Researchers reveal US corn crop's growing sensitivity to drought

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Like a baseball slugger whose home run totals rise despite missing more curveballs each season, the U.S. Corn Belt's prodigious output conceals a growing vulnerability. A new Stanford study reveals that while yields

have increased overall—likely due to new technologies and management approaches—the staple crop has become significantly more sensitive to drought conditions. The research, published Oct. 26 in *Nature Food*, uses a novel approach based on wide differences in the moisture-holding capabilities among soils. The analysis could help lay the groundwork for speeding development of approaches to increase agricultural resilience to climate change.

"The good news is that new technologies are really helping to raise yields, in all types of weather conditions," said study lead author David Lobell, the Gloria and Richard Kushel Director of the Center on Food Security and the Environment. "The bad news is that these technologies, which include some specifically designed to withstand drought, are so helpful in good conditions that the cost of bad conditions are rising. So there's no sign yet that they will help reduce the cost of climate change."

Corn production in the U.S. is a seemingly unstoppable juggernaut. Despite concerns about resistant weeds, climate change and many other factors, the industry has set record yields in five of the last seven years. Likely drivers of these bumper crops include changes in planting and harvesting practices, such as adoption of drought-tolerant varieties, and changes in environmental conditions, such as reduced ozone levels and increased atmospheric carbon dioxide concentrations that generally improve the water-use efficiency of crops.

As climate change intensifies, however, the cost to maintain crop yields will likely increase.

Using county soil maps and satellite-based yield estimates, among other data, the researchers examined fields in the Corn Belt, a nine-state region of the Midwest that accounts for about two-thirds of U.S. corn production. By comparing fields along gradients of drought stress each year, they could identify how sensitivity to drought is changing over

time.

Even within a single county, they found a wide range of soil moisture retention, with some soils able to hold twice as much water as others. As might be expected, there were generally higher yields for soils that held more water. They found yield sensitivity to soil water storage in the region increased by 55 percent on average between 1999 and 2018, with larger increases in drier states.

The results made clear soil's ability to hold water was the primary reason for yield loss. In some cases, soil's ability to hold an increased amount of moisture was three times more effective at increasing yields than an equivalent increase in precipitation.

So, why have yields become more sensitive to drought? A variety of factors, such as increased crop water needs due to increased plant sowing density may be at play. What is clear is that despite robust corn yields, the cost of drought and global demand for corn are rising simultaneously.

To better understand how climate impacts to corn are evolving over time, the researchers call for increased access to field-level yield data that are measured independently of weather data, such as government insurance data that were previously available to the public but no longer are.

"This study shows the power of satellite data, and if needed we can try to track things from space alone. That's exciting," Lobell said. "But knowing if farmers are adapting well to climate stress, and which practices are most helpful, are key questions for our nation. In today's world there's really no good reason that researchers shouldn't have access to all the best available data to answer these questions."

Lobell is also a professor of Earth System Science in Stanford's School of Earth, Energy & Environmental Sciences; the William Wrigley Senior Fellow at the Stanford Woods Institute for the Environment and a senior fellow at the Freeman Spogli Institute for International Studies and the Stanford Institute for Economic Policy Research. Study co-authors include Jillian Deines, a postdoctoral research fellow in Stanford's School of Earth, Energy & Environmental Sciences, and Stefania Di Tommaso, a research data analyst at the Center on Food Security and the Environment.

More information: Changes in the drought sensitivity of US maize yields, *Nature Food* (2020). DOI: 10.1038/s43016-020-00165-w , www.nature.com/articles/s43016-020-00165-w

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