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# Gene editing for use in horticulture

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22<sup>ND</sup> SEPTEMBER 2022



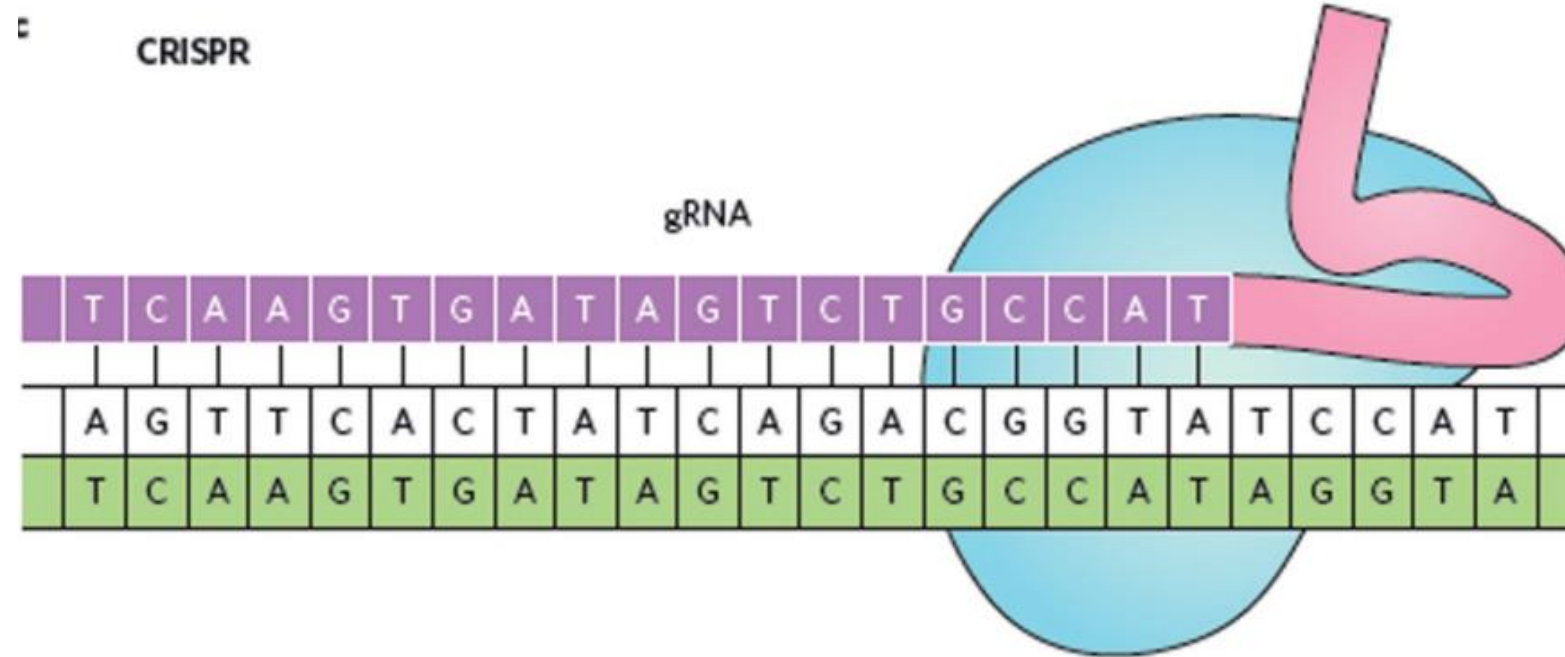
# Outline

- What is gene editing (GE)?
- Is it the same as genetic modification (GM)?
- Applications in tomato
- Regulatory position
- Freedom to operate / IP issues
- Retailer/Public perception

# What is gene editing?

Method of altering, removing or replacing DNA sequences at specific place(s) in the genome

# Methods of gene editing with CRISPR



Each complex comprises a DNA-targeting domain (sat-nav) and DNA-cutting domain (molecular scissors) (in blue).

(Jones, 2016)

# “Gene editing and beyond” video

<https://www.youtube.com/watch?v=4YKFw2KZA5o>

First 1 min 37s

# Is it the same as GM?

GMO crops are modified by using DNA from other species. Gene editing, on the other hand, produces precise changes by altering, removing or replacing genes with ones from the same (or related) species.

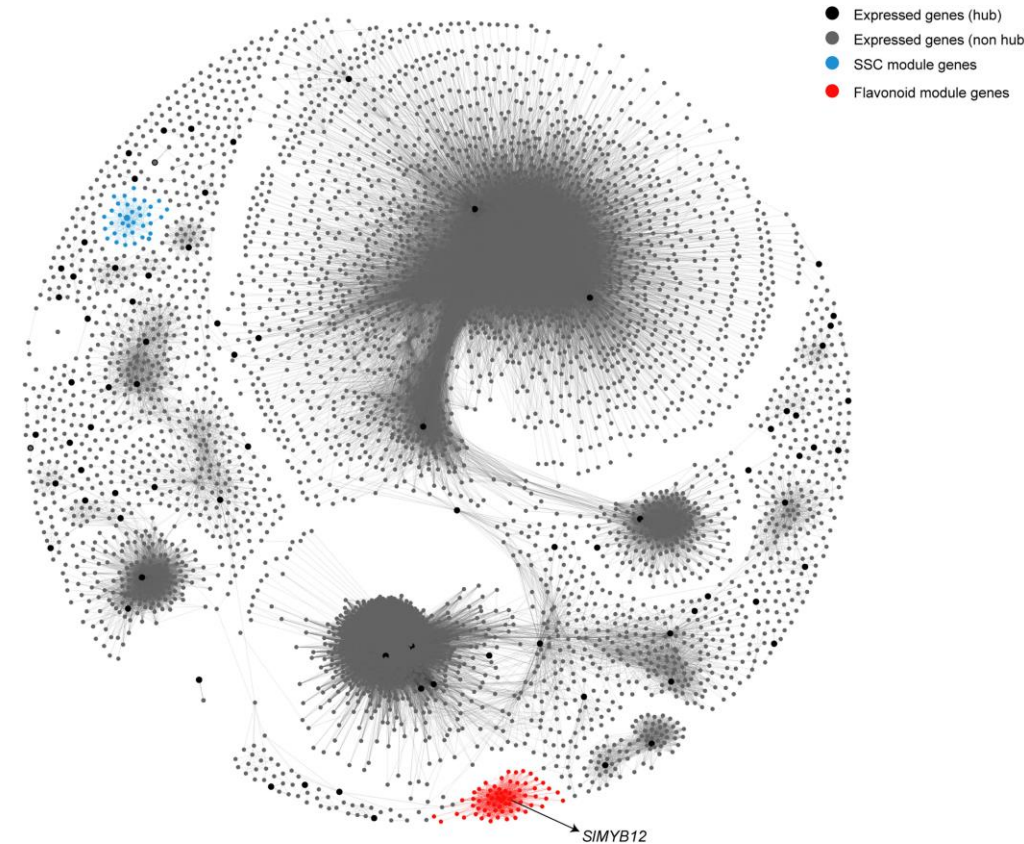
# Summary of published GE studies: May 2022





# Applications in tomato

- Depend on knowledge of complete genome
- Information now available from >800 genomes
- The number of predicted genes ranges from 33 k to 37 k with an average of 35 k
- More than 8 million small DNA changes, 11 k major variants



Network analysis reveals hub of **soluble solids** and **flavonoid** related genes

## First example



Sanatech Seed Co., Ltd. Japan

Sales of “Sicilian Rouge High GABA”, a genome-edited tomato with increased gamma-aminobutyric acid (GABA) began on September 15, 2021.

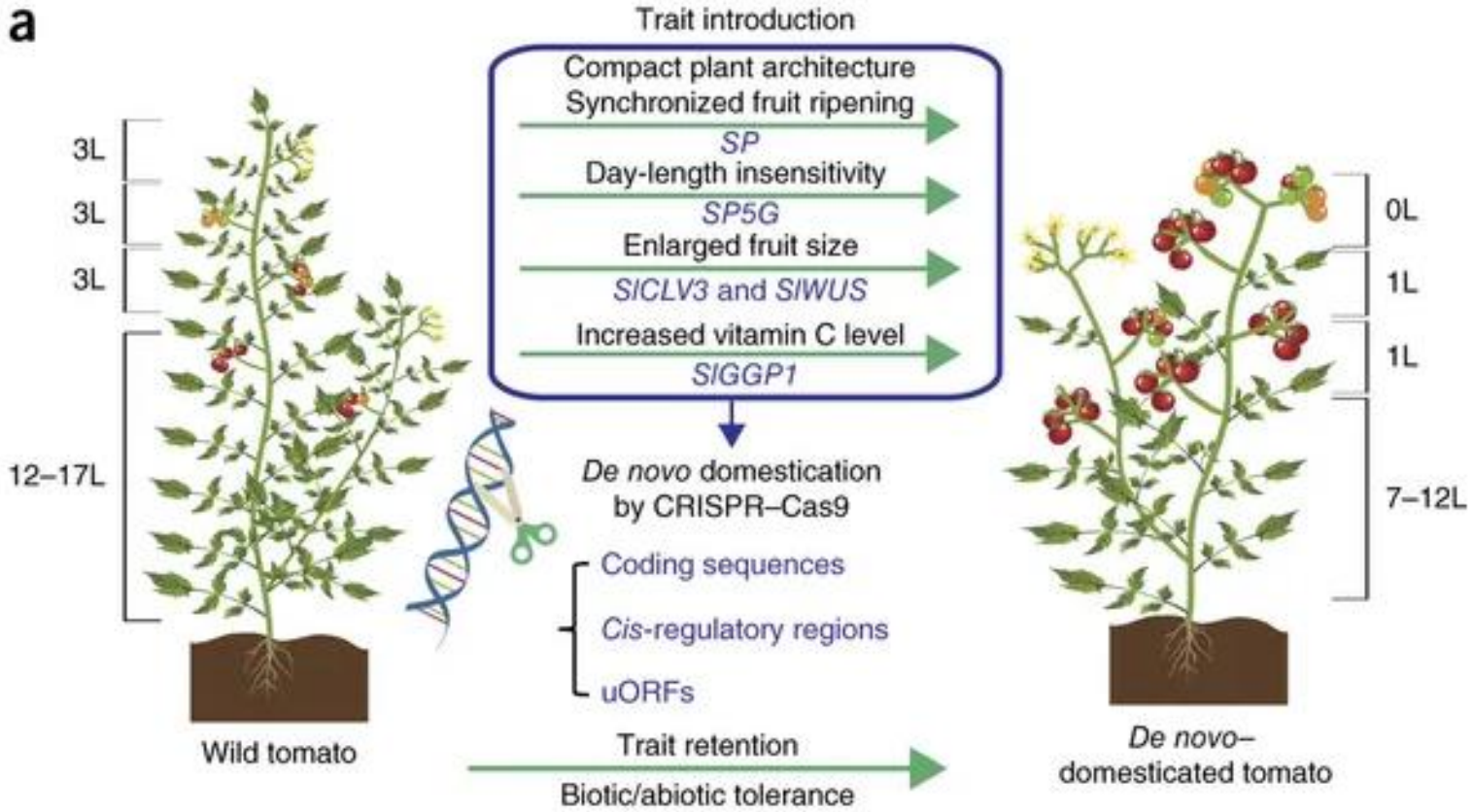
John Innes, UK (23<sup>rd</sup> May 2022)



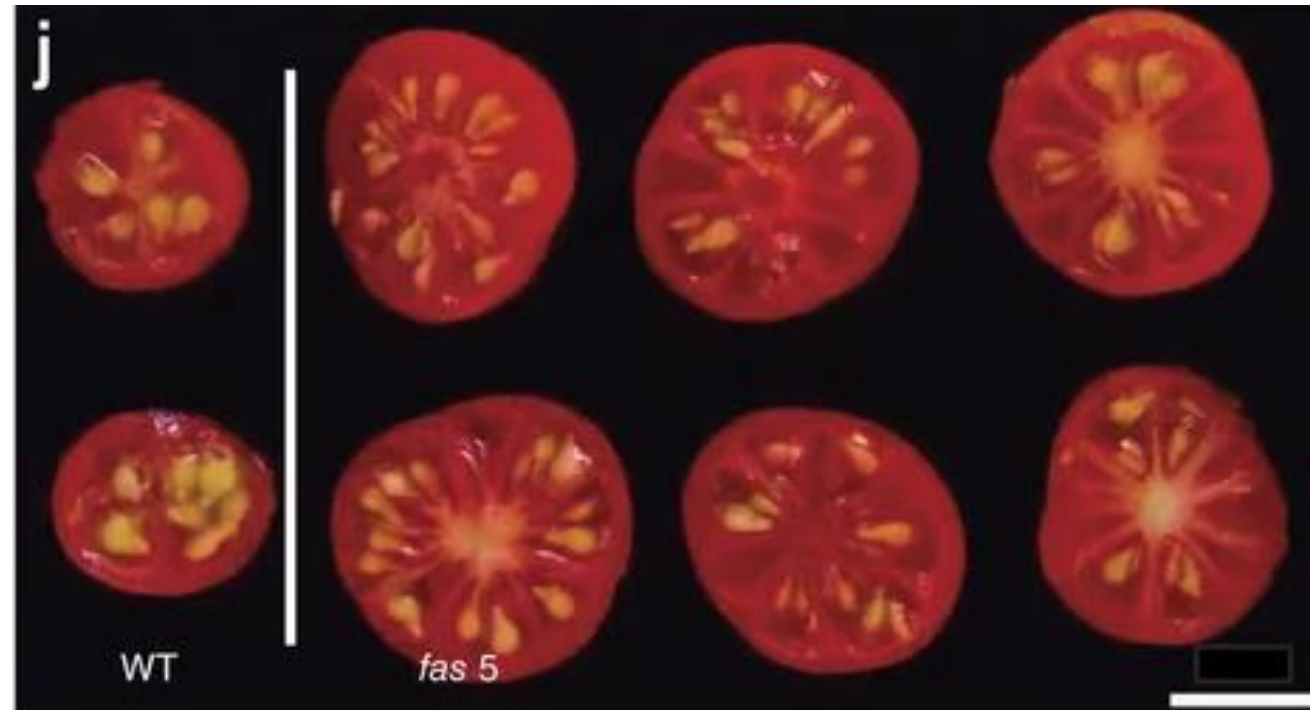
## Biofortified tomatoes provide a new route to vitamin D sufficiency

After treatment with UVB light to turn the 7-DHC into Vitamin D<sub>3</sub>, one tomato contained the equivalent levels of vitamin D as two medium sized eggs or 28g tuna – which are both recommended dietary sources of vitamin D.

# Gene editing to reproduce domestication

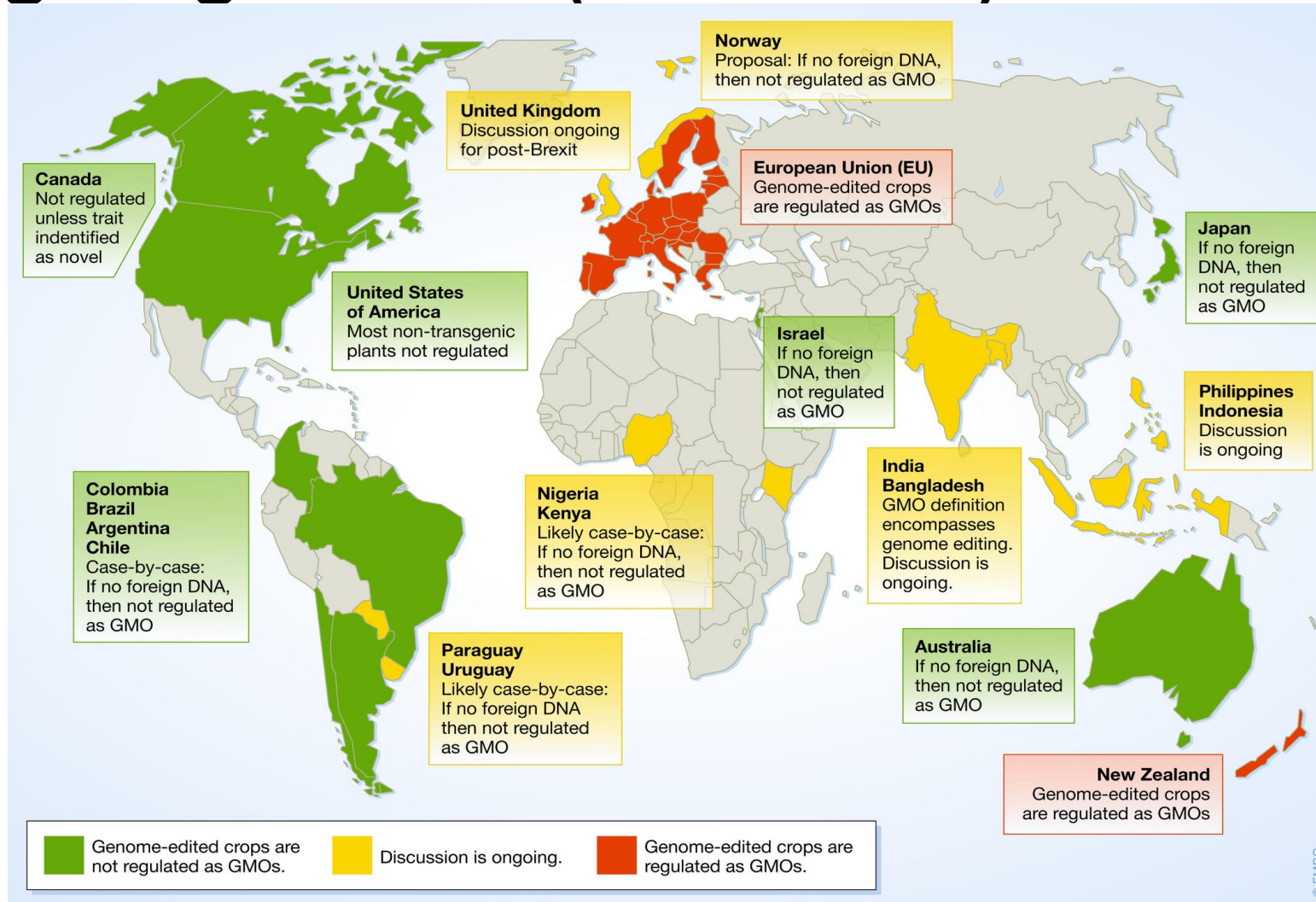


# Gene editing to reproduce domestication



Editing of gene to increase fruit size

# The international landscape around genome editing in agriculture (GM or GE?)



# EU definition of GM: Exclusions

## Annex IB:

*Techniques/methods of genetic modification yielding organisms to be excluded from the Directive*

**i) mutagenesis,**

ii) cell fusion of plant cells of organisms which can exchange genetic material through traditional breeding methods.

# Which way for the UK?





# UK Regulatory position

Genetic Technology (Precision Breeding) Bill.  
25<sup>th</sup> May 2022

Designed to remove gene-edited organisms  
from GM regulation (GE = mutagenesis)

Now at report stage in the House of Commons

<https://publications.parliament.uk/pa/bills/cbill/58-03/0011/220011.pdf>feeding Bill

## Genetic Technology (Precision Breeding) Bill

[AS INTRODUCED]

A

**B I L L**

TO

Make provision about the release and marketing of, and risk assessments relating to, precision bred plants and animals, and the marketing of food and feed produced from such plants and animals; and for connected purposes.

*Presented by Secretary George Eustice  
supported by the Prime Minister, Steve Barclay,  
the Chancellor of the Exchequer,  
Secretary Sajid Javid, Secretary Kwasi Kwarteng  
and Jo Churchill.*

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Ordered, by The House of Commons, to be  
Printed, 25th May 2022.

# EU Debate

French Minister states  
gene editing is not GM



Jan 2021  
France backs non-GMO regulation  
for crop gene-editing in EU

# EU Review: July 2022



Genome-edited  
crops and  
21st century  
food system  
challenges



IN-DEPTH ANALYSIS

Panel for the Future of Science and Technology



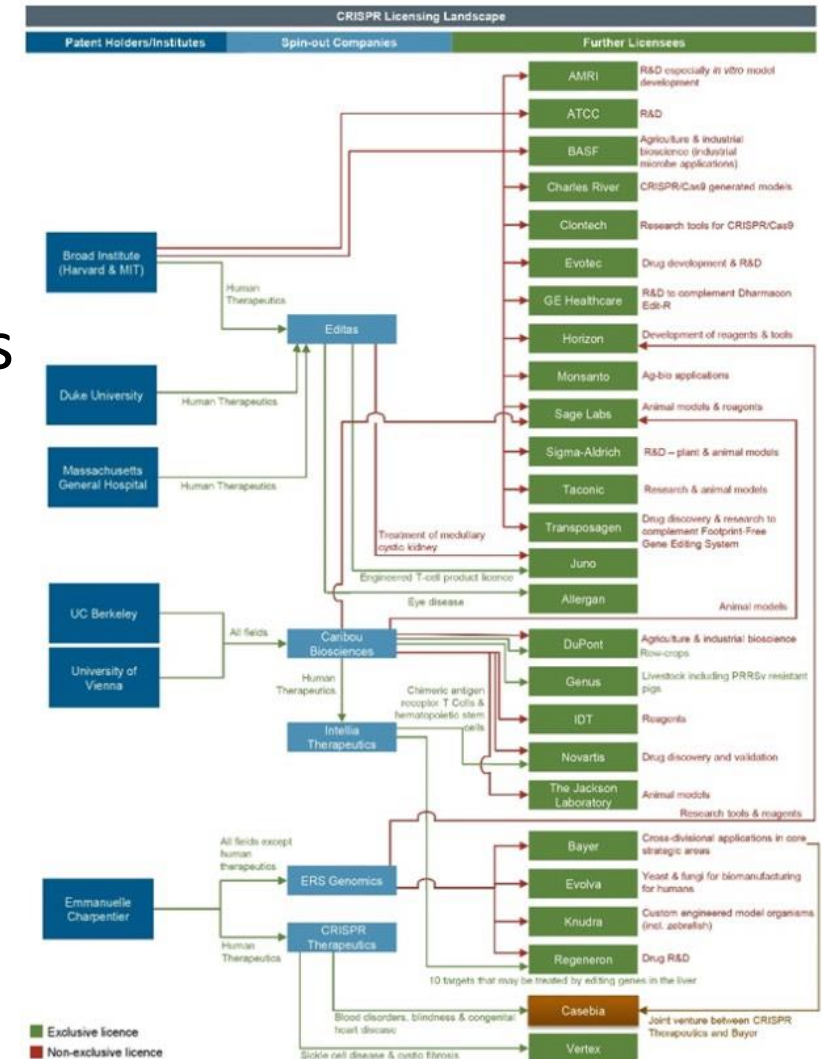
EPRS | European Parliamentary Research Service

Scientific Foresight Unit (STOA)  
PE 690.194 – July 2022

EN

# Freedom to operate / IP issues

- Two main opponents, Broad Institute and University of California, claim CRISPR-Cas9
- Different conclusions of US and EU patent systems
- No outcome for several years
- Option to obtain licenses from both parties
- New alternative (better?) systems developed



CRISPR Licensing landscape

# Retailer/Public perception

# The long view

The first commercial foodstuffs from GM crops. 1994/5



USA: Flavr Savr tomatoes Calgene



UK: Tomato puree Zeneca

# Retailer attitude neutral:

Point of sale leaflets in many supermarkets

CUSTOMER  NFORMATION  
*Genetically Modified Maize-*  
**THE FACTS**



**TESCO** *Every little helps.*

CUSTOMER  NFORMATION  
*Genetically Modified Soya-*  
**THE FACTS**



**TESCO** *Every little helps.*

# Subsequently, products withdrawn, citing consumer opposition. Now more nuanced.

Tesco 2008

Our research shows that  
75% of UK customers do  
not want GM food

M&S 2008

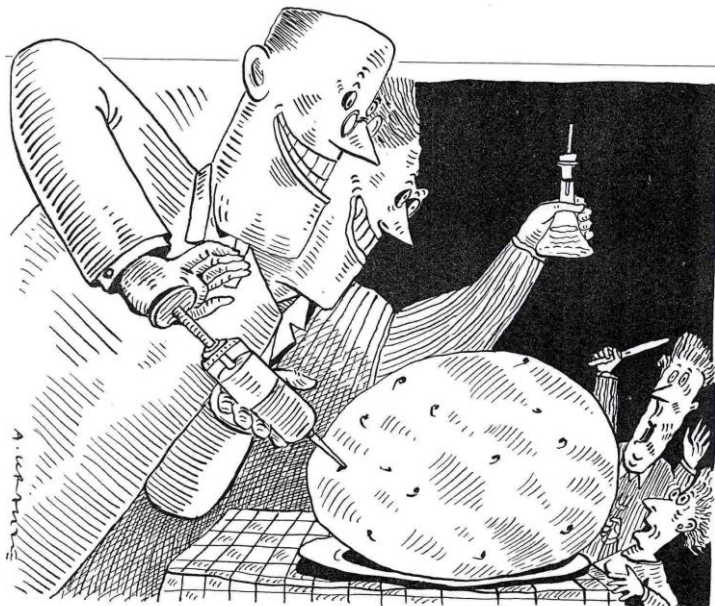
Since 1999 we  
have a strict policy  
of selling only  
non-GM products  
– a move which  
has strong backing  
from our  
customers....

Sainsbury 2007

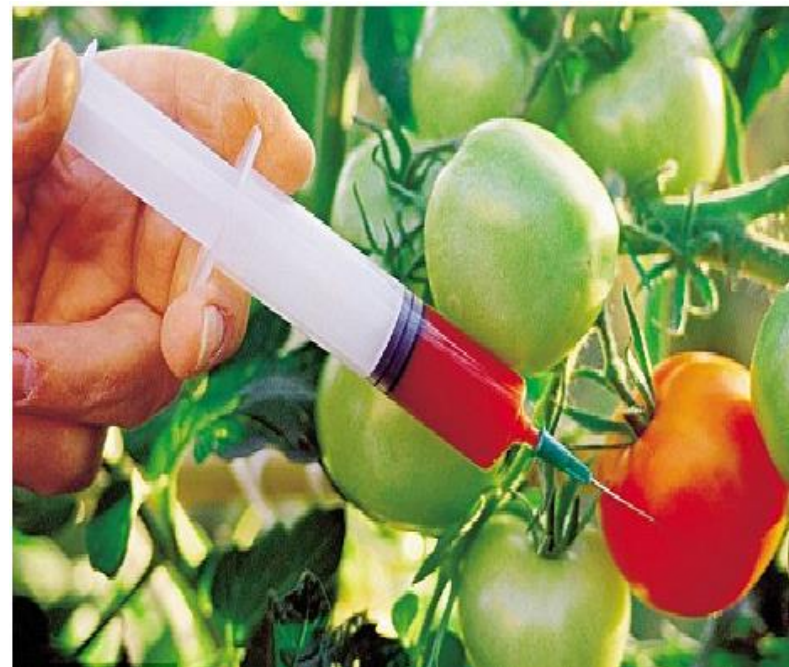
GM is invasive, and if allowed  
to develop freely, will deny  
alternative choices for ever  
to those who want to avoid it  
I remain doubtful that such a  
step should ever be taken,  
and it certainly should not be  
without thorough empirical  
evidence of safety to human  
health and the  
environment....

Dino Adriano, Former CEO

# Previous media images of GM crops



**Stop the crops**



“Evil science making modifications on natural products”



# Food Standards Agency Survey 2021

## Consumer perceptions of genome edited food

### Summary of conclusions

- Very low awareness and knowledge of GE food
- More informed were more accepting
- GE food more acceptable than GM food
- Should be regulated separately from GM food
- Should be labelled as 'genome edited'
- Suggested social media campaigns to educate the public

# Position with GE products?

No UK supermarket is willing to say it will stock gene-edited food

The UK government is working to change the law on gene-edited food, allowing it to be sold in the country for the first time, but major food retailers remain unenthusiastic.



## The Grocer 2<sup>nd</sup> June 2022

“Gene editing can translate decades of scientific research into the development of crops that are healthier to consume and reduce the environmental impacts of agriculture.

It can rightly be a boon to UK food production and productivity that not only bolsters the resilience of our food supply, but positions us as a world leader in agri-science for years to come.

But its success will, ultimately, be measured by the public, and their willingness to embrace this change at supermarket checkouts.”

<https://www.thegrocer.co.uk/supply-chain/uks-move-on-gene-edited-crops-is-a-step-forward-but-consumer-perceptions-need-to-shift/667924.article>

# Other gene-edited salad crops

Pairwise (food start-up, USA)  
New nutrient-dense, leafy salad greens called Conscious™ Greens on the market in 2023

June 3<sup>rd</sup> 2019 (Green Venus, LLC)  
Non-Browning GreenVenus™  
Romaine lettuce advances to commercial Trials in the US.

