North Central Ohio Agronomy Report

Issue 02-08

INSIDE THIS ISSUE

Dear Ag Provider,

We are in a new era of fertilizer inputs. The description from one fertilizer dealer was world record prices. Yesterday, phosphorus was at $1,000.00 ton wholesale. With inputs continuing to rise, management of nutrients based on years of land grant agronomic research will be essential. To obtain phosphorus and potassium recommendations, go to the TRI-STATE Fertilizer Guide available at http://ohioline.osu.edu/e2567/index.html

Steve

Steven C. Prochaska, Ph.D.
Associate Professor and Extension Agent
Agriculture and Natural Resources
Phone (419) 562-8731
Prochaska.1@osu.edu

http://crawford.osu.edu
http://agcrops.osu.edu
http://www.oardc.ohio-state.edu/ohiofieldcropdisease
http://www.ipm.iastate.edu
http://fcn.agonomy.psu.edu/farm
http://precisionage.osu.edu
http://www.ipm.uiuc.edu/bulletin
http://www.entim.purdue.edu/Entomology/ext/targets/newslett.htm

Wheat

Howard Siegrist, Extension Educator, Licking County
Ohio State University Extension

Wheat Yield Components

Optimum yields usually occur at a point close to 550-600 heads/yards^2. Below this range there is a direct relationship between yield and head numbers (a 50% reduction in head number will result in a 50% yield reduction). Head numbers above 600 do not result in dramatic yield loss unless severe lodging occurs; however, double crop soybean yields and combine efficiency will both suffer. It is important to target a specific set of yield components to achieve 100 bu/A yields. **Table 1** depicts values that are ideal for wheat fields in Illinois, Indiana and Ohio.

Table 1.

plants/sq yard	200
tillers/plant*	4
heads/plant	2.75
Heads/sq yard	550
spikelets/head	16
grains/head	32
seeds/lb	12500

*tillers with more than 3-4 leaves in early February

Nitrogen Timing

Spring nitrogen applications are timed to occur at two important wheat growth stages. These periods of growth are defined in **Table 2**. GS 3 N applications are used to manipulate the number of tillers surviving and to provide sufficient nitrogen for the early stages of head development. Two main factors affect tiller survival: nitrogen content and tiller size. We cannot affect tiller size after emergence, as this is temperature dependent, but we can affect available nitrogen in early spring.

Table 2.

GROWTH STAGE	SIGNIFICANCE	ROLE OF NITROGEN
GS 3: end of tillering	Start of tiller abortion & double ridge stage	Increases tiller number
GS 5-6" pseudo stem erect-first node detectable	Main vegetative growth & terminal spikelet stage	Plant growth & increases head, spikelet and grain numbers
node detectable	spikelet stage	spikelet and grain numbers

GS 5-6 signifies the onset of a period of maximum nitrogen uptake and includes a period of key embryonic growth called the terminal spikelet stage which occurs 5-7 days prior to the 1st node. During this growth phase, we are attempting to ensure optimum N availability to the 550 heads/yard^2 which should result in a large head size and a higher number of grains/head.

****

Wheat Management in Indiana

Herb Ohm & Jim Camberato
Agronomy Department
Purdue University

Given the recent high wheat commodity prices, it seems timely and useful to review or reconsider certain winter wheat management practices for Indiana. Wheat prices probably will not remain as high as currently, although it seems reasonable to expect prices to remain higher than in recent years.

Sustained wheat prices above $4 certainly warrant ‘best management’ practices to maximize grain and straw productivity. Combining early-maturing, strong-strawed varieties, optimum and balanced nutrient fertilization and harvesting at 18 – 22 percent grain moisture should maximize wheat grain and straw production, grain quality, and expand double cropping with soybean after wheat harvest farther northward than is currently practiced.

Seeding. Seeding at or in the week following the widely used guideline of the ‘Hessian fly-free’ date is useful. It is useful not only for avoiding infestation by Hessian fly, but more importantly to minimize fall infection of foliar diseases and yellow dwarf, which is transmitted by aphids that move from senescing corn and perennial grasses onto the emerging wheat. Seeding earlier than the fly-free date will increase the likelihood of getting too much growth of the wheat prior to onset of dormancy for the winter.

Fertilization. The current practice of typically applying 20 – 35 lb N at fall seeding is a good practice in most situations. Topdressing: one application of typically 90 – 100 lb N at mid- to late-February in southern Indiana to mid-March in northern Indiana is minimal for maximizing grain yield, especially considering current higher wheat prices. Producers should consider application of an additional 20 – 40 lb N as a second application in late- March in southern Indiana to mid-April in northern Indiana. Producers should avoid applying more than 100 lb N at one application in February – March, because with the normally high rainfall at this time of the season a significant portion of the N will likely be lost due to leaching. Generally, N applied early in the crop growth cycle will result in taller plants, and possibly more lodging, and N applied later in the crop growth cycle, especially after the boot stage, will result in higher grain nitrogen – not desirable in soft (pastry) wheat.

Irrigation. Rainfall in most seasons in Indiana is adequate to ample for excellent wheat yield. However, with high grain prices and short strong-strawed varieties, irrigation at critical growth stages is warranted. In some seasons hot and dry periods of two to several weeks can occur during the growing season. Irrigation at early boot stage to © 2007, Purdue Univ. pg. 1 © 2007, Purdue Univ. pg. 2 approximately 15 days after flowering can result in significantly increased grain yield and test weight in some years and especially on drought-prone soils.

Harvest. Wheat is typically harvested at 13 – 14 percent grain moisture, from about 15 – 25 June in southern Indiana to 10 – 20 July in northern Indiana. In many years, this can be a rainy part of the season that can delay harvest and, consequentially, reduce grain quality and even straw quality, in addition to limiting the opportunity of seeding soybeans immediately after wheat harvest. Wheat grain is physiologically mature at 35 percent moisture, meaning that no additional dry matter (yield) is produced in the wheat crop after the grain has dried to 35 percent moisture. If one were to harvest at 35 percent moisture, damage to the grain would be significant and the amount of energy required to dry it to 14 percent moisture for safe storage would be excessive. However, harvesting at 18 – 22 percent grain moisture, using a ‘stripper-header’ on the combine, and then drying the grain using air and minimal or no heat, would result in excellent grain quality. More importantly, one could typically harvest 7 to 10+ days earlier than at 14 percent moisture. Additionally, if one or more rainfalls were avoided by harvesting at the higher moisture, grain quality and test weight would be higher and delays in harvest would be avoided. Generally, after each rain and drying cycle after grain has dried to about 14 percent moisture, test weight is reduced by at least 0.5 lb per bushel. The earlier harvest date would also allow the practice of double cropping farther northward in Indiana. One caution if heat is applied during grain drying is to not exceed 103F, because wheat germination is easily decreased if subjected to temperatures above 105F when the grain is high in moisture.

Wheat straw. Straw can be a significant component of the total wheat crop value. If wheat grain is harvested at 18 – 22 percent moisture, moisture content of the straw can be too high for immediate baling and storage without risk of becoming moldy. One can inject ammonia into the bales to prevent mold development and then store the bales in an environment in which they can dry naturally.

Replacing the nutrients removed with straw baling can be a significant cost with the current high price of fertilizer. A ton of straw contains about 12 pounds of nitrogen, 3 pounds of P2O5 (phosphorus), and 26 pounds of K2O (potassium). About 100 pounds of straw are produced per bushel of grain, although typically only 2/3 of the total is baled. For a 70-bushel per acre wheat crop, about 25, 6, and 56 pounds per acre of nitrogen, P_2O_5, and K_2O would be removed from the field with baling. Potassium is readily leached from the straw, so the more rain that falls on the residue the lower the amount of K_2O remaining in the straw.

North Central Ohio Agronomy Report

Is Your Planter Ready?

Sjoerd Duiker, Soil Management Specialist
Crop Management Extension Group
Penn State University

The quality of your corn stand will largely depend on planter performance. An irregular stand can easily cost you 10% of your yield. Planter performance is especially critical in no-till because of high penetration resistance, crop residue at the soil surface, and a rough soil surface. Inadequate planting will result in uneven seed depth and plant spacing. Hairpinning is common if coulters and row cleaners don't work properly. Here are some tips to prepare your planter for the new season:

1. Meters. Metering units have to work well or you'll get frequent skips, doubles and triples. To guarantee optimal performance, take metering units apart every winter. Remove dirt and clean the hood with soapy water (no kerosene, diesel or oil should ever be used in metering units!). Replace cracked plastic covers. Replace broken fingers in a finger-pickup meter. Seed brushes need to be replaced when worn. If a groove has formed in the chromium house of the metering unit it is time to replace it. The belt (in finger pick-up meters) should be flexible, not have cracks in it, and should be clean. Clean with soapy water and le! t it dry before putting it back in. Put the metering unit back together. The rubber belt should be placed back in the right direction, or your meter will malfunction. You can lubricate with graphite (NO OIL or WD-40). It is recommended to take your finger pick-up metering unit to a dealer to have it calibrated every year or every 300-400 acres. Take a bag of your own seed with you, and give him the correct speed at which you'll be driving. If you have a vacuum or air meter, check for leaks and appropriate vacuum or air pressure.

2. Planter unit. Accurate depth placement can be compromised if planter units are loose or wobbly. You should not be able to easily lift up your unit or move it sideways. Look across your planter units from the side. Are they all at the same height? If one unit is either up or down compared to the others, it needs work. A common problem is that some bolts are loose or additional bushings are needed. You also need to replace cracked or broken seed hoppers.

3. Seed opener disks. Seed opener disks need to have a minimum diameter (check operator manual) or they will not place the seed at the appropriate depth. Seed opener disks also need to come together in the front (they should usually touch for 3", but this may vary depending on planter). Stick two business cards between the openers and move them as close together as possible. If opener disks are worn too much you will get a "W" shaped seed slot instead of the desired "V" slot.

4. Seed tubes. The end of seed tubes may wear to the extent that they curl inwards, catching seeds. There is often a hook halfway up that can easily break off. Seedtube guards need to have their minimum width and be fastened correctly or damage to the seed tube is likely.

5. Seed firmers. These help to press the seed down in the furrow, guaranteeing more accurate depth placement of the seeds. The tension can be adjusted with a bolt. If the seed firmers are worn too much they need to be replaced.

6. Depth wheels. Depth wheels should run tight against disks. Change washers from in- to outside (or vice versa) of depth wheel if necessary. If this doesn't resolve the problem, the depth wheel arm needs to be replaced.

7. Coulters. Check the diameter of the coulters, and replace them if needed. You should adjust the depth of worn coulters that are still usable.

8. Closing wheels. Closing wheels need to have an intact spring, and need to be checked for damage or wear. Bearings cannot be wobbly or too tight. The bottoms of rubber or cast iron closing wheels need to be 1.5"-2" apart. The closing wheel arm cannot have too much play or bushings or the entire arm may need replaced.

9. Alignment of coulters, opener disks, and closing wheels. Take a rope and pull it straight from the front coulter to the closing wheels. The firming wheels, seed openers, and coulters should all be in line. Closing wheels should not run on top of the seed furrow.

10. Insecticide boxes. The insecticide boxes should have no holes or cracks. Tubes should be blown out with air as well as the slot on bottom of meter.

11. Fertilizer unit. Fertilizer opener disks should have a minimum diameter (check manual). The bearings should not be wobbly or too tight. Hang a bucket below the tube of the unit, and do a test run of 175 feet in the field. Weigh the fertilizer in the bucket, multiply by 100, and you have the fertilizer you'll put on in pounds per acre (at 30" row spacing). Adjust as needed.

12. Chains and sprockets. Check all chains and their sprockets. If they are worn too much they need to be replaced. They need to have the appropriate tension and should be greased regularly.

****

Impact of Early-Season Weed Competition on Corn Nitrogen Needs

Bob Hartzler, Extension Weed Scientist,
Dept. of Agronomy
Iowa State University

Weeds impact crop yields primarily by competing for limited resources such as sunlight, water and nutrients. Numerous studies have investigated how changing nutrient availability via fertilization influences the competitive relationship. In some situations fertilization favors crop growth over weeds, and therefore reduces yield loss, whereas in others weed growth is benefited more than crop growth. However, most of these studies have allowed weeds to compete for the entire growing season – not a normal practice for agricultural fields.

Chris Boerboom and colleagues at the University of Wisconsin investigated the impact of glyphosate application timing in RR corn on the nitrogen needs of corn. The premise of the study was that early-season weed growth might 'tie up' nitrogen, therefore resulting in higher economic optimum nitrogen rates1 (EONR) with delayed glyphosate applications. Experiments were conducted during 2006 and 2007, evaluating corn yield response to a range of nitrogen rates (0 to 200 lb N/A) and varying lengths of weed competition.

Corn yields were not reduced when weeds were controlled at the 4-inch stage, but delaying application until weeds were 12-inches resulted in a 9% yield loss averaged over the two years. Weed densities in the experiments were moderate, with less than 100 weeds/ft2 at the 4" application timing.

The presence of early-season competition altered corn response to N fertilization, resulting in higher EONR's (Table 1). Delaying glyphosate application until weeds reached a height of 12" increased the EONR more than 100 lbs /acre in both years of the study compared to the weed-free treatment. In 2007, allowing weeds to reach 4" increased the EONR by 40 lbs. These results suggest that the utilization of N by weeds reduces N availability to corn, therefore requiring higher N rates for optimum yields. Although the N used by weeds will eventually be mineralized and become available for plant use, apparently this N did not become available quickly enough following glyphosate application to satisfy the immediate needs of the corn crop.

Table 1. Economic optimum nitrogen rates in corn at a 0.15 nitrogen: corn price ratio.

Weed management strategy	Economic Optimum Nitrogen Rate (lb N/A)	
	2006	2007
Weed-free	96	39
4" removal	97	79
12" removal	200	220
Weedy	200	193

Boerboom et al. 2008. Univ. Wisconsin-Madison.

This research shows the complexity of crop-weed interactions, and the risk associated with allowing weeds to grow along with the crop for extended periods early in the growing season. In fields with moderate to heavy weed infestations, the use of pre-emergence herbicides will reduce or eliminate the effects weeds have on crops prior to post applications. The cost of the pre-emergence herbicide should be less than the additional N that may be needed to compensate for N usage by weeds.

[1] Economic optimum N rate: the point where the last increment of N returns a yield increase large enough to pay for the additional N.

****

Possible Limits to The Value Of Seed-Treatment Fungicides In Corn

Paul Vincelli, Plant Pathology, Forages, Turf, and Corn
University of Kentucky Extension

Pythium species are fungal-like organisms commonly found in agricultural soils. These are the primary cause of seed rot and seedling damping off in corn in Kentucky, and they are typically most active in cool, wet soils.

The trend towards earlier planting dates increases disease pressure on seedlings, because earlier-planted corn is more likely to sit in cool, wet soil before successfully establishing itself. The increased use of conservation tillage also increases pressure from Pythium seed and seedling diseases, since residue-protected soil does not dry out as quickly as plowed soil. The importance of effective fungicidal treatment of corn seed has increased because of these two trends.

A recent study by plant pathologists at The Ohio State University closely examined the Pythium organisms associated with seed and seedling problems in corn and soybean in Ohio. This article focuses on their findings for corn, which are summarized as follows:

1. The most common species isolated from diseased corn seeds and seedlings were Pythium sylvaticum and Pythium dissotocum. Less common were Pythium torulosum, Pythium irregulare and Pythium inflatum. One interesting find was that Pythium ultimum, the organism that typically has been regarded far and away as the Number 1 Pythium in corn, was infrequent in their surveys. Perhaps changes in cultural practices account for this shift; perhaps something else is at work; but either way, it is interesting how P. ultimum was so far down the list now.
2. Of the five most common Pythiums found in diseased corn seeds and seedlings, none were highly aggressive on corn. Two were moderately aggressive: P. sylvaticum and P. irregulare. These two species were relatively sensitive to the seed-treatment fungicides mefenoxam and captan but insensitive to the QoI fungicides azoxystrobin and trifloxystrobin.
3. P. dissotocum, P. torulosum, and P. inflatum were slightly aggressive on corn seeds and seedlings. Based on their results, less than complete control of P. dissotocum and P. inflatum would be provided by mefenoxam, trifloxystrobin, or captan. P. torulosum would be difficult to control completely with mefenoxam or captan.
4. Pythium graminicola was isolated less commonly than the five listed above, but it was aggressive on corn and insensitive to both mefenoxam and trifloxystrobin.

Significance
These results suggest that a diversity of Pythium organisms is responsible for seed and seedling disease in corn under current production practices. Significantly, these Pythiums are not all controlled by a single fungicide used for seed treatment. Because of this diversity, improving drainage and planting when soil temperatures exceed 50°F remain important cultural practices for minimizing seed and seedling diseases in corn. For fields and farms with a history of seed-establishment problems in cool, wet soils, consider using a mixture of seed-treatment fungicides to assure the best chance of success in stand establishment.

Are Corn Trend Yields Increasing at a Faster Rate?

Mike Tannura, Scott Irwin, and Darrel Good
Department of Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign

INTRODUCTION

Crop yields are affected by a complex combination of factors, such as weather, seed genetics, and producer-level management techniques. Despite this complexity, yields tend to show a general increase over time, which is commonly referred to as the "trend yield."

There has been considerable discussion in the agricultural community that improved technology has caused corn trend yields to increase at an increasing rate in recent years. Many farmers, crop experts, and seed companies credit biotechnology-driven improvements in seed genetics for the recent corn yield increases (Fitzgerald 2006).

Figure 1 provides an example of the empirical evidence often used to support a conclusion that corn yields since the mid-1990s have increased at an increasing rate relative to prior decades. As a result, there has been fairly widespread acceptance that a new and higher trend began in the mid-1990s and it should be used as a starting point for estimating future yields. While higher yields might be due to a new trend, such claims should be treated with caution since weather can have a large effect on trend yields estimated over short periods of time (Nielsen 2006).

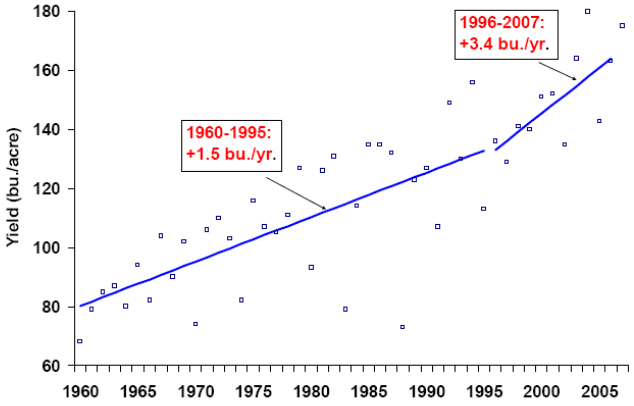

Figure 1. Illinois Corn Yields, 1960-2007

The purpose of this brief is to investigate whether trend yields in the U.S. Corn Belt have accelerated since the mid-1990s. The effect of both weather and technology on corn yields is estimated over a relatively long time period, 1960-2007, for three important corn producing states, Illinois, Iowa , and Indiana .

TREND ANALYSIS

Regression models were developed to estimate the separate effects of weather and technology on state-average corn yields in Illinois, Indiana, and Iowa over 1960-2007[1]. The three states were selected because they have similar weather and crop development time-scales and together they represent nearly half of U.S. corn and soybean production. A linear time trend variable was used as a proxy for technology. Weather variables included pre-season precipitation (September-April) and May through August monthly precipitation and temperature. The model specifications were based on the well-known work of Thompson (1963 1969 1970 1986).

Estimation results indicated that the models explained between 94 and 95% of the variation in corn yields for the three states. The results revealed that corn yields in the three states were particularly affected by technology, the magnitude of precipitation during June and July, and the magnitude of temperatures during July and August. Analysis of the estimated models showed that unfavorable weather reduced yields by a much larger amount than favorable weather increased yields. For example, 2 inches higher than average July precipitation in Illinois increased corn yields 6 bushels per acre, while 2 inches less than average reduced yields 16 bushels per acre.

Panel A of Figure 2 shows trend yield estimates for each state over 1960-2007. It is important to emphasize that these trend yield estimates were adjusted for the effect of weather, and therefore, may differ slightly from trend yield estimates based only on a technology variable. Not surprisingly, trend yield estimates over the entire sample period were similar for the three states. Corn yields increased at the fastest rate in Iowa and Illinois, with annual increases of 2.1 and 2.0 bushels per year, respectively. Trend yield increases in Indiana were slightly lower at 1.7 bushels per year.

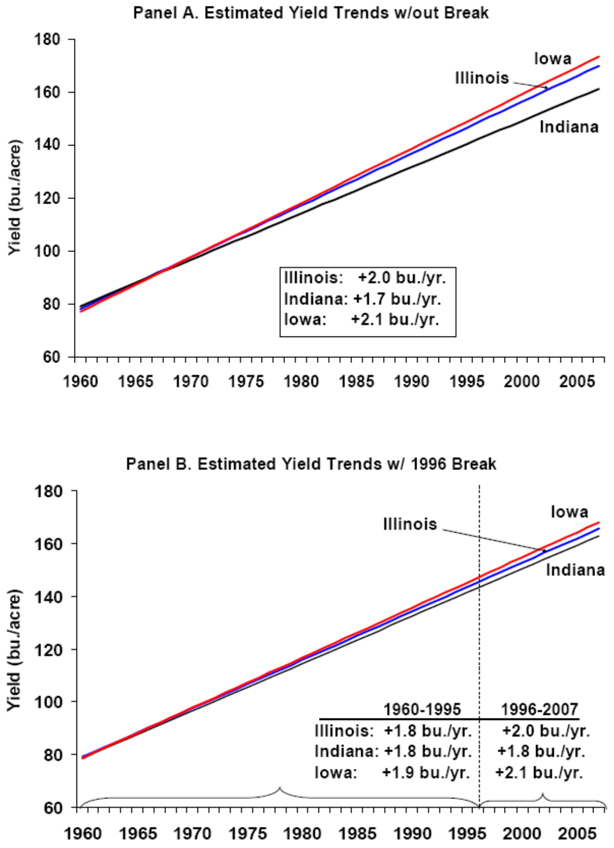

Figure 2. Estimated Trends in Illinois, Indiana, and Iowa Corn Yields after Adjusting for the Effect of Weather, 1960-2007

The regression models were re-estimated allowing separate trends before and after 1996. Panel B of Figure 2 shows the results of this analysis, which indicate that, the trend in corn yields since 1996 changed by very small magnitudes: +0.2, 0.0, and +0.2 bushels per acre in Illinois, Indiana, and Iowa, respectively. At most, the models estimated that yield trends increased by about two-tenths of a bushel after adjusting for the effects of weather. Furthermore, none of the changes in trend were statistically significant. The sensitivity of the results was examined by also fixing the breakpoint at 1994, 1995, 1997, and 1998. The magnitude of the estimated change in trend yields was not sensitive to the alternative breakpoints [2]. In sum, the regression models did not indicate that a notable increase in trend yields for corn occurred in the mid-1990s.

How can we reconcile the lack of evidence for an increase in corn trend yields with the widespread perception that trend yields accelerated over the last decade? One possibility is that observers failed to recognize the impact of relatively favorable weather since the mid-1990s, and thereby, mistakenly attributed corn yield increases to technology. Figures 3, 4, and 5 show key weather variables for the three states over 1960-2007. The top panel in each figure shows total June-July precipitation and the bottom panel shows average July-August temperatures. The regression model results indicated that these were the most important precipitation and temperature variables for corn production in Illinois, Indiana, and Iowa.

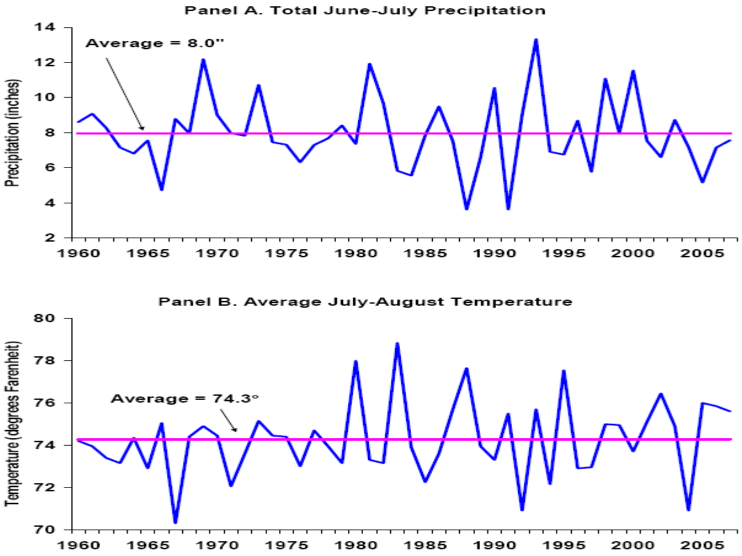

Figure 3. Key Illinois Weather Variables for Corn Production, 1960-2007

The charts show that weather for the period from the mid-1990s forward was relatively favorable for corn production. With the exception of 2005 in Illinois and 2006 in Iowa, June-July precipitation was near average or above average. July-August temperature since the mid-1990s was average or below average, particularly for Iowa. The absence of pronounced upward temperature spikes, such as those occurring in 1980, 1983, 1988, and 1995, was especially noteworthy. In fact, the 1970s through the mid-1990s in each state had at least five years in which weather was less favorable for the development of corn than any year from 1996 through 2007.

By any reasonable standard, weather in the three states since the mid-1990s has been fairly benign for corn development. While there were areas of severe drought during some years (e.g., western Illinois in 2005), the scope of these weather events was limited. If this pattern is not well-understood or ignored, the relatively “high” yields since the mid-1990s can be easily attributed to technology instead of weather.

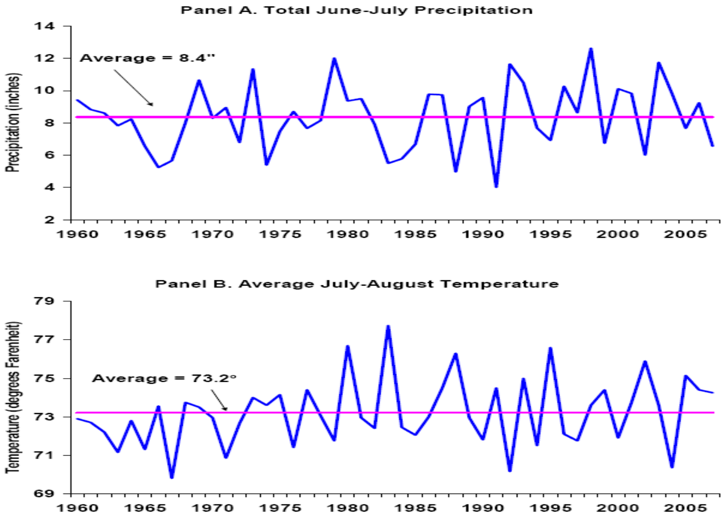

Figure 4. Key Indiana Weather Variables for Corn Production, 1960-2007

An alternative explanation for the regression results is that a shift to a higher trend in corn yields actually occurred in the last decade but there is not enough new data to detect the change. Two previous technological revolutions caused sharp jumps in trend yields (single cross hybrids in the late 1930s and nitrogen fertilizers in the late 1950s), so a shift would not be without historical precedent. As noted in the introduction, many farmers, crop experts, and seed companies credit biotechnology-driven improvements in seed genetics for recent corn yield increases.

Some experimental evidence provides support for the trend acceleration view. For example, Below et al. (2007) report that triple-stack corn varieties containing the bt-rootworm trait have a large yield advantage over non-bt varieties, as large as 50 bushels per acre. The authors note that yield advantages conferred by the rootworm trait are difficult to attribute entirely to rootworm control and hypothesize that the trait alters the corn plant's efficiency of nitrogen use. It is important to recognize that the experimental results reported by Below et al. are based on only one site (Urbana, Illinois) for one year (2007).

If the initial experimental results are confirmed, then widespread adoption of triple-stack corn varieties could well lead to an increase in trend yields. The June 2007 Acreage report prepared by the National Agricultural Statistics Service of the USDA indicated that stacked trait hybrids were planted on only 40%, 30%, and 37% of the corn acreage in Illinois, Indiana, and Iowa, respectively, in 2007.

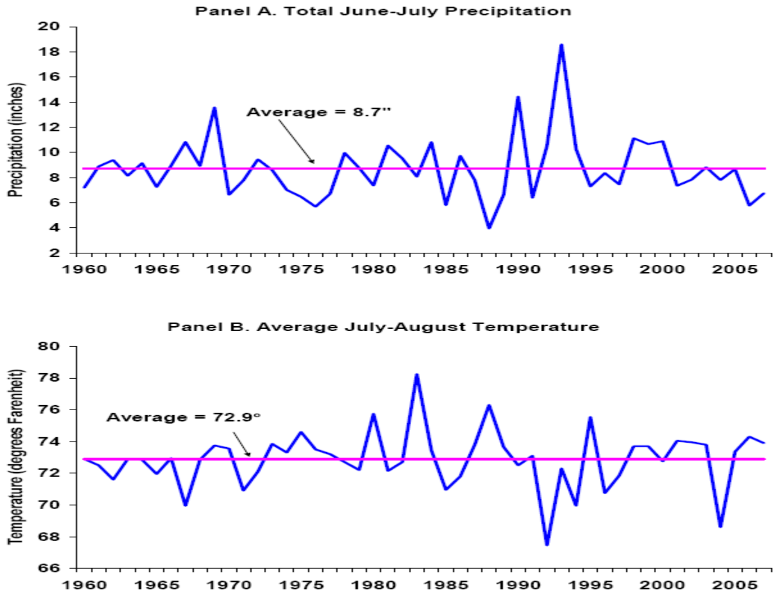

Figure 5. Key Iowa Weather Variables for Corn Production, 1960-2007

The pattern in estimation errors for the corn regression models in recent years also provides some support for the view that trend yields have accelerated. As shown in Figure 6, errors in recent years have had a tendency to be positive (actual yields greater than predicted yields). Specifically, estimation errors for the Illinois corn model were positive five out of seven years since 2001 and averaged +3.5 bushels. Errors for the Indiana corn model were also positive five out seven years since 2001 and averaged +0.9 bushels. Errors for the Iowa corn model were positive all seven years since 2001 and averaged +6.1 bushels. While intriguing, these results should be viewed cautiously for two reasons. First, the magnitude of the average errors is not large, perhaps with the exception of Iowa. Second, positive or negative runs of similar lengths can occur randomly and are not unprecedented. For example, estimation errors for the Iowa corn model were positive every year over 1969-1973 and averaged +7.0 bushels.

FUTURE TREND PROJECTIONS

The regression analysis indicated that, after adjusting for the impact of weather, a notable increase in the trend rate of yield growth for corn in Illinois, Iowa, and Indiana was not yet evident in the data through 2007. At the same time, there is some experimental evidence from university trials and anecdotal evidence from producers that stacked trait corn hybrids may be increasing trend yields. So, what assumption should be used to project corn yields into the future? This question is important not only to individual producers, but also to current policy debates about the amount of additional acreage that will be needed for corn production in the future to meet ethanol-driven demand growth. (See Dhuyvetter, Kastens, and Schroeder (2008) for an example.)

To provide an historical perspective on the question, Figure 7 plots state-average corn yields for Illinois from 1940-2007 and three alternative scenarios for future yield trends through 2030. The 1940-2007 period is divided into two sub-periods, 1940-1959 and 1960-2007. The 1940-1959 period, which coincided with the widespread adoption of single-cross corn hybrids, had a trend yield growth rate of 1 bushel per year. The 1960-2007 period was characterized by the widespread adoption of nitrogen fertilizer and chemical herbicides and had a trend yield growth rate of 1.7 bushels per year, a 70% jump compared to 1940-1959[3].

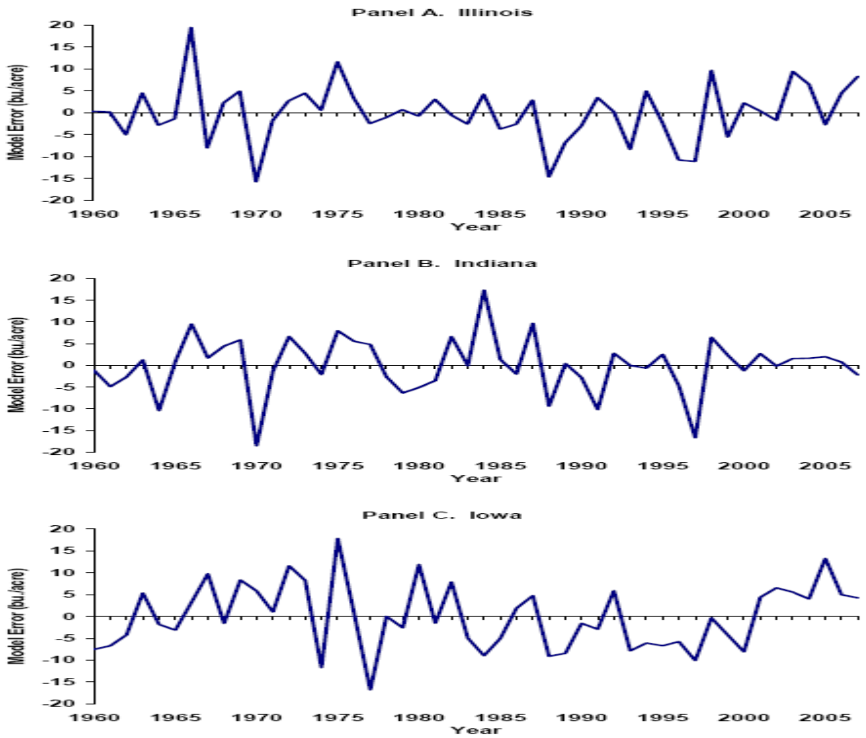

Figure 6. Weather and Technology Regression Model Errors for Corn Yields in Illinois, Iowa, and Indiana, 1960-2007

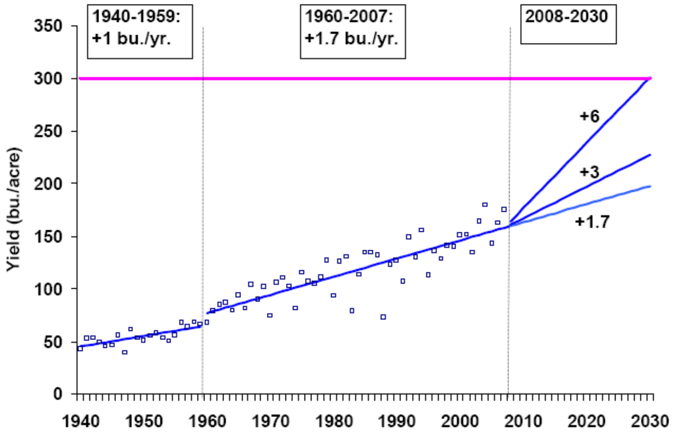

Figure 7. Illinois Corn Yields over 1940-2007 and Alternative Trend Yield Projections to 2030

The first scenario simply projects the trend yield for 1960-2007, 1.7 bushels per year, over 2008-2030. It would result in a state-average trend yield of slightly less than 200 bushels per acre in 2030. This scenario is consistent with the test results from the weather and technology regression model. The second scenario assumes that biotechnology-driven improvements in seed genetics will increase the growth rate of trend yields over 2008-2030 to 3 bushels per year, slightly more than a 75% increase compared to the 1960-2007 trend (3.0/1.7 = 76%). Note that this is about the same percentage change as the last major shift in trend yields that occurred around 1960 (1.7/1.0 = 70%). This would result in a state-average trend yield of about 225 bushels per acre in 2030. The third and final scenario is based on the much publicized goal of a 300 bushel per acre trend yield (Fitzgerald 2006). In order to achieve that goal by 2030 the rate of growth in trend yields for Illinois would have to be 6 bushels per year, or about 250% higher than the trend over 1960-2007[4].

Comparison of the trend yield projections to the historical record of Illinois corn yields suggests two important conclusions. First, reaching a trend yield of 300 bushels per acre in 2030 would require a rate of growth that is unprecedented both in terms of magnitude (6 bushels per year) and change from the previous rate (250%). Second, a jump in the trend yield growth rate to 3 bushels per year is within the range of historical experience since 1940.

FINAL THOUGHTS

It is interesting to consider the possibility that something of a historical cycle also may be at work. To begin, note the following prescient statement by Professor Louis Thompson at the end of his famous 1969 article on weather, technology, and corn production:

It is also significant that weather variability (affecting corn yields) has gradually decreased since 1930. As a consequence, there has been a decrease in year-to-year variations in corn yields. This trend in the improvement of weather and decrease in corn yield variability should be extrapolated with caution, however, because we may be near the end of a cool period occurring between periods of warmer than normal weather. Records in the U.S. Corn Belt indicate irregular cyclical weather, with periods of warmer summer weather alternating with periods of cooler summer weather. During this century, the decades of the teens, '30's, and '50's have been characterized by warm dry summers. If such a pattern persists, one might expect warmer and drier summers in the U.S. Corn Belt in the '70's and a temporary halt in the uptrend of corn yields. (p. 456)

Writing a few years later in 1975, Professor Thompson made the following observation on the importance of weather for crop yields:

There has been more than usual attention in the press to weather and climatic change since mid-1974. The United States had so little variability in weather and grain production in the past two decades (until 1974) that an attitude of complacency had developed. There was frequent reference in the early 1970's to the fact that technology had increased to such a level that weather was no longer a significant factor in grain production. (p. 535)

More unfavorable weather for the development of corn eventually followed in 1980, 1983, and 1988. This further identified the 1960s through the early 1970s as a favorable period for corn, with Professor Thompson stating in 1990 that:

The trend was very steep from 1960 to 1972 because the favorable weather each year resulted in excellent response to increasing technology. (p. 89)

The obvious question is whether a parallel should be drawn between weather patterns over 1960-1972 vs. 1973-1995 and 1996-2007 vs. future years. Without taking a position on the existence of long-term weather cycles or the potential impacts of global warming, history certainly suggests a good deal of caution in projecting recent and favorable weather patterns into the future.

[1] The analysis presented in this brief is based on the models and tests found in the research report by Tannura, Irwin, and Good (2008). The main difference is that the analysis reported here includes the recently available 2007 yield and weather observations. See the research report by Tannura, Irwin, and Good for a detailed discussion of the regression models and estimation results for 1960-2006.

[2] It should be pointed out that trend increases associated with the 1998 and 1999 breakpoints for Illinois and the 1999 breakpoint for Iowa were statistically significant. However, the magnitude of the estimated trend increases was still small, only about two-tenths of a bushel.

[3] The trend yield growth rate shown in Figure 7 for 1960-2007 is 0.3 bushels lower than the growth rate shown in panel A of Figure 2. As noted earlier, the difference is due to the adjustment for weather effects in the trend estimate reported in Figure 2.

[4] Technically, the rate of growth would have to be 6.2 bushels per year to achieve a 300 bushel state-average trend yield in Illinois by 2030.

References

Below, F.E., M. Uribelarrea, M. Ruffo, S.P. Moose, and A.W. Becker. “Triple-Stacks, Genetics, and Biotechnology in Improving Nitrogen Use of Corn.” Working Paper, Department of Crop Science, University of Illinois at Urbana-Champaign, 2007.

Fitzgerald, A. “ 300 Bushels per Acre Corn Yield No Longer a Pie-In-Sky Goal.” Des Moines Register , December 11, 2006.

Dhuyvetter, K.C., T.L. Kastens, and T.C. Schroeder. “Ethanol Industry – Impact on Corn and DGS Production.” Working Paper, Department of Agricultural Economics, Kansas State University, 2008. [http://www.agmanager.info/energy/TriStateDairyShortcourse(Jan2008)-2.pdf]

Nielsen, R.L. “Corn Grain Yield Trends: Eyes of the Beholder.” Corny News Network Articles, Department of Agronomy, Purdue University, June 15, 2006. [http://www.agry.purdue.edu/ext/corn/news/articles.06/YieldTrends-0615.html]

Tannura, M.A., S.H. Irwin, and D.L. Good. “Weather, Technology, and Corn and Soybean Yields in the U.S. Cornbelt.” Marketing and Outlook Research Report 2008-01, Department of Agricultural and Consumer Economics, University of Illinois at Champaign-Urbana, 2008. [http://www.farmdoc.uiuc.edu/marketing/reports]

Thompson, L.M. “Weather and Technology in the Production of Corn and Soybeans.” Report No. 17, Center for Agricultural and Rural Development, Iowa State University , 1963.

Thompson, L.M. “Weather and Technology in the Production of Corn in the U.S. Corn Belt.” Agronomy Journal 61(1969):453-456.

Thompson, L.M. “Weather and Technology in the Production of Soybeans in the Central U.S.” Agronomy Journal 62(1970):232-236.

Thompson, L.M. “Climatic Change, Weather Variability, and Corn Production.” Agronomy Journal 78(1986):649-653.