BRIEF

Detection of gene edited organisms in the food chain

The UK government claims that new GMOs are identical to naturally occurring organisms and cannot be detected. This is not the case.

In part this idea has arisen from misleading claims, made by Defra and in the media, in support of the Genetic Technologies (Precision Breeding) Bill, that gene editing is just a 'simple snip' that allows the organism's DNA to repair itself naturally.

In fact, the Bill encompasses a range of genetic modification techniques. Many of them – including gene editing – can be complex, invasive and involve the insertion of foreign genetic material. This can be a part of the editing tool but can also be a deliberate insertion in order to achieve a particular change or create a trait in the target organism's genome (see opposite).

Detection methods exist and can be used

These modifications can absolutely be detected. Various methods have been developed to detect CRISPR/Cas9-induced mutations in plants[1] and whilst there is no doubt that the further development and refinement of detection methods is desirable, it is clear that methods do exist right now that can be used and built on.

Whilst detection tests are facilitated by the availability of information about the gene edit or modification, they are not necessarily reliant upon it.

The developers of the Real Time PCR method[2] say: "*The method we have developed detects what is probably the most challenging class of gene edits – a modification of just a single letter in the genetic blueprint. Since the scientific community has been using similar approaches for two decades to detect more*

What is gene editing?

Gene editing technologies like CRISPR do not, in themselves, create new organisms. In most instances, these genome editing tools, which are sometimes described as 'genetic scissors', are used to cut both strands of the DNA helix at a pre-determined location. This cut then activates the cell's DNA repair mechanism. This combination of events allows genetic engineers to introduce a genetic modification at a specific location on the genome.

Currently there are three types of procedures that can be used following the 'cut'. In the simplest possible terms these are:

- **SDN-1** the cut is made, and the organism's normal cellular repair mechanisms are left to make the repair;
- **SDN-2** the cut is made, and a template is provided to instruct the organism how to repair itself;
- **SDN-3** the cut – and sometimes multiple cuts – are made and both a template for repair and the simultaneous insertion of transgenes are applied.

The majority of gene editing techniques (including CRISPR-Cas 9) are dependent on the insertion of exogenous genetic material from bacteria as a key element of the editing tool. This material may, or may not, be fully removed at some point in the organism's development.

[1] https://link.springer.com/article/10.1007/s00122-020-03600-5
[2] https://www.mdpi.com/2304-8158/9/9/1245

complex GMOs, it is likely that this approach can be used to develop detection methods for most, if not all, gene-edited crops. And the good news is that it uses procedures and equipment similar to those that regulatory and commercial laboratories are already familiar with."

There is no doubt that new detection methods will be developed as the field is expanding rapidly. For example, this year a US government collaboration announced the development of "*an initial set of computational tools …that assist trained analysts to identify genetic engineering in next generation sequencing (NGS) datasets. This software aims to make it possible for scientists to detect engineered DNA at scale*."[3]

Building on existing plant variety and patent detection

Detection of known GMOs is clearly possible because they are patented – and patents require that companies can distinguish their products from others. This is generally known and acknowledged to be feasible in the plant breeding sector.

Conventional plant breeders can already use DNA-based identification processes. Molecular techniques alongside biochemical ones are, for example, currently being used to identify conventionally bred plant varieties.

In 2018 the International Union for the Protection of New Varieties of Plants (UPOV) published a draft report explaining that a plant variety can be identified by its characteristic molecular markers, as well as phenotype, which in combination constitute a kind of signature.[4] This information is used in plant breeding and for variety description and tracing.

In 2019, UPOV released a report on DNA-based methods for variety testing, in order to protect the ownership of breeders.[5]

As early as 2015, the International Organization for Standardization (ISO) published and adopted standards to be followed to analyse the fingerprints of maize and sunflower species and to verify the identity of the varieties.[6]

Two standards using such "*horizontal methods for molecular biomarker analysis*" were developed by the same ISO working group that previously published the standards currently used to detect transgenic GMOs.[7]

In 2019 the International Seed Testing Association (ISTA) concluded on methods for variety testing that "*DNA-based techniques are 1) developed and used by breeding companies and seed companies 2) mature and available for seed testing, already used in many laboratories, in many countries*".[8]

In 2021 the European Commission acknowledged the effectiveness of biochemical and molecular techniques (BMT) in the identification of plant varieties by issuing Implementing Directive (EU) 2021/971.

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[3] https://www.prnewswire.com/news-releases/iarpa-ginkgo-bioworks-and-draper-announce-new-technologies-to-detect-engineered-dna-301650505.html. See also https://www.iarpa.gov/index.php/research-programs/felix/felix-baa
[4] https://www.upov.int/edocs/mdocs/upov/en/twa_47/tgp_15_2_draft_1.pdf
[5] https://www.upov.int/edocs/mdocs/upov/en/bmt_18/bmt_18_3.pdf
[6] https://www.iso.org/standard/60170.html; see also https://www.iso.org/standard/60171.html
[7] https://www.iso.org/committee/560239.html
[8] https://www.upov.int/edocs/mdocs/upov/en/bmt_18/bmt_18_3.pdf

The Directive contains amendments to legislation concerning various food crop seed varieties. It states, "*The use of BMT enables certification authorities to identify the plant variety on the basis of laboratory analysis instead of visual phenotypic observation of the plants in the field*." The Directive adds, "*BMT in plant breeding and seed testing are developing fast and their use in the seed sector is increasingly important*."[9]

Provenance and audit trails

It is a fact that end-product lab-based analysis is rarely the only criteria used to determine provenance in the food supply chain. Frequently it is a mix of audit trails and analysis but often it is audit trails only. Poultry products and geographical origin are two good examples of this.

All of these approaches rely on the availability of information about production and sourcing. Even lab-based analysis becomes limited without that information. Put more plainly, detection of all types depends on transparency through publicly available information.

If the government is committed to the roll out of gene edited crops and foods in the UK, then it must also be committed to funding the detection methods and audit trails necessary to reassure citizens and protect food safety standards.

The need to commit to detection methods and audit for new GMOs

Every new technological leap brings new challenges. With gene editing and other types of new GMOs one of these challenges is transparency and maintaining consumer and producer choice. Failure to deliver this will increase the lack of trust in genetic technologies and possibly in the wider food system.

The UK government may be willing to take this risk with the food system but the most recent YouGov poll on precision bred organisms suggests it is not a risk that citizens are willing to take. In this poll, commissioned by Beyond GM[10], the overwhelming preference of adults in the UK is for all GMOs in the farming and food system to be regulated, traceable and labelled:

- 79% of adults in the UK think that precision bred crops, animals and foods should be clearly labelled on the food package
- 83% think precision bred organisms should undergo safety testing before being put on sale
- 80% think they should undergo environmental safety testing
- 79% think they should be traceable through the farming and food system

If the government is committed to the roll out of gene-edited crops and foods in the UK, then it must also be committed to funding the detection methods and audit trails necessary to reassure citizens and protect food safety standards. Instead, it continues to argue that new GMOs cannot be detected. Thus, the challenge of detection becomes a self-fulfilling prophecy with worrying implications for the safety standards of a range of new genetically engineered crops and foods.

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For more information
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[9] https://eur-lex.europa.eu/legalcontent/EN/TXT/HTML/?uri=CELEX:32021L0971
[10] https://beyond-gm.org/yougov-poll-uk-citizens-demand-robust-regulation-of-gmos