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PBI at a glance
&
updates related to our business

October 1, 2025

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PLANT BREEDING INNOVATIONS AND GENOME EDITING

- ✓ Barely a decade ago, genome editing and CRISPR sounded like science fiction.
- ✓ Today, some of its first plant-products are already stepping out of papers and brushing the dinner table.

GENOME EDITING IN FOOD AND AGRICULTURE

BREEDING & RESEARCH TOOLS

- Generation of germplasm
- Gene function analysis
- De novo domestication
- Hybrid seed production
- Decoupling trade-off effects

HORTICULTURAL & POSTHARVEST TRAITS

- Plant architecture
- Fruit & berry quality
- Flower & fruit color modification
- Shelf life

CORE OUTCOMES

- Increased yield
- Improved nutrition
- Increased abiotic stress resistance
- Increased biotic stress resistance

INNOVATION IN PLANT BREEDING HAS GAINED UNPRECEDENTED IMPORTANCE

By 2025, more than 2,000 plant species have been sequenced

(more than 500 have been sequenced twice, and more than 200 have been sequenced three or more times)

- ✓ Innovation in this area is based on a deep understanding of the plant genome and the refinement of GM methods, enabling progress in efficiency, precision, and speed in developing new plant varieties.

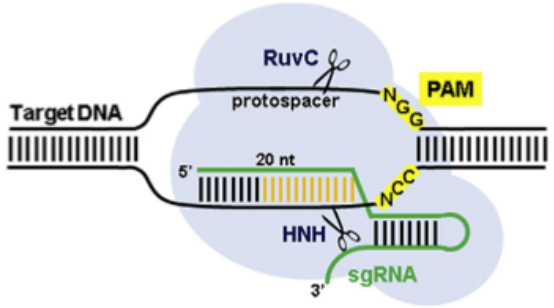
PubPlant → https://www.plabipd.de/pubplant_main.html

Schwacke et al. 2025. Front. Plant Sci. 16:1603547.

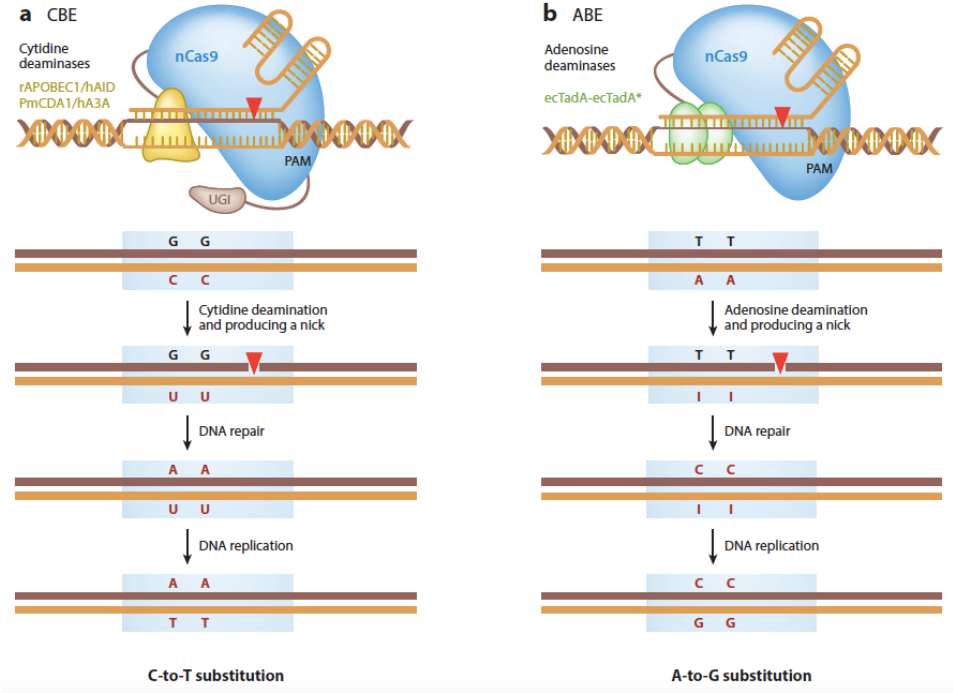
EVOLUTION OF GENOME EDITING WITH CRISPR: TO THE INFINITY AND BEYOND

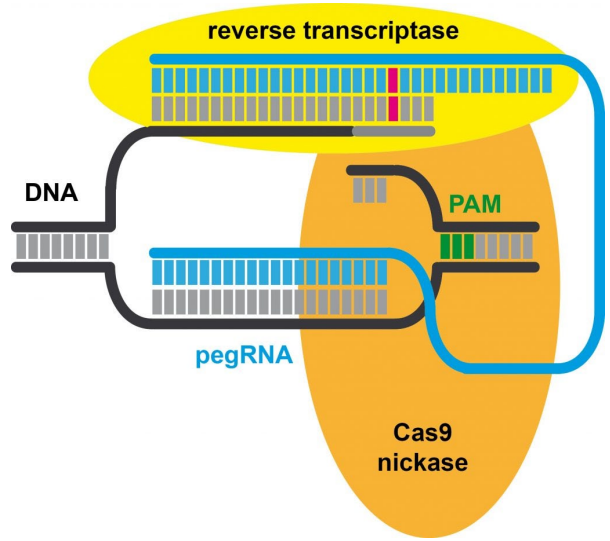
✓ *Over the past years, ever more precise and efficient plant breeding methods have been developed.*

CRISPR/Cas9 → **BASE EDITORS** → **PRIME EDITING**



Small insertions/deletions/substitutions



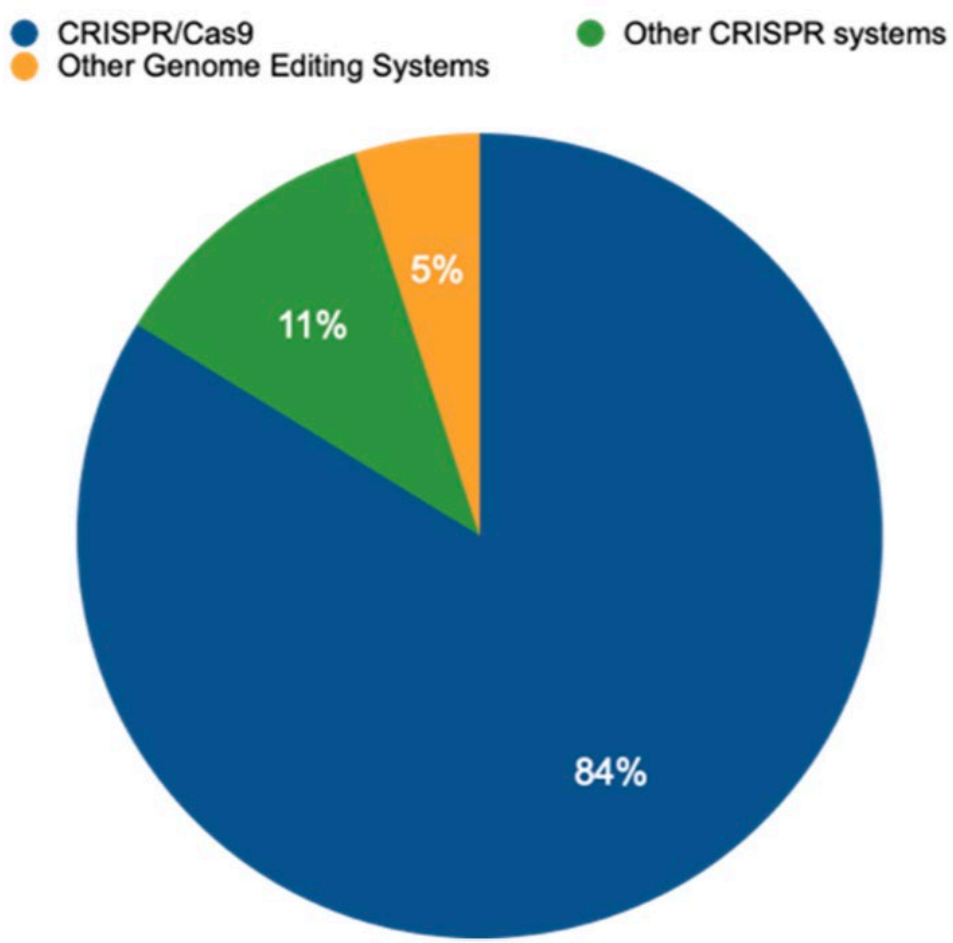


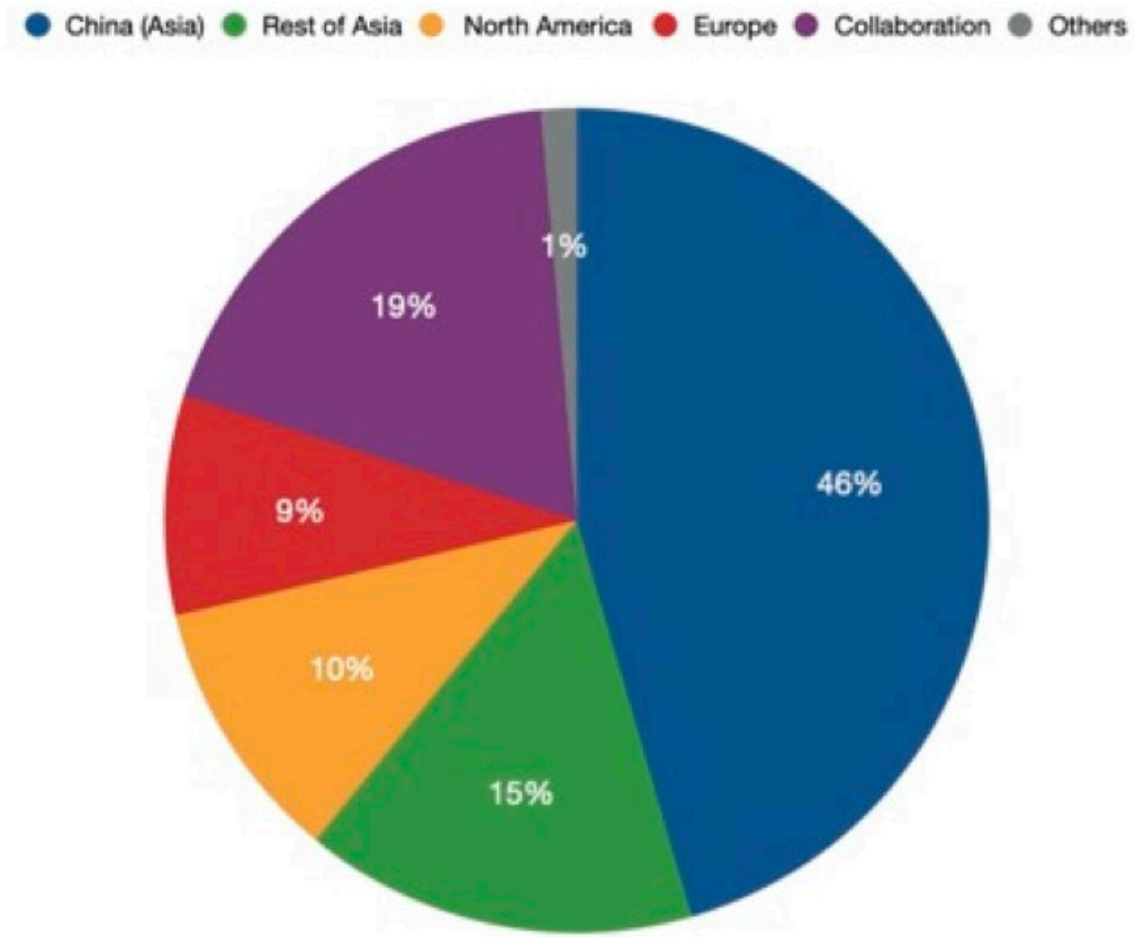
Small changes with high precision

Single-letter swaps without double-strand breaks

GENOME EDITING RESEARCH

Analysis of 837 studies



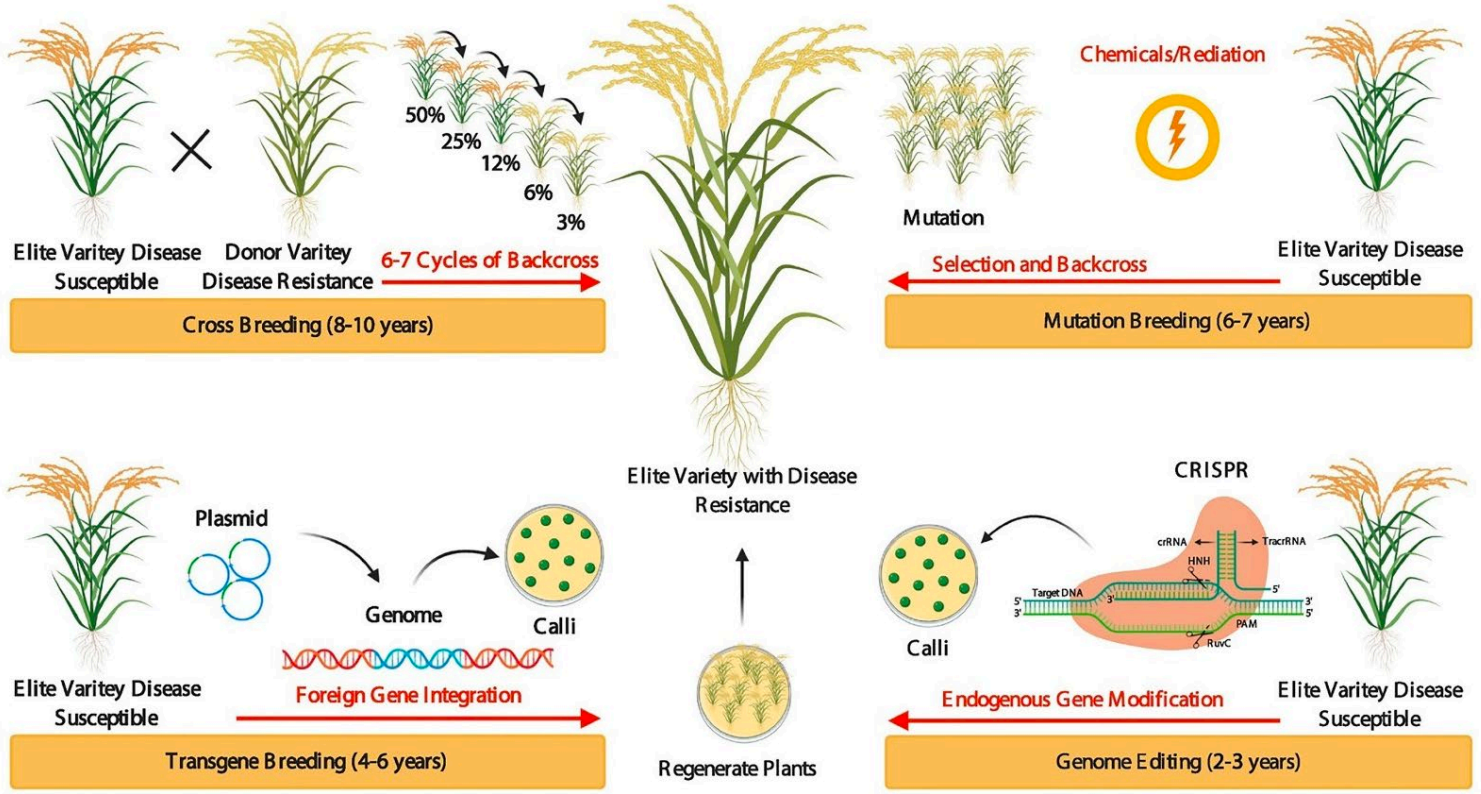


Genes **2024**, *15*, 1014. https://doi.org/10.3390/genes15081014

ADVANTAGES OF USING GENOME EDITING

- ✓ It can accelerate the delivery of improved varieties. Genes can be edited directly in elite breeding lines or commercial varieties, eliminating the need for backcrossing.

- ✓ This reduces the time needed to develop an improved variety and eliminates linkage drag caused by non-elite residual genes from the donor parent, which are impossible to eliminate by conventional backcross breeding.

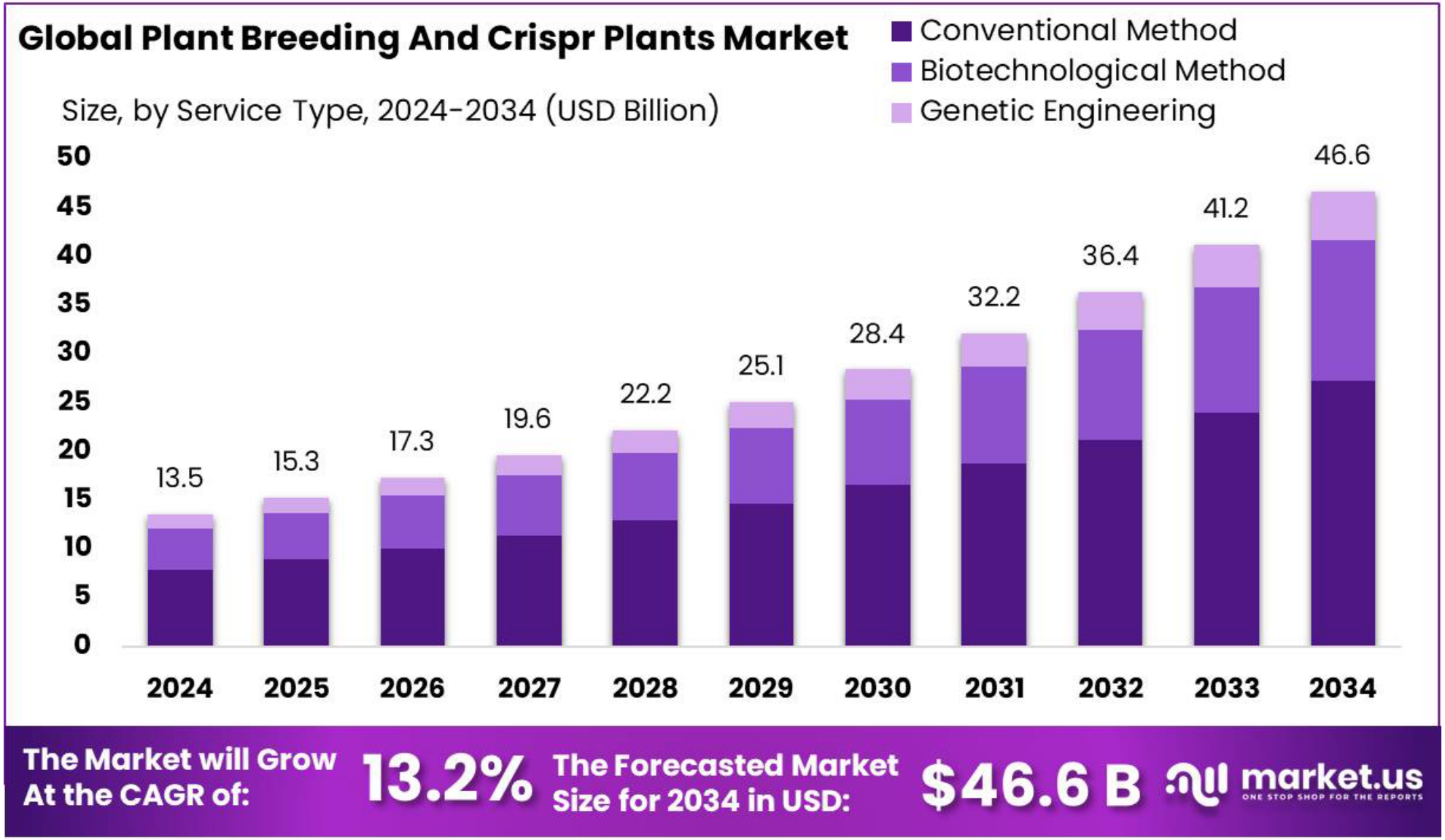


Wang et al, 2022. Cells, 11, 3928.

EXPECTATIONS FOR PLANT BREEDING AND GENOME EDITING ARE HIGH

- ✓ The significance of sustainable crop production and the lowering cost of genomic solutions are two factors that are anticipated to propel the plant breeding and CRISPR plants market´s development.

* Key role for food security and climate change adaption



GENOME EDITING ALLOW TO GET DIFFERENT TYPES OF PRODUCTS

*Methodological approaches used mostly until now

Genome editing

Gene disruption → SDN-1

Gene correction → SDN-2

These kind of modifications can occur spontaneously in nature or through conventional plant breeding (with no biotech)

DNA insertion → SDN-3 GMO

❖ May or may not:

- ➢ Involve the transitory introduction of foreign DNA sequences
- ➢ result in GMO
- ➢ generate products that substantially differ from varieties bred through conventional breeding.

*However, with biotechnology plant breeding gets:

- ✓ accuracy and avoids random
- ✓ no impacts on other traits

IMITATING ALL KINDS OF NATURAL MUTATIONS

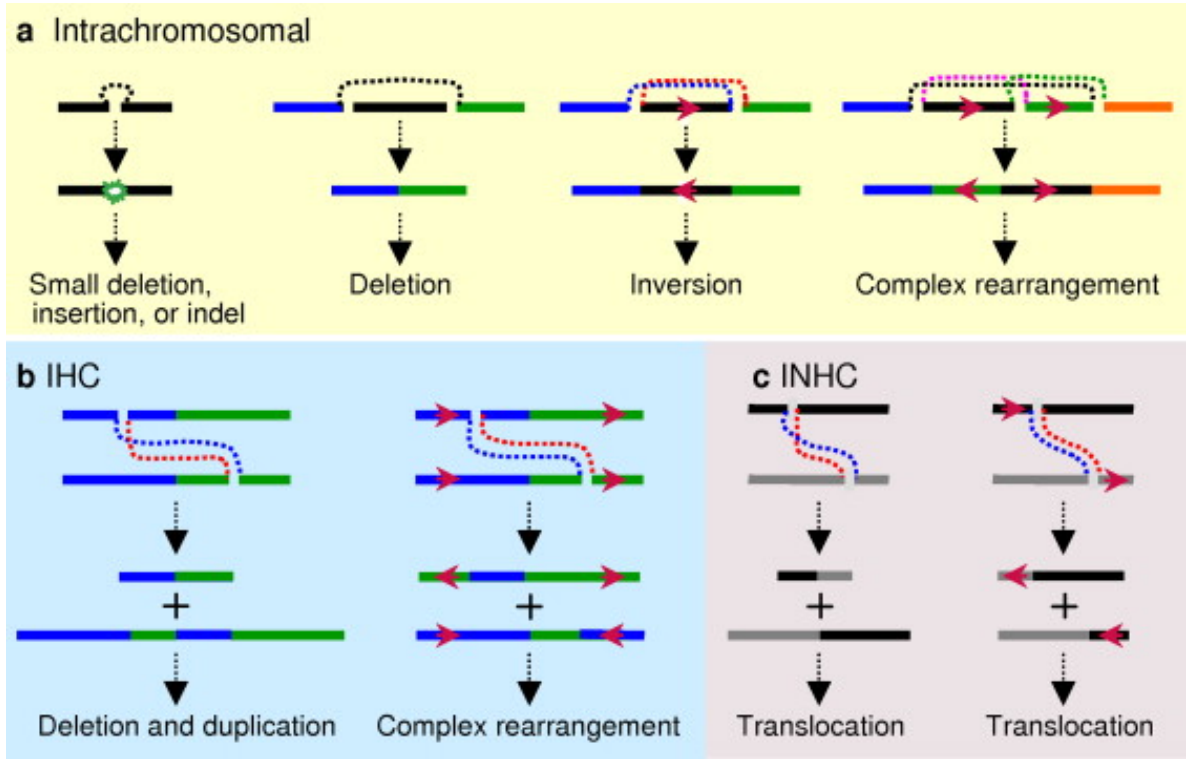
From gen inactivation and small edits to more natural complex rearrangements

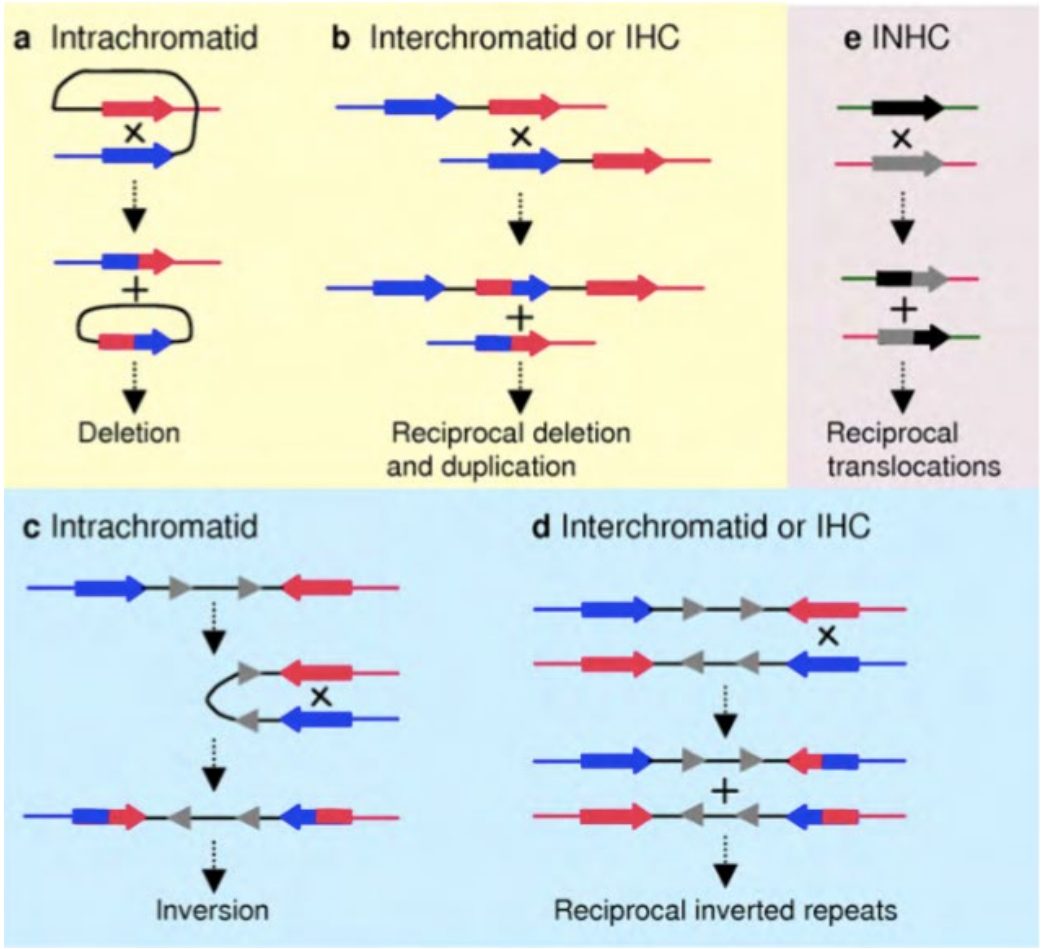
From
SDN1, SDN2

to

- ✓ Chromosomal changes (inversions, translocations, duplications)
- ✓ copy number variations
- ✓ epigenetic changes

Are regulatory frameworks prepared for this?





GENOME-EDITED PLANTS REGULATION

The vision: Genome edited plants regulated like conventional, not GMOs

The goal of PBI and genome editing
is to mimic genetic changes that occur spontaneously in nature.

Underlying Principle

"Plant varieties developed through the latest breeding methods **should not be differentially regulated** if they are similar or indistinguishable from varieties that could have been produced through earlier breeding methods or can be found in nature.

ISF International Seed Federation
Seed is Life

Plant Breeding Innovation Statement & Principles

PRINCIPLES

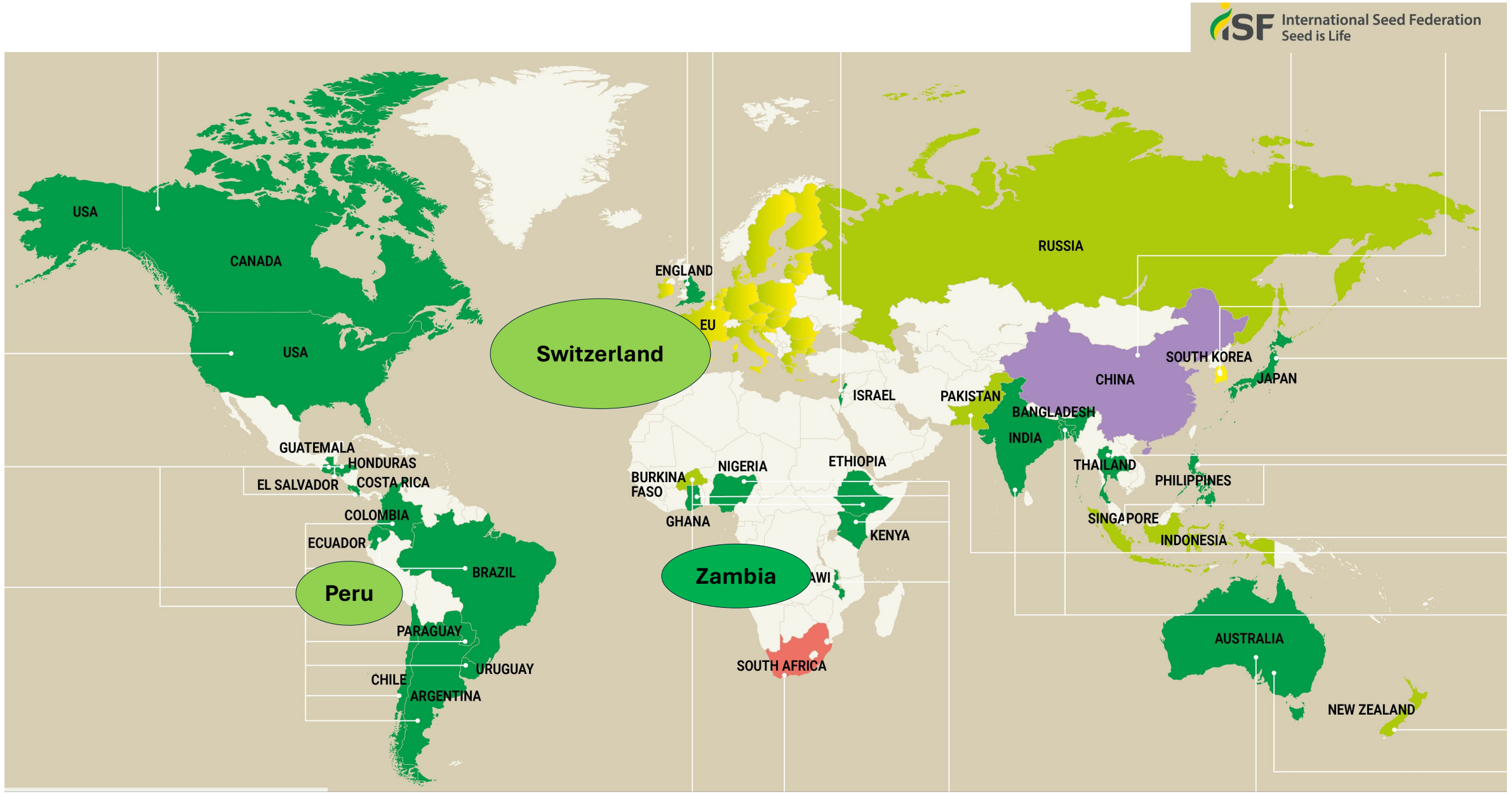
- Plant varieties developed through the latest breeding methods should not be differentially regulated if they are similar or indistinguishable from varieties that could be produced through established breeding methods.
- Plant breeders need legal certainty provided by government policies.
- Regulation should be grounded in sound scientific principles.
- Inappropriate regulation and associated costs will impede the utilization of innovative breeding methods.
- Government policies should facilitate innovation and utilization of advanced breeding applications by public and private plant breeders in developed and developing countries.
- Harmonized policies are essential for both research collaboration and trade.

1

November 2015

Like products should be treated the same under the law

POLICY DEVELOPMENTS AROUND THE WORLD (02/2025)



THE AMERICAS:
UNIFORM APPROACH WITH MANY SHARED PRINCIPLES

- Certain types of genome edited plants are exempted/excluded from GMO regs
  - "Could have" been developed through conventional breeding
  - No "foreign" DNA or "novel combinations" in the final product
  - Case-by-case review/confirmation
- Different regulatory systems and approaches can lead to inconsistent **outcomes**
- Regional and global regulatory compatibility is **very important** to support **seed/product movement**

LOCAL DEVELOPERS WORKING ON DIFFERENT CROPS AND ACCESSING REGULATORY SYSTEMS

Herbicide-tolerant sorghum

High-sucrose sugarcane

High-fiber wheat

Bacterial blight-resistant rice

Hemp that produces no THC or CBD

DESPITE MANY SHARED PRINCIPLES, NOTABLE DIFFERENCES AND CHALLENGES PERSIST

- Differences in information/data required for status determinations
- Differences in timeline and process for review (days to many months)
- Many countries DO NOT allow for consultation at early-stage development (at product conception stage)
- Lack of experience with more complex edits
- Narrow case-by-case determinations – need broader “unit of evaluation”

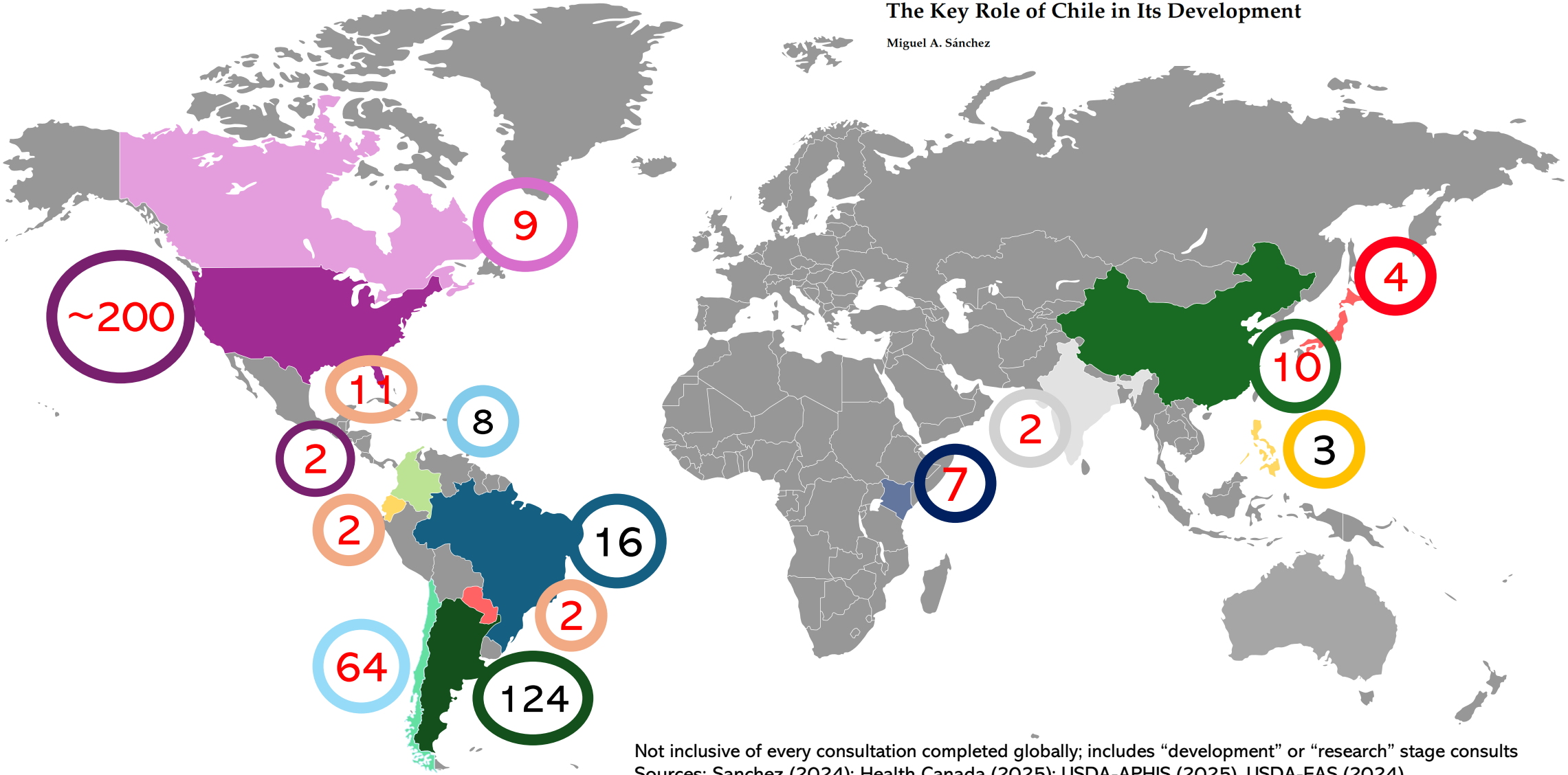
EDITED PLANTS GLOBALLY: CONSULTATIONS COMPLETED (CONSIDERED NON-GMO)

plants *Plants* **2024**, *13*, 3597. https://doi.org/10.3390/plants13243597 MDPI

Perspective

The Global Advance of Genome-Edited Plants to the Market: The Key Role of Chile in Its Development

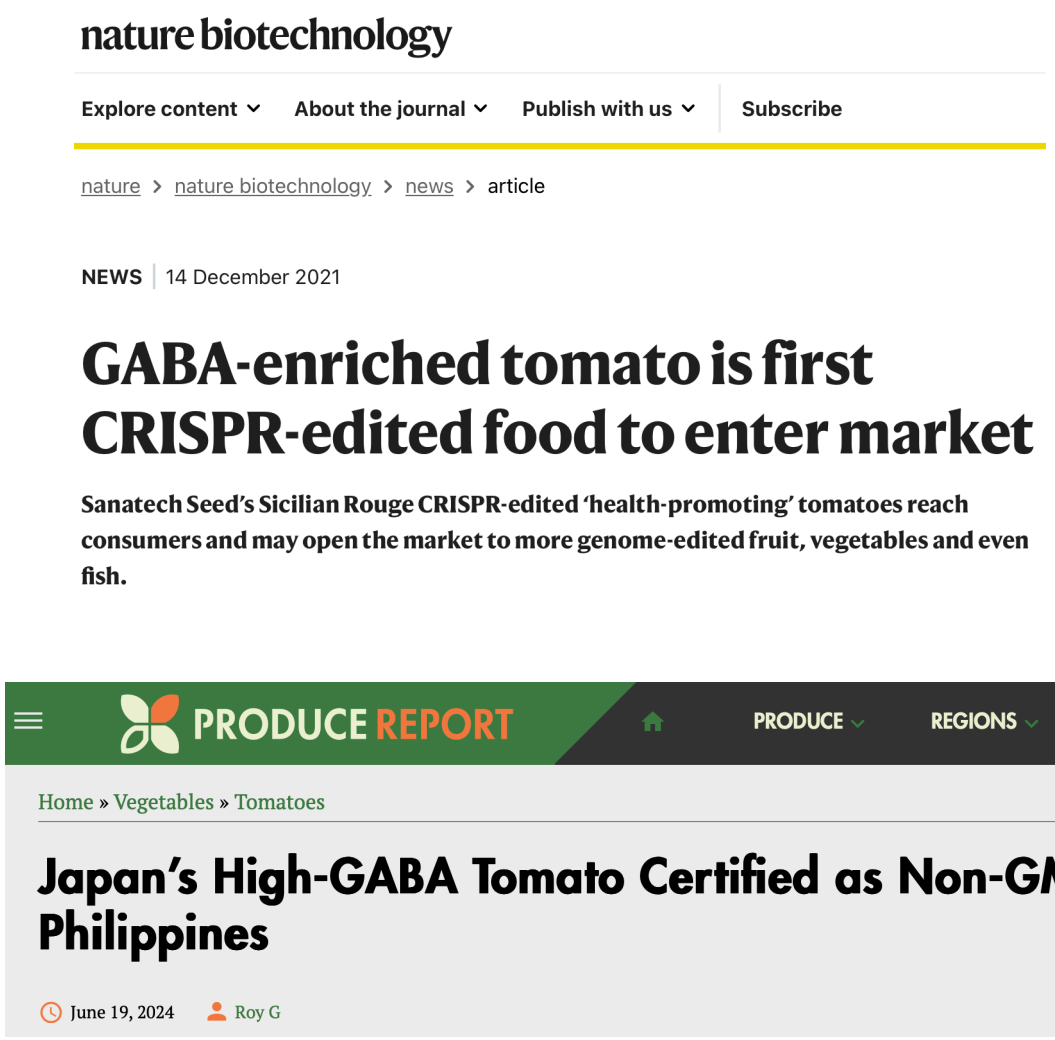
Miguel A. Sánchez



Not inclusive of every consultation completed globally; includes “development” or “research” stage consults
Sources: Sanchez (2024); Health Canada (2025); USDA-APHIS (2025), USDA-FAS (2024)

NEW GAME-CHANGING IDEAS

Consumer-centric traits



nature biotechnology

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nature > nature biotechnology > news > article

NEWS | 14 December 2021

GABA-enriched tomato is first CRISPR-edited food to enter market

Sanatech Seed's Sicilian Rouge CRISPR-edited 'health-promoting' tomatoes reach consumers and may open the market to more genome-edited fruit, vegetables and even fish.

PRODUCE REPORT

PRODUCE | REGIONS | TOPICS

Home » Vegetables » Tomatoes

Japan's High-GABA Tomato Certified as Non-GMO in Philippines

June 19, 2024 Roy G

LATES

- ✓ In 2021, Japan led the way with a genome-edited tomato that accumulates more GABA

NEW GAME-CHANGING IDEAS

Consumer-centric traits

- ✓ Mustard greens with better flavor (eliminated pungency), by knocking out all functional copies (17) of the type-I myrosinase multigene using CRISPR/Cas9.

- ✓ Mustard greens provide a greater amount of nutrients than other green salads (flavonoids, β-carotenes, lutein, vitamins A, C, E, K).

pairwise™

WIRED

NEWSLETTERS SUBSCRIBE

EMILY MULLIN SCIENCE MAY 31, 2024 11:55 AM

Gene-Edited Salad Greens Are Coming to US Stores This Fall

Biotech giant Bayer plans to distribute mustard greens that have been genetically altered to make them less bitter to grocery stores across the country.

BAYER

NEW GAME-CHANGING IDEAS

Consumer-centric traits

NewScientist

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Environment

Sweeter tomatoes are coming soon thanks to CRISPR gene editing

Selection for bigger tomatoes has made the fruits less sweet, but now it has been shown that gene editing can make them sweeter without decreasing yields

By Michael Le Page

13 November 2024

- ✓ Two genes deleted (SlCDPK27 and SlCDPK26) [they are involved in the breakdown of sugars].
- ✓ This resulted in fruits with up to 30% more glucose and fructose
- ✓ The gene-edited tomatoes maintain the same weight and productivity as current varieties

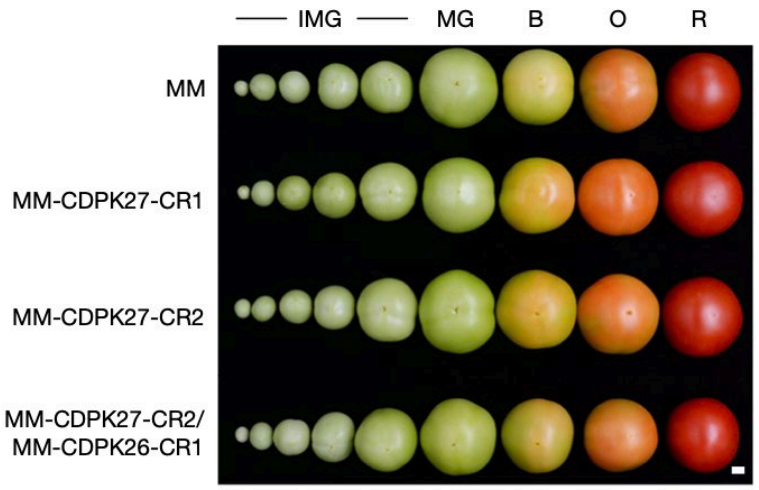
Article

Releasing a sugar brake generates sweeter tomato without yield penalty

https://doi.org/10.1038/s41586-024-08186-2
Received: 21 January 2024
Accepted: 9 October 2024
Published online: 13 November 2024
Open access
Check for updates

Jinzhe Zhang[1,12], Hongjun Lyu[2,3,12], Jie Chen[2,12], Xue Cao[4], Ran Du[2], Liang Ma[5], Nan Wang[2], Zhiguo Zhu[6], Jianglei Rao[2], Jie Wang[2], Kui Zhong[7], Yaqing Lyu[2], Yanling Wang[2], Tao Lin[8], Yao Zhou[9], Yongfeng Zhou[2], Guangtao Zhu[6], Zhangjun Fei[10], Harry Klee[2] & Sanwen Huang[2,11]✉

In tomato, sugar content is highly correlated with consumer preferences, with most consumers preferring sweeter fruit[1–4]. However, the sugar content of commercial varieties is generally low, as it is inversely correlated with fruit size, and growers prioritize yield over flavour quality[5–7]. Here we identified two genes, tomato (*Solanum lycopersicum*) *calcium-dependent protein kinase 27* (Sl*CDPK27*; also known as Sl*CPK27*) and its paralogue Sl*CDPK26*, that control fruit sugar content. They act as sugar brakes by phosphorylating a sucrose synthase, which promotes degradation of the sucrose synthase. Gene-edited Sl*CDPK27* and Sl*CDPK26* knockouts increased glucose and fructose contents by up to 30%, enhancing perceived sweetness without fruit weight or yield penalty. Although there are fewer, lighter seeds in the mutants, they exhibit normal germination. Together, these findings provide insight into the regulatory mechanisms controlling fruit sugar accumulation in tomato and offer opportunities to increase sugar content in large-fruited cultivars without sacrificing size and yield.



NEW GAME-CHANGING IDEAS

Consumer-centric traits

pairwise®

Pairwise Develops First Seedless Blackberry with Transformative CRISPR Technology

First caneberry trait of its kind, achieved in concert with thornless and compact traits to deliver enormous benefits to consumers, growers, and the environment

June 04, 2024 07:52 ET | Source: Pairwise

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NEW GAME-CHANGING IDEAS

Consumer-centric traits

- ✓ GreenVenus LLC uses CRISPR gene editing to develop sulfite-free wines by removing browning-causing enzymes in grapes, which also helps preserve color and flavor without requiring additional sulfites.

- ✓ GreenVenus' new Colombard and Malbec grape varieties are currently available for planting to growers and winemakers through licensing agreements. In addition, the company will complete gene editing on Chardonnay, Sauvignon Blanc, Grenache and Gruner Veltliner later this year and Cabernet Sauvignon, Cabernet Franc, Pinot Noir and Zinfandel by this time next year.

NEW GAME-CHANGING IDEAS

De novo domestication

- Instead of introgressing traits from wild relatives (slow and complex), take a rugged wild species and edit a handful of genes to domesticate it quickly (architecture, cycle length, fruit size).

- It was demonstrated in wild tomato and is now explored in “orphan” crops like teff and quinoa.

ANNUAL REVIEWS

Annual Review of Plant Biology

The Power and Perils of De Novo Domestication Using Genome Editing

ELSEVIER

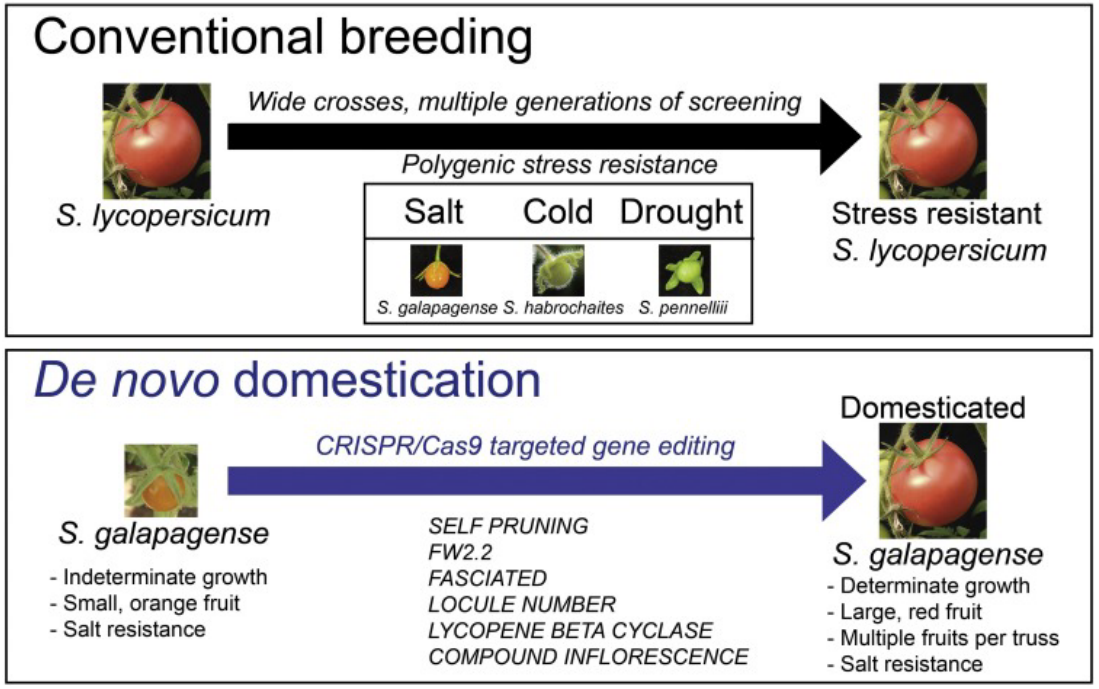
Plant Science

Volume 256, March 2017, Pages 120-130

Review article

Genome editing as a tool to achieve the crop ideotype and *de novo* domestication of wild relatives: Case study in tomato

Agustin Zsögön [a 1], Tomas Cermak [b 1], Dan Voytas [b], Lázaro Eustáquio Pereira Peres [c]



REDUCE FOOD WASTE

Extending the shelf life of some foods

- ✓ Lettuce with delayed oxidation, by editing 5 PPO genes using CRISPR/Cas9
- ✓ Post-harvest shelf life increased from 7-14 days to 21-28 days when stored refrigerated.
- ✓ Gene edited romaine lettuce seeds (non-browning) are now being sold to home gardeners

GreenVenus™

The Guardian Int

Gene-edited non-browning banana could cut food waste, scientists say

Fruit variety developed in Norwich remains fresh for up to 12 hours after being peeled

The biotech company Tropic has also developed a slow-ripening banana. Photograph: Grandbrothers/Alamy

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Philippines clears gene-edited bananas promising significant food waste reduction

Published July 4, 2024

REAL AGRONOMIC IMPACT: FEWER LOSSES, FEWER INPUTS

Editing is also targeting plant disease resistance and abiotic stress tolerance.

In 2025, India announced two edited rice varieties (DRR Dhan 100 “Kamala” and Pusa DST Rice 1) with higher yield and tolerance to drought and salinity.

nature india

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NEWS | 04 May 2025

India approves first genome-edited rice varieties

Using CRISPR-Cas9, scientists have developed high-yield, stress-tolerant, climate-resilient rice varieties free of foreign DNA

Agriculture minister Shivraj Singh Chouhan releasing the CRISPR-Cas9 edited rice varieties. C
PIB

It’s a double milestone: scientific (precise edits without external DNA) and regulatory (India has SDN-1/2 guidelines in place since 2022).

REAL AGRONOMIC IMPACT: FEWER LOSSES, FEWER INPUTS

nature

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NEWS | 25 January 2024

CRISPR-edited crops break new ground in Africa

Scientists in the global south use the popular technique to protect local crops against local threats.

Kenya: Gene hacker moves to defeat Striga

July 1, 2022 by IAPPS

Kenyan gene hacker moves to defeat witchweed

Prof Steven Runo has edited the DNA of sorghum to give it resistance to the notorious, parasitic weed

REAL AGRONOMIC IMPACT: PRODUCTIVITY

FreshFruitPortal.com

U.S. market could soon get first gene-edited strawberry

November 11 , 2021

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Simplot PLANT SCIENCES

“In December 2024, Simplot stated its intention to start selling a gene-edited strawberry in Canada as soon as 2025, gene-edited for a longer harvest season (remontant)”.

The Canadian Biotechnology Action Network

POTATOBUSINESS
supporting the potato industry worldwide

JAPAN: GREEN LIGHT FOR J.R. SIMPLOT'S CRISPR-CAS9 EDITED HIGH TUBER SET POTATO

BY POTATO BUSINESS / 26TH MARCH 2025

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REAL AGRONOMIC IMPACT: PRODUCTIVITY

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Ohalo™ Announces FruitionOne™: The World's First Self-Fertile Nonpareil Almond Variety

NEWS PROVIDED BY
Ohalo Genetics, Inc →
Oct 28, 2024, 18:02 ET

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Gene editing behind two new self-pollinating Nonpareils

"After four years of dedicated research and development, Ohalo is proud to announce completion of its USDA Regulatory Status Review process for FruitionOne with availability for early orders in late 2026 and first commercial deliveries beginning in 2027. The first FruitionOne trial orchard plantings are underway in California."

- reduction or loss of function of the enzyme that functions as the pistil-associated self-incompatibility factor, and/or reduction or loss of the pollen-associated self-compatibility factor.

THE NEAR-TERM PROMISE AND TRADE CHALLENGES

✓ Genome editing is a reality in plant breeding and global agriculture.

✓ It can become a tangible ally against climate change, food waste, and production costs delivering benefits for farmers, consumers, and the environment

- **Regulatory trend internationally – generally aligned that genome edited products treated distinct from GMOs**
  - Must be considered conventional products not as a specific category
- **Path to market – Challenges remain**
  - Regulatory schemes in major markets still TBD (EU, Mexico, S. Korea, China?)
  - Differences in implementation/data requirement
  - Differences in timeline for status evaluations (days to many months)
  - Adaptation to new methodological approaches
- **Post market requirements**
  - Labeling
- **Intellectual property**
  - Technology vs varieties

COMMUNICATION IS KEY TO AVOID MISTAKES OF THE PAST

Market acceptance and public perception

Although “editing” isn’t the same as “transgenesis,” public conversation still mixes concepts. Products with visible benefits (better flavor, more fiber, less waste) are key to building trust.

- ✓ Precise consistent use of accurate terminology to transparently explain the process, products, benefits and potential risks and mitigation strategies is essential to build public trust and consistent regulatory oversight of genome editing.

ChileBio
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PBI at a glance
&
updates related to our business

October 1, 2025

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