

What's on the Thanksgiving table in a hotter, drier world?

Wild boar. Kelp salad. Crickets in your pie crust. These are just a few things that may end up on Thanksgiving menus as climate change takes its toll on the planet.

Climate change has officially arrived at our Thanksgiving tables. As the past year has made even more clear, the consequences of a warming world have challenged farmers and food systems throughout the United States.

Drought, blistering heat waves and raging wildfires have gripped much of the West, stressing crops such as wheat — the basis of stuffing, rolls and pie crusts. In the Northeast, the fastest-warming region in the country, cranberries are budding earlier, making them more vulnerable to frost damage. And in the Southeast, intensifying hurricanes, driven by warming oceans, are forcing farmers to move turkeys northward to drier ground.

"Agriculture definitely stands to be impacted by climate change," said Sonali McDermid, a climate scientist and associate professor of environmental studies at New York University. But, she added, agriculture "is not a passive recipient of climate change impacts. It is actually facilitating and driving climate change."

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Thanksgiving, one of the few nonreligious American holidays that most Americans celebrate, is centered around the notion of gathering for the autumnal harvest, said Amy Bentley, professor of food studies at New York University. But food production is the largest cause of global environmental change, according a report authored by a [consortium of scientists](#). Agriculture is responsible for up to 30 percent of global greenhouse-gas

emissions and 70 percent of freshwater use.

It's a complicated dynamic: To mitigate the effects of global warming, we need to change agricultural practices. But food is already changing because of the warming climate.

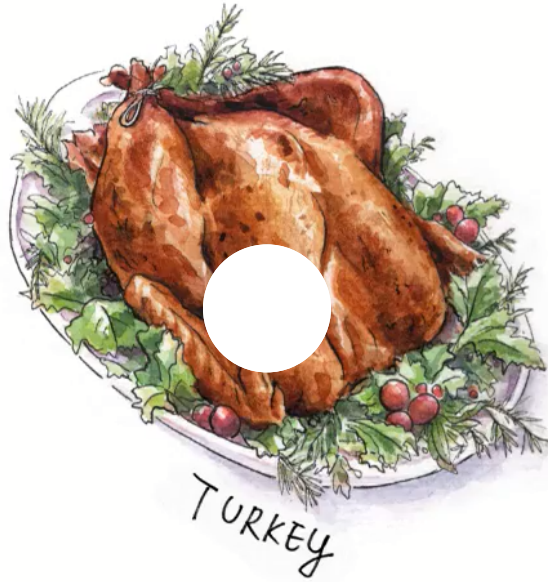
"You can bet that under climate change scenarios, corn, cranberries, leafy greens like creamed spinach [and] turkey — all of these commodities are going to be constrained," said Jessica Fanzo, professor of global food and agricultural policy and ethics at Johns Hopkins University and one of the authors of the report.

So what does this mean for the future of our Thanksgiving tables? Let's start planning the feast.

First, the centerpiece

Most turkey that ends up on Thanksgiving tables comes from [eight states](#), spread across the country: California, Minnesota, Iowa, Missouri, Arkansas, Indiana, Virginia and North Carolina. Although each region will experience the effects of climate change differently, [studies show](#) that rising temperatures can stress birds, causing them to grow at a slower rate or even die.

Farmers feed the [millions of birds](#) produced commercially each year with corn and grain crops. But lower yields — which may become more common in a changing climate — can affect the price and availability of feed, McDermid said.



It's not just a matter of keeping birds cool and fed, however. Intensifying

hurricanes are already affecting turkey growers in the Southeast. After Hurricane Katrina, many poultry farmers abandoned the coastlines, heading northward to drier ground, said Tom Tabler, a poultry science professor at Mississippi State University.



Getting a turkey onto the table may become more challenging as climate change stands to affect prices and availability. "I don't see, in the near term, a future where having it is not possible," McDermid said. "I do see a future where it's much more inequitable — and I see that happening very soon."

But if traditional turkeys do disappear from our Thanksgiving tables, what we will eat instead?

Swapping birds for swine is one possibility.





Feral pigs, also known as wild boar, are an invasive species that have [rapidly expanded across at least 35 states](#) because a lack of natural predators and an ability to adapt to a multitude of climates. One [Texas chef is taking](#) on the plague of hogs in his state by offering dishes such as wild-boar chorizo, Mexican longanisa sausage and wild-boar confit. As a holiday showstopper, wild boar could take the form of a whole roast or a decadent [ragu](#), as is custom in Tuscany, where the animal has long been considered a [highly prized game species](#).

Turkeys of the future could come from a lab instead of a farm.



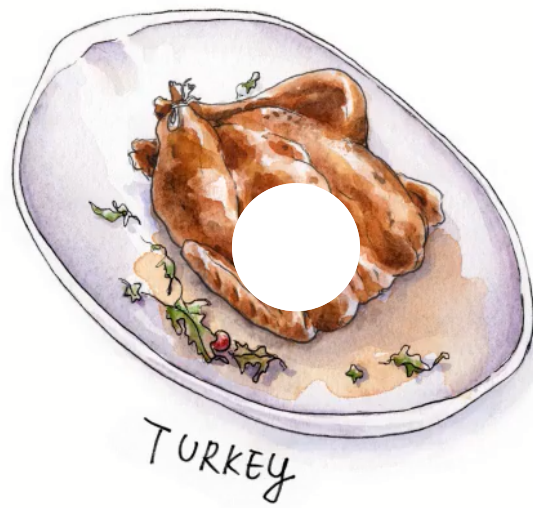
WILD BOAR

Although some are skeptical that it will go mainstream in the near term, several start-ups developing [lab-grown meat](#) and seafood are betting the future of farm-to-table will be cell-to-harvest.

As consumers grow increasingly aware of the meat and dairy industry's heavy carbon footprint — responsible for [14.5 percent](#) of the planet's greenhouse-gas emissions — cell-based alternatives are attracting a growing number of investors, such as Bill Gates and Richard Branson. Even meat industry heavyweights such as [Tyson](#) and [Cargill](#) are buying into cell-cultured technology, backing companies such as [Upside Foods](#), [Future Meat Technologies](#) and [Aleph Farms](#).

"There's probably going to be a niche for things like lab-grown meat," Tabler said. But he predicted that a majority of consumers will continue to gravitate toward conventionally grown turkey.

A pivot to plant-based is on the table.



For some, no matter where or how it's grown, meat is a non-starter. Although alternative proteins such as tofu and seitan have been available for years, plant-based meats, or alt-meats, have seen a recent [surge in popularity](#).

"One of the solutions that's kind of staring us in the face is to reduce our reliance on animal agriculture," McDermid said, adding that while meat substitutes may not be ubiquitous yet, "I do see that as being something that is widely accepted in 2050, to have these alternatives on the table substituting for turkey."

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Critics have raised concerns about the nutritional value of alt-meat products, however, which are often highly processed, while some are wary about the relatively unknown greenhouse-gas emissions and environmental costs associated with producing alternative meat products.

Pile on the (smaller) side dishes



Some would argue that Thanksgiving is all about the sides. But climate change is already affecting holiday favorites such as stuffing and mashed potatoes, making these foods more costly and hard to find.

Whether you call it stuffing or dressing, the basis of the dish typically consists of bread or cereals in concert with vegetables, herbs and eggs.

Wheat, which accounts for [20 percent of all calories](#) consumed by humans, is vulnerable to drought and deluge. Agriculture Department data shows that this year's drought caused a 10 percent decline in total U.S. wheat production compared with last year, noted Mary Kennedy, a cash grains analyst at DTN, an agriculture news and analysis organization. Of that total, other spring wheat production was down 44 percent and durum wheat production was down 46 percent vs. 2020.

"Bottom line, people may need to be ready for price increases likely in 2022," Kennedy said. "You're seeing it in bread prices already, and you could very well see it in durum-wheat-based products like pasta and oats-based foods as well."

[Researchers found](#) that at least one-quarter of the world's wheat production

will be lost to extreme weather in the coming decades if no measures to curb emissions and help crops adapt are taken. Rising greenhouse gases are also [projected](#) to strip wheat of its nutritional value, diminishing minerals such as protein, iron and zinc under high-carbon-dioxide conditions.

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But hardier alternatives may become more prevalent in a warming world. [Experiments with perennial grains such as Kernza](#), a domesticated form of wheatgrass developed by scientists at the Land Institute, are underway to help return carbon to the soil. Unlike traditional wheat crops, Kernza requires fewer pesticides and never needs to be replanted, allowing it to grow deep roots and sequester carbon underground.





Potatoes, green beans and Brussels sprouts will suffer a similar fate when faced with extreme weather. Droughts are shown to [reduce yields and quality](#), while extreme rainfall can cause diseases such as [blackheart](#), which darkens the tissue of potatoes.

Aquaculture — the breeding, raising and harvesting of animals and plants in water environments — could usher in seafood substitutes.



Since the 1990s, aquaculture production has exploded by a whopping 527 percent [according to the U.N. Food and Agriculture Organization](#) (FAO), and it's positioned as one of the most resource-efficient ways to produce protein, according to the National Oceanic and Atmospheric Administration.

Will this mean returning to some Thanksgiving traditions of old? “In the Mid-Atlantic, the dressing or the stuffing often had oysters in it,” NYU’s Bentley said. But, she said, “seafood and shellfish are endangered. The waters are polluted. We overfish. But we’re also having a renaissance of oysters,” referencing New York’s [Billion Oyster Project](#).

Many wild oyster stocks have been decimated by urbanization, pollution, habitat degradation and predators such as oyster drills, so the oysters we eat in the future may come from farms. That said, restoration efforts are underway in coastal areas throughout the country to revive native oyster reefs, which can help buffer coastlines from climate impacts including sea level rise and intensifying storm surges.

Kelp farming is also [attracting increasing attention](#) for its carbon capturing potential. A longtime staple in Southeast Asian diets, seaweeds are not just a salty, umami-packed superfood with a wide array of culinary applications — they are also among the best organisms for removing [planet-warming gases](#) out of the atmosphere. Kelp can store [20 times as much carbon](#) as an equivalent expanse of terrestrial trees.

Climate change is creating an uneven balance sheet of ecological winners and losers — and the winners could make their way to our plates.

While some crops may be losing ground, the European truffle — the highly prized gastronomic superstar of the fungi family — is a potential beneficiary of climate change. The [Burgundy truffle](#) and the black truffle are starting to be cultivated in new northerly regions as the planet warms. Truffles are also [beginning to be cultivated](#) in the United States.



The famous Chesapeake blue crab is also benefiting from warming waters.

"Blue crab is likely to be a winner out of climate change," said Thomas Miller, director of the Chesapeake Biological Laboratory at [the University of Maryland Center for Environmental Science](#).



Miller authored [a study](#) showing that the winter survival rate for blue crabs in the Chesapeake Bay will increase by at least 20 percent under warming conditions.

And another crustacean stands to gain ground in a warming world. The European green crab has made its way from coast to coast, hitchhiking on hulls of ships and taking over ecosystems from Long Island to Bolinas, Calif. As ocean temperatures increase, populations continue to explode, driving out native crabs, invertebrates and fish. Efforts [to create a fishery out of this invader](#) are underway, and a [cookbook](#) outlining how to handle the hard-shelled crabs is on shelves now.

Jellyfish swarms appear to be thriving in more acidic environments and are becoming a more common sight in our oceans — and potentially on our tables, in the future, as jellyfish salad.



Meanwhile, a number of technological innovations are underway to help buffer the global food system against the worst impacts of a warming planet.

GMOs, or genetically modified organisms, have long inspired heated debates over the merits of transferring genetic material from one organism into another. But now, an emerging technology called CRISPR allows scientists to edit genes in plants and livestock without inserting foreign DNA into food.

Put simply, CRISPR, which stands for “clustered regularly interspaced short palindromic repeats,” allows scientists to edit genes by zeroing in on a specific part of DNA inside a living cell and tweaking its genetic code.

Scientists are already demonstrating how turning certain genes on or off can increase a plant’s resistance to worsening climatic conditions, creating [heat and drought-tolerant](#) wheat, tomatoes and corn. The CRISPR technology, which is [already being applied to crops](#) such as canola and soy plants in the United States, can also help bolster crops such as [wine grapes and squash from diseases](#) and keep [mushrooms and potatoes from browning](#).



SALAD



OYSTER STUFFING

Additionally — thanks in part to advances in technologies such as artificial intelligence, robotics and [LED grow lights](#) — several companies are beginning to move crops into high-tech warehouses, greenhouses and shipping containers.

Vertical farming systems grow plants such as lettuce and tomatoes, as well as some fruits, on stacked shelves under controlled environments measuring for nutrient delivery, pH, temperature and oxygen content, and they can often do all of this without pesticides.



However, the challenge for indoor farms, as opposed to outdoors or in greenhouses, is growing plants without sunlight — a free and abundant energy source. Indoor farming can be costly and energy-intensive since plants grown indoors need controlled temperatures, humidity and ventilation.

Pop some color, please

"Thanksgiving is really a beige meal," Bentley said. "But cranberry sauce — that shocking red sauce — that's a really important accent."

Cranberries, one of the few commercially cultivated fruits native to North America, have been an essential part of the Thanksgiving table. But [extreme heat](#) in summer, warmer winters with less ice and fluctuations between heavy rain and drought are taking a toll on cranberry plants — resulting in injured berries and less nutritious crops.



[Studies show](#) that fewer cold days can lead to earlier blossoming, which could reduce yields by half. Simultaneously, these conditions are more favorable for pests that prey upon cranberries, such as [armyworms](#), [cranberry weevils](#) and [winter moths](#).

Cranberries may continue to be available, but what these products cost and where they are sourced from is already changing.

This year, supply chain delays have driven up the price of cranberries, and tough weather has decreased yields in Wisconsin, which produces more cranberries than any other state. Some [cranberry cultivation is](#) also moving northward, to new locales such as Latvia.

Save some room for pie (and drinks)

As the planet warms and Thanksgiving favorites get more expensive or harder to come by, swapping staples for sustainable alternatives may be our best options for keeping traditions alive.

[New research out of the University of California at Davis](#) shows continued

warming could spell future disaster for winemakers around the world. Harvests have already been greatly affected by severe droughts in California and bouts of frost in France, which damaged an [estimated 80 percent](#) of French vineyards this year.

Pumpkins are also susceptible to cold and frost, which can cause them to soften and rot before harvest. In 2015, record rainfall in Morton in Illinois, a top pumpkin-producing state, [caused a nationwide canned-pumpkin shortage](#). Climatologists warn that such events could become more common in a warming world.



When it comes to pie, pumpkin could be swapped for prickly pear.





The crawling cactus is a [superfood for its high nutrient content](#), and it's already considered an invasive species in places like Australia, Hawaii and South Africa. [Studies](#) show that high temperatures and an overabundance of carbon dioxide would increase the plant's productivity and root growth. During drought years, prickly pear usually [spreads](#) more readily than grasses, especially under hot, dry conditions.

Consider crickets in your crust.

Although insects seldom make appearances on mainstream menus, eating bugs is integral to the history of America.



Indigenous peoples regularly incorporated insects into their diets, [according to the FAO](#), but this practice dwindled when Western cultures suppressed insect-eating in the 18th and 19th centuries, dismissing it as primitive.

Now insects are showing up in flours, protein bars, chips and even pet feed. [Studies show](#) that crickets, grasshoppers and weevils are rich in protein and minerals including iron, zinc, copper and magnesium and that farming insects has [environmental](#) benefits including less land and water use and lower greenhouse-gas emissions.

Trade your bubbly for beer made with Kernza.





Kernza beer was first developed in 2016, and there are now [three Kernza beers](#) available in select states. Kernza in flour format can also be used in pie crusts and dinner rolls, and it [makes a mean sourdough](#).





In the end, Thanksgiving is more about community than food. "I do think that [there is] growing acceptance that Thanksgiving is not about what exactly is on the table," NYU's McDermid said, "but about who is at the table."