Are GMO critics more open to gene editing that targets plant and human diseases?

The early generations of transgenic plants focused primarily on increasing productivity, either by reducing pest damage or increasing yields by minimizing the impact of weeds. These have met with fierce opposition from anti-GMO groups and some government quarters (such as Green Party members in European parliaments).

But transgenics and other modifications in medicines (ranging from monoclonal antibodies against melanoma and lung cancer to gene therapies against inherited rare disorders and RNA interference in molecular diagnostics) have not seen the same kind of resistance. Is it possible that transgenics (or even more modern techniques like CRISPR that don't require genes from other species) directly targeting plant diseases might have an easier time gaining widespread acceptance?

It's hard to say for certain. But we can look at several efforts in recent years to deal with diseases — those facing humans and the crops we eat. Here's a brief scorecard, looking at some notable developments:

Win: The papaya harvest in Hawaii was an early victory for genetically modified plants. The Rainbow papaya, introduced in 1998, saved the state's papaya industry by countering the devastating ringspot disease. Yet, years later, the plant (created by Cornell University scientist Dennis Gonsalves) found itself in the midst of a debate over GMOs in the island state. In 2013, anti-GMO activists successfully pushed for a ban that was ultimately overruled in federal court. The win sparked efforts nationwide for local and state governments to issue their own bans or restrictions on genetic modification in food.

Possible: With banana wilt disease, Ugandan farmers faced devastating losses to their important staple crop from the disease, spread by bacteria. But they also faced false statements from anti-GMO activists, attempting to sway political decisions in the country by claiming that the banana wilt problem had been resolved. The Ugandan government has passed an overall biosafety bill back and forth between President Yoweri Museveni and Parliament, but now the government has promised that approval is imminent. Meanwhile, this video from Cornell University's Alliance for Science illustrates some of the political and biological issues:

[youtube https://www.youtube.com/watch?v=dHj99s3h5Ag&w=560&h=315]
Up in the air: Back in the United States, bacteria known as *Candidatus Liberibacter asiaticus* is threatening at least 90 percent of Florida's citrus crop. US citrus is facing several fates: no treatment (because no conventional treatments exist) and quarantine, wait several years for a possible resistant breed, introducing a CRISPR-Cas9 system (still in its research stage), or using a transgene from *Arabidopsis* to breed trees resistant to greening. Using certain insecticides at the base of growing plants seems to help stave off the disease but has other issues because of the insecticides themselves. Currently, there are no resistant citrus trees available to growers, and citrus greening has been discovered in other states, including California, Georgia, Louisiana, Puerto Rico, South Carolina, Texas and the U.S. Virgin Islands, according to the USDA.

Possible win: Crossing the line between plant and human diseases is not an unusual occurrence. Plants have been used to grow human medicines and supplements for decades. What is new is the emergence

of genetic modifications that can influence a plant to cheaply create certain molecules that treat or even prevent disease. One surprise result from an international study showed that three proteins (the 2G12 monoclonal antibody, and griffithsin and cyanovirin-N, both lectins) that are used to stave off the action of HIV-1 could be transgenically engineered to grow in rice. This means that anti-HIV compounds, usually quite expensive, could be grown in a staple already cheaply available to the developing world, where AIDS remains a significant public health threat.

Who knows?: An orphan product that might benefit from GM treatment is wheat. Currently, no transgenic or CRISPR or otherwise genetically tweaked strains of wheat have been approved. And that's a problem, according to Brande Wulff at the John Innes Center in Norwich, England, and Kanwarpal Dhugga at the International Maize and Wheat Improvement Center, Texcoco, Mexico. In a paper in Science, Wulff and Dhugga argue that "wheat, a worldwide staple food, has become an orphan among genetically modified (GM) crops." Instead, the insertion of multiple disease-resistance genes, known as a "GM stack," could help protect against wheat blast, halting the infection's now rampant spread in Southeast Asia. A possible starting country? Bangladesh, which recently approved eggplant modified to resist insects (with the Bt gene).

Win: Golden Rice almost became a brand for a losing, yet promising, genetic modification that treats disease (in this case, Vitamin A deficiency, a cause of childhood blindness in developing countries in Asia and elsewhere). The transgene efforts fell upon hard times due to technical and productivity issues, as well as fierce opposition from Greenpeace and other anti-GMO, environmental NGOs. However, this year, the FDA and Canadian, Australian and New Zealand authorities declared that Golden Rice was safe enough for use, paving the way for possible uptake elsewhere on the planet (the United States, Canada and other industrial countries don't suffer from Vitamin A deficiencies and aren't in need of this type of rice as much as other areas).

Final score: It's still a long way to the final whistle.

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