

Facing a Threat to Farming and Food Supply

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[Fifth in a monthly series](#)

Climate change may be global in its sweep, but not all of the globe's citizens will share equally in its woes. And nowhere is that truth more evident, or more worrisome, than in its projected effects on agriculture.

Several recent analyses have concluded that the higher temperatures expected in coming years -- along with salt seepage into groundwater as sea levels rise and anticipated increases in flooding and droughts -- will disproportionately affect agriculture in the planet's lower latitudes, where most of the world's poor live.

[India](#), on track to be the world's most populous country, could see a 40 percent decline in agricultural productivity by the 2080s as record heat waves bake its wheat-growing region, placing hundreds of millions of people at the brink of chronic hunger.

[Africa](#) -- where four out of five people make their living directly from the land -- could see agricultural downturns of 30 percent, forcing farmers to abandon traditional crops in favor of more heat-resistant and flood-tolerant ones such as rice. Worse, some African countries, including [Senegal](#) and war-torn [Sudan](#), are on track to suffer what amounts to complete agricultural collapse, with productivity declines of more than 50 percent.

Even the emerging agricultural powerhouse of [Latin America](#) is poised to suffer reductions of 20 percent or more, which could return thriving exporters such as [Brazil](#) to the subsistence-oriented nations they were a few decades ago.

And those estimates do not count the effects of new plant pests and diseases, which are widely expected to come with climate change and could cancel out the positive "fertilizing" effects that higher carbon dioxide levels may offer some plants.

Scenarios like these -- and the recognition that even less-affected countries such as the United States will experience significant regional shifts in growing seasons, forcing new and sometimes disruptive changes in crop choices -- are providing the impetus for a new "green revolution." It is aimed not simply at boosting production, as the first revolution did with fertilizers, but at creating crops that can handle the heat, suck up the salt, not desiccate in a drought and even grow swimmingly while submerged.

The work involves conventional breeding of new varieties as well as genetic engineering to transfer specific traits from more resilient species. As part of those efforts, scientists are also busily preserving seeds from thousands of varieties of the 150 crops that make up

most of the world's agricultural diversity, as well as wild relatives of those crops that may harbor useful but still unidentified genes.

"For agriculture to adapt, crops must adapt," said Ren Wang, director of the Consultative Group on International Agricultural Research, a network of agricultural research centers. "It's important that we have a wide pool of genetic diversity from which to develop crops with these unique traits."

At the same time, scientists are finding that agriculture and related land uses, which today account for about one-third of all greenhouse gases emitted by human activities, can be conducted in much more climate-friendly ways.

But time is of the essence if a worldwide crisis in food security is to be avoided, said William R. Cline, a senior fellow at the Center for Global Development and the Peterson Institute for International Economics, Washington-based nonpartisan economic think tanks.

"You'll have a tripling of world food demand by 2085 because of higher population and bigger economies, and I would not be surprised to see as much as one-third of today's agricultural land devoted to plants for ethanol," Cline said. "So it's going to be a tight race between food supply and demand."

The work of developing adaptive plants has begun to pay off. Researchers have discovered ancient varieties of Persian grasses, for example, that have an incredible tolerance for salt water. The scientists are breeding the grasses with commercial varieties of wheat and have found they are growing well in [Australia's](#) increasingly salty soils.

Other research is building on the recent discovery of a gene that helps plants survive prolonged periods underwater.

Even rice, which grows in wet paddies, will die if it is fully submerged for more than three or four days, said Robert Zeigler, director general of the International Rice Research Institute in [the Philippines](#). But recent tests on farms in [Bangladesh](#) show that a new line of rice containing the flood-resistance gene can live underwater for two weeks.

That's going to be important, Zeigler said, because 70 percent of the world's poor live in [Asia](#) -- most of them in south Asia -- where rice is the staple. Yet 50 million acres of that region are already subject to seasonal flooding that can temporarily submerge plants under 10 to 12 feet of water. And the problem is predicted to worsen as climate change brings more intense rainfall there.

"Crops grow in weather, not in climate," Zeigler said, meaning they must be able to survive not only the anticipated average rises in temperature but also the day-to-day extremes that come with climate change.

Corn is another staple that is getting gussied up to party with the hardy -- in this case in preparation for dry spells, which are predicted to increase in Latin America and other corn-growing regions, with a potential 20 percent drop in production over the next 25 years.

Recent tests in [South Africa](#) showed that drought-resistant maize plants, created by breeding, produced 30 percent to 50 percent more corn than traditional varieties under arid conditions. But the real test, scientists say, will be to splice in potent drought-resistance genes from plants such as sorghum and millet, which are famously productive even in parched, [sub-Saharan Africa](#). That assumes consumers and regulators will accept such engineered crops, which have been shunned in many countries because of economic and environmental concerns.

To the extent that plants cannot adapt to change, farmers will have to. In [Uganda](#), where coffee is an important cash crop but where temperature increases are expected to devastate the plants, researchers are hoping that by planting shade trees, growers can preserve the industry while perhaps even increasing biodiversity.

In other parts of Africa, farmers are being taught to add fruit trees to their subsistence farms. The trees can survive droughts and waterlogging better than crops planted annually, and so can serve as an economic bridge across hard times.

Farmers in developed countries must also prepare, experts say.

A recent study by researchers at the International Maize and Wheat Improvement Center in [Mexico](#) concluded that wheat growers in [North America](#) will have to give up some of their southernmost fields in the next few decades. But they will be able to farm a full 10 degrees north of their current limit, which extends from Ketchikan, [Alaska](#), to Cape Harrison, Labrador.

That means amber waves of grain will be growing less than 2 degrees south of the [Arctic Circle](#), and [Siberia](#) will become a major notch in the wheat belt.

By changing their practices, and not just their crops, farmers can also temper the buildup of greenhouse gases. New technologies that measure soil nutrient levels are allowing farmers to add only as much fertilizer as is really needed -- important because the excess nitrogen in those chemicals gets converted in the soil into nitrous oxide, which has 300 times the greenhouse activity of carbon dioxide.

Studies also show that by plowing or tilling less frequently -- planting seeds in the stubble of a previous crop, for example -- farmers can significantly reduce evaporation in dry areas and also cut the amount of carbon dioxide released from the soil (and from the exhaust of their tractors, if they have them).

Crops grown this way also trap carbon more effectively, becoming part of the solution instead of adding to the problem.

For the truly pessimistic, there is always the "doomsday vault," a seed bank being constructed in a Norwegian mountainside that nations around the world are stocking with every kind of seed imaginable.

After all, you never know what kind of plant trait is going to save humanity if the climate makes an unexpected turn, said Cary Fowler, executive director of the Global Crop Diversity Trust, which is leading the effort and who has boasted that the vault will be protected in part by the region's polar bears.

That is assuming, of course, that rising temperatures or the newly arrived wheat farmers will not have driven them away.