

# GREENER GENE EDITING

**N**ovel genetic technologies such as gene editing have the potential to contribute to sustainable agri-food systems, according to a European Commission study published at the end of April 2021. The study concluded that existing European legislation is not fit for purpose – a point made repeatedly by plant biotechnologists.

Now, some crop scientists see gene editing based on

Crispr-Cas9 as a chance to start over again in terms of public opinion. And not repeat mistakes made previously. The first genetically modified crops were introduced by large corporations, for example, to facilitate herbicide application in the case of Bt maize.

'Maybe we should have kept [genetic modification] in the public domain. Maybe some other applications should have been promoted first,' says Janneke Balk, a plant molecular biologist at John Innes

*New UK rules on genetic editing of crops could have a positive effect on food production and the environment, reports*  
**Anthony King**

Centre in Norwich, UK.

Many environmental groups have decried the conclusions of the EU study, with Friends of the Earth describing it as bad news for farming and the environment.

'It's heart-breaking that the so-called green groups are opposed to [genetic modification],' says Jonathan Jones, a plant geneticist at the Sainsbury Laboratory, a UK not-for-profit centre in Cambridge that studies plant-disease interactions. 'Their opposition is essentially dishonest because it is actually based on their opposition to multinationals and industrial agriculture.'



Many plant geneticists now look back at the GMO controversies – and ‘Frankenfood’ headlines – from two decades ago and advocate a different approach with gene editing. ‘If we demonstrate that new plant breeding can make varieties more resilient to climate change, and we can get more using less water, with less pesticide, perhaps people will be convinced of its merits,’ says Agnes Ricroch, a plant biotechnologist at Paris-Saclay University in France.

One approach to win over the public is to show that ‘we can offer healthier food’ that obtains a higher price for the farmer, Ricroch says. Examples include wheat with less gluten and cereals that require fewer nitrogen inputs.

While commercially driven gene-editing of crops is stalled in most of Europe, the UK has begun to shake off the shackles of the 2001 European regulation (see Box). In 2018, Defra decided that gene edited crops were not the same as GM crops and greenlighted a field trial on *Camelina* plants engineered to accumulate omega-3 fish oils in their seeds. In May 2021, Hertfordshire-based Rothamsted Research applied for a licence to carry out field trials on wheat with its DNA edited using Crispr-Cas9. This wheat will have less of the amino acid asparagine in its grain, which can be converted into the toxic contaminant acrylamide during baking and high-temperature cooking.

At the John Innes Centre, Balk has field tested wheat modified to contain two extra pieces of DNA that causes more iron to accumulate in the grain. This results in double the amount of iron in white flour and could lead to bread and confectionary products no longer needing iron as an additive. ‘When you remove the bran, you throw away a lot of iron and zinc,’ Balk explains. ‘We’ve tried to see if we could get [these metals] to accumulate in the part of the grain that makes white flour, by overexpressing an iron transporter.’

Balk believes there has been a shift in attitude amongst the public and environmentalists. ‘With our field trials, the tide has really changed. People are more concerned about climate change now than GMOs, and it’s recognised that some genetic changes can give you healthier or more disease-resistant crops,’ she



says. In 2020, representatives of the Green Party visited her field site and requested more information, whereas before it was more of a shouting match than proper conversation, she notes.

Researchers disagree on how regulations in the UK should be altered. ‘I’d like to see the government say gene editing is not the same thing as genetic modification and decide not to regulate it the same way,’ says Johnathan Napier. He leads the *Camelina* research at Rothamsted, which relies on genetic engineering, but with gene editing to assist.

But other plant geneticists are wary of the argument that gene editing is fundamentally different from genetic engineering. There is also reluctance to suggest there was anything wrong with GM crops in the first place, given that none were proven to be bad for health or the environment *per se*. ‘I don’t think gene editing should be treated differently from GMOs,’ says Balk, who would like to see the UK and the EU adopt the Canadian approach to regulating plant biotechnology. Under their system, the new trait in a crop plant is evaluated, not the method.

For most plant scientists, the focus on method over result is the original sin in the European regulatory approach to crop breeding. ‘The assumption has been that if humans [change the plant genome] intentionally, then it is potentially dangerous. But if it happens accidentally, then it is not,’ says Jonathan Jones, a group leader at The Sainsbury Laboratory. He and other crop researchers describe this as absurd because it means random mutation using a chemical agent or radiation is perfectly fine, but

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**Agnes Ricroch** plant biotechnologist, Paris-Saclay University, France

**In April 2021, the US relaxed rules on plant biotech, with gene-edited plants now exempt from regulation if they could have been bred conventionally. Moving a gene between species will still require a regulatory review, but the focus by the Animal and Plant Health Inspection Service will now be on the trait, not the technology used to generate that trait.**

**2x** **Wheat modified to contain two extra pieces of DNA has more iron in the grain. This results in double the amount of iron in white flour and could lead to bread and confectionary products no longer needing iron as an additive.**

targeted, more predictable changes to crop DNA using modern biotech is not.

Opposition to GM has arguably been counterproductive from an environmental point of view. ‘It has prevented benign implementation of these technologies, like our own late blight resistant potatoes,’ says Jones. His potatoes were genetically modified to add genes from wild relatives of potato that enabled late blight resistance. The result is indistinguishable from a regular *Maris Piper* potato, says Jones, except it does not require the continual application of fungicides. ‘Typically, each year about £55m of fungicides is applied [in the UK], [with] 15 to 20 [applications] a year, on about 120,000ha of potatoes,’ says Jones, ‘and there are no commercial varieties that do not need to be sprayed.’

Increasing crop yields has huge environmental upsides, which should be recognised, he argues. ‘It means you use less land to grow the same amount of food, and you can share more land with biodiversity and



## £55m

**Value of fungicides applied each year in the UK on about 120,000ha of potatoes. Blight resistant GM potatoes with genes from wild potato relatives are indistinguishable from Maris Piper potatoes, but do not need continual application of fungicides.**

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wildlife,' he says. Although attitudes to new genetic technologies are shifting in some countries, such as the UK, the situation in some large European nations remains fraught. 'In France, if you want to use genetic modification, you cannot have financial support, because it is not politically correct to use GMOs, except for fundamental research,' says Riccroch. She enthuses about Crispr-Cas9's potential for improving all kinds of crops, including fruit trees, vines and potatoes.

The UK may soon be able to develop new crop varieties using gene editing, but also perhaps push EU member states to revisit existing legislation. 'I assume UK farmers could start getting benefits from [gene-edited] crops soon,' says Stefan Jansson of Umeå University in Sweden, although he warns that exporting these crops to EU countries could be problematic if the EU does not change how it regulates and labels foodstuffs. He describes the EU report as an important step forward, commenting that the Commission seems to have finally 'listened to

scientific advice, despite resistance by pressure groups in Brussels and elsewhere'.

Others agree. 'The EU needs to abandon the language of the existing legislation,' says Jones. 'The [UK] government clearly has an appetite for relaxing some of the restrictions in a new law, and that will put additional pressure on the EU to be more sensible in its regulation of gene editing.' He says part of the problem is that the EU adopted a precautionary principle, but with no exit strategy, so that now they are stuck with a regime that impedes innovation.

The rest of the world is moving on. In April 2021, the US relaxed rules on plant biotech, with gene-edited plants now exempt from regulation if they could have been bred conventionally. Moving a gene between species will still require a regulatory review, but the focus by the Animal and Plant Health Inspection Service (APHIS) will now be on the trait, not the technology used to generate that trait. 'China is also producing very quickly edited plants, and they are a leader in terms of patents, followed by the Americans,' says Riccroch. 'And we know that these crops will probably be exported to Europe.'

Expectations were that a UK decision would be revealed in July 2021, before the Parliament's summer recess, but there was no announcement. Defra, says Jones, seems likely to take a cautious approach to begin with. But UK crop researchers hope this will allow them to begin playing catch-up in crop development using newer genetic techniques, although it will take many years to introduce any new crop variety. 'The EU is an outlier in terms of its regulatory approach to gene editing,' says Napier. 'I didn't vote to leave the EU. But this could be the one silver lining' in terms of how the UK repositions itself to regulate new genetic techniques for crop breeding. It might also attract crop companies back to the UK that had seen no future in EU countries due to unworkable regulatory hurdles, say proponents of such techniques.

The UK government has carried out its own consultation on genetic technologies. More relaxed UK regulation would apply to England only – not Scotland, Wales or Northern Ireland. ●

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## Crop genetics controversy

**EU crop genetics research has attracted much controversy in recent years. Currently researchers are bound by a 2001 law that focuses on how a plant is altered, rather than any new trait.**

'The rules were meant to be an approval mechanism, not a disapproval mechanism,' says Jonathan Menary, a social scientist at the University of Oxford, UK, who focuses on plant breeding. But the approval process proved so complex and expensive that it was an effective ban on new genetic techniques for commercial plant breeding. 'It wasn't seen as worth it for companies,' he says.

Only one GM crop – Bt maize – has ever successfully gone through the EU regulatory process.

In 2017, the European Court of Justice ruled that gene-edited crops – which did not involve moving in the DNA of another species, transgenics – were also subject to the same strict rules under the 2001 law. Genetic engineering often involves introducing new genes from microbes into plants, whereas gene editing can tweak or disable existing genes in a way that could happen using traditional breeding techniques, except faster and more predictably.

The court ruling triggered an outbreak of hand wringing amongst crop geneticists. The consequence is there will be no commercially focused crop breeding with gene editing in the EU under the current rules, and biotech companies will continue to avoid Europe for crop research. 'This stops any innovation in Europe using this new kind of technology,' says Agnes Riccroch, a plant biotechnologist at Paris-Saclay University in France. There are very few field trials in Europe for gene-edited crops, for example. Companies interested in gene edited crops simply moved elsewhere in the world and carried out field trials in the US, Canada, South America and China.

'As the rest of the world adopts [gene editing],' commented Jonathan Napier, a crop scientist at the UK's Rothamsted Research, at the time of the ruling, 'less and less effort will be put into more traditional breeding methods, further limiting what is available to European farmers.'

However, some EU member states have been reluctant to revisit such a controversial issue. Gene editing for better crops remains politically unpalatable in France, Germany, Austria and Italy, while Sweden, Spain, the Netherlands and the Czech Republic are more supportive.