The language of change

Can climate science help to feed the world? It's all about speaking the right language, finds **Ken Kostel**.

When David Battisti attended a gathering of agricultural specialists in Bellagio, Italy, back in 2007, he assumed they would be most interested in hearing what he and his climate models could — and could not — tell them about future precipitation patterns. But when the first day's discussion centred on how higher seasonal average temperatures could affect crop yields, Battisti realized he should revise his talk for the next day.

"Our focus had been on drought," says Battisti, a climatologist at the University of Washington, Seattle. "The idea that temperature matters was a complete surprise to me." It might have been a revelation for him, but not for many of the seed-bank representatives who were present. For Battisti, that turned out to be a good thing. "Precipitation changes are harder to model than temperature changes. Short-term spikes are hard to model, as well as most extreme events. But we can reproduce season average temperatures pretty well."

Battisti's is a common problem. Learning how to communicate is one of the most difficult and earliest challenges encountered in any new relationship. Nowhere is that more evident, or more important to overcome, than in the growing connection between climate scientists and the agronomists, plant breeders, economists and others who are behind efforts to make the world's food and agricultural systems more adaptable to a changing climate.

> "Human beings are not going to adapt to climate change unless agriculture adapts."
> Cary Fowler

With an eye to that challenge, Cary Fowler of the Global Crop Diversity Trust (GCDT), a food-security foundation based in Rome, called the 2007 meeting to bring together climate and agriculture experts and get them talking. His aim was to help seed-bank managers and developers of crop varieties better understand the future for which they are preparing and, at the same time, to help climate scientists appreciate the particular information needs of the agricultural sector. "In a sense this answered one of the big questions for us," says Fowler, the executive director of GCDT. "We need to be screening our [seed] collections more closely for heat resistance."

SCOTT HARRISON / CHARITY: WATER

Climate change could severely reduce crop yields across the world this century unless adaptive measures are taken.

TAKING THE HEAT

And that work has to begin sooner rather than later. In a recent study[1] that expanded on his GCDT presentation, Battisti teamed up with Rosamond Naylor, an economist at Stanford University in California, to look at how changes in seasonal average temperatures could affect global food security. Writing in the journal *Science*, Battisti and Naylor show that by the end of the century, average growing-season temperatures in the tropics and subtropics will exceed the most extreme seasonal temperatures of the past 100 years. Without adaptive measures, this could threaten the world's food supply, warn the authors.

Another participant at the meeting — David Lobell of Stanford University — recently led a study that found that, if no adaptation measures are taken, south Asia and southern Africa will probably experience reduced crop yields as a result of climate change as soon as 2030 (ref. 2). "Although relatively inexpensive changes, such as shifting planting dates or switching to an existing crop variety, may moderate negative impacts," wrote Lobell and co-authors in *Science*, "the biggest benefits will likely result from more costly measures including the development of new crop varieties and expansion of irrigation."

For crop breeders, who require about ten years to develop a new variety, a deadline of 2030 gives them only two tries to get the right traits into a plant and the plant into the ground. "The effects of climate change are not going to happen tomorrow, but it also takes time to adapt," says Gerald Nelson, a senior fellow at the Washington DC-based International Food Policy Research Institute. "You can't put it off until the problem becomes evident."

Climate adaptation expert Cynthia Rosenzweig had a similar experience to Battisti's when she learned that her audience was less interested than she expected in the global annual average

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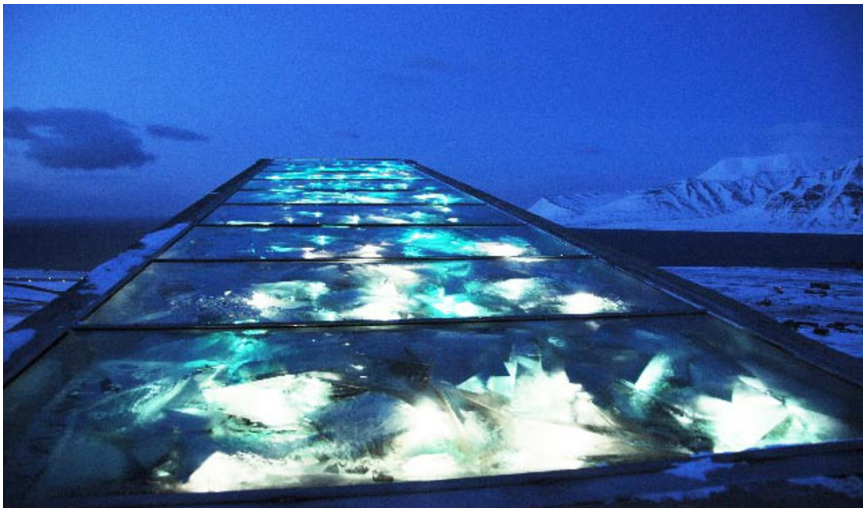
temperature, which many modellers routinely report. Rosenzweig, who is based at NASA's Goddard Institute for Space Studies in New York, is currently working with researchers from several universities across New York state to develop an assessment of the state's vulnerabilities and adaptation options for six sectors, including agriculture. Dairy farmers in the western and central part of New York informed her that although they were worried about increasingly warm weather in general, it was primarily a concern during the summer and especially if high temperatures occurred in conjunction with increased humidity — a combination that reduces milk yields.

On the other hand, she found fruit farmers to be more concerned about warmer winters, which cause their trees and vines to miss out on vernalization, the hard freeze needed for plants to flower in the spring. Although warmth-adapted varieties of dairy cows and apple trees exist, the lag time between adopting these new varieties and a return to full production is much longer for fruit farmers than for dairy farmers. As a result, their perception of uncertainty is different and their need for advance warning of change much greater. "Instead of handing out a laundry list [of adaptation measures], we have to be more targeted," says Rosenzweig. "Really, all adaptation is local."



MARI TEPRE / GLOBAL CROP DIVERSITY TRUST

Agricultural and climate experts meeting in February will refine priorities for selecting crop varieties held at the 'doomsday vault' and in seed collections around the world.

INNOVATIVE INSURANCE

In many developing nations, adaptation is not only local, but also often personal. In sub-Saharan Africa, an estimated 70 per cent of the population survives by rain-fed subsistence agriculture. For these farmers, many of whom are just one bad growing season away from being forced to sell their few assets to survive, adaptation options are extremely limited. Added to this, climate change is expected to scramble growing conditions to which local crop varieties have spent thousands of years adapting.

To give poor farmers access to new crop varieties, a group of economists and scientists is now developing a unique type of crop insurance policy. Traditional insurance against crop failure pays out only when an adjuster can verify a policy-holder's claim. This means that in the event of widespread crop failure, adjusters must verify each claim individually, which adds to the cost of premiums and often delays payments. In contrast, payment on an index insurance contract is linked to the performance of an independent variable, such as precipitation during the growing season, that has been shown to affect crop performance for a group of policy-holders in the same predictable way.

"Instead of focusing on crop failure, you focus on the thing that causes crops to fail," says Daniel Osgood, an economist at the International Research Institute for Climate and Society in New York, who helped develop a pilot index insurance program in Malawi[3]. This effectively eliminates something known as adverse selection, in which a farmer who would be paid for the failure of his or her crops has little motivation to see the crops succeed. The researchers take this one step further by linking the insurance policy to a small loan covering the cost of drought- or heat-tolerant seeds. If the index falls below an agreed-upon threshold, the policy pays off the loan, freeing the farmer to look for other ways to make money.

But teaming climate scientists with economists has exposed differences in the way the fields view the same information. Most climatologists treat a new model forecast, with all of its assumptions and calculations, as a hypothesis that needs to be proved sufficiently correct before being useful. In setting the price of insurance contracts, however, Osgood has to treat the information from the moment it becomes available as something that, until it is proved definitively wrong, might affect a person's behaviour.

And whereas scientists who regularly use tools such as rainfall models might see these as inadequate for estimating drought severity, Osgood sees their performance as more than up to the task. "It's often difficult in our first interactions," Osgood says of working with his climatologist colleagues. "Once they understand that the limitations of tools are not what we care about, but the strengths, a lot of scientists are eager to work on these questions. The bigger challenge is in publishing," he adds. "It's often difficult to know exactly how to present what we do to an audience or to reviewers."

At the end of February, Cary Fowler will host another meeting with agricultural and climate experts — this time in Svalbard, Norway, the site of GCDT's Global Seed Vault, a facility designed to house spare copies of seeds held in gene banks worldwide. The aim is to refine the group's priorities for selecting the crop varieties held in the so-called 'doomsday vault' and in seed collections around the world. He also hopes the gathering will help further reduce the misunderstandings between disciplines, not to mention the uncertainty in humanity's future. "Human beings are not going to adapt to climate change unless agriculture adapts," says Fowler.

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