



Eight billion humans currently live on planet Earth—a number that will grow to nine billion by 2050. Scientists, world leaders, humanitarian organizations, and farmers are working on ways to feed our growing population, which relies heavily on crops of wheat, corn, rice, and soybeans. In fact, two-thirds of the calories we eat come from those four grains (yes, the USDA considers the soybean legume a “grain” crop).

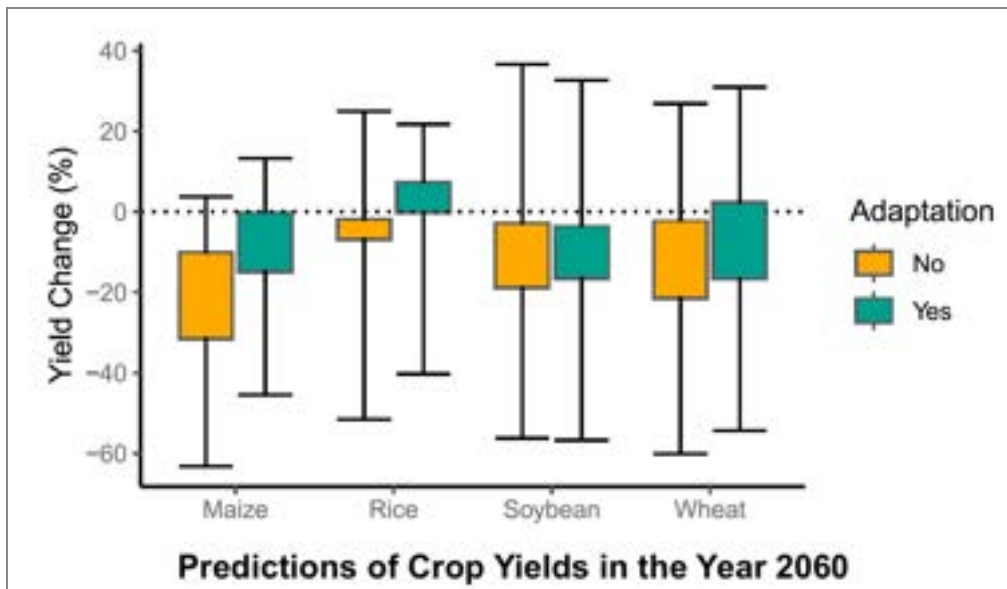
Global warming, unfortunately, will make growing these grains more difficult in the future. Higher temperatures can reduce or even halt photosynthesis, prevent pollination, and lead to crop dehydration. Heat stress decreases crop yields, so less food is produced.

A [scientific study](#) published in the March 2023 issue of *Earth's Future* used statistical modeling techniques to predict future impacts of global warming on crops. The computer simulations revealed how crops would be impacted by an average temperature increase of 2 degrees

Celsius, which is how much warmer our planet will likely be in the year 2060.

An international team of research scientists published the study, which tells a sobering tale: without adaptive farming methods, and with a 2 degree Celsius global temperature increase, broad yield losses for wheat, corn, rice, and soybeans are predicted. However, the study also found that managing cropland adaptively in the future can reduce losses considerably.

First, let's look at the worst-case scenario. According to the researchers, if no adaptive farming methods are employed, the negative change in crop yields for wheat, corn, rice, and soybeans will be significant: wheat crop yield will be -13 percent, corn yields will be -21 percent, rice yields -6 percent, and soybean crops -11 percent in the year 2060. Those percentages can be raised, however, with adaptive farming techniques, as illustrated in the chart on the next page.



In the chart at left, the green bars show how crop yields could increase through adaptive farming practices ([image source](#)).

Many different adaptive farming techniques were considered in the study's computer simulations, including changes in the timing or amount of fertilizer, changes in irrigation, shifts in planting time, and the use of heat-adapted cultivars

(selectively-bred plant varieties). Other adaptive practices that the scientists studied include switching crops, crop rotation, and crop diversification...but not all of those adaptations were proven by the researchers to grow more food in 2060.

So, which adaptation practices will be critical to growing more wheat, corn, rice, and soybeans in the future?

The authors of the study say that adaptive fertilizer methods will be important to the amount of wheat we can grow. Adaptive fertilizer management is a process used to evaluate and adjust nutrient (fertilizer) application over time, where adjustments are made continuously to achieve better use of nutrients, and to minimize nutrient losses. Switching wheat crop varieties and developing new heat-tolerant varieties will increase wheat yields in some parts of the world in 2060 as well.

For corn crops, improved irrigation is key, especially where corn is grown in South American countries. Many cornfields are watered using a flood or furrow type of irrigation, or overhead sprinkler irrigation, but those are not always efficient. Flood irrigation is problematic due to the potential for run-off (where water runs off the soil surface before the plants' roots can absorb it). Overhead sprinkler irrigation is inefficient due to water evaporating in the air before the droplets can reach the soil. The most efficient type of irrigation is subsurface drip irrigation, which waters crops through plastic tubes placed under the surface of the soil. These systems reduce water runoff and evaporation considerably, so they use much less water while still delivering the amount of water that crops require. Replacing inefficient irrigation systems with more precise methods, like subsurface drip irrigation, will go a long way in farmers' efforts to grow more corn crops.

Rice yields, in the study, were responsive to multiple adaptation strategies, especially modifying the cultivar. Breeding a rice plant that is stress-tolerant can result in higher yields under stress conditions like too much heat, and/or not enough water. While the study showed that modifying the cultivar could increase rice yields in South America and parts of China, a stress-resistant rice cultivar might not yield more rice in North America or Western Asia in the future.

The researchers' statistical modeling showed that more soybean plants can be grown through adaptive farming methods, but the study couldn't pinpoint a single, "best" adaptive strategy. This is because soybean crop simulation data was not available in key parts of East Asia (where soybeans originated and have been farmed for thousands of years). Many other researchers, however, have studied ways to grow soybeans in a warmer future climate, and the breeding of stress-resistant soybean cultivars is often cited as an important adaptation. Interestingly, soybean production will benefit from the projected high precipitation that climate change will bring. In addition, irrigation to supplement the increased rains of a warmer planet may be another effective strategy to maintain soybean yield.

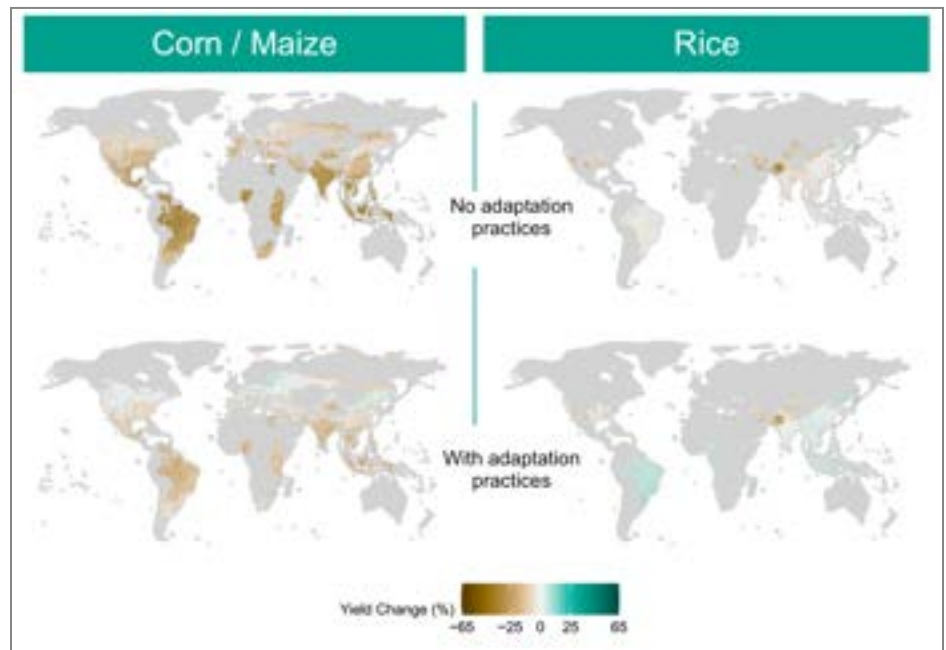
As shown in the maps at right, adaptive farming practices will go a long way toward reducing the negative impacts of global warming on crop yields ([image source](#)).

Opposing Viewpoints

Some say that adaptive farming methods employed by "big agriculture" won't go far enough to help our growing, warming planet. Those who challenge conventional agriculture's methods advocate for sustainable alternatives like

organic farming, local (vs. global) food systems, and reducing the amount of crops that are grown to feed livestock. It sure would be easier to feed nine billion people if more of the crops we grew were consumed directly by humans! Yet, only 55 percent of the world's crop calories feed people directly; the rest are fed to livestock (36 percent) or turned into biofuels and industrial products (9 percent). Finally, conventional agriculture contributes to increased greenhouse gas emissions and therefore, to global warming, while organic farming has a smaller carbon footprint. It seems like a valid argument: feeding a growing population requires a focus on local, organic, environmentally-friendly farming, as well as reduced meat consumption.

However, proponents of conventional agriculture are correct in maintaining that their methods—modern mechanization, better irrigation, adaptive fertilizer use, and improved crop genetics—can increase yields to help meet demand. Thus, the benefits of adaptive farming methods employed by big agriculture are important too. Jonathan Foley, Director of the Institute on the Environment at the University of Minnesota, wrote in a popular [National Geographic](#) article that "we would be wise to explore all of the good ideas, whether from organic and local farms or high-tech and conventional farms, and blend the best of both. It needn't be an either-or proposition. Both approaches offer badly needed solutions; neither one alone gets us there."





Vital Global Policies

The United States and other developed countries can afford to embrace the adaptation strategies necessary to feed a growing population. Policies and programs must be developed, however, to help poorer countries adapt. In particular, scientists, world leaders, and NGOs must turn their attention to increasing yields on less productive farmlands, especially in parts of Africa, Latin America, and Asia,

where there are yield gaps between current production levels and those possible with adaptive farming practices. Food insecurity and chronic hunger are common in those same parts of the world (illustrated in the [Hunger Map](#) image). People in those countries will experience greater food insecurity in the future if action isn't taken to help them grow more of their own food using adaptive technologies and other best practices from developed nations.

Extension services aimed at boosting agricultural efficiency on farms in developing countries will be important, too. In the world of agriculture, "extension" means giving farmers knowledge of growing techniques and skills to improve their productivity, food security, and livelihoods. An agricultural knowledge transfer from countries like the U.S. and the U.K. to less-developed countries is critical. In addition, policies that support the implementation of modern farming technologies need to be put in place. Says Foley, "Using high-tech, precision farming systems, as well as approaches borrowed from organic farming, we could boost yields in these places several times over." 

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