7. Gene editing is not a fast or reliable route to desired outcomes

MYTH

Gene editing achieves desired traits more quickly than conventional breeding.

REALITY

There are many lengthy steps in bringing a gene-edited product to market, even without considering regulation, and conventional breeding is more successful in achieving desired traits.

Gene editing is promoted as the fastest and most efficient way to achieve plant breeding goals.[1,2] According to Corteva, "CRISPR-produced plants can be developed in just a few years versus what often takes decades",[3] and Bayer insists that useful crops can be developed "in a fraction of the time compared to older methods".[4]

The companies often suggest it is onerous regulations that hold back what would otherwise be rapidly introduced gene-edited products. Corteva argues that "treating CRISPR-produced crops as GMOs would substantially slow down their path to market and adoption of CRISPR innovation in agriculture."[3]

However, while breeding a new plant variety is generally a lengthy process, there is no evidence that producing a viable gene-edited variety will be any quicker. Even in countries with light-touch regulations like the US and Canada, only very few gene-edited products have made it to market. A gene-edited tomato approved by the Japanese government in 2020, which was engineered to contain a compound said to lower blood pressure, took 15 years to develop.[5] That is the same time period that experts estimate is needed to develop a sexually propagated non-GM crop – or an older-style transgenic GM crop.[6,7,8]

> Gene-edited plants need to go through a laborious process of screening, selection and backcrossing with the parent lines to remove any obvious undesired mutations

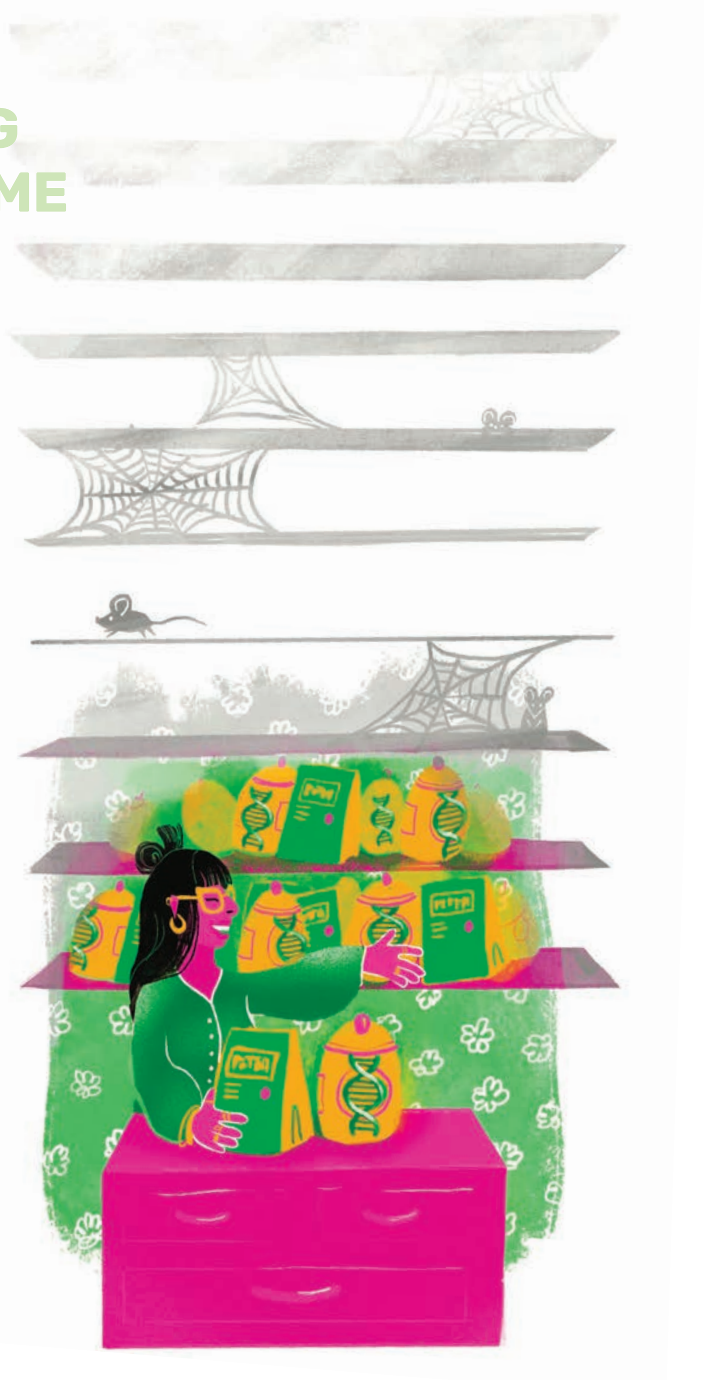
PROCESS FOLLOWING THE "EDIT" TAKES TIME

As shown in chapter 2, gene editing and its associated processes (such as tissue culture) lead to many unintended effects, some of which will affect plant performance and growth as well as the desired trait. So gene-edited plants need to go through a laborious process of screening, selection and backcrossing with the parent lines to remove any obvious undesired mutations.

In addition, several years of greenhouse and field trials must be done to ensure that the desired trait expresses in a stable way through the generations and that the plant copes with environmental stresses, such as bad weather conditions and pest attacks.

Moreover, genetically modified products are normally only placed on the market once patents are granted – and the patenting process can take years. This means the overall process before products can be commercialised can be lengthy.

All this is without the time needed to put the plant through regulatory processes.



UNIMPRESSIVE RECORD

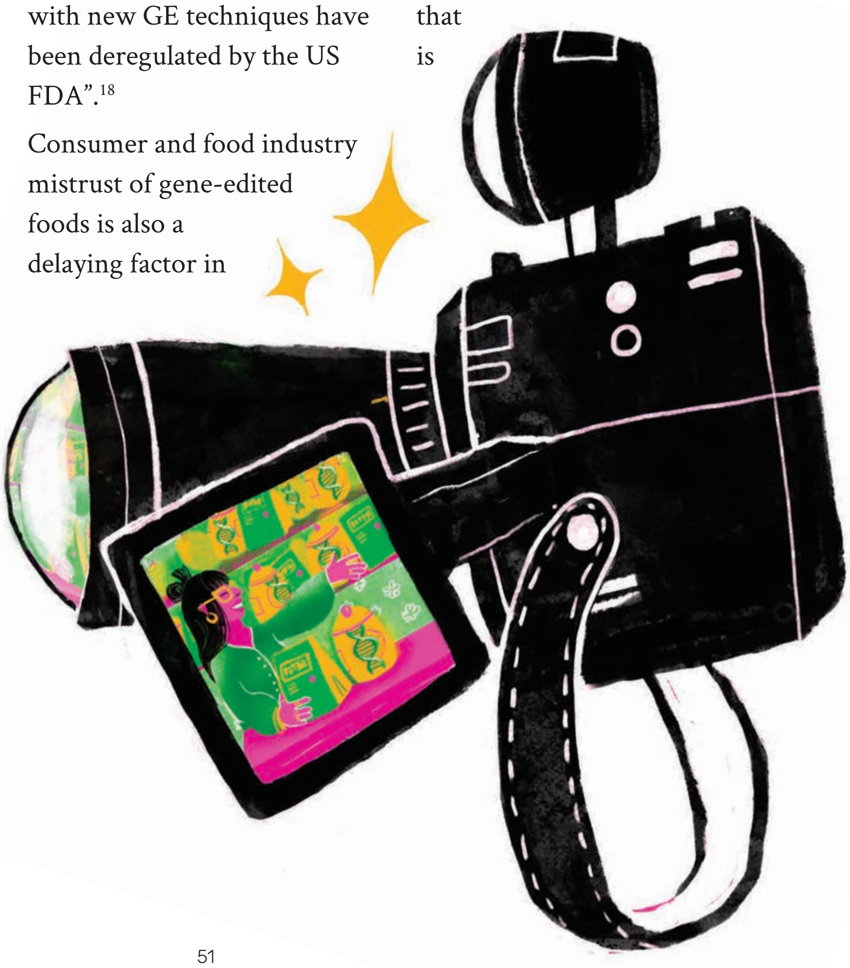
While gene editing is presented as a cutting-edge new technology, it has actually been around for some years. In 2012, Jennifer Doudna and Emmanuelle Charpentier proposed that CRISPR could be used for programmable editing of genomes[9] and it was first shown to work in plants in 2013.[10] The editing tool later named TALENs was described in 2009–2010.[11,12] Regarding crops engineered with the editing tool called oligonucleotide-directed mutagenesis (ODM), maize was described in 2000[13] and rice in 2004.[14]

Yet to date, despite the permissive egulatory systems in place in North and South America,[15] only two gene-edited plants have made it to market – neither of which were engineered using the much-touted CRISPR technology. These are Calyxt's altered-fat-profile soybean, engineered with TALENs,[16] and Cibus' herbicide-tolerant canola/oilseed rape, engineered with ODM. The ODM maize[13] and rice[14] do not appear to have been commercialised anywhere in the years since they were announced in 2000 and 2004. The same is true of a non-browning mushroom, engineered with CRISPR/Cas,[17] as well numerous other products. According to Testbiotech, "around 80 plants developed with new GE techniques have been deregulated by the US FDA".[18]

> **To date, only two gene-edited plants have made it to market – neither of which were engineered using the much-touted CRISPR technology**

Consumer and food industry mistrust of gene-edited foods is also a delaying factor in commercialisation. The gene-edited tomato approved by the Japanese government has not yet been commercialised, reportedly due to food producers shying away from the technology in the face of consumer rejection. A survey of about 10,000 people by the University of Tokyo found that 40% to 50% did not want to eat gene-edited crops or animal products, with just 10% showing interest in trying them.[5]

This record suggests that gene editing is not the efficient and speedy route to obtaining successful agricultural traits that is



claimed. The unimpressive record of products brought to market in countries like the US and Canada shows that it is not regulations that slow market access, but factors inherent in the development of GM products, as well as market rejection.

During the 20 years that gene editing has existed, there has been much research activity – often generously funded with taxpayer money – but very few marketable products. In the meantime solutions have already been found to problems such as extreme weather conditions linked to climate change. These solutions rely on already proven and available approaches.

In the meantime solutions have already been found to problems such as extreme weather conditions linked to climate change

For example, while research on gene-edited saline-tolerant crops struggles to progress beyond the early stages,[19] farmers in India have rapidly and successfully remediated soil that was made saline by a devastating tsunami. The key was found in organic soil regeneration methods and local seeds adapted to the conditions.[20]

Also, conventional breeding has consistently outstripped genetic engineering techniques (old and new) in producing crops tolerant to stresses such as drought,[21] floods,[22] pests,[23] and diseases.[24] For more examples of successful alternatives to GM approaches, see chapter 8.

IS SPEED DESIRABLE?

Speed in bringing new products to market and fast replacement of products is a business model that is interesting for some seed/agrochemical companies and livestock breeders, but less relevant for farmers, who may be better served with robust, locally adapted varieties and breeds that they can use over a long timespan. In addition, it does not serve consumers, whose primary concern is a safe, wholesome, and accessible food supply.

In cases where speed is important, gene editing is not the quickest or most reliable way to produce crops with desired traits. In contrast, conventional breeding has proven highly efficient and successful in producing such crops.

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