Crop biotechnology opponents are losing their war against genetic engineering, but the battle for science is not yet won

Steven E. Cerier

February 2024
Science for Sustainable Agriculture

After years of reaping the tainted rewards of disinformation, the ground is shifting against anti-biotech activists. The world's eight most populous countries now either grow GM crops and or have approved the deregulation of gene-edited crops. That's more than 50 percent of the global population. But for a number of countries, GMOs still remain in regulatory limbo as a residue of the Frankenfood branding by anti-biotech campaigners. In an ideal, science-driven world, with overwhelming evidence that both transgenic and gene-edited crops pose no identifiable unique health or environmental threats, the two complementary breeding techniques would face minimal regulatory hurdles. We will eventually look back upon this period of hyped worries and predictions of impending environmental catastrophe and be mystified at what all the fuss was about, writes Steven Cerier.

It was not so long ago that the strident opponents of agricultural biotechnology were dictating the narrative over sustainable crops. They promoted insidious lies about their supposed dangers to humans, animal health and the environment — misrepresentations that have poisoned public perceptions about the value of this fast-developing technology.

To frighten the public, the anti-biotechnology campaigners stigmatised genetically modified (GM) foods as Frankenfoods, the product of out-of-control scientific experiments conducted by nefarious and greedy agri-businesses determined to fatten their corporate treasuries, the public and the environment be damned. One of the most popular symbols they used to scare people into opposing GE crops was a syringe injecting a tomato; the implication was that dastardly chemicals were being injected into our food supply.

The science rejectionists found eager allies in Hollywood and beyond. From Dr. Oz. to Jill Stein, Gwyneth Paltrow, Neil Young, Mark Ruffalo, Joe Mercola and Woody Harrelson, celebrities who knew nothing about science let alone biotechnology climbed on the anti-GM bandwagon, impugning the integrity of scientists; even in 2015, at the height of the hysteria campaigns, 88% of US scientists endorsed the safety of the

technology, higher than the consensus view that climate is being primarily driven by human activities. The percentage is likely near 100% today.

Then and even now, a figurative handful of scientists acted as willing fronts for GMO-rejecting advocacy groups. Influential NGOs such as Friends of the Earth, Greenpeace, Environmental Working Group, Union of Concerned Scientists and the Natural Resources Defense Council joined in campaigns against agrobiotechnology and crop chemicals. It was cynical, but it proved to be a lucrative fund-raising strategy.

From scepticism to acceptance

After years of reaping the tainted rewards of disinformation, the ground is shifting against anti-crop biotechnology activists with its benefits apparent in agriculture and medicine. Recent advances in agriculture are stunning. Crops are being developed that are disease, drought, stress, salt, insect and browning resistant, more nutritious, colourful, tastier and with longer shelf lives. Among the products of so-called new breeding techniques (NBTs) recently approved for cultivation and sale around the world: heart-heathy soybean oil, late blight resistant, low acrylamide and reduced bruising potatoes, non-browning apples, drought-resistant wheat, insect-resistant cowpeas, which are a major staple crop in west Africa, a purple tomato with increased anti-oxidants and a longer shelf life, mustard greens that are less bitter, a heart-healthy tomato, fish oil made from canola, and pigs that are resistant to Porcine Reproductive and Respiratory Syndrome.

That's just the beginning of the genetic engineering bounty. In the pipeline and likely to be approved in the next few years: non-browning avocados and bananas, disease-resistant bananas, disease-resistant citrus crops, disease-resistant chestnut trees, seedless blackberries and raspberries and pitless cherries, chickens resistant to avian flu, allergy free wheat and peanuts, drought-resistant rice, disease resistant cassava and disease-resistant rice.

The promise of NBTs has become so self-evident that nations long on the genetic modification sidelines are rushing to deregulate the technology to boost farm productivity. One of the most prominent of these is China. After becoming one of the first countries to embrace crop genetic modification, in 1993, production stalled for decades as the government equivocated in the face of public opposition, although it did import GM soybeans from the US and South America. Now China is determined to be a global CRISPR innovator.

In 2022, it announced it was deregulating crop gene editing. Last year, the government preliminarily approved 37 genetically modified corn seeds and 14 GM soybean seed varieties. In January, China authorised the domestic production of six additional varieties of GM corn, two of soybeans, one of cotton, and another two of gene-edited soybeans.

With China opening the door wide to the cultivation of GMOs and the deregulation of gene editing, the top eight most populous countries —China, India, the US, Indonesia, Pakistan, Nigeria, Brazil and Bangladesh —now either grow GMO crops and or have approved the deregulation of gene-edited crops. That's more than 50 percent of the world's population.

Food exporting countries are jumping on the NBT bandwagon. Latin America, led by Brazil and Argentina, has long been a crop biotechnology innovator. Cuba has been developing GMO crops for years, and has begun experimentation with gene

editing. Only a few countries — Peru, Belize, Ecuador and Venezuela — seem determined to remain crop technology backwaters.

Africa is gradually opening its doors to crop technology innovation, with GMO laws in place in Nigeria, Ethiopia, Kenya, Sudan, Malawi, Ghana, Zambia and South Africa. Each of these countries is debating reforming regulations to allow gene-edited crops for import and domestic cultivation. South Africa grows GMOs but has refrained from deregulating gene editing.

India, Japan, Israel, and Australia grow GM crops and recently have deregulated gene-editing for crop production. New Zealand's new government has indicated it is open to considering deregulating gene editing.

Perhaps the most consequential change is unfolding across Europe. In March 2023, the UK Parliament deregulated gene editing (although the legislation applied only to England). Last July, the European Commission issued a report outlining a plan to relax the rules and regulations on gene-edited crops. How that debate plays out in coming years will determine whether the EU will emerge as a technology leader or a backwater in agricultural production.

How anti-biotechnology activists lost their battle to ban next-generation engineered crops

First, they cried 'wolf' and the sky never fell.
Since the introduction of GM crops in the mid-1990s, opponents have warned that new breeding techniques would have catastrophic consequences for human and animal health, and the environment. We were told that GMOs would cause cancer and infertility, and disastrously corrupt the DNA of those consuming genetically altered crops (ignoring the fact that humans have been 'corrupting' the DNA of crops since the dawn of humankind, through wide crosses, hybridisation, cloning and mutagenesis). We were warned that GMOs would alter the environment in catastrophic ways. We were lectured that farmers were being brainwashed by global agribusinesses to adopt farming strategies that were against their own and the public's interests.

None of these apocalyptic warnings came to pass. You would think that after thirty years since the introduction of GM crops and no credible incident of anyone or any GM-fed animal being harmed by consuming GMO foods, anti-GE crusaders would move on to another cause. Instead, they continue to peddle their nonsense even as their credibility sinks day by day.

Second, they are technology hypocrites.
Crop biotechnology critics oppose the use of genetic engineering for the cultivation of crops but for the most part endorse their use in medicines and vaccines, even though the processes are similar. GMO insulin was developed decades ago and has been used safely with no public controversy. Highly effective and safe COVID mRNA vaccines are a product of genetic engineering as are many vaccines such as those for Ebola and HPV. Scientists are now utilising gene editing to develop malaria and shingles vaccines. Authorities in Europe and the US recently approved a gene-edited treatment for sickle cell anemia. More cancer treatments using gene editing are in development.

A positive note: News coverage around the use of gene editing to develop medicines, although not as advanced as its applications in agriculture, does appear to be softening

public opposition to genetic innovation. It simply makes no sense to welcome gene editing in health care but oppose it in agriculture.

Third, opponents of genetic engineering are wrong in claiming that gene-editing deregulation will result in the 'control' of global food and seed supply by multinational agri-businesses.
There is scant evidence to support that claim, and much evidence to suggest that the gene editing revolution is democratising seed development. Because of the dense and politicised GMO approval process, it took on average 7 years and more than $130 million to get a GMO crop trait approved.

With gene editing, innovation has been unleashed. It can now take as little as a few million dollars and two years or less to develop a crop with a beneficial new trait. One faculty researcher at Penn State developed an anti-browning mushroom for less that $50,000.

There is a plethora of new gene editing-focused companies in the US funded by venture capitalists: Pairwise, Cibus (which merged with Calyxt), Green Venus, Elo Life Systems and Yield 10 Biosciences, to name a few. Some of them, such as Pairwise and Calyxt, have already brought products to market.

Fourth, the challenges of confronting increased disease and weather dislocations caused by climate change make it clear that biotechnology obstructionism is indulgent and dangerous.
We cannot continue to grow food the way we do now. With food demand predicted to soar by 50 percent by mid-century, according to UN predictions, and with no more large tracts of arable land yet unexploited, we need to produce more crops on less land. Growing less food and/or clear-cutting forests to increase output is a strategy for planetary suicide. Sustainable intensification using genetically-tweaked crops is now widely recognised as the only tenable path forward to meet the challenges of climate change-induced droughts, persistent plant diseases, increased insect infestations, worsening soil conditions and shortened growing seasons.

Fifth, only GE crops offer innovative and scientifically realistic new ways to reduce waste and spoilage.
A significant part of the food shortage crisis results from food waste. Genetically modified crops designed to resist browning and bruising, and spoil far less quickly, could significantly reduce crop waste.

Sixth, only next-generation crops can produce more food with less chemicals.
Insect-resistant and herbicide-tolerant crops have resulted in a net global decrease in the volume of crop chemical applications. A meta-analysis documents that on average, GM technology adoption has reduced chemical pesticide use by 37%, increased crop yields by 22%, and boosted farmer profits by 68%. Environmental Impact Quotient (EIQ), which measures the toxic impact of chemicals rather than just volume, has shown a 17.3% decrease between 1996 and 2020, almost all the result of GM crop adoption. And even as crop chemical usage per acre is decreasing in countries that grow genetically engineered crops, food production is soaring.

Gene editing promises even more reductions in chemical usage, including the development of plants that can generate their own nitrogen, thus reducing the need for chemical fertilisers.

Seventh, anti-crop biotechnology activists are being recognised as scientifically regressive.
Scientific innovation is quickly passing genetic engineering rejectionists by. Gene editing pioneers in medicine and agriculture are now working tougher to educate the public as to the benefits of this emerging technology. Jennifer Doudna, the co-winner of the Nobel Prize for chemistry in 2020 for discovering CRISPR gene-editing, has become vocal in her support for its use for agriculture. And in January 2024, 35 Nobel laureates and more than 1,000 European scientists signed an open letter to the European Parliament urging it to deregulate gene-editing for crops, writing it has the potential to dramatically reduce pesticide and fertiliser use, increase food supply and enhance food security.

Innovation vs. Obstructionism — What the future holds for gene editing and other New Breeding Techniques
Although opponents of genetic engineering are in retreat, they remain an intractable and dangerous foe. They are disinformation machines. Their current strategy: to tar and feather CRISPR gene editing and other new breeding techniques with the stigma long associated with what they call Frankenfood GMOs. That's the term wielded for decades by activists to convince the public that seeds engineered using genetic modification are 'not natural' and are therefore unpredictable, risky and dangerous.

Let's unpack this misinformation trope. How did the term Frankenfoods come about and how are current generation science rejectionists using it to scare the public and policymakers?

For years, biotechnology sceptics grounded their opposition to GMO crops on the premise that the process of creating new crop varieties, known as transgenesis, posed unique and unknown health and environmental dangers. A transgenic, or genetically modified, seed has been altered through recombinant DNA technology, which involves either the combining of DNA from different genomes or the insertion of what is technically called "foreign DNA" into a genome.

The use of the term "foreign" by scientists is not a judgment; it means merely that the DNA is from another living form. Because all life on earth shares DNA, there is technically no such thing as "foreign DNA" as GMO opponents wield the term. Yet, anti-GMO activists have weaponised the term "Frankenfood", claiming for example that a new and bizarrely dangerous variety of tomato was being created using fish genes.

That's simplistic, farcical, and a non-scientific framing of the process of genetic modification. Nonetheless, it's worked its damaging, public relations magic, helping to turn an uncertain public against GM crops. As recently as 2020, a Pew Research survey indicated only 27 percent of Americans believed GMO foods were safe while 38 percent said they were unsafe; 33 percent were not sure. The reason most people cite for being wary of genetic modification: the claim by opponents that the foods are not natural because the seeds were created using genes from a different species – like tweaking tomatoes with fish genes!

Is there any validity to their claims that GMOs present a unique risk because they use "foreign genes"? And what about the newest generation of GM crops, which use a different breeding technology known as gene editing, which includes CRISPR?

No crops that we eat today are 'natural'; all our plant-derived food has been modified over the centuries by human intervention. The corn we eat today consisted of hard black

nubs many centuries ago. Seedless watermelons were created by hybrid breeding. An entire genus of edible plants known as Brassica were once inedible weeds; human manipulation has turned the plant into some of our most beloved vegetables, including: red and green cabbage, broccoli, cauliflower, romanesco, Brussels sprouts, collards, kales, Savoy cabbage and kohlrabi.

Genetic modification of crops in laboratories is just a more precise form of plant breeding than what humans have been doing for millennia. Gene editing is the latest tool used by humans It does not involve the use of "foreign genes" at all, as changes to the plant genome are made within the species itself, a process known as cisgenesis.

From the perspective of a scientist, neither GMO transgenesis nor gene editing cisgenesis is inherently safer or more dangerous; they are just different techniques. It's absurd that many countries are relaxing regulations on New Breeding Techniques while continuing to shackle the approval process for GM products.

In an ideal, science-driven world, with overwhelming evidence that both transgenic GMOs and gene-edited crops pose no identifiable unique health or environmental threats, the two complementary breeding techniques would face minimal regulatory hurdles. But we don't live in that science-shaped world.

Sadly, many GMO crops remain in regulatory purgatory as a residue of the Frankenstein branding by anti-biotech activists. In contrast, crops grown from new breeding techniques are quickly being embraced, and regulatory hurdles are falling globally. So, we have the bizarre situation in which many countries, including Nigeria, Israel, England and Japan, are deregulating gene-editing for crop cultivation, yet they still place stringent regulations on transgenic crops which pose no more health or environmental hazards. Even while the European Union edges towards de-regulating gene editing, any thoughts of fast-tracking GMO approvals remain off the table.

No matter how the public and policy debate plays out, crop biotechnology is roaring forward. In not too many years, the vast bulk of the food we consume will soon be genetically tweaked using one form of technology or another. Advanced countries will de-regulate crop genetic engineering because it will increase farm productivity and is one of the only available tools to battle the crop-killing impacts of climate change. As a result, we will have many insect, disease, drought, stress and browning-resistant crops that will be tastier, more colourful, more nutritious and have longer shelf lives.

We will eventually look back upon this period of hyped worries and predictions of impending environmental catastrophe and be mystified at what all the fuss was about.

Steven E. Cerier is a retired international economist and frequent commentator on the application of biotechnology to producing food and medicine. A version of this article first appeared on the Genetic Literacy Project website here and is reproduced with kind permission.