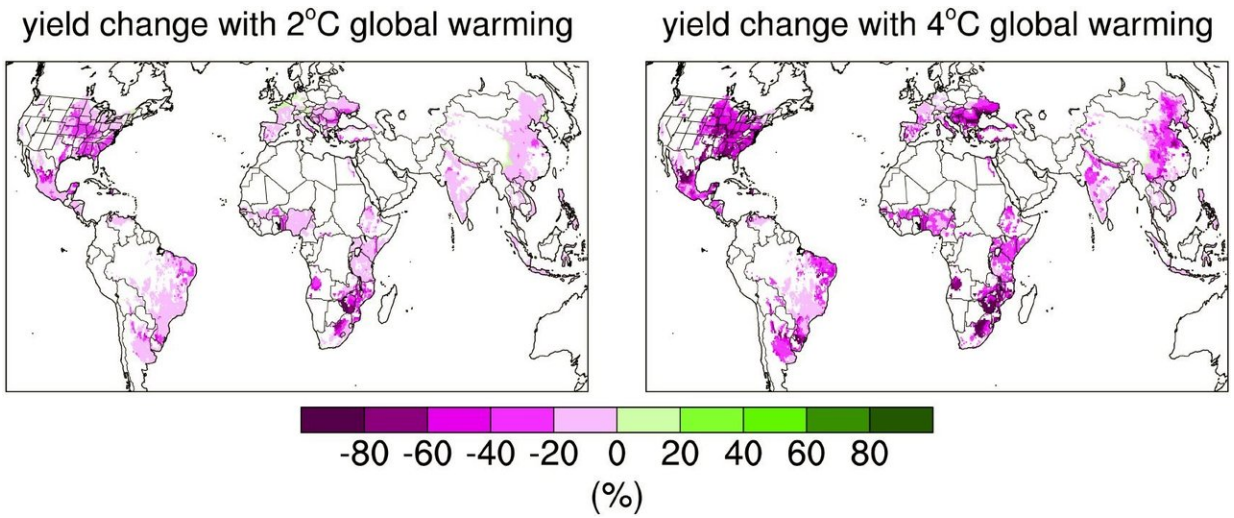
Warmer climate will dramatically increase the volatility of global corn crops

June 11 2018



These maps show how average temperature increases of 2 degrees or 4 degrees Celsius, depending on future emissions, will reduce average annual corn yields. The study also looked at crop variability and the overall effects on international markets. Credit: Michelle Tigchelaar/University of Washington

Corn, or maize, is the most widely grown crop in the world. Used in food, cooking oil, industrialized foods, livestock feed and even automobile fuel, the crop is one that both rich and poor people rely upon.

Research led by the University of Washington looks at what climate

change will mean for global yields of this crop. The results show that warmer temperatures by the end of this century will reduce yields throughout the world, confirming previous research. But the study also shows dramatic increases in the variability of corn yields from one year to the next and the likelihood of simultaneous low yields across multiple high-producing regions, which could lead to price hikes and global shortages.

The study was published the week of June 11 in the *Proceedings of the National Academy of Sciences*.

"Previous studies have often focused on just climate and plants, but here we look at climate, food and international markets," said lead author Michelle Tigchelaar, a UW postdoctoral researcher in atmospheric sciences. "We find that as the planet warms, it becomes more likely for different countries to simultaneously experience major crop losses, which has big implications for food prices and food security."

In the wake of a recent UW study looking at the nutritional value of rice crops under climate change, this study addressed overall yields and price volatility of corn.

While most rice is used domestically, corn is traded on international markets. Four countries—U.S., Brazil, Argentina and the Ukraine—account for 87 percent of the global corn exports (China mostly produces for domestic use). Today the probability that all four exporters would have a bad year together, with yields at least 10 percent below normal, is virtually zero.

But results show that under 2 degrees Celsius warming, which is projected if we succeed in curbing greenhouse gas emissions, this risk increases to 7 percent. Under 4 degrees Celsius warming, which the world is on track to reach by the end of the century if current greenhouse

gas emissions rates continue, there's an 86 percent chance that all four maize-exporting countries would simultaneously suffer a bad year.

In other words, it suggests cases like the 2003 heat wave in Western Europe, which devastated crops there, will be more likely to coincide with bad years in other regions.

"Yield variability is important for determining food prices in international markets, which in turn has big implications for food security and the ability of poor consumers to buy food," Tigchelaar said.

The study used global climate projections with maize growth models to confirm previous research showing that warmer temperatures will negatively affect corn crops.

"When people think about climate change and food, they often initially think about drought," Tigchelaar said, "but it's really extreme heat that's very detrimental for crops. Part of that is because plants grown at a higher temperature demand more water, but it's also that extreme heat itself negatively affects crucial stages in plant development, starting with the flowering stage and ending with the grain-filling stage."

The results show that while warmer temperatures will severely decrease average maize yields in the southeastern U.S., Eastern Europe and sub-Saharan Africa, and will increase the variability in the U.S. and other exporting nations.

"Even with optimistic scenarios for reduced emissions of greenhouse gases, results show that the volatility in year-to-year maize production in the U.S. will double by the middle of this century, due to increasing average growing season temperature," said co-author David Battisti, a UW professor of atmospheric sciences. "The same will be true in the other major maize-exporting countries. Climate change will cause

unprecedented volatility in the price of maize, domestically and internationally."

The study did not include precipitation changes, since those are harder to predict, and projections show that changes will be small compared to the natural changes in rainfall from one year to the next. It also assumed that temperature swings will stay the same as today, though some models project temperatures will become more variable under climate change.

"We took a conservative approach and assumed the 'weather' will be the same, only acting on top of an overall warmer climate," Battisti said.

The findings support efforts to pursue new agricultural technology to ensure food security for a growing global population. The authors write that their results "underscore the urgency of investments in breeding for heat tolerance."

More information: Michelle Tigchelaar el al., "Future warming increases probability of globally synchronized maize production shocks," *PNAS* (2018). www.pnas.org/cgi/doi/10.1073/pnas.1718031115

Provided by University of Washington