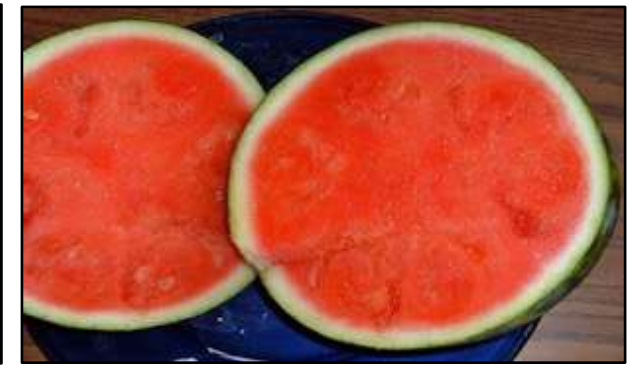
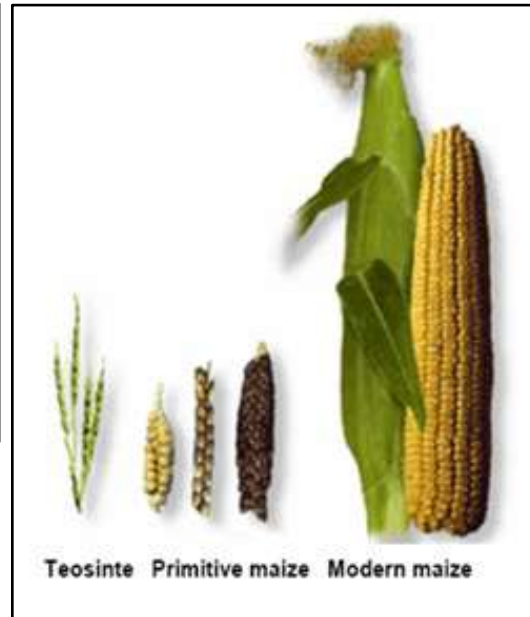
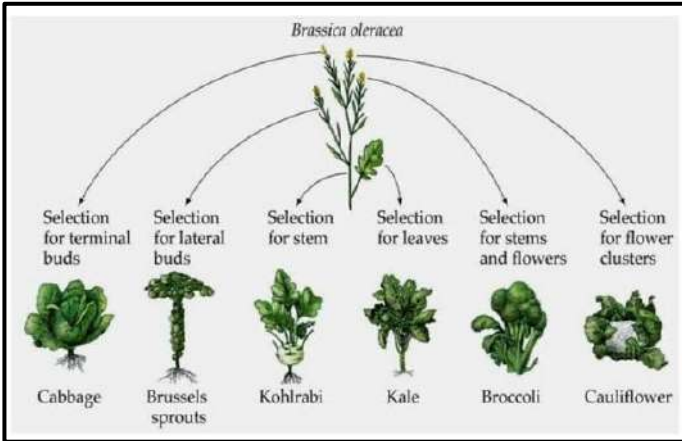


What are these NGTs?

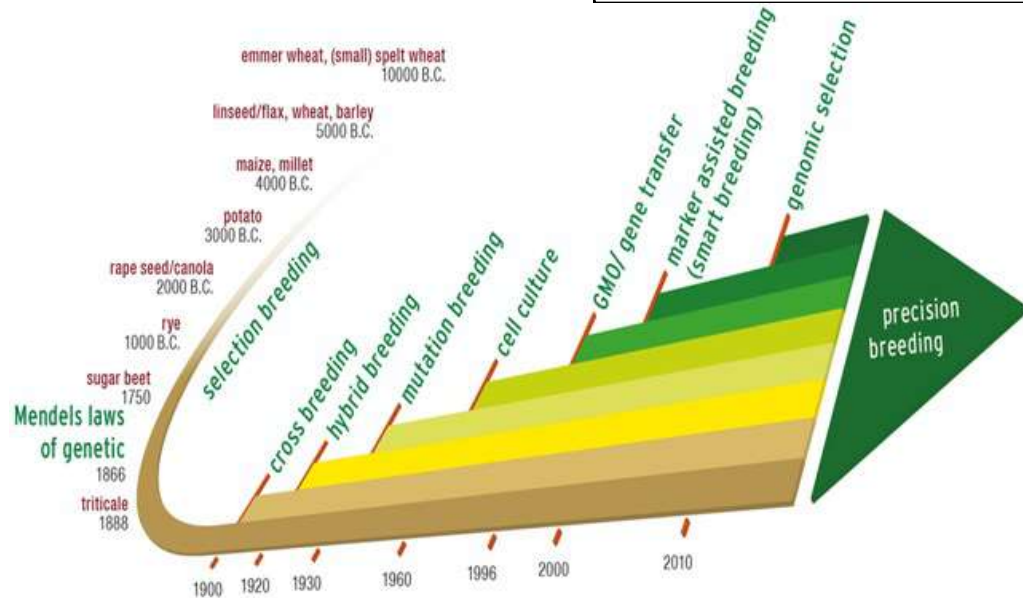
Oana Dima



Everything we eat is the result of plant breeding



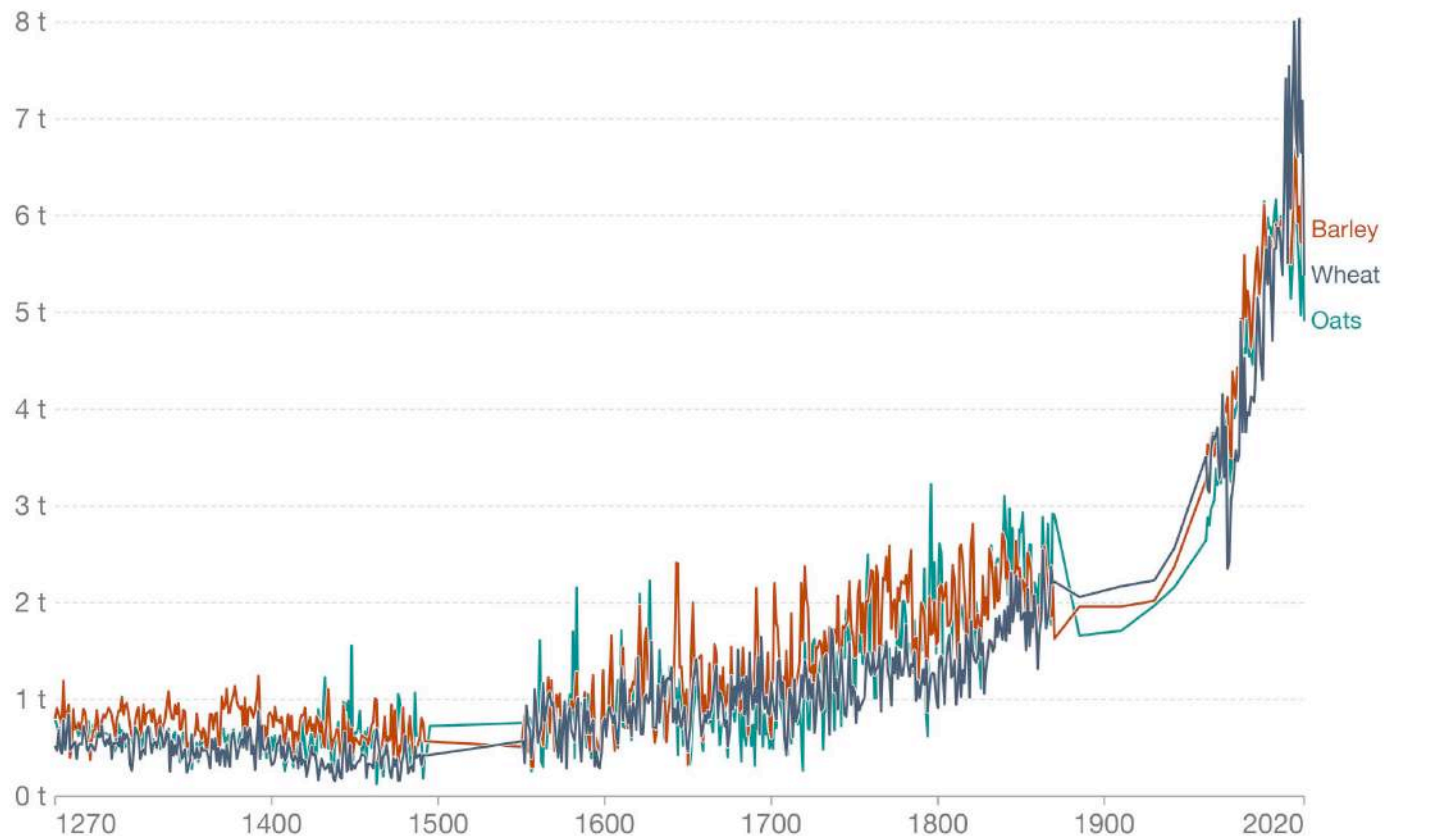
Milestones in Plant Breeding



Knowledge of genetics was key to unlocking genetic potential

Cereal yields in the United Kingdom

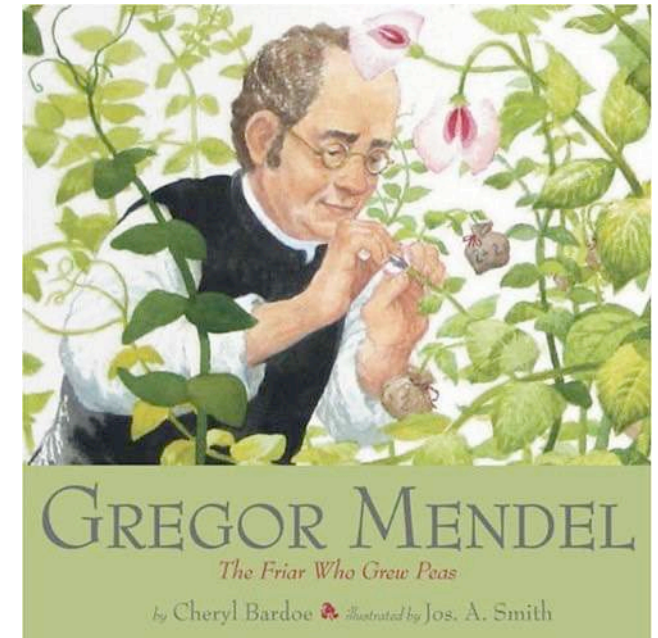
Crop yields are measured in tonnes per hectare.



Source: Broadberry et al. (2015) and Food and Agriculture Organization of the United Nations

OurWorldInData.org/crop-yields • CC BY

Rediscovery of Mendel's findings in 1900 (from 1865)
Breeding becomes a science

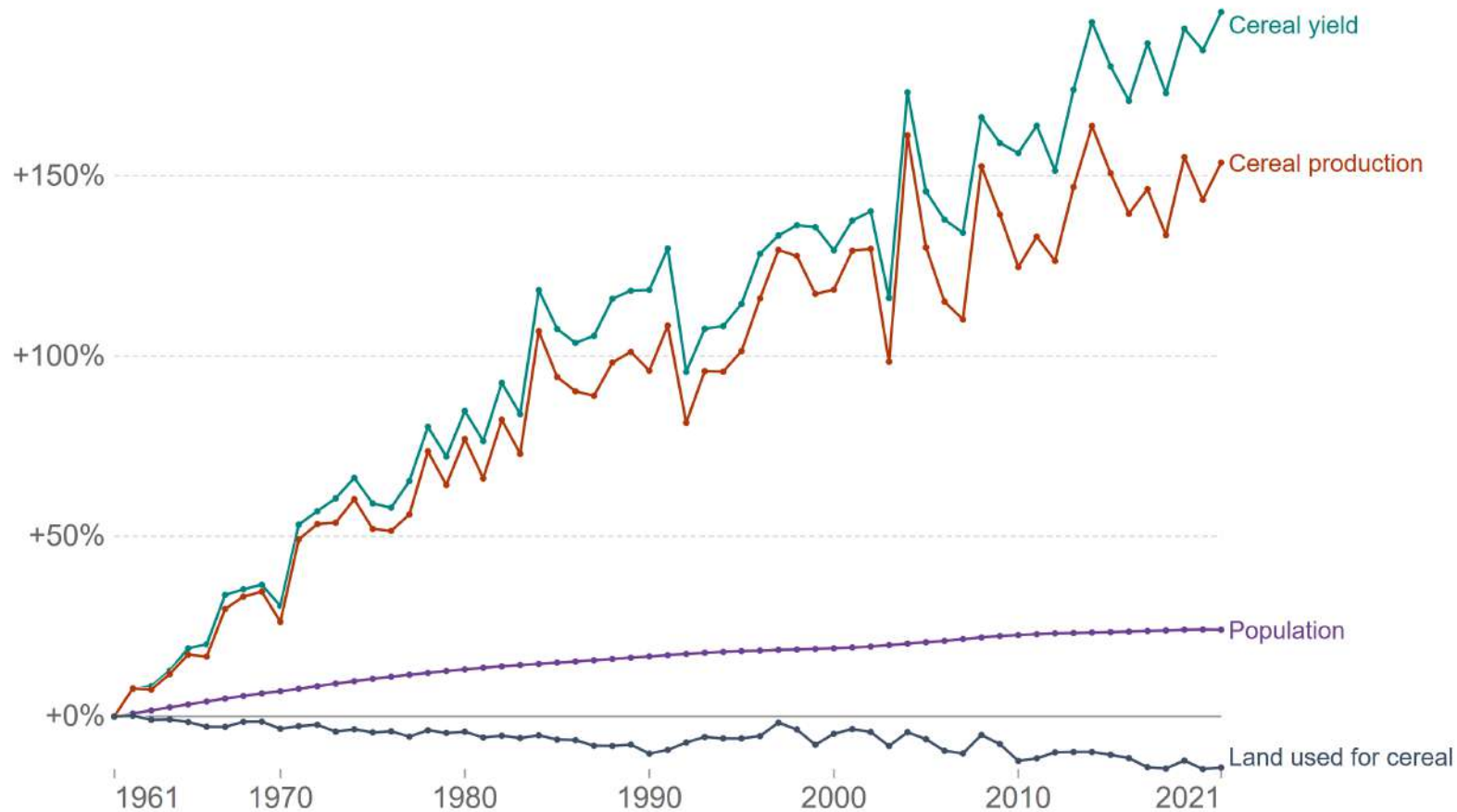


Knowledge of genetics was key to unlocking genetic potential

Change in cereal production, yield, land use and population, European Union (27)

Our World
in Data

All figures are indexed to the start year of the timeline. This means the first year of the time-series is given the value zero.



In the past two decades,
plant breeding alone has
contributed to

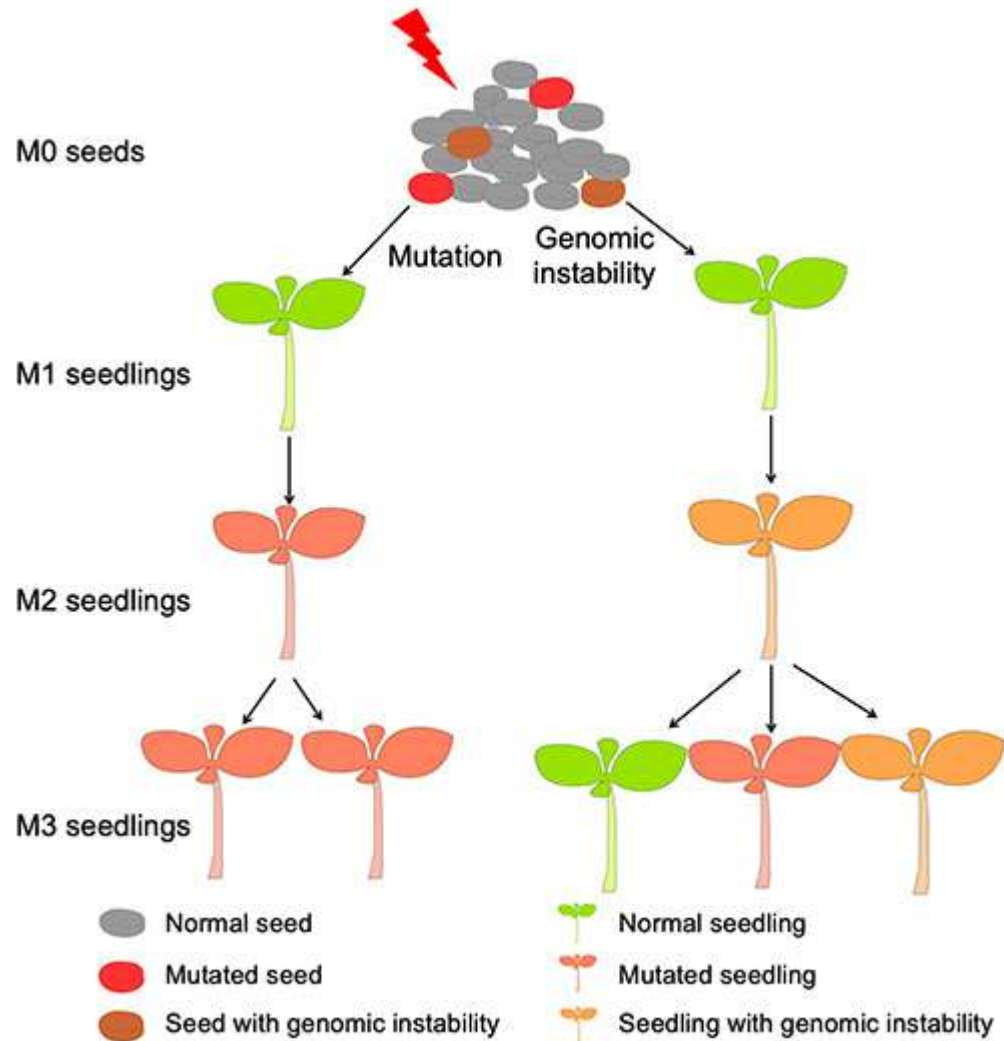
**~67% increase of crop
production***

in the EU, ensuring a stable
supply of food and feed for
the EU and beyond, while
reducing the need for
agricultural land

Spontaneous mutations were for a long time the only source of variability

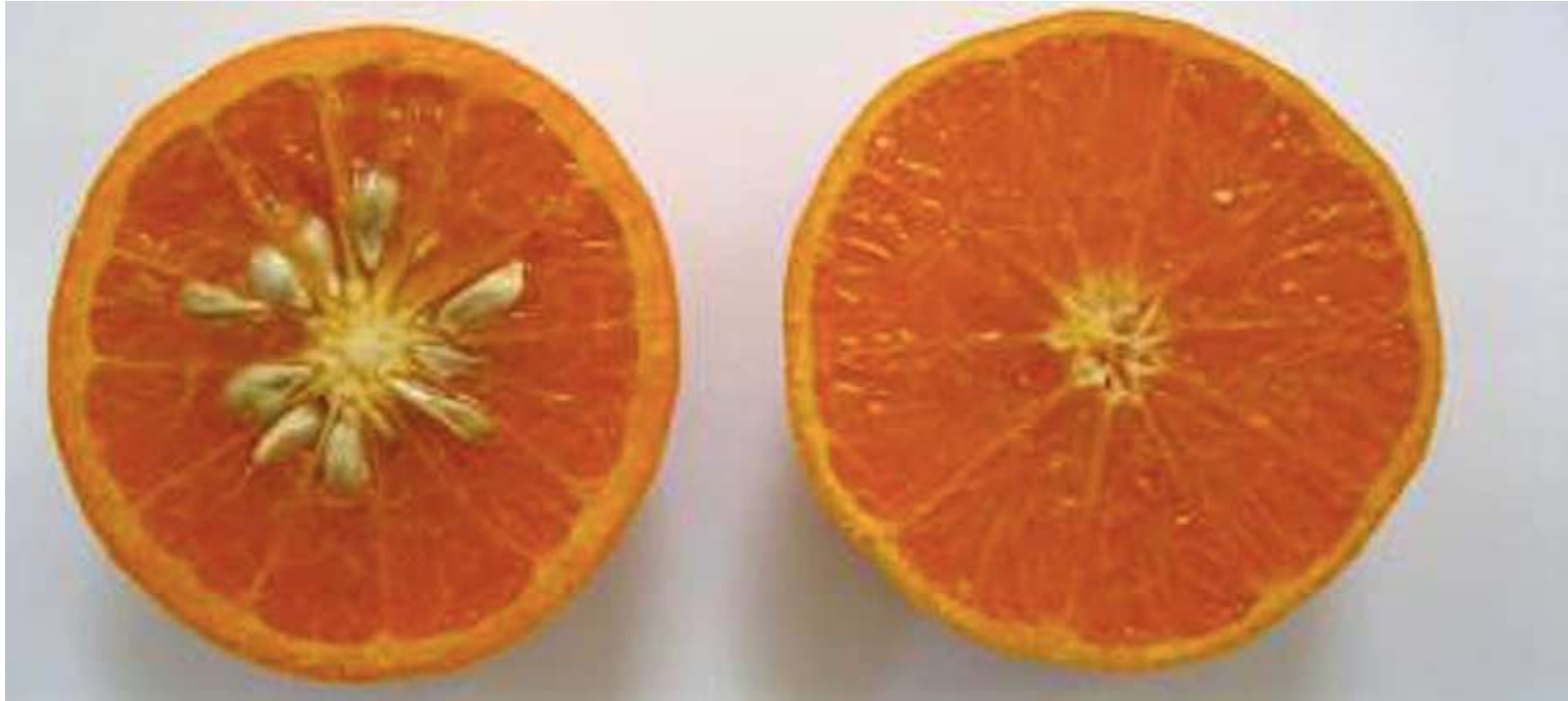


Increasing the mutation frequency by chemicals or irradiation



Non-targeted mutations

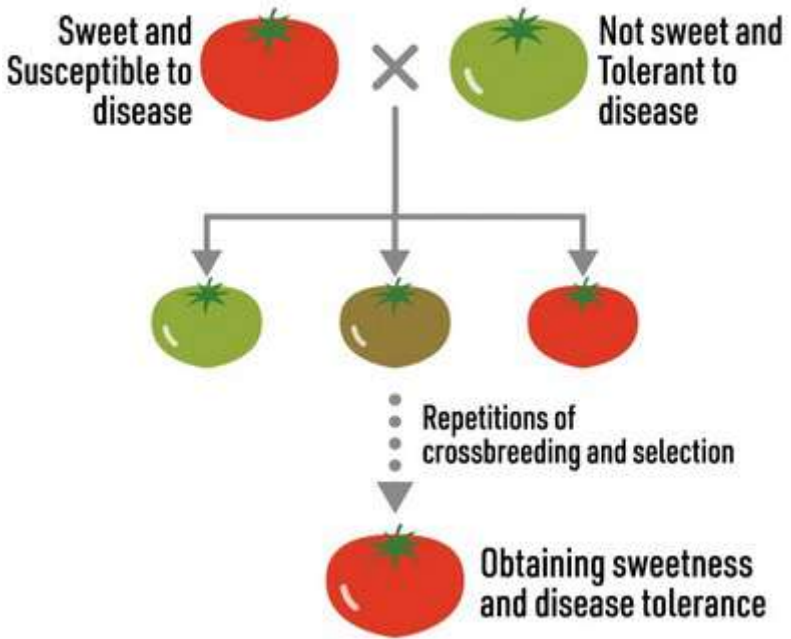
Increasing the mutation frequency by chemicals or irradiation



- More than 3,200 mutant varieties – including numerous crops, ornamentals and trees – have officially been released for commercial use in more than 210 plant species from over 70 countries (Source: [FAO/IAEA Mutant Varieties Database](#))

Variation in the genetic blue print is the basis of plant breeding

Conventional Breeding



Random mutations
Non-targeted

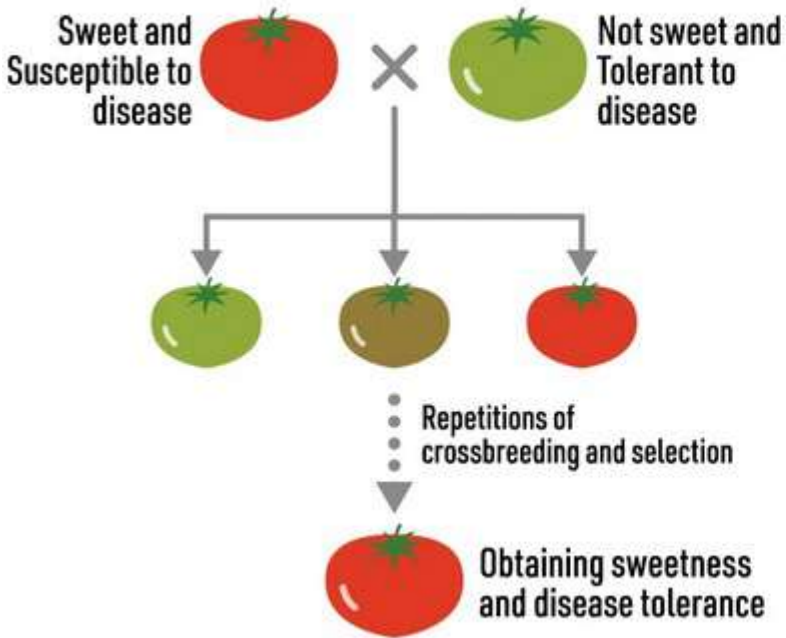
Conventional breeding has served mankind but ...



- Requires a lot of time (7-25 year)
- Non-targeted: based on co-incidence: searching for a needle in a haystack
- Not applicable for a number of plants (eg. grapes, trees,...)
- Often difficult to separate positive and negative traits
- Requires vast investments despite the use of molecular markers

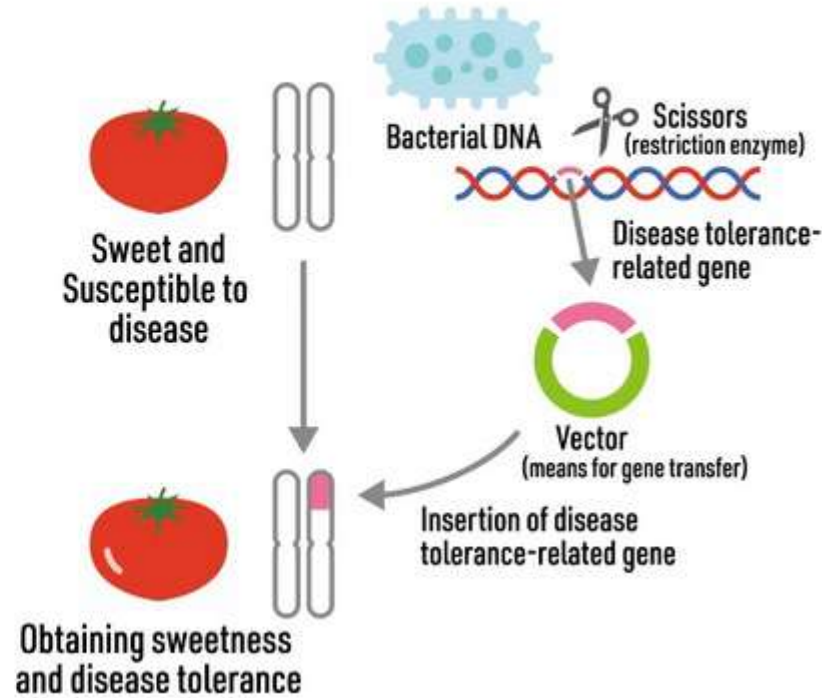
Variation in the genetic blue print is the basis of plant breeding

Conventional Breeding



Non-targeted

Genetic Modification

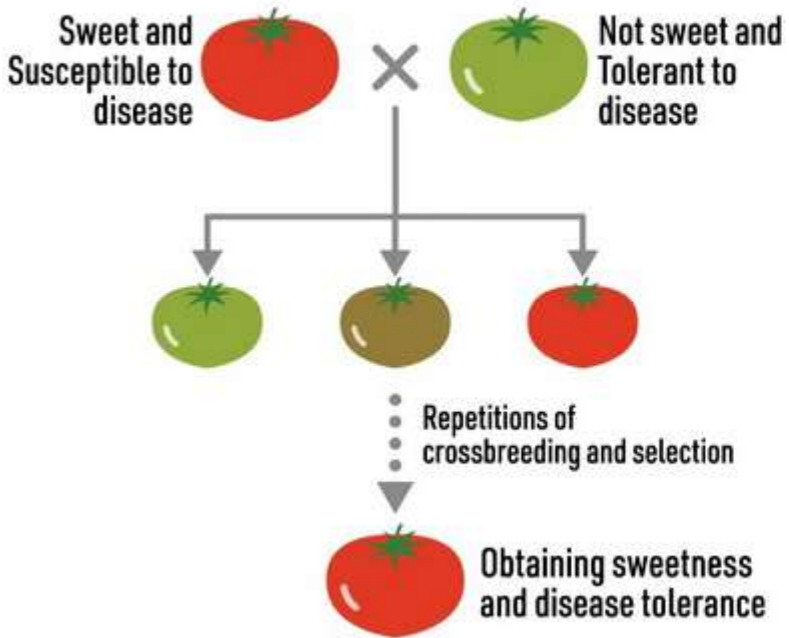


GMO

Contains 'foreign' DNA

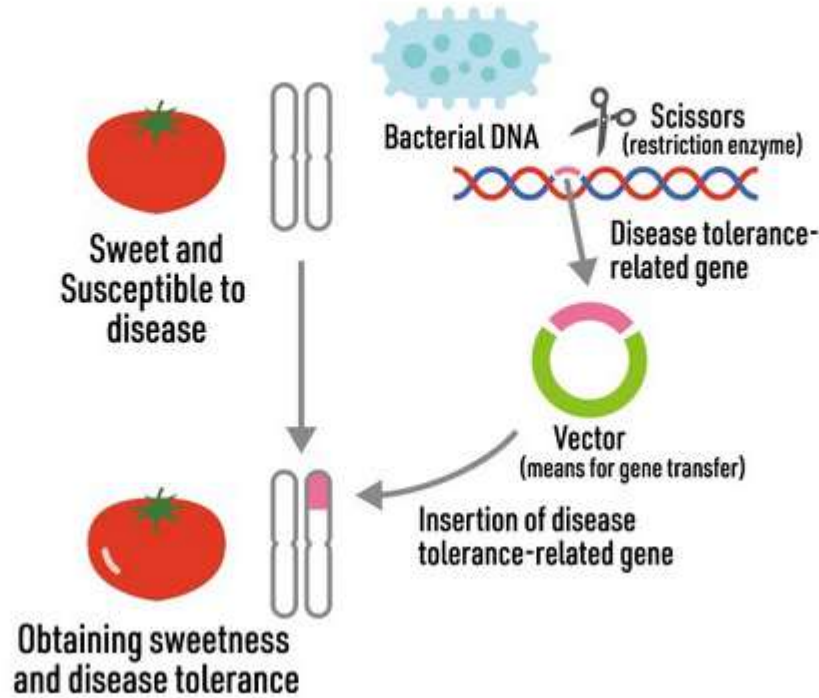
Variation in the genetic blue print is the basis of plant breeding

Conventional Breeding



Non-targeted

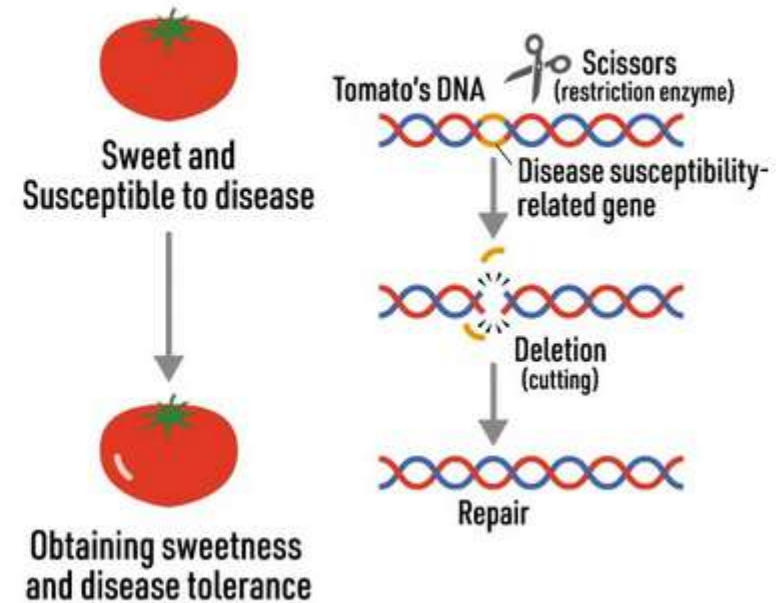
Genetic Modification



GMO

Contains 'foreign' DNA

Gene Editing



CRISPR-Cas

Does not contain
'foreign' DNA

2012

Precision breeding of crops using gene editing



Emmanuelle
Charpentier

Jennifer A.
Doudna

2020 Nobel Prize

- Very efficient (2 - 7 year)
- Very precise: targeted changes
- Cheap and easy
- Improved varieties can not be distinguished from varieties obtained by conventional breeding
(no DNA from unrelated species)
- Can rely on an overwhelming knowledge on plant genes and genomes
- Increasing agrobiodiversity -> from elite commercial varieties to improving low acreage varieties of regional and cultural relevance
- Specific contributions to sustainability incl. the time and resource benefits of using NGTs vs conventional breeding

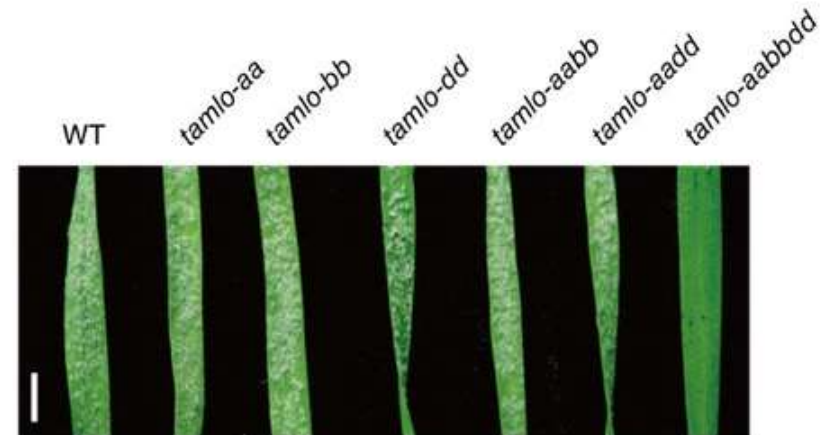
NGT applications in crops: examples

WHEAT RESISTANT TO POWDERY MILDEW

Using genome-editing breeders made this wheat variety more **resistant to powdery mildew**. Farmers using this kind of wheat obtain **higher yields**.



- Inactivation of six MLO susceptibility genes in wheat results in disease tolerance



- Reduction of breeding time to 3-4 years vs 10-15 years by conventional breeding; directly in modern varieties, no trade offs

NGT applications in crops: examples

POTATO VARIETY WITH LESS BROWNING

A genome-edited potato variety was developed containing undetectable levels of reducing sugars.

Chips and French fries made from these potatoes are **healthier and look better**.



BETTER TASTING YELLOW PEAS

Genome editing was successfully deployed to **slash levels of bitter-tasting saponins** in yellow peas.



MULTIPURPOSE PENNYGRASS

With genome editing, this penny grass was developed into a cover crop that can be used outside of cropping seasons. It is used to **protect soil and control carbon loss**.



BROCCOLI WITH HIGHER NUTRITIONAL VALUE

Broccoli contains **substances which help prevent a variety of chronic diseases**. Researchers used CRISPR to develop a variety of broccoli with **even more of these beneficial substances**.



LETTUCE WITH HIGHER VITAMIN CONTENT

This genome-edited lettuce variety contains more vitamin C which makes this kind of lettuce **extra healthy**.



GRAPEVINE HIGHLY RESISTANT TO FUNGUS

This specific genome-edited grapevine variety is highly resistant to fungus. Farmers that plant this grapevine need to use **less fungicides**.



MORE TOLERANT RICE

Using CRISPR, researchers developed a semidwarf type of rice.

This variety shows **better tolerance of low-nutrient conditions** and **higher resistance to pathogens and insects**.



HIGH-OLEIC SOYBEAN

This species of genome-edited soybean contain more omega-9 fatty acids, less saturated fatty acids, and no trans fats. This **aids to reduce coronary heart disease**.



NGT is applied on large scale



European Sustainable Agriculture
Through Genome Editing

HOME ABOUT OUR NETWORK DATABASE NEWS JOIN CONTACT

TRAITS CATEGORIES

- Traits related to biotic stress tolerance (16)
- Traits related to abiotic stress tolerance (69)
- Traits related to improved food/feed quality (179)
- Traits related to increased plant yield and growth (184)
- Traits related to industrial utilization (107)
- Traits related to herbicide tolerance (57)
- Traits related to product color/flavour (49)
- Traits related to storage performance (21)

GENOME EDITING TECHNIQUE

- CRISPR/Cas (752)
- TALENs (30)
- BE (26)
- ZFN (7)
- ODM (6)
- PE (4)

COUNTRIES

- China (468)
- USA (171)

Displaying 826 results

Traits related to biotic stress tolerance

Highly significant reduction in susceptibility to fire blight, caused by the bacterium *Erwinia amylovora*. Apple is one of the most cultivated fruit crops throughout the temperate regions of the world. (Pompili et al., 2020)

SDNI
CRISPR/Cas
Università degli Studi di Udine
Fondazione Edmund Mach, Italy

READ MORE

Viral resistance: Enhanced resistance to sweet potato virus disease (SPVD). SPVD is caused by the co-infection of sweet potato chlorotic stunt virus (SPCSV) and sweet potato feathery mottle virus. (Yu et al., 2021)

SDNI
CRISPR/Cas
Jiangsu Normal University
Jiangsu Academy of Agricultural Sciences
Xuzhou Institute of Agricultural Sciences in Jiangsu Xuhuai District, China

READ MORE

Fungal resistance: enhanced resistance to *Phytophthora infestans*.

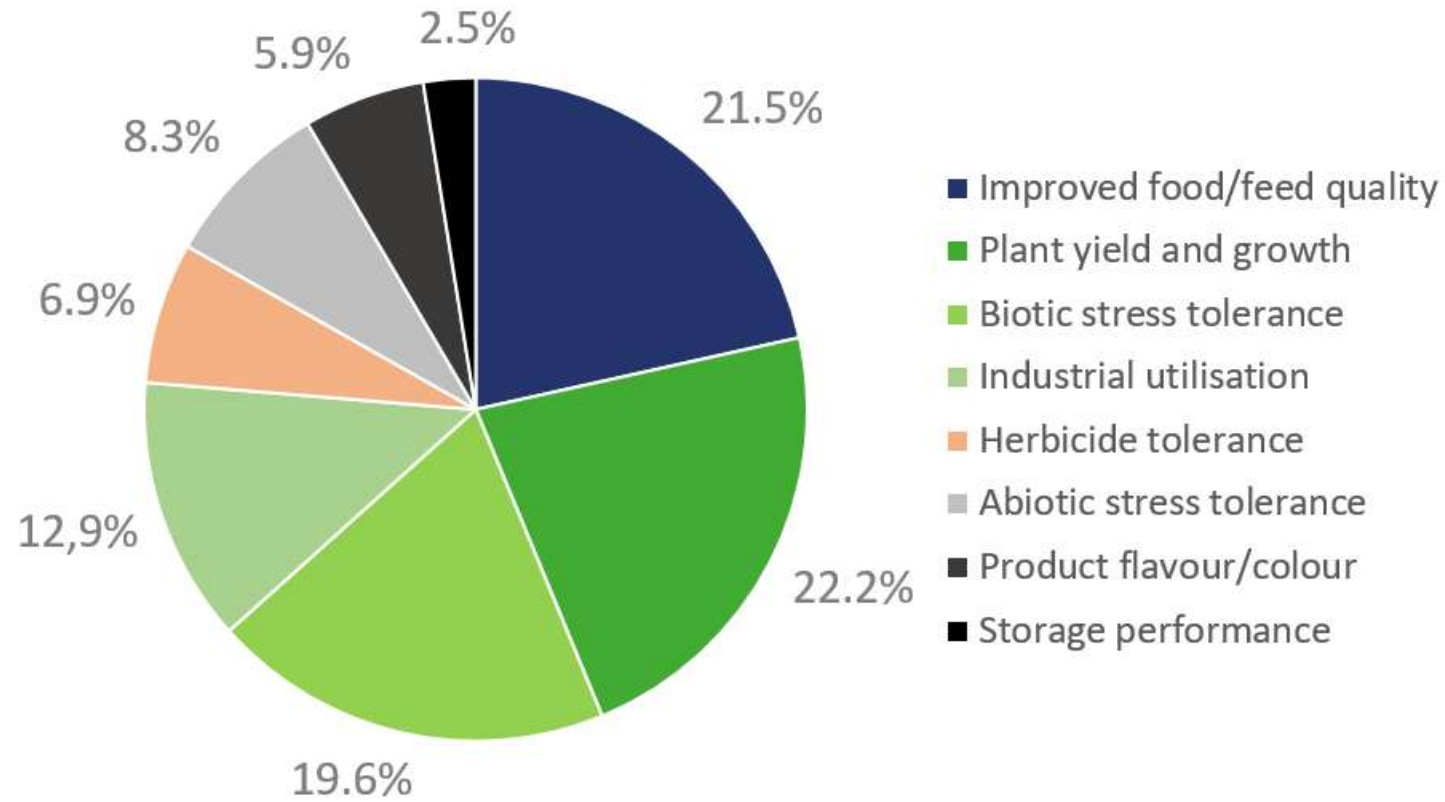
SDNI
CRISPR/Cas
Dalian University of Technology

READ MORE

www.eu-sage.eu/genome-search

- > 800 peer reviewed publications on gene editing in **crops**
- > 70 different crops species
- Mostly category 1-“conventional-like”- applications
- High diversity of applications with benefits for the producer and the consumer

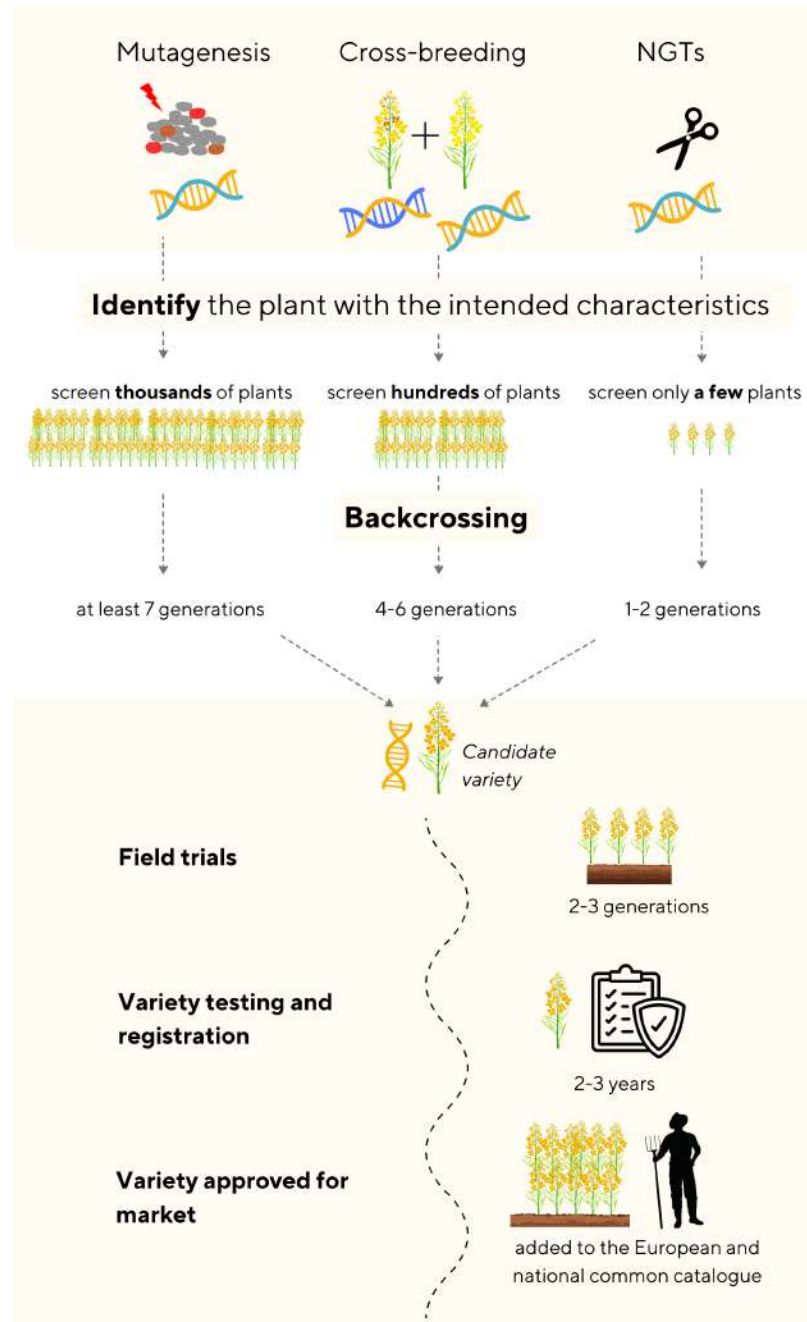
High diversity of applications




N 826

70 different species

The process of bringing new varieties on the market





The legislation and its' implementation will determine if and how NGTs will be used in shaping our future agri-food systems

If the **future** could whisper, it would call out for

CRISPR

eusage
European Sustainable Agriculture
Through Genome Editing

Thank you

oana.dima@vib.be

