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## Indoor Farming Is a 'No-Brainer.' Except for the Carbon Footprint.: Guest Essay

Alexander, William. *New York Times (Online)*New York Times Company. Jun 21, 2022.

# The New York Times

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## Abstract

None available.

## Full Text

It's shaping up to be a tough year for agriculture: With record drought gripping the West, farmers in California's Central Valley are leaving vast tracts of fertile land unplanted. A January cold snap in Florida devastated tomato crops there, leaving the survivors vulnerable to disease. Two months later, an unusually hard freeze in the Carolinas left some farmers with little to no strawberries and blueberries.

Yet neither drought nor frost is ever a concern for the growers of tomatoes, strawberries and other crops currently ripening inside enormous greenhouses, some sprawling across 175 acres, in North America and Europe. Here a revolution is quietly taking place, perhaps the most potentially disruptive since Cyrus McCormick's reaper. Vegetables are increasingly being grown indoors, using an advanced and intensive form of growing called controlled environment agriculture, a method that has the potential to help feed the planet, even while it threatens to further warm it.

Indoor farming has the potential to shake the very nature of agriculture down to its roots. But this innovation comes with higher upfront costs and a larger carbon footprint.

Tomatoes, peppers, cucumbers, lettuce and berries are increasingly as likely to come from Canadian or American greenhouses as from fields in Florida or Mexico. Last year, more than a third of the fresh tomatoes sold in the United States, including every slice that topped a Wendy's burger, were grown indoors.

The advantages of controlled agriculture, a technology pioneered in the Netherlands, are many. Crops are not subject to the vagaries of extreme weather, such as frost, heat or hail; will never be recalled because of E. coli contamination from the dairy farm upstream; and tomatoes and other vegetables can be bred for flavor, instead of for tolerance to heat, rain and long-distance transportation.

Furthermore, these greenhouses can produce more food with fewer pesticides and less water. Computer-controlled root and air temperatures, nutrients and carbon dioxide levels, plants are grown in nutrient-laden water rather than soil and provide yields up to 400 times greater per acre than field agriculture, with one-tenth the water used. Controlled agriculture also allows vegetable farms to operate where there is no arable land, whether in Kentucky coal country or an Egyptian desert.

A vast majority of the more than 2,300 controlled environment greenhouses in the United States — 100-acre structures or smaller "vertical farms" that grow crops on trays stacked to the ceiling — replace the warmth and light from the sun with fossil-fuel power, giving a new meaning to the term "greenhouse gas." While there are efforts to make controlled agriculture more energy efficient — such as locating greenhouses adjacent to power or water treatment plants (or even server farms) to capture the waste heat those facilities generate — even greenhouses that boast renewable electricity sources for lighting generally use natural gas for heating because it's far more cost-effective.

The carbon footprint of any given greenhouse tomato, the leading indoor crop, can vary quite a bit depending on energy sources, ambient temperatures and available natural light. But various studies conducted in the United States, Europe and Canada have estimated that, on average, the production of a pound of tomatoes in an American or Northern European greenhouse using fossil fuel energy releases 3 to 3.5 pounds of carbon into the atmosphere.

That is, these studies suggest, about six times the carbon footprint of a field tomato, even taking into account the diesel emissions from refrigerated trucks that often transport field vegetables hundreds or even thousands of miles to reach consumers. Greenhouses, by contrast, can be located near major population centers, as is the case with large vertical farms often constructed in repurposed factories and warehouses.

Feeding the planet already accounts for roughly one-quarter of all greenhouse gas emissions. Animal protein, in particular beef and dairy cattle production, has a more consequential carbon footprint than vegetable farming. Nevertheless, in a rapidly warming world, should we be increasing agriculture's contribution by moving some of it indoors?

*We have little choice*, say proponents. With the global population expected to grow by 25 percent to nearly 10 billion people by 2050, food production will need to increase by 60 percent to 100 percent. With fresh water supplies and arable land dwindling, and droughts exacerbated by climate change threatening to turn California's fertile heartland into barren desert, where will this additional food come from?

For the first time in the 10,000-year history of agriculture, societies don't need to be blessed with fertile soil and favorable weather to farm. Already, greenhouses have helped turn tiny, soggy Holland, a county with a land mass just two-thirds the size of West Virginia, into the world's second-largest agricultural exporter by value, sending \$10.7 billion in tomatoes, cucumbers and bell peppers annually to its neighbors, including Germany, Belgium and Britain. Arid Egypt has dedicated thousands of acres to new greenhouses to grow a variety of vegetables.

Just how rapidly this growth is happening in the United States is hard to quantify, because the U.S. Department of Agriculture does not track controlled environment production. But controlled environment agriculture investments in 2021 were up 77 percent over the previous year, and they have more than tripled since 2019.

Jonathan Webb, the 37-year-old chief executive of AppHarvest, a start-up that recently built a 60-acre controlled environment greenhouse in the heart of Appalachian Kentucky, told Yahoo Finance last month that "20, 30 years from now, you're going to be growing most fruits and vegetables at scale globally in a controlled environment." AppHarvest raised \$475 million from venture capitalists and other investors before going public last year with an initial valuation of \$1 billion. This, mind you, is a company that sells tomatoes.

Neil Mattson, who leads Cornell University's controlled environment agriculture research group, believes that, at least when it comes to the most perishable vegetables, such as tomatoes and greens, greenhouses are the future, even with their climate problem.

"It's a balance," he told me recently. "You put these things on a scale and you say, OK, which side is weightier than the other side?" The benefits include "a higher quality product, more consistent supply, somewhat better control over food safety, and insect and disease control using beneficial insects and microbes instead of conventional pesticides."

The list on the negative side is far shorter: "Mainly energy," meaning its cost in both dollars and carbon dioxide emissions. Some of the largest greenhouses in the Netherlands have had to turn off the lights because of spiraling energy prices exacerbated by the war in Ukraine. Some 8.2 percent of annual Dutch natural gas consumption goes to heat greenhouses.

The energy price spike may be temporary, but the greenhouse gas emissions are not. "The carbon footprint," Dr. Mattson said, "is the main hurdle we have to clear. Then greenhouses are a no-brainer."

McCormick's 19th-century reaper, in making the harvesting of vastly greater acreage feasible, transformed wheat farming and helped turn the Midwest into America's breadbasket. Will controlled agriculture have a similar impact? The money pouring into it suggests that many think it will. If they're right, then growing tomatoes in soil warmed by the sun and watered by the rain may one day seem as old-fashioned as harvesting wheat with a scythe.

William Alexander is the author, most recently, of "Ten Tomatoes That Changed the World: A History."

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