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Corn, Soybean, and Wheat Trends by Ohio County, 1972-2018

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Corn, Soybean, and Wheat Yield Trends by Ohio County, 1972-2018

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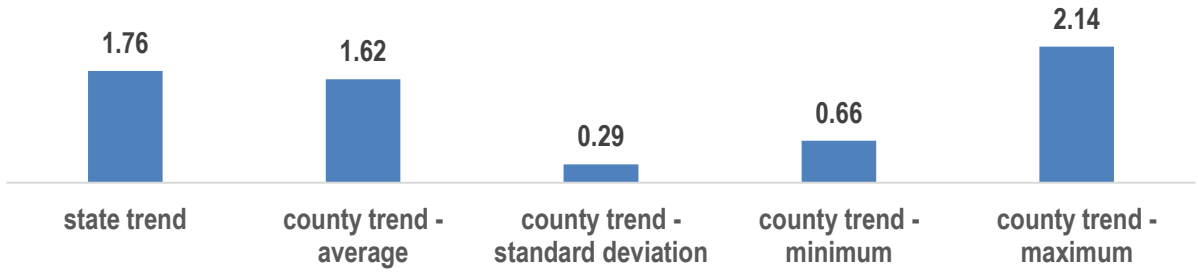
Yield growth is the primary source of increased production of crops in Ohio and most of the US. Most land that can be cropped is being cropped. Understanding historic yield trends is thus important to an informed understanding of Ohio agriculture. This article examines trends in corn, soybean, and wheat yields since 1972 at the Ohio state level and across Ohio counties. These three crops composed 87% of Ohio harvested crop acres in the *2017 Census of US Agriculture*. Trend yield is higher for corn than soybean and wheat, both in terms of bushel / acre and percent of yield. Trend yields vary across Ohio counties, particularly for corn. Implications are drawn for Ohio crop agriculture, with a particular point of interest being the implication for the CAUV (Current Agricultural Use Value) program that taxes farm land at its agricultural use value rather than its appraised value.

Analysis: Yield per harvested acre is analyzed. Source for the data is USDA, NASS (US Department of Agriculture, National Agricultural Statistics Service). The analysis starts with the 1972 crop and ends with the 2018 crop. It spans 47 years that include periods of prosperity, financial stress, and tight profit margins. Not all counties have 47 years of observations for each crop. It was decided a county should have at least half or 24 years of observations to be included in the analysis. This decision reflects (1) consideration of the power of statistical tests, (2) that 24 years is a "natural break" in the distribution of number of county yield observations, and (3) a feeling that it seems reasonable to require yields for at least half of all years in order to have confidence in a county's estimated trend yield. Counties with 24 years of harvested yields total 86, 78, and 69 for corn, soybeans, and wheat, respectively. The county yield trends were tested for statistical difference from the yield trend for Ohio. For additional discussion of the analytical procedures, see the Data Note.

Corn Yield Trend: Ohio linear corn yield trend is +1.76 bushel / year over 1972- 2018 (see Figure 1). In comparison, average of the 86 county yield trends estimated for corn is +1.62 bushel / year. Since the state yield is the average of county yield weighted by the amount of production in the county, the higher state trend yield suggests counties with more corn production had a higher yield trend.

Figure 1. Corn linear yield trend summary statistics, Ohio, 1972-2018



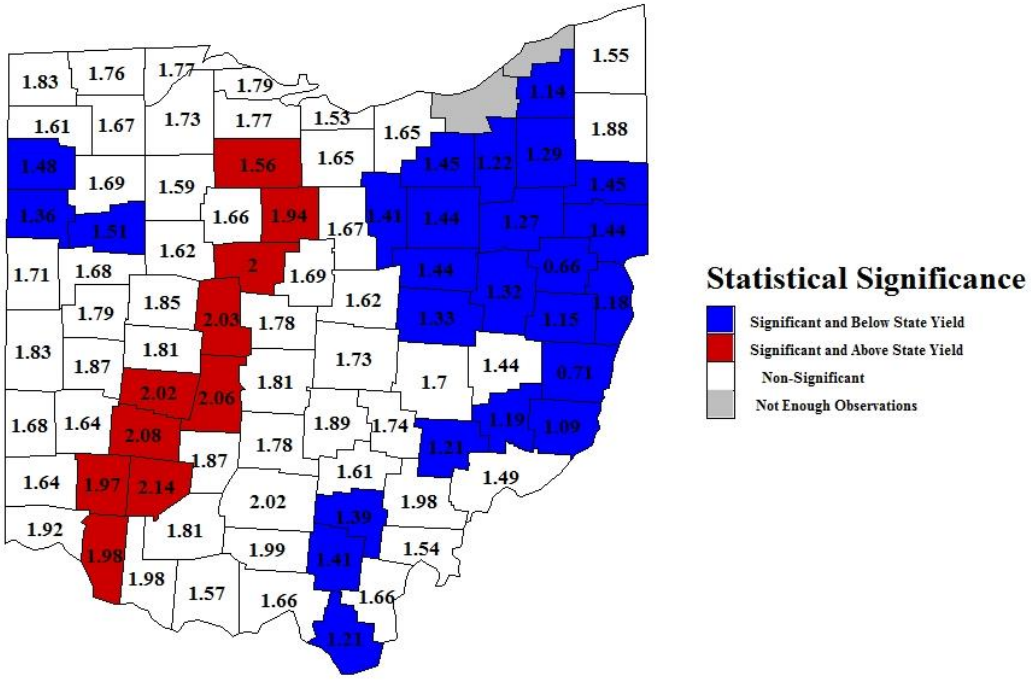
County corn yield trend ranged from +0.66 (Carroll County) to +2.14 (Clinton County) (see Figures 1 and 2). When examining the range of values, it is useful to assess if the extreme values are outliers. Examination of the county corn yield trends suggests that both Carroll and the county with the next lowest trend (Belmont - +0.71) are outliers as the next lowest yield trend is +1.09 for Monroe County.

Individual county yield trends were tested for statistically significant deviation from Ohio's yield trend (see Date Note). Thirty-five (41%) of county corn yield trends deviated from the state yield trend with the commonly-used 95% level of statistical confidence (see Figure 2). Corn yield trend was above (below) the state corn yield trend in 9 (26) counties. It was thus almost three times more likely for statistically significant county yield trends to be below than above the Ohio trend yield. Counties with

a statistically significant lower trend have a tendency to be in eastern Ohio (see Figure 2). Statistically significant higher corn yield trends have a tendency to be in southwestern and central Ohio.

Figure 2. Annual Trend in Yield (bushel per harvested acre)

Corn-Ohio Counties, 1972-2018



Significance is calculated as different than state yield trend at 95% confidence

Soybean Yield Trend: Ohio linear soybean trend yield is +0.48 bushel per year over 1972-2018, the same as the average of the 78 county trend yields estimated for soybeans (see Figure 3). Unlike corn, this comparison does not suggest county soybean yield trend varied with amount of county production.

Figure 3. Soybean linear yield trend summary statistics, Ohio, 1972-2018

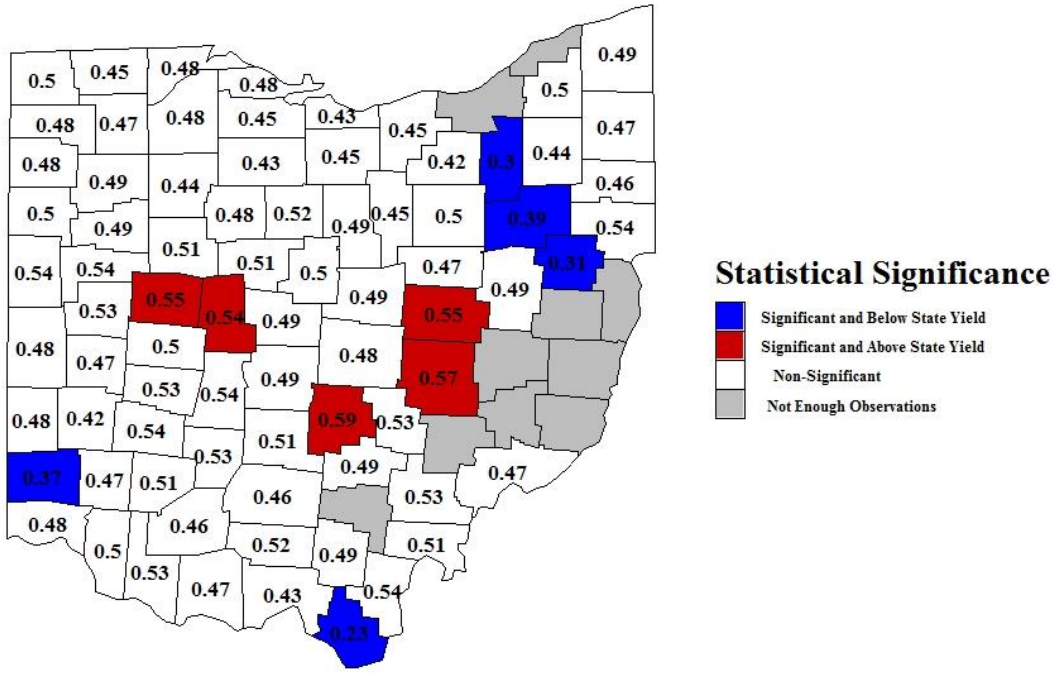
County soybean yield trend ranged from +0.23 (Lawrence County) to +0.59 (Fairfield County) (see Figures 3 and 4). Lawrence County may be an outlier as the next lowest soybean yield trend was Summit County at +0.30 bushel per year.

Statistically significant deviation from the state yield trend was far less common for soybeans than corn. Only 10 (13%) of county soybean yield trends deviated from the state yield trend with 95% statistical confidence (see Figure 4). Five were below and 5 were above the state trend. The small

number of counties with statistically significant deviations from the state yield trend calls for caution in making regional categorization of these deviations. Given this caveat, the 5 counties with trend yield above the Ohio trend yield are in central Ohio.

Figure 4. Annual Trend in Yield (bushel per harvested acre)

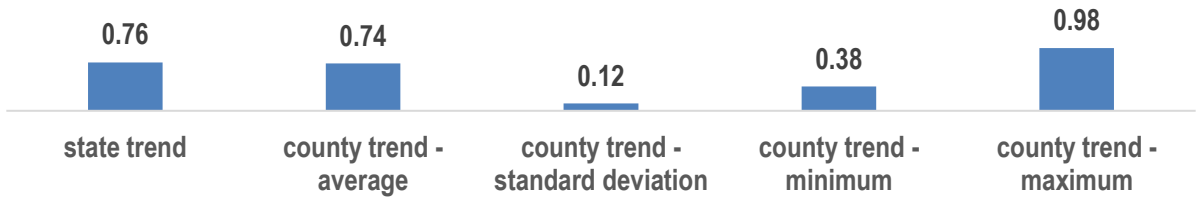
Soybean-Ohio Counties, 1972-2018



Significance is calculated as different than state yield trend at 95% confidence

Wheat Yield Trend: Ohio's linear wheat yield trend is +0.76 bushel per year over 1972-2018, nearly identical to the average of the 69 county yield trends estimated for wheat (see Figure 5). Similar to soybeans and unlike corn, this comparison does not suggest wheat county yield trend varied with amount of county production.

Figure 5. Wheat linear yield trend summary statistics, Ohio, 1972-2018



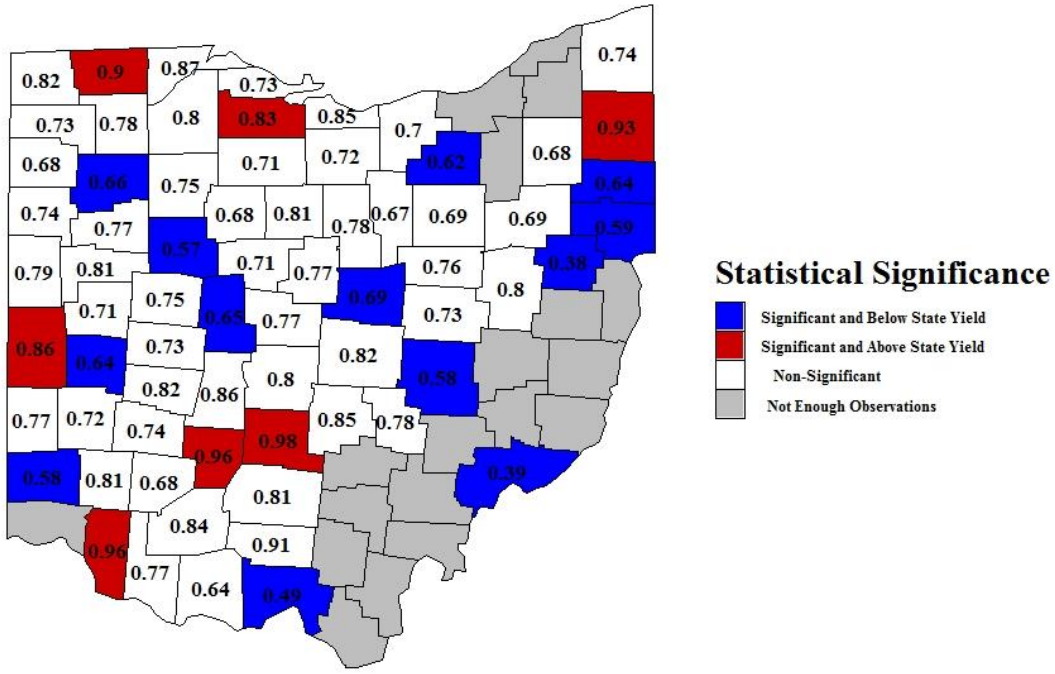
County wheat yield trend ranged from +0.38 (Carroll County) to +0.98 Pickaway County) (see Figures 5 and 6). There did not appear to be any obvious outlier county wheat yields.

Twenty (29%) of the county wheat yield trends deviated from Ohio's wheat yield trend with 95% statistical confidence (see Figure 6). As with corn, it was more common for a county yield trend that

differed from the Ohio yield trend with statistical significance to be above than below Ohio's trend (13 vs. 7). No clear regional category of deviations from the state wheat trend yield is apparent. Counties with significant deviations from the state trend are dispersed across Ohio (see Figure 6).

Figure 6. Annual Trend in Yield (bushel per harvested acre)

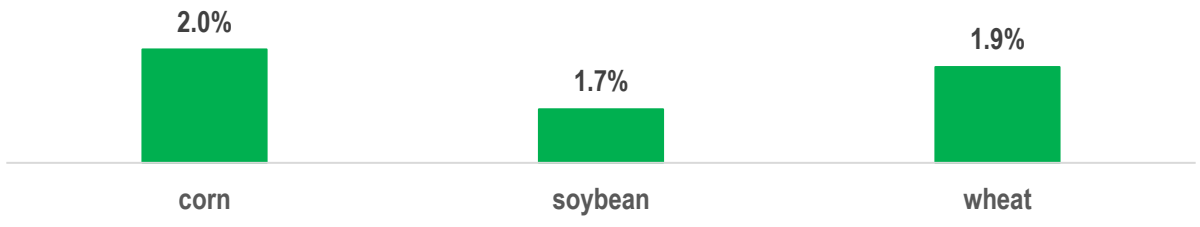
Wheat-Ohio Counties, 1972-2018



Significance is calculated as different than state yield trend at 95% confidence

Comparing Yield Trend across Crops: Comparing yield trend across corn, soybeans, and wheat is complicated by their different yield levels. Given the use of regression analysis, one useful measure of yield level is the estimated intercept value for 1972. These intercepts for Ohio corn, soybeans, and wheat are 87, 29, and 40 bushels/acre, respectively. Taking the ratio of Ohio trend yield to the Ohio intercept finds that yield grew fastest for corn (2.0%) and slowest for soybeans (1.7%) (see Figure 7). The difference may seem small, but it is an annual difference that has extended over 47 years.

Figure 7. Ratio of linear yield trend to yield intercept, Ohio corn, soybeans, and wheat, 1972-2018



Another useful comparison is to examine the relative variation in county yield trends by crop. One such measure is the ratio of the standard deviation of county yield trends to the average county yield trend. Using the values in Figures 1, 3, and 5, the so-called coefficient of variation ratio is 18% for

corn, 12% for soybeans, and 16% for wheat. Eliminating the two outlier county yield trends for corn reduces its coefficient of variation to 15%. The coefficient of variation thus suggests that soybean yield trends varied less across Ohio counties than did corn and wheat yield trends.

Summary Observations:

- ► Linear yield trend is higher for Ohio corn than soybeans, with wheat in between.
- ► Among the three crops, soybean yield trends differ the least across Ohio's counties.
- ► County yield trends are more likely to deviate from Ohio's yield trend with statistical significance for corn than for soybeans.
- ► Only readily-apparent regional patterns in yield growth are a higher probability of slower yield growth for corn in eastern Ohio and faster yield growth for corn in central and southwestern Ohio.
- ► Corn's differential yield trends have likely differentially impacted profitability of crop agriculture across Ohio's counties.
- ► Statistically significant differences in county yield growth from state yield growth pose a potential policy issue for Ohio's CAUV (Current Agricultural Use-Value) Program. CAUV determines assessed value for a majority of agricultural land in Ohio. It uses a net-income approach partially based on a soil type's yield potential for corn, soybeans, and wheat. Potential yield for a soil type partially comes from the state's most recent comprehensive soil survey (Zobeck, Gerken, and Powell, 1983). This yield value, from the early 1980s, is then adjusted based on the state-wide trend in harvested yield for each of the three crops. The significant differences between county and state-wide yield trends raises the potential issues of whether or not the use of state-wide yield trends to adjust a soil productivity index dating to the early 1980s continues to be appropriate policy and thus if an update of the soil productivity index may be an appropriate policy option.

Data Note: The statistical method used for this analysis is multiple linear regression. Unit of observation is a county-year in Ohio from 1972 to 2018. Statewide yield is included as well. Dependent variable is county yield (for corn, soybeans, or wheat) for a given year. It is regressed on time, measured as a count of years starting with 1972 equal to zero. A county specific intercept and a county specific annual trend are estimated. The statistical test of interest is if a county specific annual yield trend is statistically different from the statewide annual yield trend for a given crop. Since the county specific annual trend and statewide annual trend are both estimated coefficients, an F-Test is constructed with the null hypothesis that the two trend coefficients are equal to each other. An F-test rejection of a null hypothesis is a function of both the difference between the two estimated coefficients and the estimated standard error of the coefficients.

References and Data Source:

US Department of Agriculture, National Agricultural Statistics Service. (April 2019). *2017 Census of Agriculture: United States Summary and State Data*. Volume 1, Geographic Area Series, Part 51. AC-17-A-51 www.agcensus.usda.gov

Zobeck, TM, JC Gerken, and KL Powell. 1983. "Ohio Soils with Yield Data and Productivity Index." Ohio State Univeristy Cooperative Extension Service. Bulletin 685.