The Irony of Climate

By Brian Halweil

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High in the Peruvian Andes, a new disease has invaded the potato fields in the town of Chacllabamba. Warmer and wetter weather associated with global climate change has allowed late blight—the same fungus that caused the Irish potato famine—to creep 4,000 meters up the mountainside for the first time since humans started growing potatoes here thousands of years ago. In 2003, Chacllabamba farmers saw their crop of native potatoes almost totally destroyed. Breeders are rushing to develop tubers resistant to the “new” disease that retain the taste, texture, and quality preferred by Andean populations.

Meanwhile, old-timers in Holmes County, Kansas, have been struggling to tell which way the wind is blowing, so to speak. On the one hand, the summers and winters are both warmer, which means less snow and less snowmelt in the spring and less water stored in the fields. On the other hand, there’s more rain, but it’s falling in the early spring, rather than during the summer growing season. So the crops might be parched when they need water most. According to state climatologists, it’s too early to say exactly how these changes will play out—if farmers will be able to push their corn and wheat fields onto formerly barren land or if the higher temperatures will help once again to turn the grain fields of Kansas into a dust bowl. Whatever happens, it’s going to surprise the current generation of farmers.

Asian farmers, too, are facing their own climate-related problems. In the unirrigated rice paddies and wheat fields of Asia, the annual monsoon can make or break millions of lives. Yet the reliability of the monsoon is increasingly in doubt. For instance, El Niño events (the cyclical warming of surface waters in the eastern Pacific Ocean) often correspond with weaker monsoons, and El Niños will likely increase with global warming. During the El Niño-induced drought in 1997, Indonesian rice farmers pumped water from swamps close to their fields, but food losses were still high: 55 percent for dryland maize and 41 percent for wetland maize, 34 percent for wetland rice, and 19 percent for cassava. The 1997 drought was followed by a particularly wet winter that delayed planting for two months in many areas and triggered heavy locust and rat infestations. According to Bambang Irawan of the Indonesian Center for Agricultural Socio-Economic Research and Development, in Bogor, this succession of poor harvests forced many families to eat less rice and turn to the less nutritious alternative of dried cassava. Some farmers sold off their jewelry and livestock, worked off the farm, or borrowed money to purchase rice, Irawan says. The prospects are for more of the same: “If we get a substantial global warming, there is no doubt in my mind that there will be serious changes to the monsoon,” says David Rhind, a senior climate researcher.
with NASA’s Goddard Institute for Space Studies.

Archaeologists believe that the shift to a warmer, wetter, and more stable climate at the end of the last ice age was key for humanity’s successful foray into food production. Yet, from the American breadbasket to the North China Plain to the fields of southern Africa, farmers and climate scientists are finding that generations-old patterns of rainfall and temperature are shifting. Farming may be the human endeavor most dependent on a stable climate—and the industry that will struggle most to cope with more erratic weather, severe storms, and shifts in growing season lengths. While some optimists are predicting longer growing seasons and more abundant harvests as the climate warms, farmers are mostly reaping surprises.

**Toward the Unknown (Climate) Region**

For two decades, Hartwell Allen, a researcher with the University of Florida in Gainesville and the U.S. Department of Agriculture, has been growing rice, soybeans, and peanuts in plastic, greenhouse-like growth chambers that allow him to play God. He can control—“rather precisely”—the temperature, humidity, and levels of atmospheric carbon. “We grow the plants under a daily maximum/minimum cyclic temperature that would mimic the real world cycle,” Allen says. His lab has tried regimes of 28 degrees C day/18 degrees C night, 32/22, 36/26, 40/30, and 44/34. “We ran one experiment to 48/38, and got very few surviving plants,” he says. Allen found that while a doubling of carbon dioxide and a slightly increased temperature stimulate seeds to germinate and the plants to grow larger and lusher, the higher temperatures are deadly when the plant starts producing pollen. Every stage of the process—pollen transfer, the growth of the tube that links the pollen to the seed, the viability of the pollen itself—is highly sensitive. “It’s all or nothing, if pollination isn’t successful,” Allen notes. At temperatures above 36 degrees C during pollination, peanut yields dropped about six percent per degree of temperature increase. Allen is particularly concerned about the implications for places like India and West Africa, where peanuts are a dietary staple and temperatures during the growing season are already well above 32 degrees C: “In these regions the crops are mostly rain-fed. If global warming also leads to drought in these areas, yields could be even lower.”

As plant scientists refine their understanding of...
climate change and the subtle ways in which plants respond, they are beginning to think that the most serious threats to agriculture will not be the most dramatic: the lethal heatwave or severe drought or endless deluge. Instead, for plants that humans have bred to thrive in specific climatic conditions, it is those subtle shifts in temperatures and rainfall during key periods in the crops’ lifecycles that will be most disruptive. Even today, crop losses associated with background climate variability are significantly higher than those caused by disasters such as hurricanes or flooding.

John Sheehy at the International Rice Research Institute in Manila has found that damage to the world’s major grain crops begins when temperatures climb above 30 degrees C during flowering. At about 40 degrees C, yields are reduced to zero. “In rice, wheat, and maize, grain yields are likely to decline by 10 percent for every 1 degree C increase over 30 degrees. We are already at or close to this threshold,” Sheehy says, noting regular heat damage in Cambodia, India, and his own center in the Philippines, where the average temperature is now 2.5 degrees C higher than 50 years ago. In particular, higher night-time temperatures forced the plants to work harder at respiration and thus sapped their energy, leaving less for producing grain. Sheehy estimates that grain yields in the tropics might fall as much as 30 percent over the next 50 years, during a period when the region’s already malnourished population is projected to increase by 44 percent. (Sheehy and his colleagues think a potential solution is breeding rice and other crops to flower early in the morning or at night so that the sensitive temperature process misses the hottest part of the day. But, he says, “we haven’t been successful in getting any real funds for the work.”) The world’s major plants can cope with temperature shifts to some extent, but since the dawn of agriculture farmers have selected plants that thrive in stable conditions.

Climatologists consulting their computer climate models see anything but stability, however. As greenhouse gases trap more of the sun’s heat in the Earth’s atmosphere, there is also more energy in the climate system, which means more extreme swings—dry to wet, hot to cold. (This is the reason that there can still be severe winters on a warming planet, or that March 2004 was the third-warmest month on record after one of the coldest winters ever.) Among those projected impacts that climatologists have already observed in most regions: higher maximum temperatures and more hot days, higher minimum temperatures and fewer cold days, more variable and extreme rainfall events, and increased summer drying and associated risk of drought in continental interiors. All of these conditions will likely accelerate into the next century.

Cynthia Rosenzweig, a senior research scholar with the Goddard Institute for Space Studies at Columbia University, argues that although the climate models will always be improving, there are certain changes we can already predict with a level of confidence. First, most studies indicate “intensification of the hydrological cycle,” which essentially means more droughts and floods, and more variable and extreme rainfall. Second, Rosenzweig says, “basically every study has shown that there will be increased incidence of crop pests.” Longer growing seasons mean more generations of pests during the summer, while shorter and warmer winters mean that fewer adults, larvae, and eggs will die off.

Third, most climatologists agree that climate change will hit farmers in the developing world hardest. This is partly a result of geography. Farmers in the tropics already find themselves near the temperature limits for most major crops, so any warming is likely to push their crops over the top. “All increases in temperature, however small, will lead to decreases in production,” says Robert Watson, chief scientist at the World Bank and former chairman of the Intergovernmental Panel on Climate Change. “Studies have consistently shown that agricultural regions in the developing world are more vulnerable, even before we consider the ability to cope,” because of poverty, more limited irrigation technology, and lack of weather tracking systems. “Look at the coping strategies, and then it’s a real double whammy,” Rosenzweig says. In sub-Saharan Africa—ground zero of global hunger, where the number of starving people has doubled in the last 20 years—the current situation will undoubtedly be exacerbated by the climate crisis. (And by the 2080s, Watson says, projections indicate that even temperate latitudes will begin to approach the upper limit of the productive temperature range.)

**Coping With Change**

“Scientists may indeed need decades to be sure that climate change is taking place,” says Patrick Luganda, chairman of the Network of Climate Journalists in the Greater Horn of Africa. “But, on the ground, farmers have no choice but to deal with the daily reality as best
they can.” Luganda says that several years ago local farming communities in Uganda could determine the onset of rains and their cessation with a fair amount of accuracy. “These days there is no guarantee that the long rains will start, or stop, at the usual time,” Luganda says. The Ateso people in north-central Uganda report the disappearance of asisinit, a swamp grass favored for thatch houses because of its beauty and durability. The grass is increasingly rare because farmers have started to plant rice and millet in swampy areas in response to more frequent droughts. (Rice farmers in Indonesia coping with droughts have done the same.) Farmers have also begun to sow a wider diversity of crops and to stagger their plantings to hedge against abrupt climate shifts. Luganda adds that repeated crop failures have pushed many farmers into the urban centers: the final coping mechanism.

The many variables associated with climate change make coping difficult, but hardly futile. In some cases, farmers may need to install sprinklers to help them survive more droughts. In other cases, plant breeders will need to look for crop varieties that can withstand a greater range of temperatures. The good news is that many of the same changes that will help farmers cope with climate change will also make communities more self-sufficient and reduce dependence on the long-distance food chain.

Planting a wider range of crops, for instance, is perhaps farmers’ best hedge against more erratic weather. In parts of Africa, planting trees alongside crops—a system called agroforestry that might include shade coffee and cacao, or leguminous trees with corn—might be part of the answer. “There is good reason to believe that these systems will be more resilient than a maize monoculture,” says Lou Verchot, the lead scientist on climate change at the International Centre for Research in Agroforestry in Nairobi. The trees send their roots considerably deeper than the crops, allowing them to survive a drought that might damage the grain crop. The tree roots will also pump water into the upper soil layers where crops can tap it. Trees improve the soil as well: their roots create spaces for water flow and their leaves decompose into compost. In other words, a farmer who has trees won’t lose everything. Farmers in central Kenya are using a mix of coffee, macadamia nuts, and cereals that results in as many as three marketable crops in a good year. “Of course, in any one year, the monoculture will yield more money,” Verchot admits, “but farmers need to work on many years.”

Desertification in China

Top: Dust storms bury electricity poles and it’s easier to extend the poles than dig them out. The extensions are left in place against the next encroaching dune.
Bottom: Depleted grasslands mean hungry goats. Their owners cover the animals with cloth so they won’t eat each others’ hair.
These diverse crop mixes are all the more relevant since rising temperatures will eliminate much of the traditional coffee- and tea-growing areas in the Caribbean, Latin America, and Africa. In Uganda, where coffee and tea account for nearly 100 percent of agricultural exports, an average temperature rise of 2 degrees C would dramatically reduce the harvest, as all but the highest altitude areas become too hot to grow coffee.

In essence, farms will best resist a wide range of shocks by making themselves more diverse and less dependent on outside inputs. A farmer growing a single variety of wheat is more likely to lose the whole crop when the temperature shifts dramatically than a farmer growing several wheat varieties, or better yet, several varieties of plants besides wheat. The additional crops help form a sort of ecological bulwark against blows from climate change. “It will be important to devise more resilient agricultural production systems that can absorb and survive more variability,” argues Fred Kirschenmann, director of the Leopold Center for Sustainable Agriculture at Iowa State University. At his own family farm in North Dakota, Kirschenmann has struggled with two years of abnormal weather that nearly eliminated one crop and devastated another. Diversified farms will cope better with drought, increased pests, and a range of other climate-related jolts. And they will tend to be less reliant on fertilizers and pesticides, and the fossil fuel inputs they require. Climate change might also be the best argument for preserving local crop varieties around the world, so that plant breeders can draw from as wide a palette as possible when trying to develop plants that can cope with more frequent drought or new pests.

Farms with trees planted strategically between crops will not only better withstand torrential downpours and parching droughts, they will also “lock up” more carbon. Lou Verchot says that the improved fallows used to make and transport 90 percent of its supplies.

However, “carbon farming is a temporary solution,” according to Marty Bender of the Land Institute’s Sunshine Farm in Salina, Kansas. He points to a recent paper in Science showing that even if America’s soils were returned to their pre-plow carbon content—a theoretical maximum for how much carbon they could lock up—this would be equal to only two decades of American carbon emissions. “That is how little time we will be buying,” Bender says, “despite the fact that it may take a hundred years of aggressive, national carbon farming and forestry to restore this lost carbon.”

“We really should be focusing on energy efficiency and energy conservation to reduce the carbon emissions by our national economy,” Bender concludes. That’s why Sunshine Farm, which Bender directs, has been farming without fossil fuels, fertilizers, or pesticides in order to reduce its contribution to climate change. The farm runs essentially on sunlight. Homegrown sunflower seeds and soybeans become biodiesel that fuels trucks and no energy is used to make and transport 90 percent of its supplies. (Including the energy required to make the farm’s

Best of all, for farmers at least, systems that store more carbon are often considerably more profitable, and they might become even more so if farmers get paid to store carbon under the Kyoto Protocol. There is a plan, for instance, to pay farmers in Chiapas, Mexico, to shift from farming that involves regular forest clearing to agroforestry. The International Automobile Federation is funding the project as part of its commitment to reducing carbon emissions from sponsored sports car races. Not only that, “increased costs for fossil fuels will accelerate demand for renewable energies,” says Mark Muller of the Institute for Agriculture and Trade Policy in Minneapolis, Minnesota, who believes that farmers will find new markets for biomass fuels like switchgrass that can be grown on the farm, as well as additional royalties from installing wind turbines on their farms.

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machinery lowers the figure to 50 percent, still a huge gain over the standard American farm.)

But these energy savings are only part of this distinctly local solution to an undeniably global problem, Bender says. “If local food systems could eliminate the need for half of the energy used for food processing and distribution, then that would save 30 percent of the fossil energy used in the U.S. food system,” Bender reasons. “Considering that local foods will require some energy use, let’s round the net savings down to 25 percent. In comparison, on-farm direct and indirect energy consumption constitutes 20 percent of energy use in the U.S. food system. Hence, local food systems could potentially save more energy than is used on American farms.”

In other words, as climate tremors disrupt the vast intercontinental web of food production and rearrange the world’s major breadbaskets, depending on food from distant suppliers will be more expensive and more precarious. It will be cheaper and easier to cope with local weather shifts, and with more limited supplies of fossil fuels, than to ship in a commodity from afar.

Agriculture is in third place, far behind energy use and chlorofluorocarbon production, as a contributor to climate warming. For farms to play a significant role, changes in cropping practices must happen on a large scale, across large swaths of India and Brazil and China and the American Midwest. As Bender suggests, farmers will be able to shore up their defenses against climate change, and can make obvious reductions in their own energy use which could save them money.

But the lasting solution to greenhouse gas emissions and climate change will depend mostly on the choices that everyone else makes. According to the London-based NGO Safe Alliance, a basic meal—some meat, grain, fruits, and vegetables—using imported ingredients can easily generate four times the greenhouse gas emissions as the same meal with ingredients from local sources. In terms of our personal contribution to climate change, eating local can be as important as driving a fuel-efficient car, or giving up the car for a bike. As politicians struggle to muster the will power to confront the climate crisis, ensuring that farmers have a less erratic climate in which to raise the world’s food shouldn’t be too hard a sell.

Brian Halweil is a senior researcher at Worldwatch Institute, and the author of Eat Here: Reclaiming Homegrown Pleasures in a Global Supermarket.

Desertification in China

Top: Collecting facai (hair grass), a prized herb whose name sounds like the word for “making a fortune.” The herb grows on the roots of grass, so raking it up pulls out the grass too, leading to desertification. Bottom: Children on a facai-collecting trip. They cover 10 miles a day over several days, camping out in below-freezing temperatures. Each will earn about $25.