

Ask the Experts: Does Rising CO₂ Benefit Plants?

Climate change skeptics have many arguments for why we do not need to cut carbon emissions. Some claim that rising CO₂ levels benefit plants, so climate change is not as bad as scientists state. “A higher concentration of carbon dioxide in our atmosphere would aid photosynthesis, which in turn contributes to increased plant growth,” Rep. Lamar Smith (R–Texas) wrote last year. “This correlates to a greater volume of food production and better quality food.” Scientists and others calling for decreasing carbon emissions are being hysterical, he contends.

So, is it true rising atmospheric CO₂ will help plants, including food crops? *Scientific American* magazine asked several experts to talk about the science behind this question.

There is some evidence for this claim, experts say, based on what scientists call the CO₂ fertilization effect. “CO₂ is essential for photosynthesis,” says Richard Norby, a corporate research fellow in the Environmental Sciences Division and Climate Change Science Institute of Oak Ridge National Laboratory. “If you isolate a leaf [in a laboratory] and you increase the level of CO₂, photosynthesis will increase. That’s well established.”

However, Norby notes the results scientists produce in labs are generally not what happens in the vastly more complex world outside. Many other factors are involved in plant growth in forests, fields, and other ecosystems. For example, “nitrogen is often in short enough supply that it’s the primary controller of how much biomass, (total mass of plant material) is produced” in an ecosystem, he says. “If nitrogen is limited, the benefit of the CO₂ increase is limited.... You can’t just look at CO₂, because the overall context really matters.”

Scientists have observed the CO₂ fertilization effect in natural ecosystems, including a series of trials conducted over the past several decades in outdoor forest plots. In those experiments, artificially doubling CO₂ from pre-industrial levels increased trees’ productivity (the rate of increase of plant material) by around 23 percent, according to Norby, who was involved in the trials. For one of the experiments, however, that effect significantly diminished over time due to a nitrogen limitation. That suggests “we cannot assume the CO₂ fertilization effect will persist indefinitely,” Norby says.

In addition, he says, many skeptics also fail to mention the potentially most harmful outcome of rising atmospheric CO₂ on vegetation: climate change itself. Its negative consequences—such as drought and heat stress—would likely overwhelm any direct benefits that rising CO₂ might offer plant life. “It’s not appropriate to look at the CO₂ fertilization effect in isolation,” he says. “You can have positive and negative things going on at once, and it’s the net balance that matters.”

Scientists have also looked at the effects of rising CO₂ on agricultural plants and found a fertilization effect. “For a lot of crops, [more CO₂] is like having extra material in the atmosphere that they can use to grow,” says Frances Moore, an assistant professor of environmental science and policy at the University of California, Davis. For most of the plants humans eat—including wheat, rice and soybeans—“having higher CO₂ levels will help them directly,” Moore says. Doubling CO₂ from pre-industrial levels, she adds, does boost the productivity of crops like wheat by 11.5 percent and corn by around 8.4 percent.

A lack of nitrogen or other nutrients does not affect agricultural plants as much as wild ones, thanks to fertilizer that farmers add to their fields. Still, research shows plants “get some benefits early on from higher CO₂, but that [benefit] starts to level off” after the gas reaches a certain level, Moore says. “The more CO₂ you have, the less and less benefit you get.”

While rising carbon dioxide might seem like a boon for agriculture, Moore also emphasizes any potential positive effects cannot be considered in isolation and will likely be outweighed by many drawbacks. “Even with the benefit of CO₂ fertilization, when you have 1 to 2 degrees of warming, you see negative effects,” she says. “There are a lot of different ways that temperature can negatively affect crop yield: loss of soil moisture [or] heat can directly damage the plants and interfere with their reproduction.” Moore also points out that increased CO₂ also benefits weeds that compete with farm plants.

Rising CO₂'s effect on crops could also harm human health. “We know that when you grow food at elevated CO₂ levels in fields, it becomes less nutritious,” notes Samuel Myers, principal research scientist in environmental health at Harvard University. “[Food crops] lose significant amounts of iron and zinc—and grains [also] lose protein.”

Myers and other researchers have found atmospheric CO₂ levels predicted for mid-century—around 550 parts per million—could make food crops lose enough of those key nutrients to cause a protein deficiency in an estimated 150 million people and a zinc deficit in an additional 150 million to 200 million. (Both of those figures are in addition to the number of people who already have such a shortfall.) A total of 1.4 billion women of child-bearing age and young children who live in countries with a high prevalence of anemia would lose more than 3.8 percent of their dietary iron at such CO₂ levels, according to Meyers.

Researchers do not yet know why higher atmospheric CO₂ alters crops' nutritional content. But, Myers says, “the bottom line is, we know that rising CO₂ reduces the concentration of critical nutrients around the world,” adding that these kinds of nutritional deficiencies are already significant public health threats and will only worsen as CO₂ levels go up.