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In a Race Against Warming, Growers Try to Outsmart Climate Change

From California to Costa Rica and beyond, farmers are experimenting with new crops and growing tactics.

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It was a long, hot summer, like most in the San Joaquin Valley. The pistachio trees planted in orderly rows — and the growers who nurture them — are accustomed to harsh conditions. With their deep roots and tough, gnarly branches, pistachio trees are hardy, tolerant of salty soils and brutal heat waves. Some can live for centuries.

But while sweltering summers are the norm in this part of central California, there's a new, existential threat to these trees, one that scientists warn could spell the end of the pistachio harvest: warmer winters. Many crops are facing similar threats as agricultural regions across the world experience previously unseen extremes in heat, rain and drought.

Chilly winters are critical to nut and fruit trees, particularly pistachios. To break their slumber and spread their pollen, pistachios need to spend about 850 hours, or five weeks, at temperatures below 45 degrees.

So as the San Joaquin Valley warms and its cooling fogs retreat, growers have found their orchards out of sync: Many male trees are no longer producing pollen when the females need it.

After suffering a billion-dollar loss from a recent warm winter, California pistachio growers don't need much convincing that their livelihoods are endangered by climate change. Heeding warnings that the industry may not survive past the middle of the century, they are among the world's earliest adapters. Scientists are wrangling and crossing genes to breed trees that can survive a warmer world, and growers are hedging their bets by planting experimental trees that need fewer chilly days.

"There's a lot to be said about traditional knowledge. But this is new territory," said Rebecca Carter of the World Resources Institute, a nonprofit research group that is working with growers around the world to adapt to the threats of climate change, including warmer winters, dried-up aquifers and record-breaking heat waves.

Scientists in 2013 urged "immediate adaptation" by farmers to ensure that they can feed the 10 billion people expected to inhabit the planet by 2050. They warned in a study that world hunger would worsen as crop yields declined, pests and diseases increased, water demand skyrocketed and highly vulnerable crops vanished. "The whole food system needs to change," according to the report published in the journal Science.

Coping, Dr. Carter said, would "require fundamental changes in how food is produced, how land is used, who lives where and what economic activities occur in specific areas."

Those changes are already happening worldwide. After growing coffee for generations, farmers in parts of Costa Rica are switching to oranges. Kenyan herders, facing intense droughts, are raising camels instead of cattle. Farmers in the Midwestern United States are planting corn several weeks early so their crops can pollinate before the hotter summers.

Camels have replaced cattle in parts of Kenya. Thilo Thielke/picture alliance, via Getty Images

In India, millet, an alternative to rice, does well in poor soil. Sam Panthaky/Agence France-Presse — Getty Images

In China's drought-prone Fujian province, farmers who grew wheat and corn have switched to apples. In India, some farmers have replaced rice with millet, an ancient grain that thrives in parched, infertile soils. And as seawater swamps Bangladesh, some rice fields have been transformed into shrimp farms.

Yet adaptation is a gradual, decades-long process. Whether it's California or China, transforming a society and an economy takes research, patience, guts — and money. California growers with lucrative, specialized crops have the income and savvy to test new climate-smart varieties, while in Costa Rica, Kenya and India, growers have been forced to abandon their long-held traditions and livelihoods.

"The poorest farmers, the most vulnerable farmers, are the ones who are least able to make these changes. They're going to need help to make them," Dr. Carter said.

A single county in the San Joaquin Valley, Fresno, produces and sells more agricultural products than 25 states, and over a third of the country's vegetables and two-thirds of its fruits and nuts are grown in California. So if the state's growers fail to adapt to climate change, it would cause nationwide food shortages and have a severe economic impact, according to a University of California study published last year.

"We can't continue to do the exact same thing we are doing now," said Katherine Jarvis-Shean, a University of California researcher who advises orchardists on how to cope with climate change. "There are a lot of solutions to the anticipated problems. We just have to get on top of them, testing them and making them available to growers."

Among the most threatened crops in California are cherries, pistachios and walnuts, which need a large number of chilly winter days, and wine grapes, which cannot tolerate extreme heat waves.

Melons and broccoli, though, might thrive in a warming world, according to a 2017 study by the Department of Agriculture. But consumers are unlikely to rush to buy them to replace their favorite stone fruits and nuts.

“For the most part, the world gets fed by row crops,” said Pat J. Brown, an associate professor at the University of California-Davis, referring to wheat, corn and other staples. “But a lot of the stuff that makes life really worth living comes from trees. Think of the world without chocolate or wine or coffee.”

That’s the world farmers and scientists are now actively working to avoid.

Pat J. Brown, an associate professor at the University of California-Davis, checks pistachio trees. Max Whittaker for The New York Times

‘Never seen anything like it’

For pistachios, the clear warning came in the winter of 2014-15, the warmest on record in the southern San Joaquin Valley. Historically, orchards there, about 125 miles north of Los Angeles, enjoy cool, rainy winters and dense fog. But statewide, average temperatures have increased more than 2 degrees Fahrenheit in the past century.

In particular, the valley’s wintertime lows have risen four times faster than its summertime highs. Making matters worse, the famous Tule fogs that cool the valley have dissipated by 46 percent.

In the winter of 2014-15, the southern valley experienced only about half the chill hours that the pistachios needed and not a single day of fog. The industry had its lowest yield in more than 20 years.

Cherries had a similar dismal year in 2014. Production dipped 63 percent, to the smallest crop since 1998. Then, last winter, a cold snap killed walnut trees up and down the valley.

“Walnut growers had never seen anything like it,” said Dr. Brown, who breeds walnuts and pistachios. “In this case, it didn’t just destroy a year’s crop. It killed mature trees.”

Farmers couldn’t help but be alarmed by the wild temperature swings. “Farming in general is like gambling in Vegas,” said Rob Yraceburu, the president of Wonderful Orchards, the largest producer of pistachios in the United States. “We’ve always had uncertainty. But now there’s even more uncertainty.”

The first warnings came in 2009, when a team of scientists reported that chilling hours in some parts of California had already dropped by 30 percent between 1950 and 2000, and that the decrease would reach 80 percent by the end of this century.

“For some crops, production might no longer be possible,” the scientists wrote. “Areas where safe winter chill exists for growing walnuts, pistachios, peaches, apricots, plums and cherries are likely to almost completely disappear by the end of the 21st century.”

Expanding their scope, the scientists warned that all growing regions — the southeastern United States, South America, Africa, China, Australia — “will experience severe declines in safe winter chill.”

Growing for a warmer world

After the dismal 2015 harvest, California growers decided that they needed pistachio trees designed for warmer winters. But it takes some 20 years to breed, test, grow and harvest a new variety of nut tree, so experiments undertaken now won’t have quick results.

“We have a saying: You don’t plant pistachios for yourself, you plant them for your children and your grandchildren,” said Bob Klein, manager of the California Pistachio Research Board. “Now perhaps it’s not so much for your kids and your grandchildren” as the future climate has become so uncertain, he said.

Wonderful Orchards took the stopgap step of planting some experimental male trees that shed pollen at various times, hoping their cycles would match more females.

The company is still waiting to see if any of its efforts will work.

“It’s a challenge for all permanent crops, because it takes so long,” Mr. Yraceburu said. “Others like carrots or lettuce are 90-day or 120-day crops, so you can try something and know right away if it works. For trees, you don’t even get any results until four to eight years down the road. You don’t know if your experiment works for a long time.”

For some crops, scientists are going back to their origins, searching, for instance, for old varieties of nuts grown in the Middle East. “All of the things we grow in California have a wild relative or a variety on the market elsewhere that does O.K. with warmer winters,” Dr. Jarvis-Shean said.

The Agriculture Department has repositories that store genetic material from every type of tree on earth. Dan Parfitt, a now-retired University of California-Davis plant geneticist, started breeding pistachios using tissue from those repositories more than 30 years ago in an effort to help growers economize their harvest.

As the climate changed, Dr. Parfitt got the idea to plant a few hundred of the trees in the California desert. “The Coachella Valley is the closest to the warmer winters and drier conditions that we will see in the San Joaquin Valley in 20 to 30 years,” he said.

These new breeds go by an array of odd names: Gumdrop, Tejon, Lost Hills, Famoso. Many growers have already planted some in their orchards. Dr. Parfitt is confident that the pistachios of the future will be dominated by trees bred for climate change.

Oranges adapt better to dry conditions and have supplanted coffee in areas of Costa Rica. Carlos Vásquez Hernández

Swapping coffee for oranges

A similar adaptation effort is underway in Guanacaste, Costa Rica, where coffee has been grown for two centuries. But instead of waiting for climate-smart beans, Javier Zeledón Jimenez is growing something else.

About 20 years ago, as coffee was becoming less profitable, he switched to oranges, a crop that also happens to cope better with dry conditions. He is now doing much better financially, and other Guanacaste growers, seeing his success, have joined him.

The unpredictability of climate change is raising the cost of harvesting coffee just as prices for the product are dropping, said Carlos Luis Vásquez Hernández, the general manager of Coope Pilangosta, a coffee cooperative in Guanacaste. As a result, he said, about 40 percent of the coffee farmers in his co-op have switched to oranges.

Coffee is temperature sensitive; highs and lows must fall within a certain range, and it needs a long dry period, then a gradual start to the rainy season, to thrive. Rising temperatures and erratic shifts in rainfall have devastated Guanacaste's coffee growers. Almost half the crop was lost in the 2015-16 season because of drought, Mr. Vásquez Hernández said.

"With climate change, something we've heard over and over from farmers is that the climate is becoming really irregular and unpredictable," said Stefanie Tye of the World Resources Institute, who is advising Costa Rican growers. "It's incredibly difficult to be a coffee producer right now. A lot of the farmers are heavily in debt."

It will get worse. By 2050, Costa Rica's average temperatures are projected to rise 2 to 4 degrees Fahrenheit, rendering some regions incapable of growing Arabica beans. That will mean fundamental changes to a culture that has had a rich history of coffee growing.

"If we lose the coffee crop, job opportunities in the rural areas will decrease," Mr. Vásquez Hernández said. "Immigration from the rural areas will be a fact, without a doubt. People will try to find jobs opportunities in bigger cities because coffee won't be a good opportunity."

For farmers around the world, "these are hard conversations to have," Dr. Carter said. "Agriculture hasn't changed a whole heck of a lot. But they are willing to change if it makes sense to them, if there is a market, if they can do it gradually, rather than when they're backed into a corner.

"What we hope to avoid," she said, "is farmers in crisis."

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