Precision Agriculture Adoption and Corn Yields in the United States: An Ecological Analysis

Introduction

Advances in agricultural technology have increasingly emphasized precision agriculture, which integrates digital monitoring, automation, and data-driven decision-making to improve efficiency and sustainability. In recent years, U.S. government agencies have begun tracking precision agriculture adoption and offering incentive programs to encourage its use.

This study examines whether counties located in states with higher reported precision agriculture adoption exhibit higher average corn yields. Using county-level yield data combined with state-level adoption estimates, this analysis evaluates the association between reported precision agriculture use and corn productivity across the United States.

Methods:

The variables used in analysis were bushels of corn per acre (a numeric variable in bushels), and a categorical binary variable of high precision agricultural use (1 for yes, and 0 for no; this was determined by a statewide precision agriculture use of more than 40% for 1). Due to there being one numeric variable versus a binary categorical variable, I used a left-tailed 2 sample t-test. I created histograms to check the distribution of corn yield for both groups. The group without high precision agriculture had a normal, bell-shaped curve. The group with high precision use was a bit skewed but still centered around higher yields. Since each group had a large sample size (over 600 counties), it's appropriate to use a two-sample t-test because the Central Limit Theorem says large samples make the test valid even if the data isn't perfectly normal.

Precision agriculture adoption is measured at the state level and assigned uniformly to all counties within each state. As a result, county observations are not independent with respect to the precision agriculture variable. While county-level yield data provides granular outcome measurement, statistical inference must account for clustering at the state level. Accordingly, this study reports descriptive comparisons using a two-sample t-test and conducts corrected inference using state-clustered standard errors and state-level aggregation as robustness checks.

Results

Counties located in states with higher reported precision agriculture adoption exhibit higher average corn yields, with a mean difference of approximately 16.6 bushels per acre. Descriptive comparisons using a two-sample t-test indicate a statistically significant difference in mean yields between counties in high-adoption and low-adoption states.

However, when statistical inference accounts for clustering at the state level, this difference is not statistically significant at conventional levels. These results suggest a positive association between reported precision agriculture adoption and corn yields, though the magnitude and statistical significance of the relationship are sensitive to the level at which adoption is measured.

Conclusion

This analysis finds that corn yields are higher, on average, in counties located within states reporting higher precision agriculture adoption. Because adoption is measured at the state level, the results should be interpreted as ecological associations rather than causal effects.

Future research would benefit from county- or farm-level adoption data, as well as controls for soil quality, climate, and regional agricultural practices. Improved data granularity would allow for more precise estimation of the relationship between precision agriculture technologies and crop productivity.