How needless precaution kept a GMO ‘superfood’ off the market: Q&A with Golden Rice author Ed Regis

For us in the West, the ferocious debate over genetic engineering isn’t a matter of life and death. We argue about the safety of Impossible Burgers and the potential risks associated with new breeding techniques like CRISPR gene editing, but nobody will go hungry or die of malnutrition pending the outcome of these arguments. Sadly, the same isn’t true in the developing world.

The tragic tale of global vitamin A deficiency (VAD) and the life-saving (but still unavailable) solution known as Golden Rice has been told millions of times, 246 million according to Google. But to briefly recap: roughly 250 million people, mostly preschool children in southeast Asia, are vitamin A deficient. Between 250,000 and 500,000 of them go blind every year—and half die within 12 months of losing their sight. Genetically engineered Golden Rice, fortified with the vitamin A precursor beta carotene, could alleviate much of this suffering without otherwise harming human health or the environment, according to a mountain of studies.

[Editor’s note: Final regulatory approval of Golden Rice is pending in the Philippines and Bangladesh, according to the International Rice Research Institute.]

So why are so many people still dying of a preventable condition?

Ed Regis. Image: Pepi Khara

That’s the rather frustrating part of the story science writer Ed Regis examines in his new book Golden Rice: The Imperiled Birth of a GMO Superfood. In just over 200 pages, Regis gives a crash course on genetic engineering and explains the messy history of Golden Rice, disabusing the reader of many popular myths along the way. Environmental activist group Greenpeace, for example, is often identified in

the press as the primary obstacle to releasing Golden Rice. Despite all its lobbying, however, the NGO has had a relatively minor impact on the crop's development.

Instead of pointing the finger at Greenpeace, Regis says the blame lies mostly with overly cautious governments, many of which regulate GMOs as if they were biological weapons. Hoping to avoid the unintended (and so far undiscovered) consequences of growing genetically engineered crops, regulators unintentionally rob people of their eyesight and often their lives.

In a Q&A session with Genetic Literacy Project editor Cameron English, Regis offers a bird's eye view of the ongoing controversy and highlights some lesser-known but still significant aspects of the Golden Rice story.

Cameron English: Golden Rice seems simple conceptually. As you point out, scientists just had to direct the plant's existing biochemical machinery to synthesize beta carotene in the rice grain, as it does in the rest of the plant. Why did this prove so challenging to achieve in the lab?

For one thing, it had never been done before—rewriting a plant's genes to make it express a trait that it normally did not have. Nobody was sure that it was even possible. There were different ways of accomplishing that goal, and there were a lot of technical difficulties in doing the actual hands-on lab work, and getting everything lined up correctly at the genetic level so that beta carotene would appear in the rice grain. There were incredible numbers of false starts, dead ends, and unforeseen technical problems to overcome, and it took years of trial and error for the inventors to get it all working properly. It was just a hard problem, both scientifically, in theory, and technologically, in practice.

CE: You write that Golden Rice could make VAD "a thing of the past" in developing Asian countries. Why is this biotech crop a better solution than alternative proposals, like distributing vitamin supplements?

Supplement programs have been tried, and of course they do some good, but the problem is that such programs require a substantial and permanent infrastructure. They require a supply chain, personnel to distribute the stuff, record keeping, and the like, plus sufficient and continuous funding to keep it all going across time. Also, there is no way to guarantee that supplements will reach every last person who needs them.

Golden Rice, by contrast, requires none of that. The seeds will be given at no cost to small landowner farmers, and the rice will be no more expensive to consumers than plain and ordinary white rice. Plus, there's the principle that "Plants reproduce, pills don't." Once Golden Rice is introduced, it's a system that just goes of itself. The product replaces what people already eat on a daily basis with something that could save their sight and lives in the process.

CE: Tell us the story about night blindness you recount from Catherine Price's book. Does that anecdote underscore the problem that Golden Rice could solve?

We in the rich, developed Western countries know practically nothing about [VAD]. We have virtually no experience of it because we get the micronutrients we need from ordinary foods and vitamin supplements. One of the first symptoms of vitamin A deficiency is night blindness, which means pretty much what it says. But to convey this as an actual, lived experience I quote from Catherine Price's excellent book, Vitamania, in which she describes what happens to vitamin A deficient children in poor, developing countries.

While they lead an active life during the day, they gradually withdraw and stop playing as twilight approaches. With the fall of night, they basically just sit in place and wait for help, because they have lost their sight in darkness, and their life grinds to a halt. In countries such as the Philippines, where people eat rice as a staple, at every meal, Golden Rice could prevent this from happening, and even reverse the symptoms in children already affected by VAD.

These photos highlight the difference between healthy eyesight and night blindness (nyctalopia). Image: Wikipedia

CE: You point out that Greenpeace struggled with a "moral dilemma" before forcefully coming out against Golden Rice. Tells about that situation.

In 2001, the year after the Golden Rice protype was announced in *Science*, a Greenpeace official by the name of Benedikt Haerlin visited Ingo Potrykus, the co-inventor, at his home in Switzerland. Haerlin discussed whether or not to make the provitamin A rice an exception to Greenpeace's otherwise absolute and rigid opposition to any and all genetically engineered foods. He had initially acknowledged that there was a moral difference between GMOs that were merely agriculturally superior—in being pesticide- or herbicide-resistant, for example—and a GMO that was so nutritionally beneficial that it actually had the potential to save people's lives and sight.

But apparently that distinction made no difference because in the end both Haerlin himself and Greenpeace as an organization soon took the view that Golden Rice had to be opposed, even stopped, no matter what its possible health benefits might be.

CE: Greenpeace also claimed that poverty and insufficiently diverse diet were the root causes of vitamin A deficiency. Therefore, they said, developing biofortified crops was misguided. That sounds like a reasonable argument, so what's wrong with Greenpeace's analysis here?

This is like arguing that until we find a cure for cancer we should not treat patients by means of surgery, chemotherapy or radiation therapy. This is totally illogical on the face of it. And the same is true of the argument that since poverty is the cause of the problem that therefore the only solution is to eradicate it. Everyone's in favor of eradicating poverty, but there are things we can do in the interim while advancing that far-off and utopian goal, which arguably will take some time to accomplish. Biofortified Golden Rice, along with supplementation and a more diverse diet, can help prevent vitamin A deficiency. If a solution, or a set of solutions, is available, let's implement them while also striving to reduce poverty. Both can be done together, you don't have to choose between one and the other.

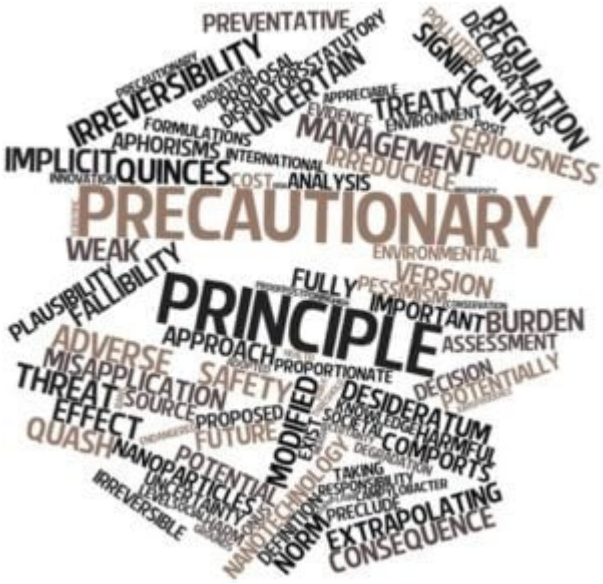
CE: Many people believe that Greenpeace and other anti-GMO groups are the main roadblock to getting Golden Rice into the hands of farmers. But you write that the activists don't deserve that much credit. What else has kept Golden Rice off the market?

Greenpeace's long history of anti-GMO rhetoric, diatribes, street demonstrations, protests, dressing up in "monster crop" costumes, and all the rest of it actually did nothing to halt research and development of

Golden Rice. There are two reasons why it took 20 years to bring Golden Rice to the point where it won approval for release in four countries: Australia, New Zealand, the United States and Canada. The first is that it takes a long time to breed increasingly higher concentrations of beta carotene (or any other valuable trait) into new strains of rice (or any other plant). Plant breeding is not like a chemistry experiment that you can repeat immediately as many times as you want. Rather, plant growth is an inherently slow and glacial process that can't be [sped] up meaningfully except under certain special laboratory conditions that are expensive and hard to foster and sustain.

The second reason is the retarding force of government regulations on GMO crop development. Those regulations, which cover plant breeding, experimentation, and field trials, among other things, are so oppressively burdensome and costly that they make compliance inordinately time-consuming and expensive.

CE: What's the Cartagena Protocol and how has it affected the development of Golden Rice?



The Cartagena Protocol was an international agreement, sponsored and developed by the United Nations, which aimed "to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking into account also risks to human health."

On the face of it, this "precautionary approach" is plausible, even innocuous. In actual practice, the protocol amounts to a sweeping set of guidelines, requirements, and procedures pertaining to GMOs that were legally binding on the nations that were parties to the agreement, coupled with a set of mechanisms to enforce and ensure compliance. These oppressive and stifling rules and regulations soon turned into a nightmare for GMO developers, and did more than anything else to slow down the progress of Golden Rice.

Ingo Potrykus, the co-inventor of Golden Rice, has estimated that adherence to government regulations

on GMOs resulting from the Cartagena Protocol and the precautionary principle, caused a delay of up to ten years in the development of the final product. That is a tragedy, caused by the very governments that are supposed to protect our health, but in this case did the opposite.

CE: Once a prototype of Golden Rice was developed, the prestigious science journal Nature refused to publish the study documenting the successful experiment. Why do you think Nature reacted that way, and what does it tell us about the cultural climate during the period when Golden Rice was first developed?

Well, I can't speak for the Nature editors, so in this case you're asking the wrong person. In my book, I quote what Ingo Potrykus had to say about the matter, which was:

> The Nature editor did not even consider it worth showing the manuscript to a referee, and sent it back immediately. Even supportive letters from famous European scientists did not help. From other publications in Nature at that time we got the impression that Nature was more interested in cases which would rather question instead of support the value of genetic engineering technology.

And I will leave it at that.

CE: The classic objection to GMOs, including Golden Rice, is that they're unnatural. Would you summarize your response to that claim in the book?

In the book I show that in fact most of the foods that we eat are "unnatural" in the sense that they are products of years of artificial selection, often using techniques other than conventional crossbreeding.

In particular I cite the example of Rio Red grapefruit, which is sold all over America and is not considered a GMO, despite the fact that its genes have been scrambled over the years by artificial means including radiation mutation breeding, in the form of thermal neutron (thN) bombardment, which was done at the Brookhaven National Laboratory. This highly mutant and genetically modified grapefruit variety is on file at the "Joint FAO/IAEA Mutant Variety Database," at the headquarters of the International Atomic Energy Agency (IAEA), in Vienna, Austria. You can hardly get more "unnatural" than Rio Red grapefruit.

Image: The Telegraph

By contrast, there is a plant whose roots in the ground are potatoes, but whose above ground fruit are tomatoes. This is the so-called “TomTato,” and was created by exclusively conventional means, i.e., grafting, which goes back thousands of years. But which of the two is more unnatural—the Rio Red grapefruit or the freakish “TomTato”? And why does it matter?

CE: There are a lot of transgenic crops being developed, so why did Golden Rice become such a lightning rod for controversy in the GMO debate?

Because if it gets approved, works, and ends up saving lives and sight, it will lead to greater acceptance of GMO foods in general, which is the very last thing that GMO opponents want. That cannot be said of any other GMO.

CE: Bangladesh appears poised to release Golden Rice in the near future. Are you hopeful that farmers will soon have access to it, or do you foresee more political and regulatory obstacles getting in the way?

In the words of Jack Reacher (the hero of Lee Child’s crime novels), “Hope for the best, prepare for the worst.” Seeing what has happened to Golden Rice over the course of 20 years, nothing would surprise me going forward. I would sort of be more surprised if Bangladesh approved it and it was grown and people ate it than if it were banned outright in the countries where it’s needed most. That is the most infuriating part of the whole story.

Ed Regis is a science writer whose work has appeared in Scientific American, Harper's, Wired, Nature, Discover and the New York Times, among other publications. He is the author of ten books, including *What Is Life? Investigating the Nature of Live in the Age of Synthetic Biology.*

Cameron J. English is the GLP's senior agricultural genetics and special projects editor. He co-hosts the Biotech Facts and Fallacies podcast. Follow him on Twitter @camjenglish

This story originally appeared on the GLP on November 5, 2019.