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

Long Term Relationship between Yield and Acres of U.S. Field Crops

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The U.S. has been more dependent than other major exporters on yield to increase production of corn, soybeans, and wheat (*farmdoc daily,* July 13, 2017). This article continues to examine the role of yield. A strong, positive association is found between long-term growth in U.S. yield and change in acres planted to 9 historically large acreage U.S. farm program field crops. Planted acres increased or declined less for the crops with the largest increase in yield (corn, upland cotton, peanuts, rice, soybeans) while declining most for crops with the smallest increase in yield (barley, oats, sorghum, wheat). This finding implies both the importance of funding yield-enhancing research and a potential role for it to improve environmental performance.

Data and Procedures: Percent change in planted acres and yield per planted acre is calculated between two 5-year periods: 1978-82 crop years and 2013-17 crop years. Five year averages are used because of the annual variability in yield and acres. Data for the calculations are from *Quick Stats* (U.S. Department of Agriculture (USDA), National Agricultural Statistics Service). Three other decisions regarding the data and procedures are discussed in data note 1.

Long-Term Yield Growth: The growth in average yield per planted acre from crop years 1978-82 to 2013-17 divides crops into 2 groups: corn-cotton-peanuts-rice-soybeans with increases of 57% to 63% vs. barley-oats-sorghum-wheat with increases of 21% to 30% (see Figure 1).

Long-Term Yield Growth and Acreage Change: A strong positive relationship exists between long-term yield growth and acreage change. A linear regression finds that the different percent changes in yield across the 9 crops explains 82% of the variation in their different percent changes in planted acres (see Figure 2 and data note 2). A 1 percentage point larger cumulative increase in yield is associated with a 1.9 percentage point increase in planted acres. Planted acres increased for soybeans, corn, and peanuts,

which have 3 of the 4 largest increases in yield. In contrast, planted acres declined by at least 30% for the 4 crops with the lowest growth in yield (oats, barley, sorghum, wheat).

Figure 1. Percent change in yield per planted acre, U.S., 1978-82 to 2013-17 (oats is yield per harvested acre)

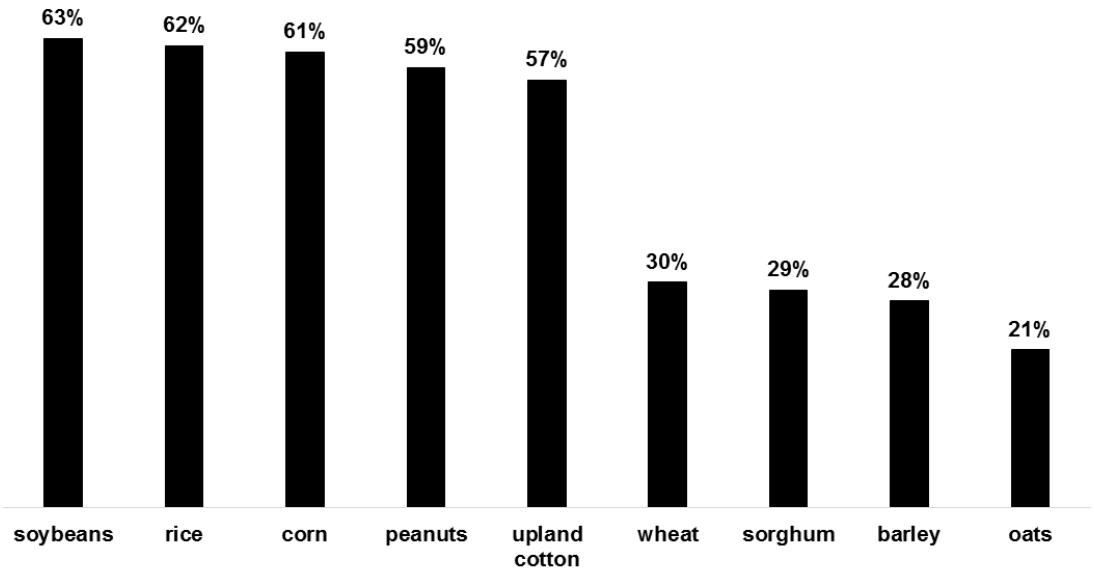
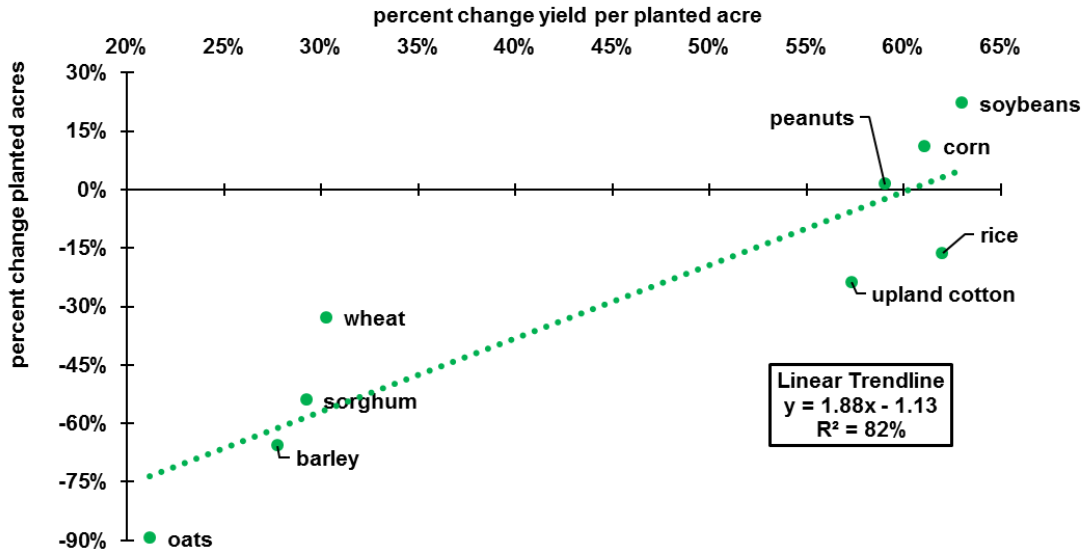


Figure 2. Percent change in planted acres vs. percent change in yield per planted acre, 1978-82 to 2013-17, selected field crops, U.S.



Summary Observations

- A strong positive relationship is found between the increase in yield and change in planted acres since 1978 for 9 historically large acreage farm program field crops.
- Regression analysis does not imply causality; however, good reasons exist to believe a causal relationship exists. All else equal, higher yield growth should result in higher profits for the crop which, in turn, should encourage farmers to plant more acres of that crop.

- Importance of yield-enhancing research to the future of U.S. corn, soybean, and wheat exports was noted in the July 13, 2017 *farmdoc daily* article. This analysis implies its importance to the portfolio of crops planted in the U.S. In particular, acres of barley, oats, sorghum, and wheat will likely continue to decline unless their yield growth accelerates.

- Substitution of high yield-growth corn for low yield-growth barley, oats, and sorghum in the feed grain market is part of this storyline (see also, *farmdoc daily* April 25, 2017).

- Part of a broader storyline is differential change in demand (for example, soybeans benefit from growth in high protein livestock feed while cotton faces competition from synthetic fibers).

- Potential for yield-enhancing research to improve environmental performance also exists. Barley, oats, and wheat are often cited for their ground cover and rotational benefits, yet acres are declining. This analysis suggests that low yield growth is likely a contributing factor.

Data Notes

1. (a) The analysis begins with crop year 1978 because the 1977 farm bill ended marketing and production quotas for rice and cotton (USDA, Economic Research Service, December 1984). Moreover, annual acreage set-asides were limited during 1978-82 and did not exist in 2013-17. (b) Even though peanuts had marketing quotas until the 2002 farm bill, this analysis includes peanuts since excluding them had little impact on the analysis. For example, R^2 for the regression of percent change in yield on percent change in planted acres only changed from 82% to 81% when peanuts were excluded. (c) Harvested acres and yield per harvested acre are used for oats because share of planted oats acres harvested has declined from 69% in 1978-1982 to 36% in 2013-2017, or by 33 percentage points. The next largest decline is 8 percentage points for barley. The large decline in harvested share for oats is usually attributed to the use of oats as a cover crop, including establishment of hay fields.

2. Given that yields are not final for the 2017 crop year, the linear regression was estimated using data ending with the 2016 crop year. This analysis also serves as an empirical sensitivity test. The different percent changes in yield across the 9 crops from 1978-82 to 2012-16 explains 73% of their different percent change in acres. While the share of variation explained is smaller, it remains statistically significant at the 99.7% level of statistical confidence. A 1 percentage point larger cumulative increase in yield is associated with a slightly smaller 1.8 percentage point increase in planted acres. In summary, the linear regression results are robust with respect to the two different ending dates for the analysis period.

References and Data Sources

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