GENETICALLY MODIFIED CONSERVATION

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It sounds like an oxymoron, but genetic engineering is already ushering in a new brand of agriculture that slashes pesticide use and thrives in a warmer, wetter world.

By Erik Vance

In the mid-1940s, Norman Borlaug started the Green Revolution on a small farm in southern Mexico. His idea was simple. As the human population skyrocketed, he would grow a new kind of wheat with a thicker stem and bigger seed heads, thus increasing its yield and allowing farmers to grow more wheat—and feed more people—per acre.

The results were staggering. Within two decades, Mexico's wheat harvest had swollen six-fold, thanks to crops descended from Borlaug's original modified wheat. Borlaug then turned his talents toward rice in the Philippines, and high-yield crops spread into almost every major food staple. In all, Borlaug's revolution helped feed millions of people in poor and developing countries who would otherwise have starved—an achievement that earned him the 1970 Nobel Peace Prize.

But the Green Revolution wasn't "green" in the modern sense of the word. In fact, it exacted a huge environmental toll. Its crops require liberal use of fertilizer and pesticides that bleed into the land and sea, poisoning wildlife and creating nitrogen-rich dead zones in the oceans.

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Now, with climate change threatening to upend many of the world's crops, a new generation of researchers is poised to correct some of the original revolution's flaws and rethink agriculture once again. One of its newest spokespersons is Pam Ronald, a University of California, Davis, researcher who sees a future dominated not by Monsanto-like corporations but by small partnerships between farmers and scientists.

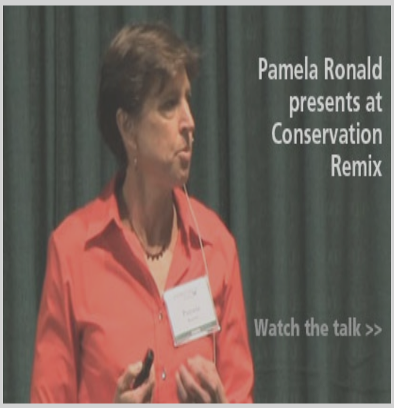
By combining genetically modified crops with organic farming and other eco-friendly practices, Ronald believes, we can create a system that slashes pesticide use, insulates crops against floods and drought, and protects the livelihoods of poor farmers in the developing world. To many, the idea of using genetic engineering as a conservation tool is an oxymoron, but the scales may finally be tipping in Ronald's favor.

Her ideas have drawn attention at the highest levels and become a favorite of opinion makers such as Michael Pollan and Bill Gates. What's more, they serve as a stark reminder that genetically modified foods are here—whether we like it or not. Which means that, at a time when we need to reinvent the world's food supply, the critical question may be: can we get it right?

Ronald is an unlikely genetic-engineering advocate. Pulling into her driveway, I see that her yard looks like that of any eco-foodie. Her garden—a tangled mix of herbs and native plants—has a happy, New Age feel. Her barn sports a mural that is "Diego Rivera meets Cesar Chavez." And her husband, Raoul Adamchak, is an organic farmer.

But Ronald, a plant geneticist, is also an unabashed supporter of genetically modified (GM) crops. Her recent book on the benefits of bioengineered organic crops, *Tomorrow's Table* (which she co-wrote with Adamchak), has started reshaping the way we look at GM foods. (1)

While the GM debate has traditionally been focused on genetically modified corn and other lucrative foodstuffs, Ronald has been doing pioneering work on a crop that is largely ignored: rice. In fact, while companies such as Monsanto pour billions into GM crops, rice research is almost solely the province of publicly funded academics. "The big companies aren't working on broccoli or carrots—there's just not enough profit in that," she says. "And they don't work on rice. It feeds half the world, but it doesn't feed the wealthy half."



Sitting in her eclectic, pesticide-free garden, she says rice could be the ideal proving ground for genetic engineering to improve the environment while preparing for a warmer world.

Take flooding, for instance. No one knows for certain how much flooding will increase as the planet warms, but scientists believe it will become more frequent and last longer in places such as Southeast Asia, where it already causes around $1 billion in annual damage to rice crops.

That's why Ronald's lab teamed up with colleague Dave Mackill in the late 1990s to create a species of rice that could be submerged for weeks during a flood and still survive. Unlike many crops, rice has a dizzying number of varieties (as many as 140,000), all with distinct genetic codes. Mackill had found one from eastern India with an unusual ability to live underwater for long spans. So Ronald's team undertook the painstaking task of sorting through the genome until they found a single gene that seemed to act as a "master switch" for flood tolerance.

It was a neat trick, but the researchers wanted something that could be used easily by poor rice farmers. One method would have been to slice the gene out and simply slide it into a commercial crop, making it "genetically modified." However, they finally decided to simply breed the old with the new while targeting that specific place in the gene that held the precious submergence trait. This so-called "marker-assisted" breeding blends genetic work with old-school, dirty-fingernails farming. Because the actual genetic transfer was done in rice fields rather than labs, the new strain is not considered modified and is thus under less scrutiny from government agencies.

In a 2006 paper in *Nature*, the team announced a new strain of rice that could survive two weeks totally underwater. What's more, it was easy to grow. By the end of this year, the new, flood-proof rice will cover 125,000 acres in four countries. Next year that's projected to jump ten-fold. (2)

And Ronald says this is just the beginning. Flooding is one of climate change's three key threats to agriculture—drought and pest outbreaks are the other two—and Ronald believes lab-aided rice can be designed to resist them all. She is just beginning to work on drought-tolerant rice, and she believes a bug and weed resistant rice could slash the amount of pesticides rice farmers spew into the environment.

For Ronald, it's an example of how genetic engineering has accomplished exactly what many environmentalists and organic farmers want. Genetically modified cotton is a prime example. Little more than a decade ago, farmers in China started using "Bt cotton," a genetically engineered variety containing a protein that kills pests but is nontoxic to mammals. (The Bt protein is a favorite insecticide among organic farmers.) Within four years, the Chinese cotton farmers reduced their annual use of poisonous insecticides by 70,000 metric tons—almost as much as is used in all of California each year.

Of course, not everyone agrees. Opponents of genetic engineering worry that GM food carries some still-undiscovered health risks or that it's just a tool for big corporations to sell more pesticides. And Doug Gurian-Sherman, with the Union of Concerned Scientists, worries that expensive GM research siphons money from less-sexy techniques. He says he likes marker-led breeding but wants to see more money spent on organic techniques that reduce sprawling monocultures and mix together crops, more like a natural ecosystem.

For Ronald, the danger of pesticides far outweighs that of switching a few base pairs in the DNA. She frequently notes that there's no record of anyone ever becoming sick from a GM crop. On the other hand, pesticides kill 200 to 1,000 Americans a year, according to the World Health Organization.

Ronald also points out that the debate over GM revolves around several false dichotomies. While naysayers declare genetic modification to be a new and evil practice, for example, Ronald says the line between “genetically engineered” and “traditional” crops really exists only in the media and politics. For scientists, she says, it’s more of a continuum—with traditional breeding on one end and crops with genes borrowed from vastly different creatures on the other. “It’s not the process that is good or bad, it’s the product,” she says.

Another false trade-off is the idea that embracing GM means doing away with other environmentally friendly agriculture practices. If we are to feed the world without destroying the planet, Ronald believes, we must incorporate not just GM but also many ideas promoted by organic farmers, such as crop rotations and crop diversity.

To explain what might finally tip the scales in GM’s favor, Ronald points to the situation in the developing world. As global warming grinds forward, poor subsistence farmers will be devastated by food insecurity far more than the wealthy West. “If farmers don’t change the seed they’re planting now, in 25 years they’re going to be getting half the yield,” Ronald says. She believes altering rice and other crops—such as strains of bananas crucial to small African economies—could help prevent future famine, much in the way that Borlaug’s wheat spared millions of people from starvation. If we’re going to accomplish that, environmentalists need to think more broadly. “You don’t have to choose between productivity and sustainability,” she says, leaning back and looking around her ecclectic garden. “You can have both.” ❧

Literature Cited:

1.Ronald, P.C. and R.W. Adamchak. 2008. *Tomorrow's Table: Organic Farming, Genetics, and the Future of Food*. Oxford University Press, New York.

2. Xu, K. et al. 2006. Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice. *Nature*. doi:10.1038/nature04920.

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