CORTEVA™ agriscience

A rice geneticist sees an urgent need for a more nuanced understanding of agricultural genetics.

Plant geneticist Pamela Ronald has some big ideas about genetically modified organisms (GMOs). To begin with, she prefers to steer clear of the term altogether. Ask her why, and she'll answer succinctly: "It's scientifically meaningless. It's so loaded, you can't even have a conversation about it!"

Ronald navigates the subject of agricultural science with a deftness that reflects her decades of experience, and believes that, despite the controversy around GMOs, a shared goal motivates everyone involved in the discussion. "Most people want to advance sustainable agriculture, feed the poor or malnourished, and use our land and water more efficiently."

Ronald has worked in agriscience since the 1990s, helping to solve some of the most persistent problems farmers face in growing staple crops. Her position on GMOs is worth considering for anyone concerned about the value, and the risks, they offer. While the debate over the impact of modified crops continues, and dozens of countries have banned them outright, the technology can also be a powerful tool in fighting world hunger.

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A deeply rooted career

Ronald traces her interest in science to a childhood hike in her native California. "On a backpacking trip at age 14, I met some botanists studying wildflowers and thought, 'Wow, that looks fun!'" As she imagined shaping this interest into a career, Ronald also knew she wanted to create a lasting, positive impact on the world. "I thought a lot about people in developing countries when I was growing up. My father is a German Jewish refugee, and my mother grew up during the Depression, so I learned that you'd better help others—especially if you're privileged with education and family." Encouraged by a beloved genetics professor as an undergraduate at Oregon's Reed College, Ronald discovered her niche and thrived.

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Today, Ronald is a distinguished professor in the Department of Plant Pathology and the Genome Center at the University of California Davis, key scientist at the Joint BioEnergy Institute in Emeryville, Calif., and the director of the UC Davis Institute for Food and Agricultural Literacy. Ronald also gave a 2015 TED talk that's captured the attention of more than 1.7 million viewers in 26 languages.

Calling for caution

For all of her expertise, Ronald can still make it easy to understand how the study of plant genes impacts daily life. And she makes a compelling case for interrupting the oversimplified narratives that often define GMO debates. Ronald understands the concern over crops modified to be resistant to herbicides, but cautions that these are individual applications. She's also concerned that terms are often tossed around casually, both in the media and in conversation, leading to misunderstanding.

"People think their language about genetics doesn't harm anyone—but it does. It's hard to understand farming and hard to understand poverty, but I wish people would push themselves a bit more to ask, 'What are the benefits of using this technology?'"

As an example, Ronald offers Golden Rice, which has been engineered to produce and accumulate β-carotene in the edible part of the grain. This gives the grains a golden color, as opposed to regular white rice, which is practically devoid of carotenoids. When the rice is consumed, the β-carotene is either stored in the fatty tissues of the body or converted into vitamin A. This new breed is engineered to address vitamin A deficiency, which, according to the World Health Organization, affected 190 million children and 19 million pregnant women in 2005. Golden Rice has the potential to substantially relieve the symptoms of vitamin A deficiency—and save lives.

Golden Rice is expected to be released this year in Bangladesh, where rice is a staple food. Ronald worries that disinformation about Golden Rice may create harmful misunderstandings similar to those surrounding vaccines. "False information frightens many consumers. If it prevents people from helping their children thrive, this is a tragedy. People who have enough to eat don't realize that what they say impacts the rest of the world."

It's no surprise that many of us don't understand the importance of crop genetics. To begin with, the concept of self-reliance for nourishment is inconceivable to most people living in the developed world. "Many of us can just buy food at the store. But it's different from subsistence farmers who grow only enough to feed themselves and their family," she notes. "I once was speaking to someone in Paris who said, 'I prefer to eat locally and in season. I never let my children eat strawberries out of season.' It's understandable. But is it realistic? In the winter in Paris, beets and cabbage are in season, but few other fruits and vegetables. Few wealthy families are likely willing to restrict their diet so radically, and probably none are willing to return to the life of a subsistence farmer."

Conversations like these show that many of us forget that much of our food is imported—and, as Ronald points out in her TED talk, "virtually everything we eat has been genetically altered." She juxtaposes an image of the modern banana's ancient

ancestor and the fruit we eat today. There's no contest: the tiny, seed-filled predecessor just isn't fit for breakfast cereal.

Discovering solutions

Ronald also notes that we all eat genetically modified crops, whether we know it or not, and that the practice of modifying plants is thousands of years old. For people in the developed world, genetically modified crops may make meals cheaper, tastier, and more varied. But for subsistence farmers, they are a lifeline.

> **The practice of genetically altering plants to make their produce more abundant and more appealing is, after all, thousands of years old.**

With this in mind, Ronald has devoted decades to rice, which has an almost unparalleled impact on world nutrition—in places like Bangladesh, some people get two thirds of their total calories from the crop. Unfortunately, rice is also vulnerable to weather fluctuations and disease.

One serious threat to the crop is rice blight, caused by the bacteria *Xanthomonas oryzae* pv. *oryzae*, commonly known as *Xoo*. It's a devastating, fast-spreading pathogen—at its worst, it can destroy 75 percent of a crop—that primarily impacts farmers in Asia, the western coast of Africa, Australia, Latin America, and the Caribbean.

Ronald's work fighting *Xoo* began in the 1980s with a question: "Why are some plants resistant and others susceptible to infection?" For more than a century, breeders had been introducing "resistance" genes into crops to reduce loss and the need for pesticides. However, scientists were uncertain how resistance worked. In 1995, Ronald and her team identified a rice gene called XA21. She showed that it encodes a receptor predicted to recognize *Xoo* and launch a defense response. This type of receptor is also found in humans and, as in rice, is critical for a functioning immune system.

In 1995, Ronald and her team began searching for the molecule produced by *Xoo* that triggered the rice resistance response. After a misidentification in 2009, in 2015 Ronald and her team were finally able to report on the microbial partners that tell the plant it's under attack.

As the climate changes, flooding is another increasingly prevalent threat to rice and food security. While rice plants can grow in standing water, most will die if they're completely submerged. Working in conjunction with the Philippines-based International Rice Research Institute, Ronald played a central role in isolating the so-called submergence tolerance 1 gene. This enabled the creation of a flood-tolerant variety that doesn't compromise taste or nutritional value. Last year, more than 6 million farmers in the poorest regions of India and Bangladesh grew Sub1 rice and harvested twice as much grain after floods, compared to older varieties.

With her work, Ronald makes an important counterpoint to the GMO controversy. She reveals the profound impact that plant genetics have on human lives, and questions

the wisdom of limiting that work based on unfounded fears. With more people inhabiting an overtaxed planet, our needs will only grow. Ronald's discoveries have done more than just address the problems plaguing growers—they have also helped sustain the millions of people consuming the crops themselves.

All of this in a simple bowl of rice.