons per year, then the blend wall is about 15 billion gallons of ethanol. The highest level of ethanol production we project in 2011-12 is 14.3 billion gallons (5.1 billion bushels of corn X 2.8 gallons of ethanol per bushel). Since this is less than 15 billion gallons, we do not forecast the blend wall to bind in 2011-12, but it is getting perilously close to binding.

The forecast of the use of corn for ethanol production in the 2011-12 marketing year is

certainly not straightforward. The challenge is to determine if both the blending margin and the ethanol/corn price relationship will motivate ethanol blending and production above the mandated level The approach here is first to assume that the blenders tax credit will not be extended beyond December 31, 2011. Second, we calculate the likely price of gasoline (and therefore the maximum price of ethanol) at various levels of crude oil prices. Third, we calculate the maximum price an ethanol producer could afford to pay for corn for each gasoline/ethanol price scenario and still cover all variable costs of production, assuming all non-corn costs remain constant. Those calculations are presented in Table 1.

The calculation of the breakeven price for ethanol producers is subjectively evaluated to judge if corn prices would likely be high enough under any of the yield scenarios to: (1) require ethanol prices to be above gasoline prices, or (2) to force a shut-down of ethanol production. Either of these conditions could result in ethanol production being limited to or falling short of the mandated level. Our judgment is that ethanol production breakeven prices would be sufficiently high to avoid either of those conditions with crude oil prices above $95 per barrel. While we assume different levels of ethanol use of corn for each yield scenario, ethanol production is assumed to exceed the mandated level for each of the scenarios.

Balance Sheet Projections for 2011-12

Table 2 presents the current projection of the corn supply and demand balance sheet for the 2010-11 marketing year, projections of the 2011-12 marketing year balance sheets for each of the yield scenarios described above, and the USDA's projected 2011-12 balance sheet as presented on February 25, 2011.

Under the trend yield assumption, total corn consumption would have to decline modestly from the levels of the current year in order to maintain the year ending stocks-to-use ratio at a minimum pipeline level of 5 percent. Consistent with the arguments made above, we project exports near the long term average of 2 billion bushels. Use for food and industrial products other than ethanol is projected at the same level as expected this year since use this year is elevated due to unusually strong demand for high fructose corn syrup from Mexico.

The use of corn for ethanol production is forecast at 4.9 billion bushels, near the level expected for the current year and well above the mandated level of 4.65 billion bushels. This projection follows the logic for favorable ethanol blending and production margins developed earlier.

Feed use of corn is projected to be only slightly less than expected for the current year, with the reduction reflecting limited supplies of corn. Relatively tight supplies would be expected to support corn prices at high levels. In addition the marketing year average farm price would likely be supported by current opportunities to sell the crop at relatively high prices. This is in contrast to the pattern of a year ago when substantial pre-harvest sales were made at relatively low prices. The average farm price is projected at $5.75.

The good weather scenario would likely result in higher levels of consumption, larger year ending stocks, and lower prices than the other scenarios. Since we have argued that both exports and domestic non-ethanol processing uses of corn are not especially sensitive to price, projections of use in those categories are not changed from the trend yield scenario. Larger corn supplies and lower feed prices will likely result in an expansion in feed use of corn. Since expansion in livestock numbers takes time, we project a small year-over-year increase of 100 million bushels. In addition, lower corn prices and relatively high crude oil prices suggest that ethanol blending and production would be very profitable even

without the blenders tax credit. Use in that category is projected at 5.1 billion bushels. Total use is projected at 13.8 billion bushels and year ending stocks are projected at 1.233 billion bushels, or 8.9 percent of projected consumption. Substantially lower prices would be expected, with the average farm price projected at $4.75.

The poor weather scenario would force a sharp reduction in consumption and result in minimum carryover stocks and much higher prices. Prices would be high enough so that export and domestic processing uses of corn would be expected to be marginally smaller than under the previous two scenarios. Even at high prices, ethanol blending and production would likely remain profitable due to the expectation of high crude oil and gasoline prices. Margins, however, would likely be less attractive than in the previous scenarios. Use of corn for ethanol production is projected at 4.8 billion bushels. Total use would be limited to 12.55 billion bushels, allowing for feed use of only 4.5 billion bushels. Corn prices would have to be high enough to force a 13.5 percent year-over year reduction in feed use in the face of record high livestock prices. This scenario for feed demand would be similar to that of 1995-96 when feed use declined by 14 percent from use during the previous year. The 2011-12 marketing year average farm price under this scenario is projected at $7.00

The three yield scenarios presented here result in 2011-12 marketing year average farm prices ranging from $4.75 to $7.00 per bushel. The USDA projection on February 25, 2011 was for an average price of $5.60, resulting from an average yield of 161.7 bushels per acre. Corn futures prices for the December 2011 through July 2012 contracts on March 1, 2011 reflected a 2011-12 average farm price of about $5.75.

POLICY IMPLICATIONS OF POOR WEATHER

The high corn prices implied by the poor weather scenario outlined here would likely result in the call for policy initiatives to alleviate the economic impact on various sectors of the agricultural industry and on consumers.

In the past, some policy changes have been implemented in cases of a shortfall in crop production, but for the most part it has been left to the market to sort out the allocation of a short crop. In some instances, rules preventing haying and grazing on conservation lands were altered to allow livestock producers access to additional feed supplies. Another option that has been proposed and implemented occasionally is a temporary restriction on exports. Such a restriction was implemented for soybeans in the spring of 1973. Corn exports to Russia were restricted in January 1980, but for political and not economic reasons. In 2008, there were some calls for providing relief from high corn prices for livestock producers by limiting the use of corn for ethanol production. There was also some effort to allow early release of some Conservation Reserve Program (CRP) land for crop production in 2009. Since the 2008 crop was large and prices moderated fairly quickly, no changes in ethanol policy were implemented and no change in CRP enrollment was made. The question still remains: Should additional policy options be considered in the case of a shortfall in corn production, or should the role of allocation be left solely to the market?

Short-term policy responses to a small crop and extremely high prices are likely limited. Early release of CRP acres back into crop production would be complicated and the impact would not be immediate. Easing biofuels mandates and tax subsidies might be ineffective in slowing ethanol demand for corn if crude oil prices remain high and blending margins remained favorable. One of the few ways to moderate demand in a

short-supply situation is to impose restrictions on corn consumption by one or more consumption sectors. The sectors restricted would presumably be a function of the specific policy objective. If controlling domestic food price inflation was the primary goal, for example, restrictions could be imposed on exports and/or domestic industrial uses of corn, including ethanol production. There is little precedent for restrictions of this type outside of wartime. Whatever the policy response, it would be critical for the policy initiative to be implemented early and for the policy to be implemented and enforced in a straightforward manner.

It is certainly hoped that a shortfall in corn production can be avoided. The time to develop a policy response to such an event, however, is before it occurs.

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Table 1. Alternative Scenarios for Crude Oil Price, Gasoline Price, and Shutdown Price of Corn for Ethanol Plants during the 2011-12 Marketing Year

Crude Oil Price ($/bbl.)	Wholesale Gasoline Price ($/gal.)	Shutdown Price of Corn for Ethanol Plants ($/bu.)
75	2.00	5.89
95	2.50	7.84
110	3.00	9.78
130	3.50	11.72
150	4.00	13.66

Table 2. U.S. Corn Balance Sheets for the 2010-11 and 2011-12 Marketing Years

		2011-12 Yield Scenario			
	2010-11	Trend	Good Weather	Poor Weather	USDA
Supply					
Planted acreage (mil.)	88.2	92.0	92.0	92.0	92.0
Harvested acreage (mil.)	81.4	84.9	84.9	84.9	84.9
Yield (bu/ac.)	152.8	158	169	147	161.7
Production (mil. bu.)	12,447	13,414	14,348	12,480	13,730
Beginning stocks (mil. bu.)	1,708	675	675	675	675
Imports (mil. bu.)	20	10	10	20	20
Total (mil. bu.)	14,175	14,099	15,033	13,175	14,425
Consumption					
Exports (mil. bu.)	1,950	2,000	2,000	1,900	2,000
Feed and residual (mil. bu.)	5,200	5,125	5,300	4,500	5,150
Ethanol (mil.bu.)	4,950	4,900	5,100	4,800	5,000
Other processing (mil. bu.)	1,400	1,400	1,400	1,350	1,410
Total (mil. bu.)	13,500	13,425	13,800	12,550	13,560
Ending stocks (mil. bu.)	675	674	1,233	625	865
Stocks-to-use (%)	5.0	5.0	8.9	5.0	6.4
Average farm price ($/bu.)	$5.40	$5.75	$4.75	$7.00	$5.60

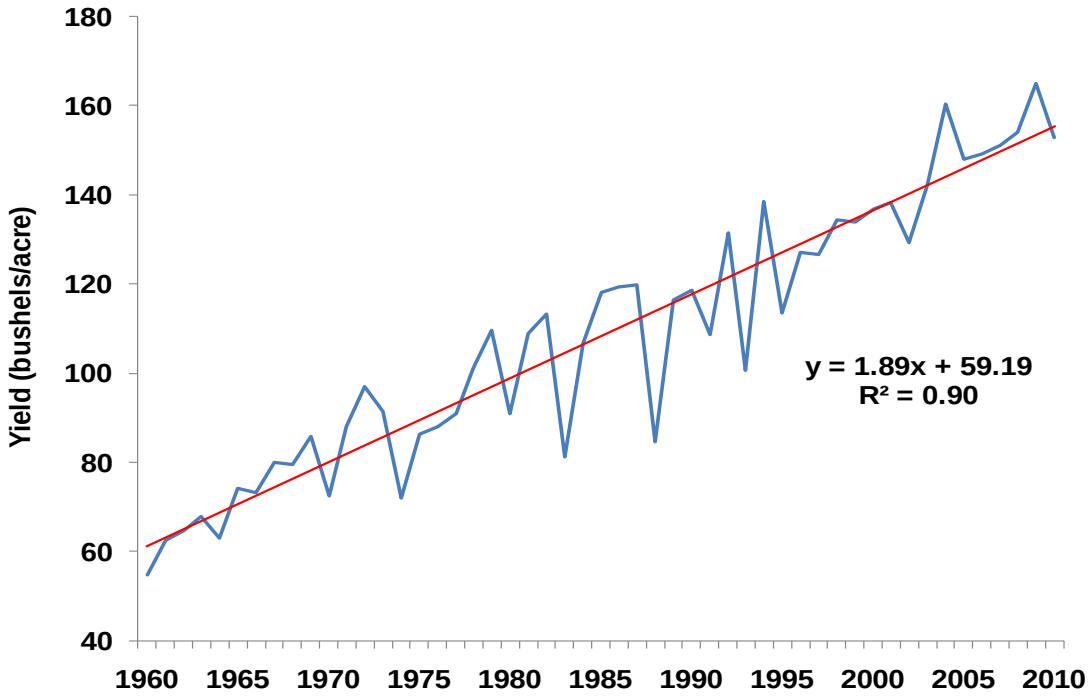

Figure 1. U.S. Average Corn Yield over 1960-2010

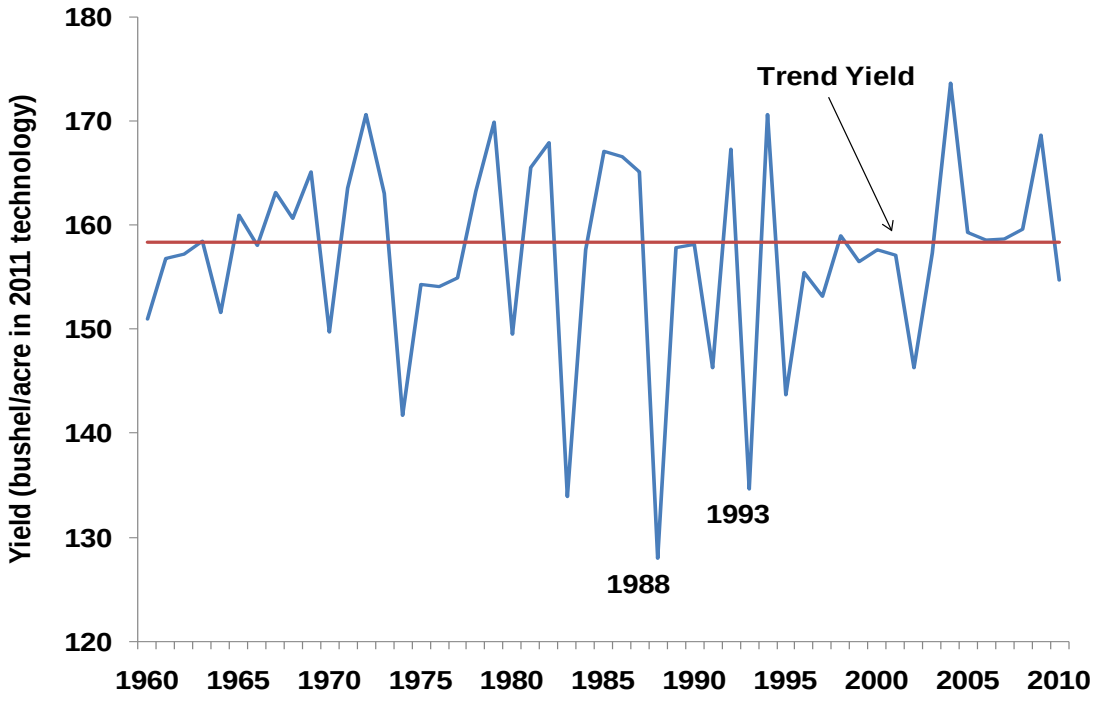

Figure 2. De-trended (2011 technology) U.S. Average Corn Yield over 1960-2010

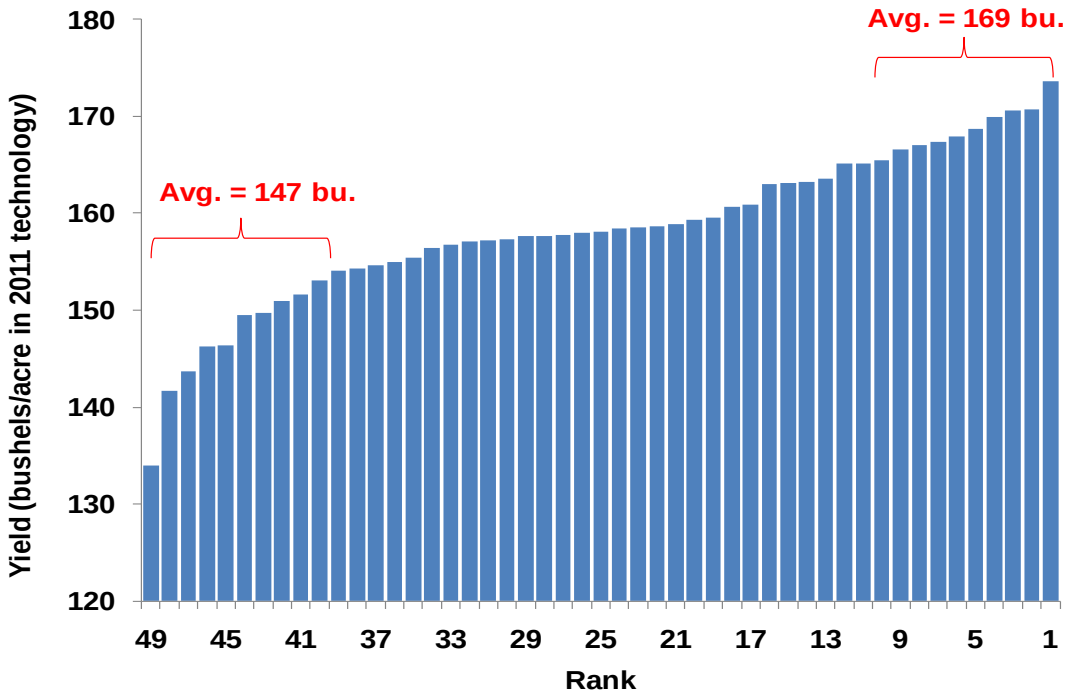

Figure 3. De-trended (2011 technology) U.S. Average Corn Yield Ranked from Lowest to Highest over 1960-2010, excluding 1988 and 1993