Majority of production shocks for major US crops explained by fluctuations in planted and harvested area

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Abstract

Ensuring the stability of food production is essential for adapting food systems to rising climate variability. Food production instability is determined by changes in yield, planted area, and the ratio between planted and harvested area. Yet most research has focused on evaluating and improving the response of crop yields to climate fluctuations, and there remains a poor understanding of whether and to what extent changes in planted and harvested areas affect crop production stability. Here we use the example of corn in the United States, the country's most widely produced crop, to evaluate the relative importance of disruptions in yield, harvested area, and the planted: harvested area ratio in contributing to production instability. We apply a new time-series shock detection approach to data covering 2511 counties from the years 1970 to 2020. We find that disruptions in yield, ratio, and planted area explain 34%, 32%, and 20% of total production instabilities, respectively. Considering multiple shocks could happen simultaneously, 48% of the production fluctuations coincided with area (either ratio or planted area) instabilities. In terms of shocks (negative disruptions), the proportion of production shocks occurring concurrently with area shocks rises to 54%, and with yield shocks rise to 45%. The greater impact on production shocks confirms the risk of area shocks to production fluctuation and food security. Based on correlation analysis between the county level ratio shocks and the frequencies of six natural disasters, we show that ratio shocks are significantly correlated with the occurrence of flood, drought, and hail ($P<0.001$). These findings suggest that fluctuations in planted and harvested area may determine production instability more frequently than yield and that decisions about cropping patterns can thus play a crucial role in stabilizing food production in the face of climate variability.

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Majority of production shocks for major US crops explained by fluctuations in planted and harvested area

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Ensuring the stability of food production is essential for adapting food systems to rising climate variability. Food production instability is determined by changes in yield, planted area, and the ratio between planted and harvested area. Yet most research has focused on evaluating and improving the response of crop yields to climate fluctuations, and there remains poor understanding of whether and to what extent changes in planted and harvested areas affect crop production stability. Here we use the example of corn in the United States, the country's most widely produced crop, to evaluate the relative importance of disruptions in yield, harvested area, and the planted:harvested area ratio in contributing to production instability. We apply a new time-series shock detection approach to data covering 2511 counties from the years 1970 to 2020. We find that disruptions in yield, ratio, and planted area explain 34%, 32%, and 20% of total production instabilities, respectively. Considering multiple shocks could happen simultaneously, 48% of the production fluctuations coincided with area (either ratio or planted area) instabilities. In terms of shocks (negative disruptions), the proportion of production shocks occurring concurrently with area shocks rises to 54%, and with yield shocks rises to 45%. The greater impact on production shocks confirms the risk of area shocks to production fluctuation and food security. Based on a correlation analysis between the county level ratio shocks and the frequencies of six natural disasters, we show that ratio shocks are significantly correlated with the occurrence of flood, drought, and hail ($P<0.001$). These findings suggest that fluctuations in planted and harvested area may determine production instability more frequently than yield and that decisions about cropping patterns can thus play a crucial role in stabilizing food production in the face of climate variability.

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MAJORITY OF PRODUCTION SHOCKS FOR U.S. CORN EXPLAINED BY FLUCTUATIONS IN PLANTED AND HARVESTED AREA

Dongyang Wei, Kyle F Davis

Dec. 2021

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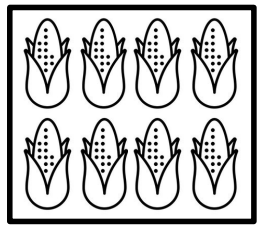
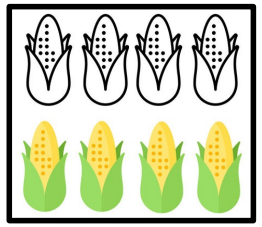
Majority of production shocks for U.S. corn explained by fluctuations in planted and harvested area

Food Security → **Food Stability**

$$\underset{(acre)}{planted\ area} \times \underset{fraction}{harvestable} \times \underset{(bushel/acre)}{yield} = \underset{(bushel)}{production}$$

Loss in Harvestable Fraction



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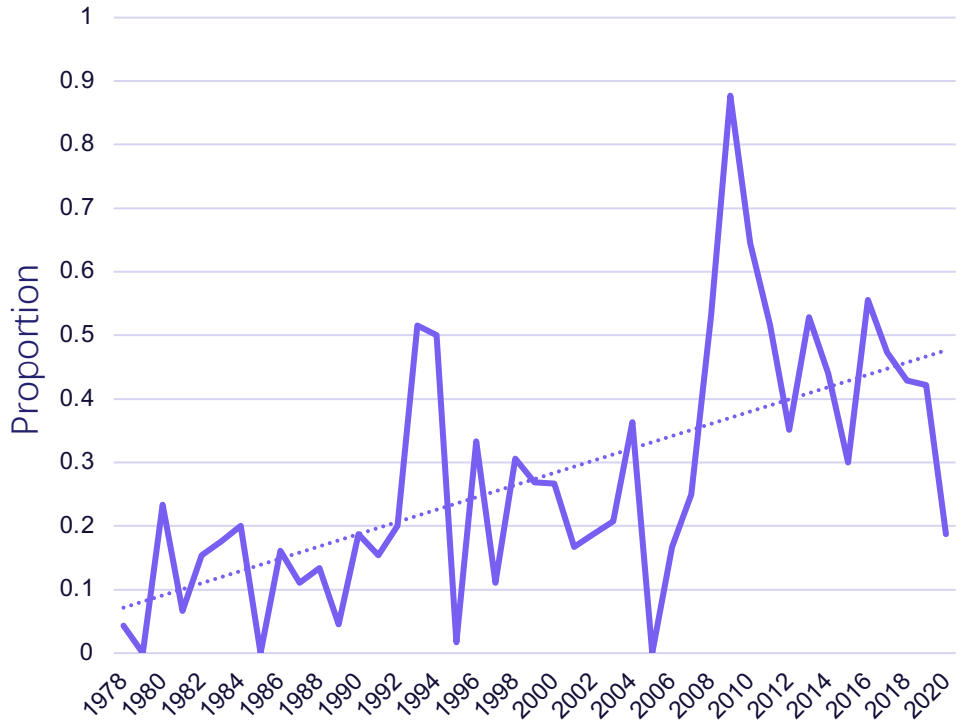
RESULT

Fluctuations in harvestable fraction are important to determine production instability, and the impact is growing throughout the time.

Proportion of production shocks that coincide with harvestable fraction shocks



Contributions of each factor in US annual production shocks.

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THANK YOU

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Wei, D., & Davis, K. F., (2021)
Environ. Res. Lett.

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