Agribusiness 2020

New Horizons for the UK Agri-food supply chain

Gene editing – A new dawn for a productive and sustainable UK agriculture?

Professor Huw Jones
University of Aberystwyth

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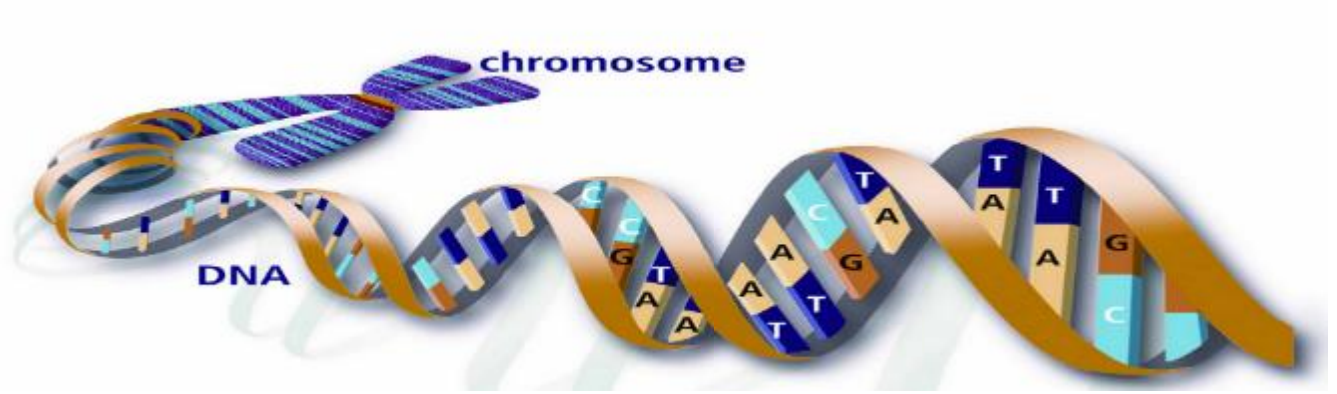
aic agricultural industries confederation

Gene editing – a new dawn for a productive and sustainable UK?

Huw D Jones PhD FRSB

Professor of Translational Genomics for Plant Breeding, IBERS, Aberystwyth University



Agribusiness 2020: New Horizons for the Agri-food supply chain

Peterborough

13th Nov 2019

Structure of the talk

- *What is gene editing*
- *Current and future applications*
- *How is it perceived by public / media*
- *Regulatory status*

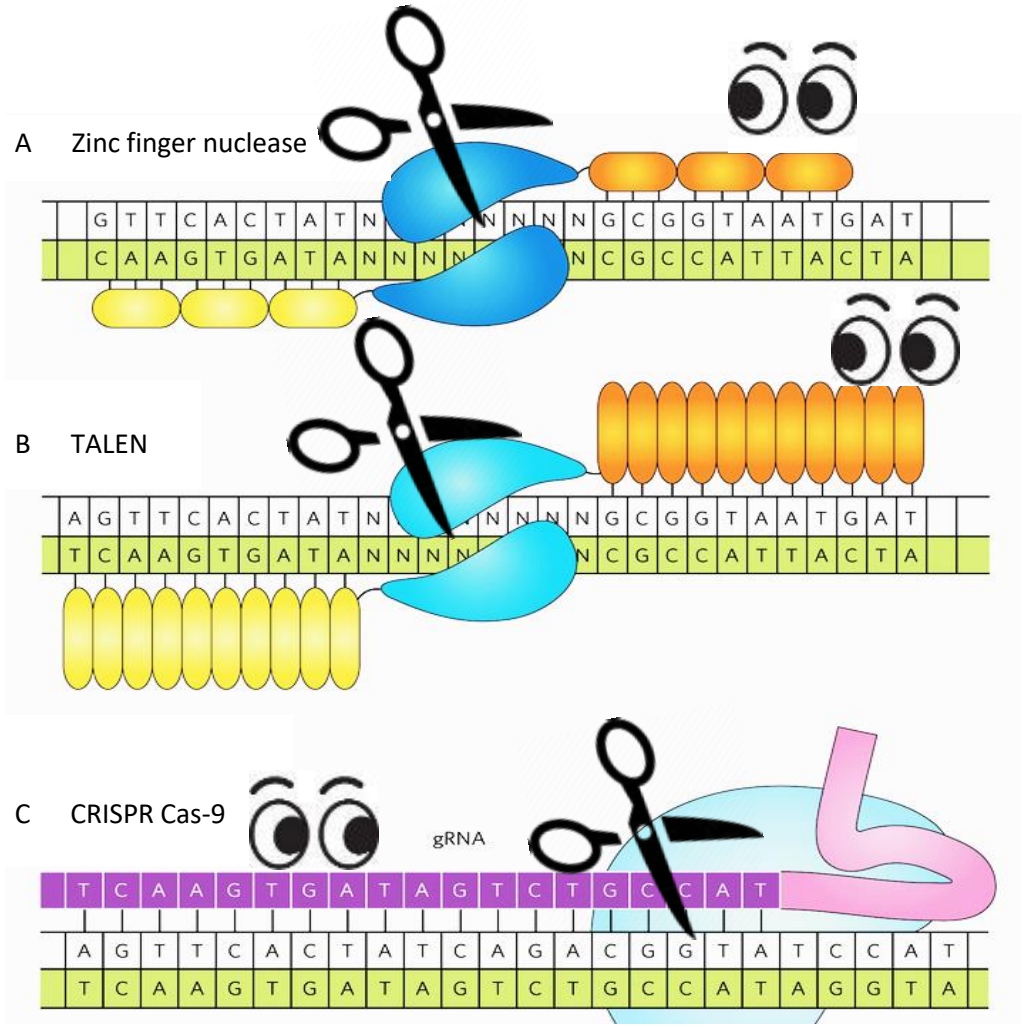
Disclaimer: Views expressed are my own, based on my academic role at Aberystwyth University and not necessarily those of EFSA or FSA

Genome editing: Suite of technologies to make targeted changes to genomes

'A collection of advanced molecular biology techniques that have been developed over recent years that allow precise, targeted changes to an organism's DNA'.

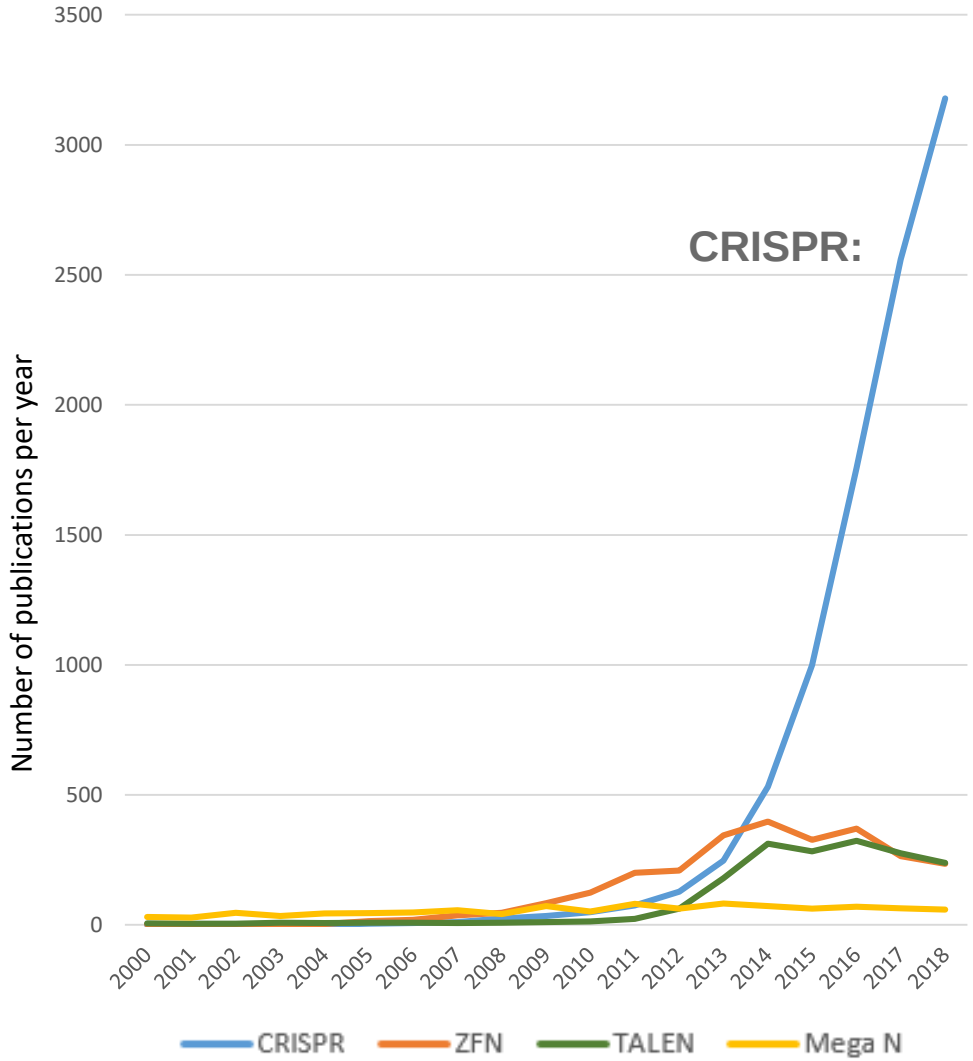
(BBSRC Genome editing working group 2017).

- **Zinc-Finger Nuclease (ZFN)**
- **Transcription activator-like effector nucleases (TALENs)**
- **Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR CAS-9)**
- **Meganucleases**
- **Oligonucleotide Directed Mutagenesis (ODM)**



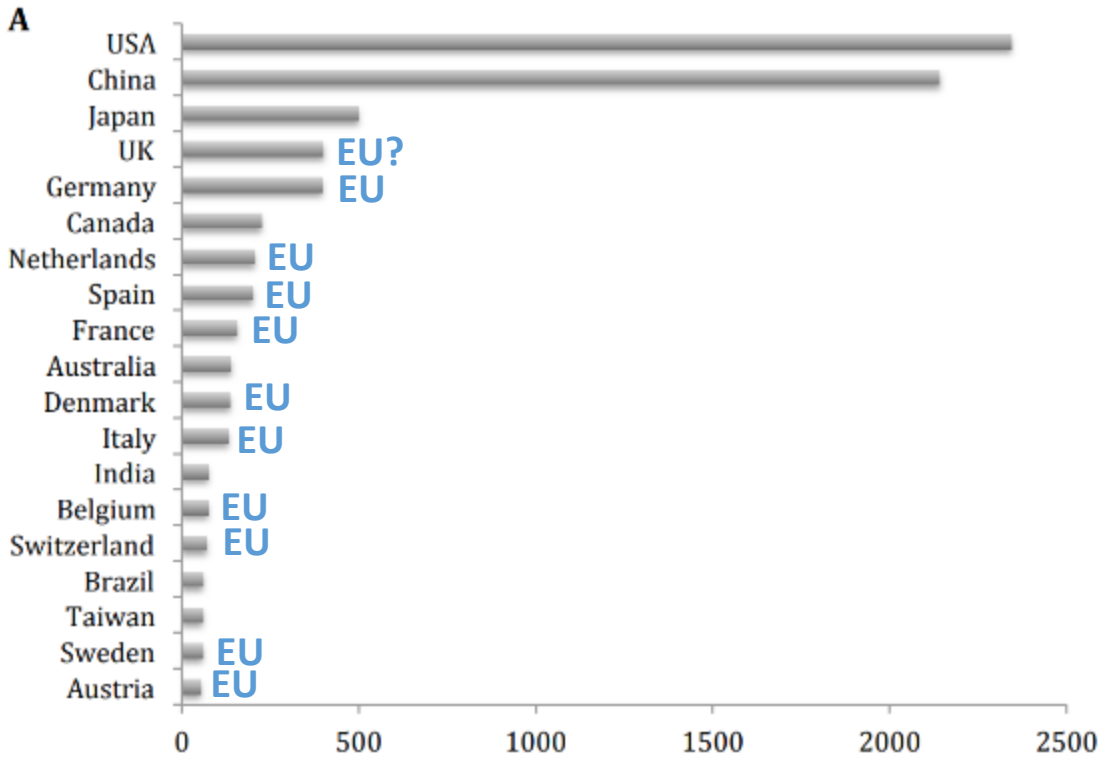
HD Jones (2015) Nature Plants 1: 14011

Primary research papers on genome editing since 2000. CRISPR Cas9 system is by far the most well-researched.



Adapted from: Huang, Y., Porter, A., Zhang, Y. *et al.* Collaborative networks in gene editing. *Nat Biotechnol* 37, 1107–1109 (2019)

A ranking of the top countries publishing on CRISPR gene editing (inc. reviews, opinion pieces etc).

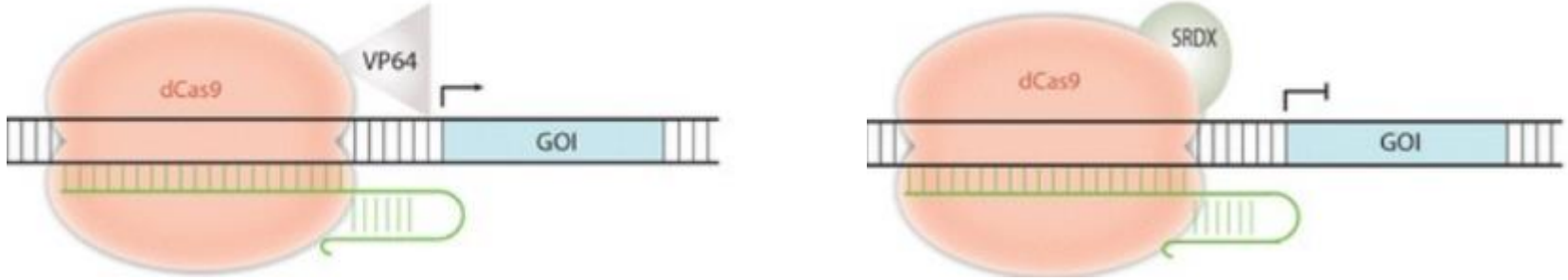


Geoffrey H. Siwo (2018). The Global State of Genome Editing bioRxiv 341198; doi: https://doi.org/10.1101/341198

CRISPR editing tools are continuously advancing

Cpf1 (Cas12a) better for experiments targeting AT-rich DNA sequences where a staggered ds cut is needed.
Cas14a targets single-stranded DNA and does not require PAM sequence for activation.
Cas9 Nickases: cut only one DNA strand. Two single nickases give a double-strand break with fewer off-targets
High-Fidelity Cas9s e.g. eSpCas9, SpCas9-HF1, HypaCas9, FokI-Fused dCas9,
Deactivated (Catalytically Dead) Cas9 has many novelties including being fused to other proteins (see below).
Nucleotide/ Base pair Editors give precise Genome Engineering by converting GC to AT or AT to GC.
RNA Editors: Cas13a and Cas13b altered gene expression with no change in genome sequence.
CasX is smaller than Cas9 and not found in bacterial pathogens of humans so lower immune response.
MAD7 Crispr (Inscripta Co.)

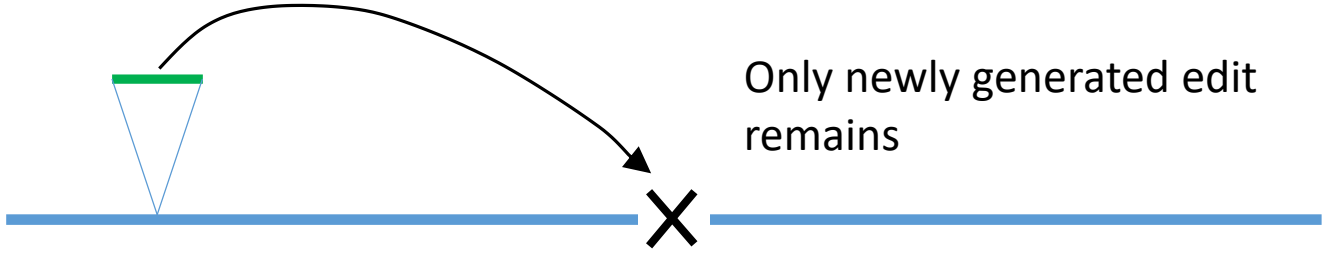
Deactivated (dead) CAS9 plus transcriptional activators or repressors lead to altered gene expression but no change in DNA sequence



Malzahn 2017 Plant genome editing with TALEN and CRISPR. Cell Biosci. 2017; 7: 21.

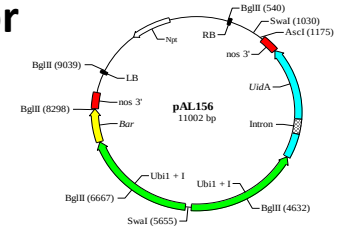
Basic gene editing in the lab

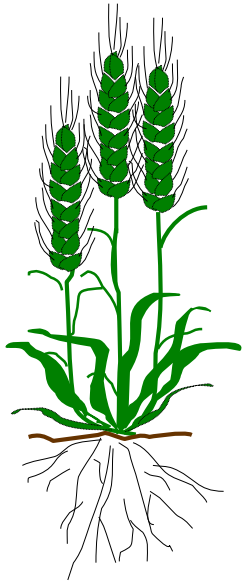
Inserted recombinant DNA removed by segregation = null segregant



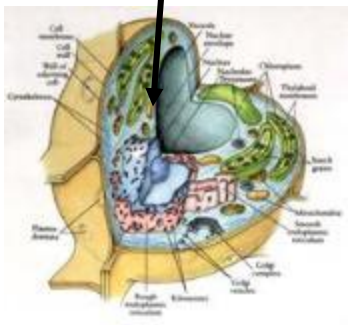
Only newly generated edit remains

Recombinant DNA encoding editor

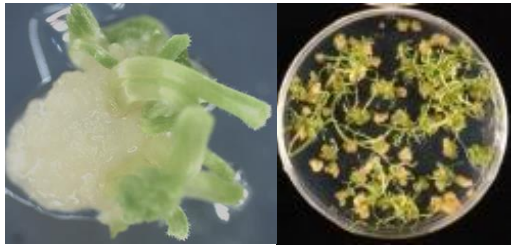




Host plant variety



Single cell



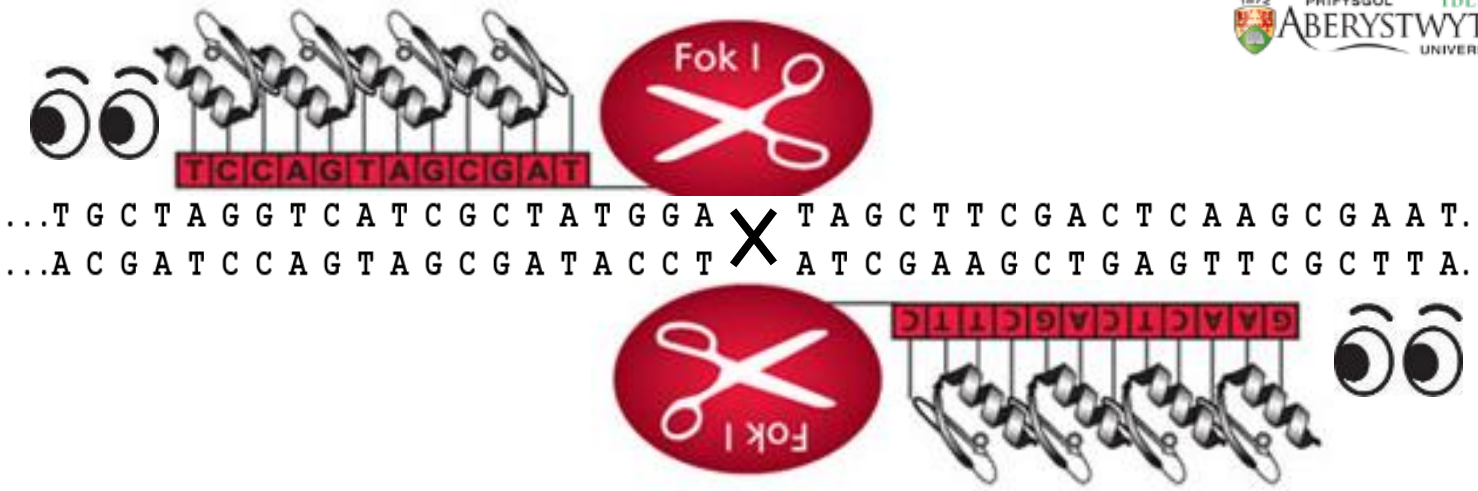
Recover whole plants via In-vitro plant tissue culture

Transgenic plant with gene edit

Selfing or crossing

Non-transgenic plant with gene edit

At the molecular level



Gene editing via NHEJ targeted generation of SNPs

Non Homologous End Joining (NHEJ)

Loss or gain of few nucleotides

Altered gene function or knockout

Whether generated by ZFN, Talen or Crispr etc. and whether delivered as DNA, mRNA or protein etc.

Outcome can be categorised into two basic types:

```
WT CTATATATGATCTGGACCCTAAGTTGGAGGAATTCAAGGATCACTTCAACTATAGGATAA
   CTATATATGATCTGGACCCTAAGTTGGAGGAATACAAGGATCACTTCAACTATAGGATAA
   CTATATATGATCTGGACCCTAAGTTGGAGGATTTCAAGGATCACTTCAACTATAGGATAA
   CTATATATGATCTGGACCCTAAGTTGGAGGA-TTCAAGGATCACTTCAACTATAGGATAA   -1
   CTATATATGATCTGGACCCTAAGTTGGAG--ATTCAAGGATCACTTCAACTATAGGATAA   -2
   CTATATATGATCTGGACCCTAAGTTGGAG---TTCAAGGATCACTTCAACTATAGGATAA   -3
   CTATATATGATCTGGACCCTAAGTTGGA----TTCAAGGATCACTTCAACTATAGGATAA   -4
   CTATATATGATCTGGACCCTAAGTTGG-----TTCAAGGATCACTTCAACTATAGGATAA   -5
   CTATATATGATCTGGACCCTAAGTTG-----ATTCAAGGATCACTTCAACTATAGGATAA   -5
   CTATATATGATCTGGACCCTAAGTTG------TTCAAGGATCACTTCAACTATAGGATAA   -6
   CTATATATGATCTGGACCCTAAGTTGG--------AAGGATCACTTCAACTATAGGATAA   -8
```

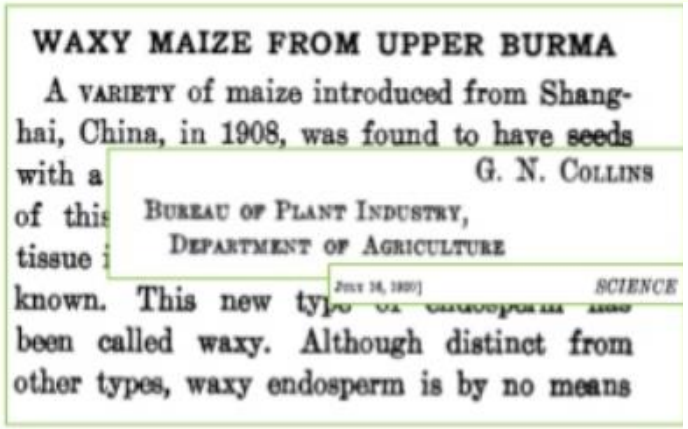
Initial commercial applications for agriculture?

Traits under simple genetic control ie. single functional genes or a single transcription factor that regulates a transcriptional cascade.

Also target existing valuable ‘natural’ mutations in poor genetic backgrounds where costs / technical challenges of introgressing trait into elite inbreds or F1 parents are higher than gene editing.

Waxy corn characteristics

A long history of safe use as a specialty crop



WAXY MAIZE FROM UPPER BURMA

A VARIETY of maize introduced from Shanghai, China, in 1908, was found to have seeds with a

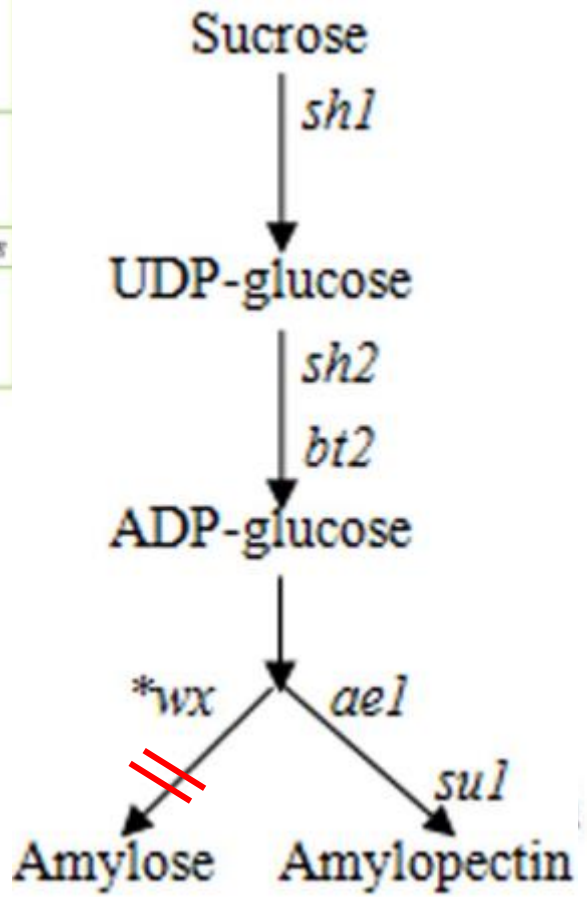
G. N. COLLINS

BUREAU OF PLANT INDUSTRY,
DEPARTMENT OF AGRICULTURE

of this
tissue i
known. This new ty
been called waxy. Although distinct from
other types, waxy endosperm is by no means

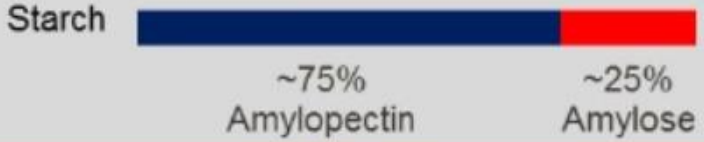
SCIENCE

- **Known since 1908**
- **Commercially cultivated since 1940's**
- **Sold by Pioneer since 1980's**

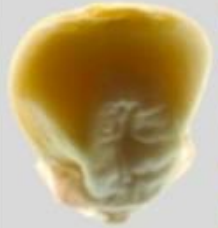


No. 2 Yellow Dent

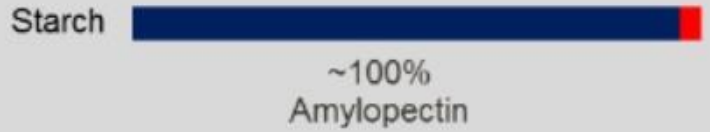
- Translucent appearance
- Dominant Wx1 allele
- Food / feed / ethanol



Waxy



- Opaque, candlewax-like appearance
- Recessive wx1 allele
- Tapioca substitute during WWII
- Food ingredients
- Envelope, cardboard & label adhesives

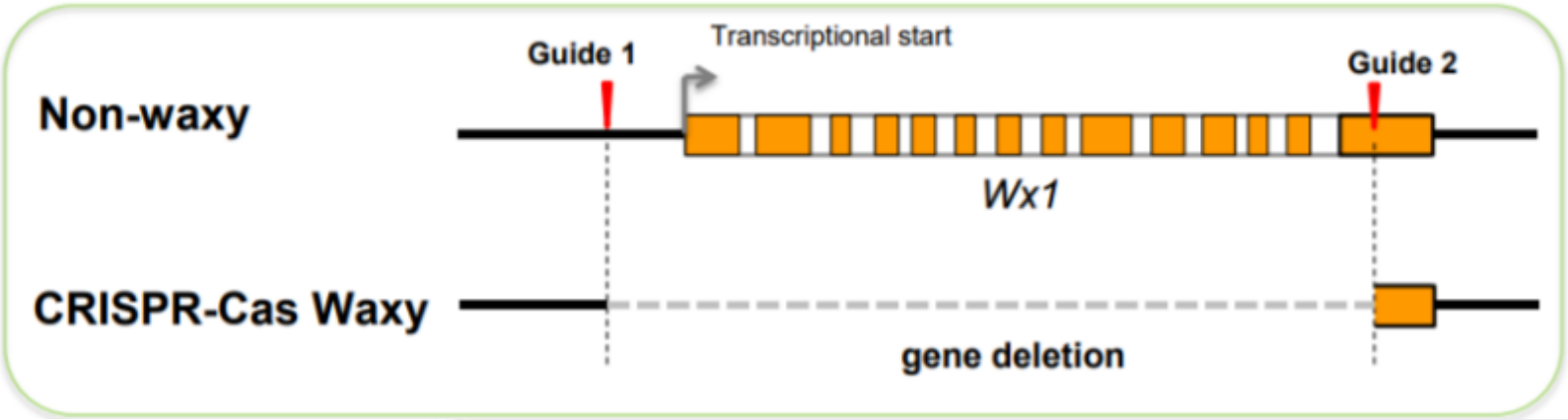


Next Generation Waxy Corn

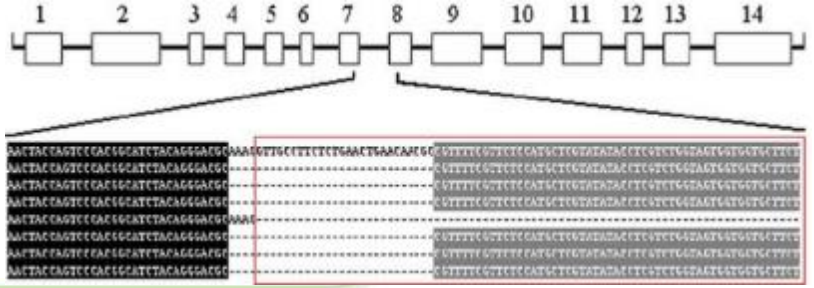
Current waxy product:

- Time lag to introgress *wx1* allele into elite inbreds
- Some *y*ield penalty, partially due to linkage drag

Solution:
***Wx1* mutation directly in elite inbred lines using CRISPR-Cas technology**



Waxy maze in current Pioneer varieties 30 bp intronic deletion



Extensive Seed New Product Pipeline

Launches Through 2021

TRAIT	CROPS	GEOGRAPHIES
QROME	Corn	North America
Enlist	Cotton, Corn, Soy	U.S., Latin America
ConkestaE3	Soy	Latin America
Optimum GLY HERBICIDE TOLERANCE	Canola	Canada
Omega-9 Oils	Sunflower	Canada, Europe

TRAIT	CROPS	GEOGRAPHIES
ProPound ADVANCED CANOLA MEAL	Canola	Canada
SmartStax	Corn	North America
POWERCORE ULTRA	Corn	Latin America
Next Gen Waxy	Corn	U.S.
LIBERTY LINK	Canola	Canada
Lumisena FUNGICIDE SEED TREATMENT	Soy	Global

Launches pending applicable regulatory approvals

calyxt™

ABOUT US ▾ PRODUCTS WITH PURPOSE ▾

WHO WE ARE

Calyxt, Inc. is a consumer-centric, food- and agriculture-focused company. Calyxt is pioneering a paradigm shift to deliver healthier food ingredients, such as healthier oils and high fiber wheat, for consumers and crop traits that benefit the environment and reduce pesticide applications, such as disease tolerance, for farmers.

* USDA confirmation that product is not a regulated article under PPA 7 CFR part 340

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Gene-Edited Soybean Oil Makes Restaurant Debut

A Minnesota-based company reports the sale of a soybean oil engineered to have greater stability and no trans-fat.

Mar 13, 2019
CAROLYN WILKE

545 37 52

ABOVE: © ISTOCK.COM, OTICKI

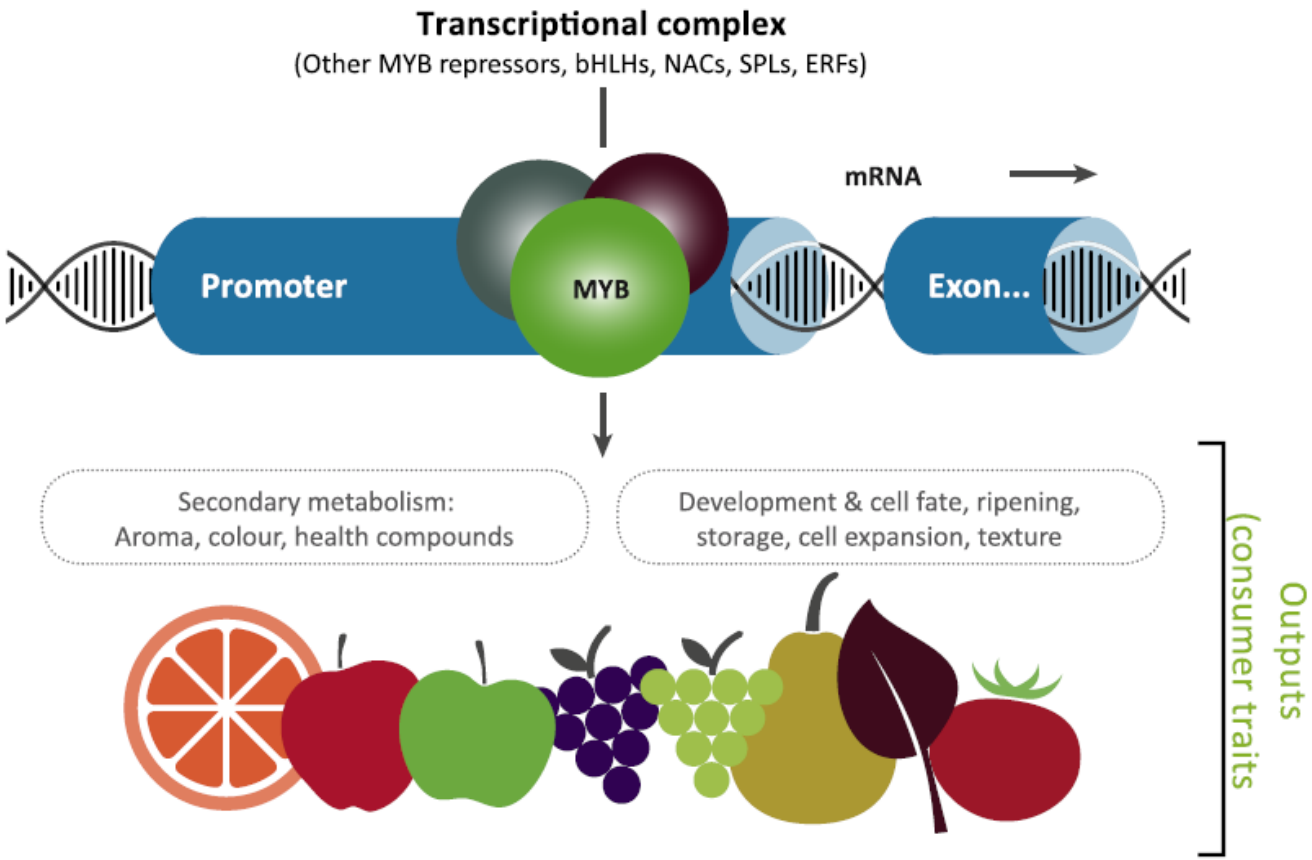
At the end of last month, Calyxt, an agriculture-focused company based in Minneapolis-St. Paul, Minnesota, announced its first sale of a gene-edited soybean oil for commercial use. The new product has made its way to a Midwestern restaurant with multiple locations for use in frying, salad dressings, and sauces, according to the *Associated Press*.

Trends in Plant Science
Volume 23, Issue 8, August 2018, Pages 693-705
CellPress REVIEWS

Review

MYBs Drive Novel Consumer Traits in Fruits and Vegetables

Andrew C. Allan[1,2,*] and Richard V. Espley[1]



***Arabidopsis* putative function**	**Example genes and functions in other species**
Cold tolerance, inflorescence architecture: AtMYB13/14/15	Chili pepper capsaicinoid biosynthesis: CaMYB31 Grape MYB14 and MYB15, stilbene biosynthesis
Activation of lignin synthesis: AtMYB63/58	Loquat lignification: EjMYB1
Transcriptional repressors, inhibit proanthocyanidin synthesis: MYB3, MYB4, MYB7, MYB32 UV-dependent sinapate ester biosynthesis: MYB4 Pollen-wall composition: MYB32	Anthocyanins/flavonols: FaMYB1, lignin: AmMYB308, grape repressors: VvMYB4A and MYB4B, MYBC2-L1 and MYBC2-L3 isoprenoid and flavonoid biosynthesis: conifers, loquat lignification repression, EjMYB2
Proanthocyanins: AtMYB123/TT2 Anthocyanin biosynthesis: PAP1, PAP2, MYB113, MYB114 Betalain biosynthesis Flavonol biosynthesis, all tissues: PFG2, PFG1, PFG3 (AtMYB111/11/12)	Grape: VvMYBPA2, peach: MYB7 AmROSEA1, CaA, GmMYB19, GtMYB3, IbMYB1, InMYB1, 2, 3, PhMYBAN2, SlANT1 potato StMYBA1, StMYB113, StAN1 Grape flavonols VvMYBF1 Phlobaphenes, 3-deoxy-flavonoids: SbY1, ZmP1/P2, apple MYB22 Tomato SlMYB12, yellow flavonoid pigment naringenin
Petal epidermis cell shape: MIXTA/AtMYB16 Early inflorescence development, seed germination: MYB17	AmMIXTA (conical epidermal cells), AmMYBML1 (trichome formation, conical cells, mesophyll cells) PpeMYB25: peach/nectarine skin type GhMYB25 (cotton fibre initiation)

REVIEW ARTICLE

Front. Chem., 19 February 2018 | https://doi.org/10.3389/fchem.2018.00026

Heat and Drought Stresses in Crops and Approaches for Their Mitigation

Mouna Lamaoui[1], Martin Jemo[1,2], Raju Datla[3] and Faouzi Bekkaoui[1*]

[1]AgroBioSciences Division, University Mohammed VI Polytechnic, Benguérir, Morocco

[2]Office Chérifien des Phosphates Africa, Casablanca, Morocco

[3]National Research Council Canada, Saskatoon, SK, Canada

Table 1. Summary of genes that were shown to have a role in heat and drought tolerance in wheat and maize

Gene/origin	Function/Mechanism	Type of promoter/Expression	Trait	Crop	Author
DREB1A/*A. thaliana*	TF	rd29A gene promoter/stress-inducible gene, upregulated	Improved drought salt and freezing tolerance	Wheat	Pellegrineschi et al., 2004
HsfA6 (heat shock factor)/wheat	TF	Barley *HVA1s* promoter/Drought inducible, upregulated	Improved thermo tolerance	Wheat	Xue et al., 2014
AtHDG11/*A. thaliana*	TF	Actin1 promoter/overexpression	Improved drought tolerance	Wheat	Li et al., 2016
TOR/*A. thaliana*	Signaling Factor	CaMV35S promoter/overexpression	Improved drought tolerance	Wheat	Datla et al., 2014 (Patent application and unpublished results)
EF-Tu/maize	Elongation factor/cheperone like activity	Maize ubiquitin 1 promoter/overexpression	Improved thermos tolerance	Wheat	Fu et al., 2008
Stress-responsive NAC gene/rice	TF	Maize ubiquitin 1 promoter/overexpression	Enhanced tolerance to drought and salt stresses	Wheat	Saad et al., 2013
HVA1/barely	Group 3 LEA - HVA1	Maize ubi1 promoter/overexpression	Improved drought tolerance and field evaluation for drought tolerance	Wheat	Sivamani et al., 2000; Bahieldin et al., 2005
P5CS/*Vigna aconitifolia*	Proline Biosynthesis	Stress-induced promoter complex—AIPC/upregulation	Increased tolerance to water deficit	Wheat	Vendruscolo et al., 2007
Phosphoenolpyruvate carboxylase (PEPC)/maize	C4, CAM and the citric acid cycles	Maize PEPC promoter/overexpression	Improved yield and drought tolerance	Wheat	Qin et al., 2016
OsMYB55/rice	TF	Maize ubiquitin Ubi1 promoter/overexpression	Increased drought and heat stress tolerance	Maize	Casaretto et al., 2016
ZmNF-YB2/maize	TF (Nuclear factor Y B subunit 2)	Rice actin 1 constitutive promoter/overexpression	Enhanced drought tolerance and photosynthetic capacity	Maize	Nelson et al., 2007
ZmPIS gene/maize	Precursor of signal molecules	Maize ubiquitin promoter/overexpression	Enhanced drought tolerance	Maize	Liu et al., 2013
NPK1/tobacco	Protein kinase	Constitutive 35 S promoter/overexpression	Enhanced drought tolerance	Maize	Shou et al., 2004
CspA, CsB/bacteria	RNA chaperones, cold shock protein	Rice actin1 promoter/overexpression	Improved kernel yield under water limiting conditions in the field	Maize	Castiglioni et al., 2008
1-aminocyclopropane-1-carboxylic acid synthase 6/maize	Ethylene Biosynthesis	Maize ubiquitin promoter/downregulation	Improved grain yield under drought stress conditions in the field	Maize	Habben et al., 2014
ZmARGOS1/maize	Down regulator of ethylene response and modulator of ethylene signal transduction	Maize ubiquitin promoter/overexpression	Drought tolerance enhancement in the field	Maize	Shi et al., 2015
ZmARGOS1/maize	Down regulator of ethylene response and modulator of ethylene signal transduction	Genetic editing/downregulation	Drought tolerance enhancement in the field	Maize	Shi et al., 2017
LOS5/*A. thaliana*	Cofactor sulfurase gene	"Super" promoter (manopine synthase)/overexpression	Enhanced drought tolerance	Maize	Lu et al., 2013
betA gene/*E. coli*	Biosynthesis of glycine betaine	CaMV35S promoter/overexpression	Enhanced drought stress tolerance	Maize	Quan et al., 2004
Trehalose-6-phosphate phosphatase (OsMADS6)/rice	Sucrose metabolism	OsMads6 promoter/overexpression	Enhance yield under well-watered and water stressed plants in the field	Maize	Nuccio et al., 2015

Opportunities for breeding: new varieties for VF

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£5.4m funding boost for Scottish 'vertical farm' firm

18 June 2019 Share

The firm opened its demonstration centre in Invergowrie last year

Equipment manufacturers are developing fully autonomous tractors for future use.
Photo courtesy of Case IH

Robots will end blanket pesticide spraying and ‘slaughter harvesting’
But will need new genetics to optimise their application

Iron Ox uses robots to assist in the process of growing produce. | Photo: Iron Ox

Source: *Blue River Technology*

Hydraulic shaker removing all apples whether ripe or not

Robot apple picker selecting only ripe fruits

Wall Street Pit WSP NEWS THETAPE LATEST FOLLOW WSP

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7 Disruptive Technologies Destined To Change The World

ARK Invest recently came out with 'Big Ideas' -- a yearly report that breaks down what they believe are the technologies to look out for as these are bound to make significant progress in the near future.

Science Contents News Careers Journals

In a lab chamber in Beijing, Gao Caixia grows CRISPR-modified wheat plants that she hopes will have a higher yield. SHARON CHOW

SHARE

To feed its 1.4 billion, China bets big on genome editing of crops

By Jon Cohen | Jul. 29, 2019 , 8:00 AM

TIME HEALTH • RESEARCH

The Gene-Editing Revolution Is Already Here

A researcher performs a CRISPR/Cas9 process at the Max-Delbrueck-Centre for Molecular Medicine in Berlin. Gregor Fischer—picture alliance/Getty Images

BY JENNIFER DOUDNA OCTOBER 24, 2019

NATIONAL GEOGRAPHIC

Gene editing is already saving human lives and there is general consensus that research into <u>somatic cell</u> cures <u>should</u> progress with caution.

New Scientist

DAILY NEWS 5 November 2015

Gene editing saves girl dying from leukaemia in world first

For the first time ever, a person's life has been saved by gene editing.

One-year-old Layla was dying from leukaemia after all conventional treatments failed. "We didn't want to give up on our daughter, though, so we asked the doctors to try anything," her mother Lisa said in a statement released by Great Ormond Street Hospital in London, where Layla (pictured above) was treated.

Baby Layla Richards with her family following successful leukaemia treatment (Photo: PA)

World-first gene therapy saves second baby from killer cancer giving hope to millions

Layla Richards beat leukaemia last year with revolutionary treatment and an unnamed baby has given hope to millions more sufferers

SCIENCE

The unnamed baby underwent live-saving treatment at Great Ormond Street Hospital

Science Home News Journals Topics Careers

Brian Madeux, who has Hunter syndrome, has received a treatment aimed at editing the genome of his liver cells. AP PHOTO/ERIC RISBERG

A human has been injected with gene-editing tools to cure his disabling disease. Here's what you need to know

By Jocelyn Kaiser | Nov. 15, 2017, 6:00 PM

1872 PRIFYSGOL ABERYSTWYTH UNIVERSITY IBERS

The Washington Post
Democracy Dies in Darkness

Health and Science

Gene-edited farm animals are coming. Will we eat them?

Cutting-edge lab techniques could improve animal breeding, but society may not be ready

PoultryNews -- Our Other Websites -- FREE to UK Subscrib

Analysis: Perfecting poultry. What does CRISPR gene editing technology mean for our sector?

BY CHLOE RYAN ON JANUARY 24, 2018 PRODUCTION

THE WALL STREET JOURNAL.

MOVING UPSTREAM Season 2 Episode 2 | October 01, 2018

This Gene-Edited Calf Could Transform Brazil's Beef Industry

World's first Angus calf engineered to be heat tolerant could beef up meat production in warmer climates

By Jason Bellini
Oct. 01, 2018 10:30 am

MOVING
UPSTREAM

WSJ's Jason Bellini explores the trends, technologies, ideas and challenges that are headed our way in this video series. In each episode, we visit the places, and meet the people who can help us to better understand what's upstream.

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Weird new fruits could hit aisles soon thanks to gene-editing

Nicola Davis
@NicolaKSDavis
Thu 19 Jul 2018 18.16 BST

Supermarkets stocked with peach-flavoured strawberries and seedless tomatoes on horizon, scientists say

▲ A red-fleshed apple of the Redlove hybrid variety. Unusual fruits such as this could soon become more common thanks to use of technologies such as Crispr. Photograph: Bailey-Cooper Photography/Alamy Stock Photo

Smooth or hairy, pungent or tasteless, deep-hued or bright: new versions of old fruits could be hitting the produce aisles as plant experts embrace cutting-edge technology, scientists say.

While researchers have previously produced plants with specific traits through traditional breeding techniques, experts say new technologies such as the gene-editing tool Crispr-Cas9 could be used to bring about changes far more rapidly and efficiently.

USA TODAY

Tiny rare fruit that tastes like pineapple could hit stores thanks to gene editing

Josh Hafner | USA TODAY
Published 8:35 PM EDT Oct 3, 2018

A groundcherry.
avillaschi, Getty Images

A rare fruit could wind up in U.S. stores in the near future after scientists spliced its DNA to make it heartier and more efficient. It's called the groundcherry, and its success could lead to the modification of more rare fruits and vegetables.

Farmers Guardian

Topics Insights Events Buy & Sell Jobs

New survey shows overwhelming public support for British farmers

News 28 Oct 2019

A massive four in five British shoppers think food should only be imported if it meets UK animal welfare and environmental standards, new research has found.

Abi Kay and **Lauren Dean** report...

A ComRes survey of 2,000 British adults, commissioned by the British Guild of Agricultural Journalists and carried out in Sept 2019

34 per cent agreed that new plant-breeding technologies, such as GM and gene-editing, should be used in the UK to grow food.

27 per cent said they should not

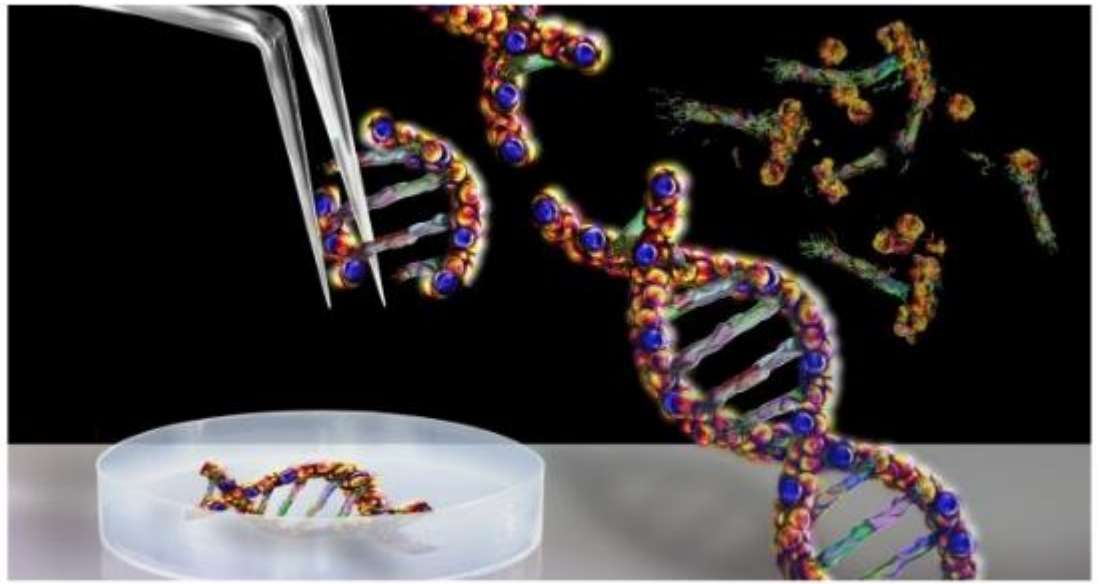
Those aged 18-24 were more likely to agree with the statement than any other age group.

THE IRISH TIMES

Advances in gene editing top poll of Irish Times readers

Ability to alter how genes work seals votes for innovation of the decade among respondents

Tue, Nov 5, 2019, 22:30 | Updated: Tue, Nov 5, 2019, 23:11 **Michael McAleer**

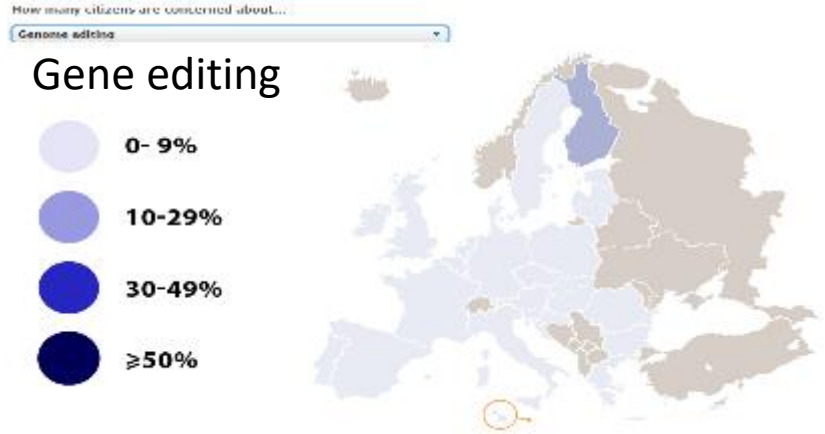


Researchers are using the gene-editing tool Crispr to turn bacterium's machinery against itself, or against viruses that infect human cells.

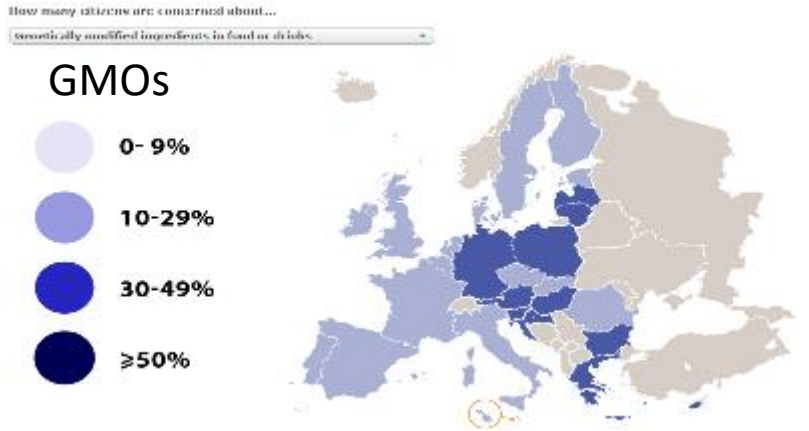
Irish Times readers have voted for advances in gene editing as their innovation of the decade in an online poll. The scientific innovation won out with 33.8 per cent of the vote against smarter phones, which secured 22.5 per cent. Improvements in battery technology came third with 17.5 per cent.

Eurobarometer 2019: Food Safety in the EU

Familiarity:
21% of people had heard of genome editing. Ranged from 8% in Italy, 9% in Romania, 30% in UK and 62% in Finland.



Concerns:
Antibiotic, hormone or steroid residues in meat (44%), followed by pesticide residues in food (39%), environmental pollutants in fish, meat or dairy (37%) and additives like colours, preservatives or flavourings used in food or drinks (36%).



Topics registering lower levels of concern: traces of materials that come into contact with food (16%), poisonous moulds in food and feed crops (11%), plant diseases in crops (9%), nanoparticles found in food (8%) and genome editing (4%).

Global status of regulatory oversight of genome editing of crops and animals

- USDA have ruled that at least 7 plant products generated using genome editing are NOT Regulated as biotech products (a low-phytate maize, a herbicide-tolerant (HT) canola, a mildew-resistant wheat; a non-browning mushroom, PPO knock-out potato, FAD3 knockout soybean and the first 'CRISPR crop', a waxy maize.

- Canada use 'novel product' regulation so should accommodate editing

- Japan, Israel, Australia, Argentina, Brazil, Colombia and Chile have given guidance that on a case-by-case basis Type I genome editing in plants wound not be regulated as a GMO

In Japan, genetically modified products have to be labeled; an advisory panel did not say whether that should apply to gene-edited food as well. SHIHO FUKADA/BLOOMBERG/GETTY IMAGES

Gene-edited foods are safe, Japanese panel concludes

By Dennis Normile | Mar. 19, 2019 , 1:15 PM

Japan will allow gene-edited foodstuffs to be sold to consumers without safety evaluations as long as the techniques involved meet certain criteria, if recommendations agreed on by an advisory panel yesterday are adopted by the Ministry of Health, Labour and Welfare. This would open the door to using CRISPR and other techniques on plants and animals intended for human consumption in the country.

Significant media reaction to ECJ ruling

Almost all covered the critical view of industry and researchers

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Science & Environment

Gene editing is GM, says European Court

By Paul Rincon
Science editor, BBC News website

25 July 2018 Share

The European Court of Justice has ruled that altering living things using the relatively new technique of genome editing counts as genetic engineering.

"I was shocked and disappointed at the ruling which will effectively block EU innovation in gene editing for animal and plant breeding," Professor Huw Jones, of Aberystwyth University and one of the signatories of the letter, told i.

"The UK has an opportunity to show leadership and improve regulatory policy for biotechnology."

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Industry shocked by EU Court decision to put gene editing technique under GM law

In 2016, France asked the ECJ to clarify whether a variety of herbicide-resistant rapeseed obtained through new plant breeding techniques (NPBTs) should follow the GMO approval process. [Shutterstock]

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Regulating simple gene editing with GMO laws is illogical, disproportionate and unworkable.

Why illogical?

Conventional mutation breeding (which has generated 1000's of new crop varieties) through *uncharacterised* and *untargeted* mutations are ***not*** regulated as GMOs

Simple gene editing generates less genetically disruptive and better characterised mutations but ***are*** regulated in EU as GMOs.

Why disproportionate?

Because the time and cost of the full GMO risk assessment process, for both the applicant and the EU, is not proportional to the safety benefits implied for gene edited crops.

Why unworkable?

Current EFSA guidance that support the GMO risk assessment process cannot be applied to organisms produced from simple gene editing. There is no inserted DNA, no newly expressed protein, no unique event identifier etc.

Imports of gene edited food/feed cannot be tested at ports but EU has a zero-tolerance of unauthorised GMOs.

Andriukaitis: 100-year old production models cannot achieve food sustainability

By Sarantis Michalopoulos | EURACTIV.com

Oct 16, 2019 (updated: Oct 24, 2019)

Bayer official: "I see some examples in some new, young Green leaders that are questioning the decisions of the past [...] they see that in order to get to this sustainable future that they aspire, they need innovation." [Shutterstock]

"We cannot achieve sustainability with the exact same production models that we used 100 years ago when all the other variables have changed," the outgoing EU Health Commissioner Vytenis Andriukaitis told EURACTIV.com

"So, before we reject and ban science – be it GMO or New Plant Breeding Techniques (NPBTs), let's have a very serious discussion on how the progress in science can benefit us while addressing the challenges of the global warming and biodiversity," he said.

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EU law on gene editing 'barrier to innovation'

By Editors - 27th September 2019

Gene editing has many potential applications in the aquaculture industry

THE European Union Commission must support innovation in biotech and gene editing if it is to achieve its ambitions for creating clean technology and high value jobs, a British MEP warned this week.

Anthea McIntyre, UK Conservative spokeswoman on agriculture and the environment, said population increase, climate change and pressures from alternative land use all challenged future food production.

'The current legislation is not fit for purpose and urgently needs review to ensure risk based, proportionate and science based policy.

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Genetically Modified Insects

Oral and Written evidence

1st Report of Session 2015-16 - published 17 December 2015 - HL Paper 68

"Mr Eustice: The point I would make is that there is a reason why I think we should be a bit concerned about switching to a trait-based approach, and that is that the Commission is currently considering whether other novel breeding techniques, such as cisgenics and gene editing, should be covered by GM legislation. Our view is that they should not, because this is about moving genes within species; it is not about moving them between species. We would not want those to be treated as GM, otherwise you are going to hold back the development of a very exciting new area, modern gene techniques, that has its genesis, if you like, and is still rooted in conventional techniques."

Still the view of George Eustace (Minister of State at Defra) who gave evidence to a Lords select committee in 2015 and who reiterated this view in a face-to-face meeting in Nov 2017

Date: Tuesday 21st November

Time: 10:45am

Location: Abbey Room, Church House, Great Smith St, Westminster, London SW1P 3NZ

Confirmed attendees

- **George Eustice MP**, Minister of State for Agriculture, Fisheries and Food
- **Renaud Wilson**, GM team, Defra
- **Mark Buckingham**, Chair of abc and Corporate Affairs Lead, Monsanto UK & Ireland
- **Dr Julian Little**, Deputy Chair of abc and Communications & Government Affairs Manager, Bayer CropScience
- **Karen Holt**, abc member and Regulatory Manager, Syngenta
- **Sarah Mukherjee**, Chief Executive, CPA
- **Helen Ferrier**, Acting Head of Policy Services, NFU
- **Professor Huw Jones**, Aberythwyth University
- **Dr Helen Munday**, Chief Scientific Officer, FDF
- **Paul Rooke**, Head of Policy, AIC
- **Judith Batchelar**, Director of Brand, Sainsbury's
- **Julian Sturdy MP**, Member of the EFRA Select Committee and Chair of the APPG for Science and Technology in Agriculture.

Michael Gove pledges genetic food revolution

November 30 2018, 12:01am, The Times

David Brown

Michael Gove, the environment secretary, said scientists and farmers would be freed from a European court ruling that stopped the use of food produced with gene editing

‘There are some people who think that simply because we have committed to maintaining high environmental standards that we will remain subject to the jurisdiction of the ECJ.

We won’t, what we will be doing is achieving high environmental goals by different means and means that do allow for greater innovation.’

11th Feb 2019

“The Government has always been clear that we take a science-based approach to GM regulation and our priority is safeguarding health and the environment.

“Our view remains that gene-edited organisms should not be subject to GM regulation if the changes to their DNA could have occurred naturally or through traditional breeding methods.

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