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Corn Grain Yield Trends: Eyes of the Beholder

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Determining state and/or national trends in corn grain yield and predicting future yields is a popular summer pastime of the locals down at the Chat 'n Chew Café. Yield trends based on long-term historical yields are relevant when yield change is steady over a long period of time. Conversely, changes in yield trend lines can occur when major improvements in genetics or production technology result in significant changes in productivity.

Corn grain yields in Indiana from 1866 to about 1930 changed very slowly, if at all (Fig. 1). The adoption of hybrid seed corn in the 1930's, followed by nitrogen fertilizers and herbicides in the 1940's represented "quantum leaps" in corn production technology for the Indiana corn grower. Consequently, the rate of increase in trend yield changed dramatically beginning about 1930 (Fig. 1).

The ability to recognize such "quantum leaps" in genetic potential or technology improvement can be difficult in the short term. The long-term effects of genetic or technological improvements are, by definition, not recognized for quite some time. Consequently, the time frame appropriate for determining yield trends is often in the "eyes of the beholder."

Personally, I believe current yield trends calculated from relatively lengthy historical time-spans are more reliable for predicting near-term future yields than those calculated from relatively short time-spans. Read on for the arguments I use to support that belief.

Supporting Arguments

Using historical corn grain yield data from USDA-NASS (2006), I performed simple linear regressions of yield versus production year for a number of datasets representing differing lengths of time-spans (Fig. 2). For example, calculating the trend line from the past 30 years of data (1976-2005) results in a linear rate of yield gain of ~1.7 bu/ac/yr with an R^2 of ~ 0.46. Yield trend lines calculated for time-spans varying from 30 to 70 years exhibit similar rates of yield increase per year (~ 1.7 bu/ac/yr), but ever-decreasing R^2 values (i.e., less reliable) as the reference time-span decreases.

Trend lines calculated from shorter time-spans (< 30 years) suggest that the rate of annual yield improvement in corn is increasing, but the R^2 values associated with these shorter-term regressions are generally quite small (i.e., even less reliable). The latter issue of ever-smaller R^2 values makes me naturally less trusting of short-term trend lines.

If the actual rate of yield gain in recent years was significantly greater than that calculated over a much longer time-span (e.g., 3.7 bu/ac/yr calculated from the past 10 years in Fig. 2 versus 1.7 bu/ac/yr calculated from the past 70 years), then I believe one should begin to see ever-larger departures from that 70-year trend line. The data shown in Fig. 3 represent such departures (%) from trend yield in Indiana since 1960 relative to a trend line calculated from state corn yields of the past 75 years (~1.6 bu/ac/yr, $R^2 = 0.9$).

There does not appear to be either an increase in the frequency of positive departures from trend in recent years or an increase in the magnitude of the departures that do occur. To me, this suggests that a trend line calculated with 70+ years of yield data accounts nicely for the variability in actual yields throughout that time period, including those in recent years ($R^2 = 0.90$) and that there is likely no significant change in the slope of the trend line in recent years.

Finally, I can illustrate the hazards of calculating trend lines based on short-term datasets with the two trend lines depicted in Fig. 4. The data points shown represent state average corn grain yields over the past 46 years (1960-2005).

The blue trend line was calculated from the entire 46-year dataset and would suggest a linear rate of yield gain of ~1.6 bu/ac/yr with an R^2 of 0.7 (not bad, but not as good as that based on 70+ years of data). The red trend line was calculated for a 10-year time-span from 1970 to 1979 and would suggest a linear rate of ~2.5 bu/ac/yr with a smaller R^2 of 0.3 (much less reliable than that calculated from 46 years of data). If one then extrapolates the red trend line all the way to 2005, the reliability issue becomes clear because a trend line equal to ~2.5 bu/ac/yr based on 10 years of data would have significantly over-estimated future yields for the overwhelming majority of the subsequent 26 years.

Summary

Admittedly, I picked a 10-year period that supported my argument. But that's the point, isn't it? One never knows whether any particular 10-year period is truly predictive of the future. In summary, what I'm trying to say is that what we think we see today as a short-term trend based on the past 10 years may be just as erroneous as that we would have calculated in 1980 from the 10 years prior to that. This opinion will change come the day when another truly "quantum leap" in corn production technology occurs. In the short term, weather likely impacts year-to-year departures from trend yields more significantly than do current genetics or production technologies.

The eyes of this beholder.

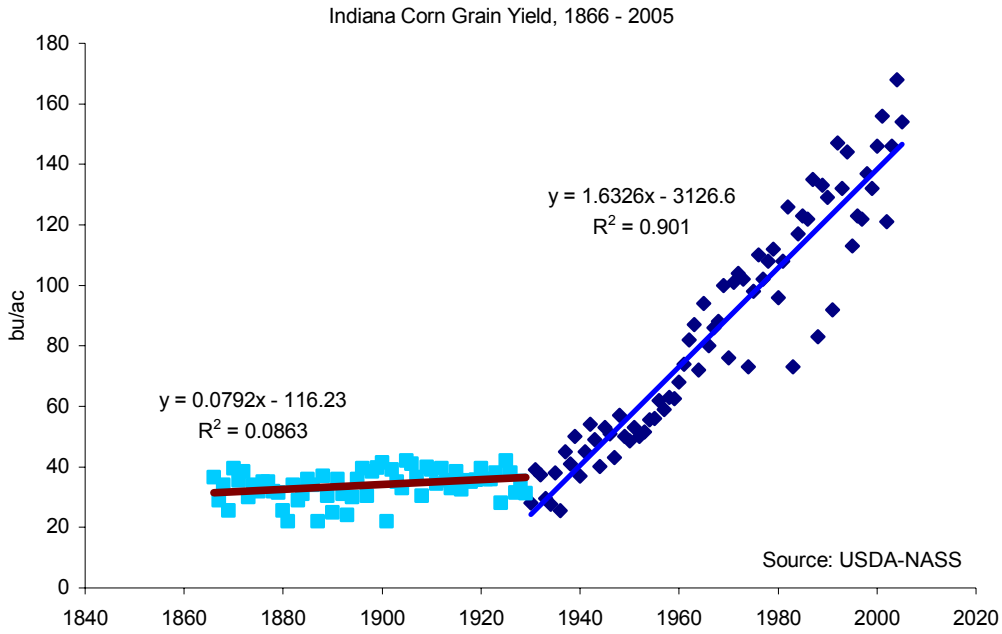

Fig. 1. Historical corn grain yields for Indiana from 1866 to 2005 and linear regressions of yield versus production year for two time periods. Source of yield data = USDA-NASS (2006).

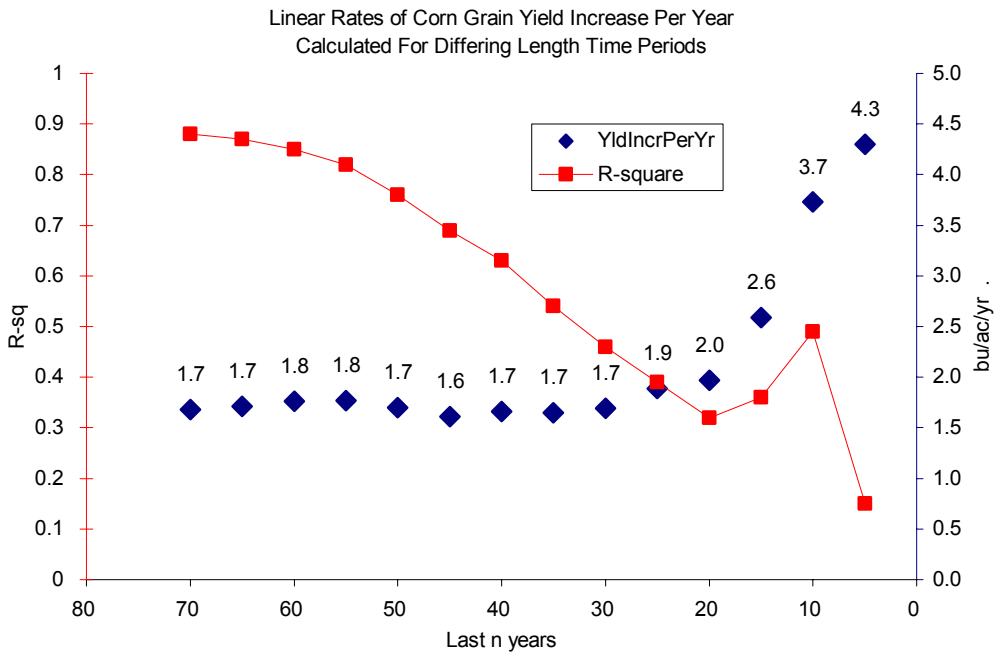

Fig. 2. Linear rates (b coefficients) of corn grain yield increase per acre per year calculated by simple linear regression of state average corn grain yield (Indiana) versus production year over differing length time periods. Source of yield data used in the regressions = USDA-NASS (2006).

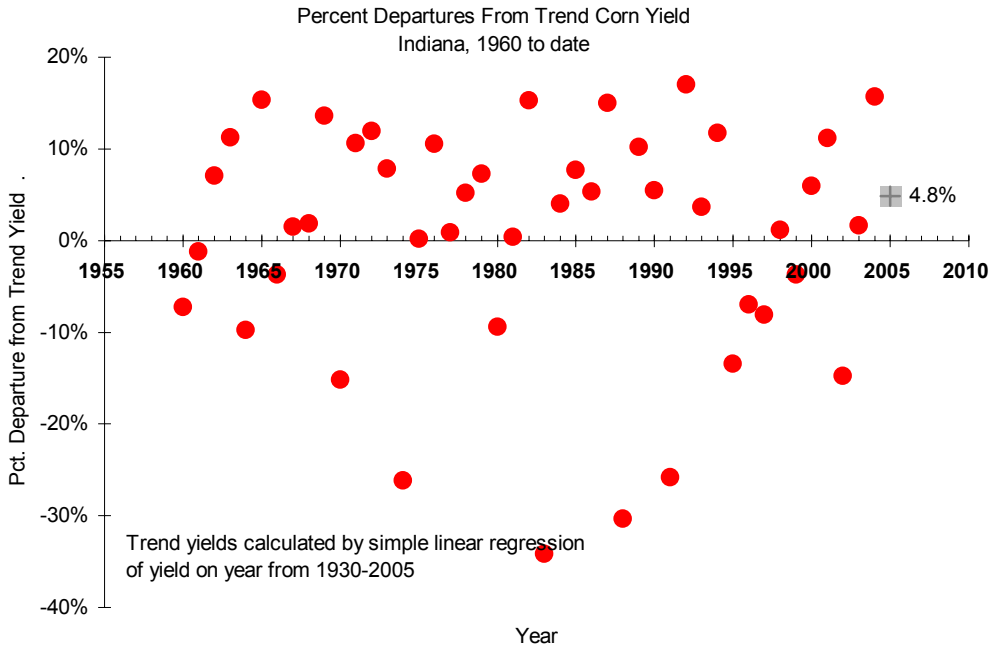

Fig. 3. Departures from estimated trend corn yield for Indiana over the past 46 years. Trend yields estimated from simple linear regression of grain yield versus production year for the time period 1930-2005. Source of yield data used in the regressions = USDA-NASS (2006).

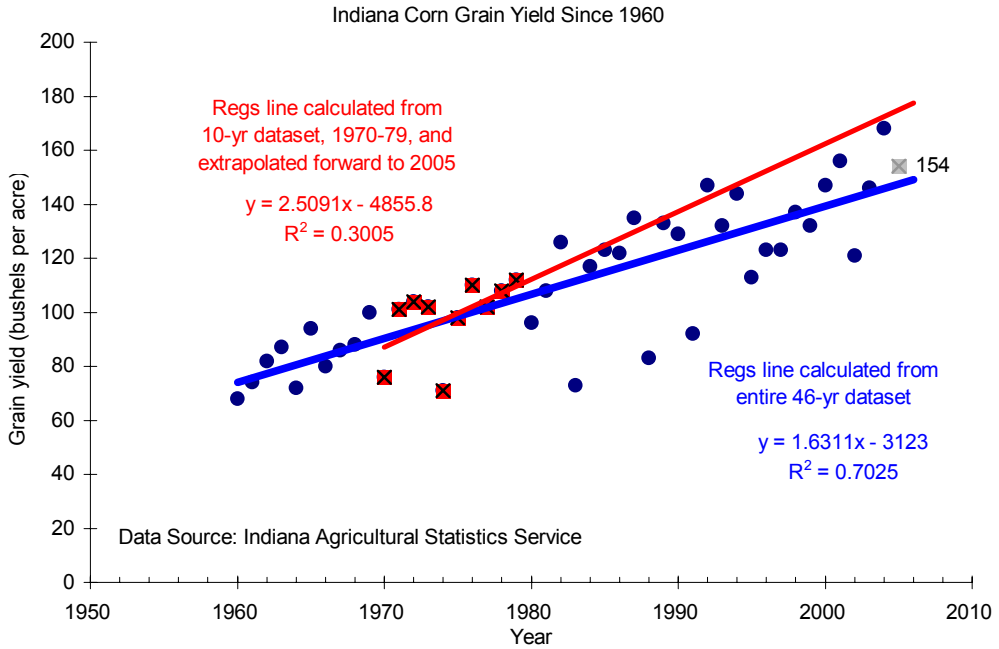

Fig. 4. Two trend lines for Indiana corn grain yield over time based on short-term (10 years) versus long-term (46 years) yield data. Short-term trend line was extrapolated to 2005. Source of yield data used in the regressions = USDA-NASS (2006).

References

USDA-NASS. 2006. **Quick Stats - U.S. & All States Data - Crops.** USDA-National Agricultural Statistics Service. Online at http://www.nass.usda.gov:8080/QuickStats/Create_Federal_All.jsp [URL verified 6/15/06].

Don't forget, this and other timely information about corn can be viewed at the Chat 'n Chew Café on the Web at http://www.kingcorn.org/cafe. For other information about corn, take a look at the Corn Growers' Guidebook on the Web at http://www.kingcorn.org.