REIMAGINE PLANET RIE

The role of the new breeding techniques in European agriculture

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The OECD Co-operative Research Programme: Sustainable Agricultural and Food Systems

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Global Conference on
Sustainability in Agriculture & Food Systems
Innovation, Indicators & Implementation

Did you know

that there are already more than 700 different genome-editing applications in crops published in peer-reviewed research studies?

HAVE A LOOK AT THE DATABASE:
www.eu-sage.eu/index.php/genome-search
or just scan the QR-code:

EU-SAGE DEVELOPED AN INTERACTIVE, REGULARLY UPDATED, PUBLICLY ACCESSIBLE ONLINE DATABASE OF GENOME-EDITED CROPS

European Commission

Organisms obtained by new mutagenesis techniques that have appeared or have been mostly developed since the adoption of Directive 2001/18 are GMOs and subject to the provisions of the GMO legislation

European Commission

Food Safety

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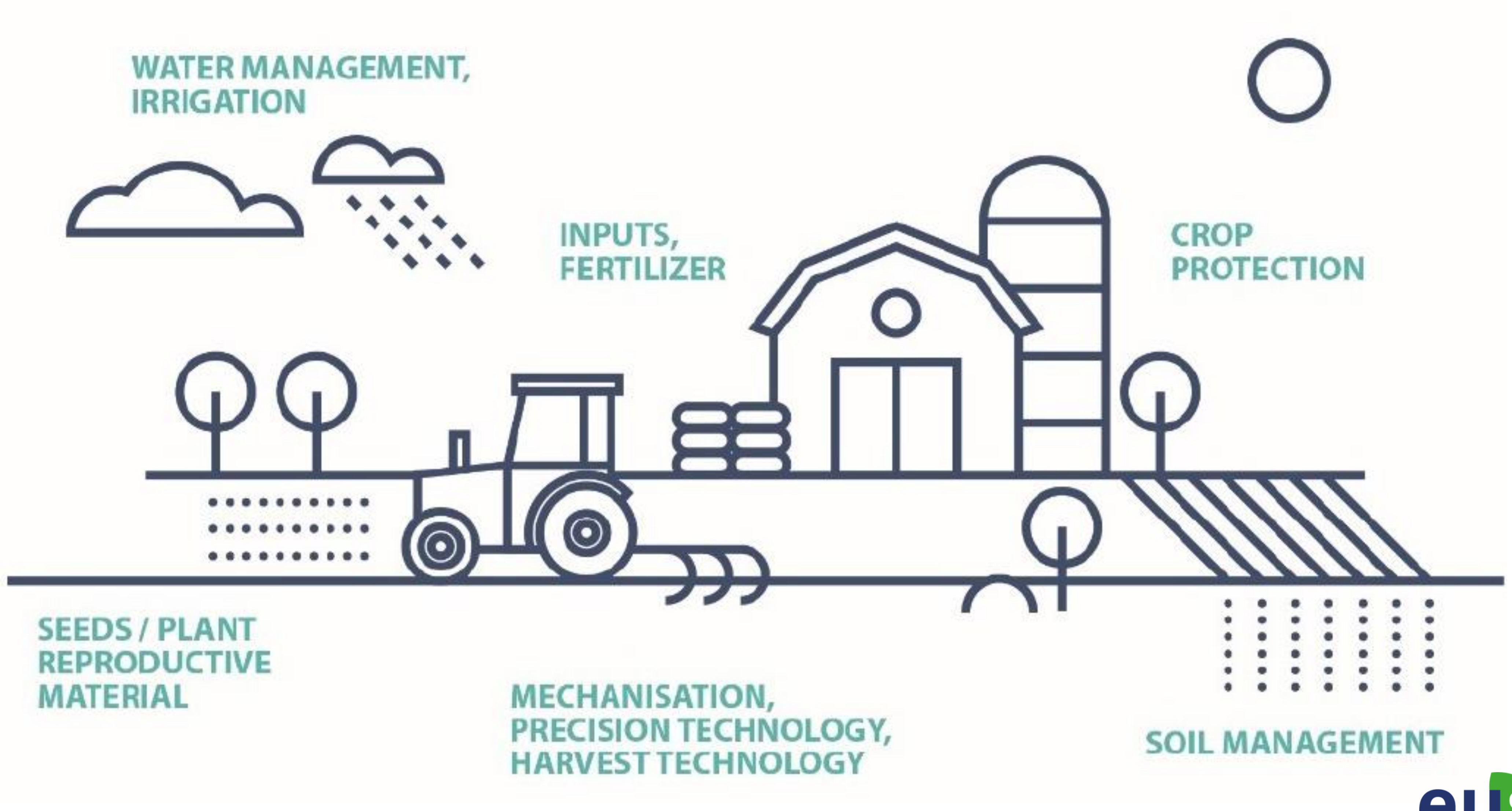
Crop production depends on many different factors



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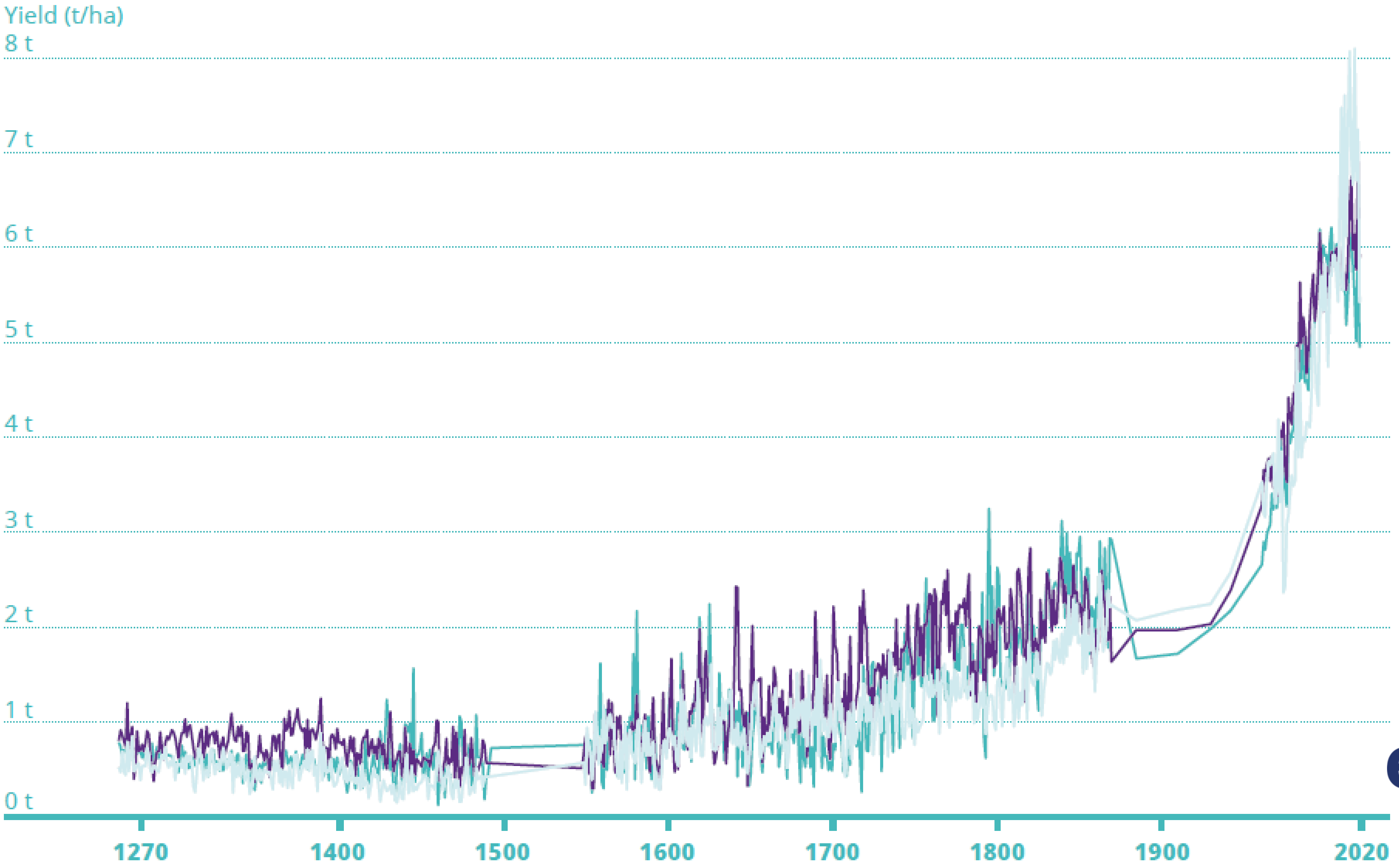
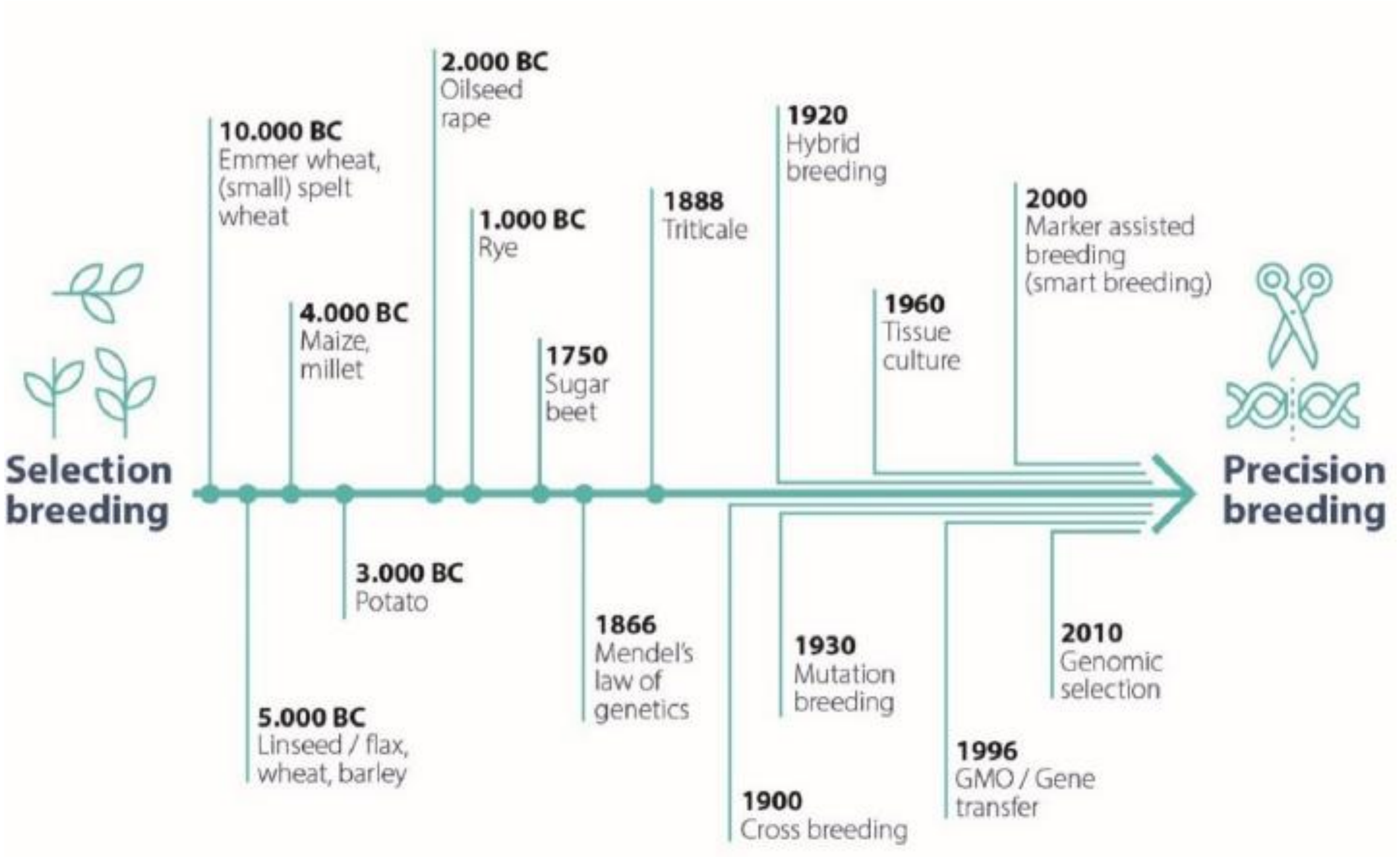
Evolution of barley, wheat and oats yields over the last seven centuries



Development of breeding technologies over time



Initiative from plant scientists stating that the GMO legislation is not fit-for-purpose and outdated

Policy aim

A **differentiated regulatory framework** for genome edited plants with DNA changes that also could have occurred naturally or through conventional breeding.

Prof. dr. Dirk Inzé
Scientific Director of the VIB-UGent center for Plant Systems Biology
Coordinator of the EU-SAGE network
Member of the Scientific Council of ERC

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European Sustainable Agriculture
Through Genome Editing

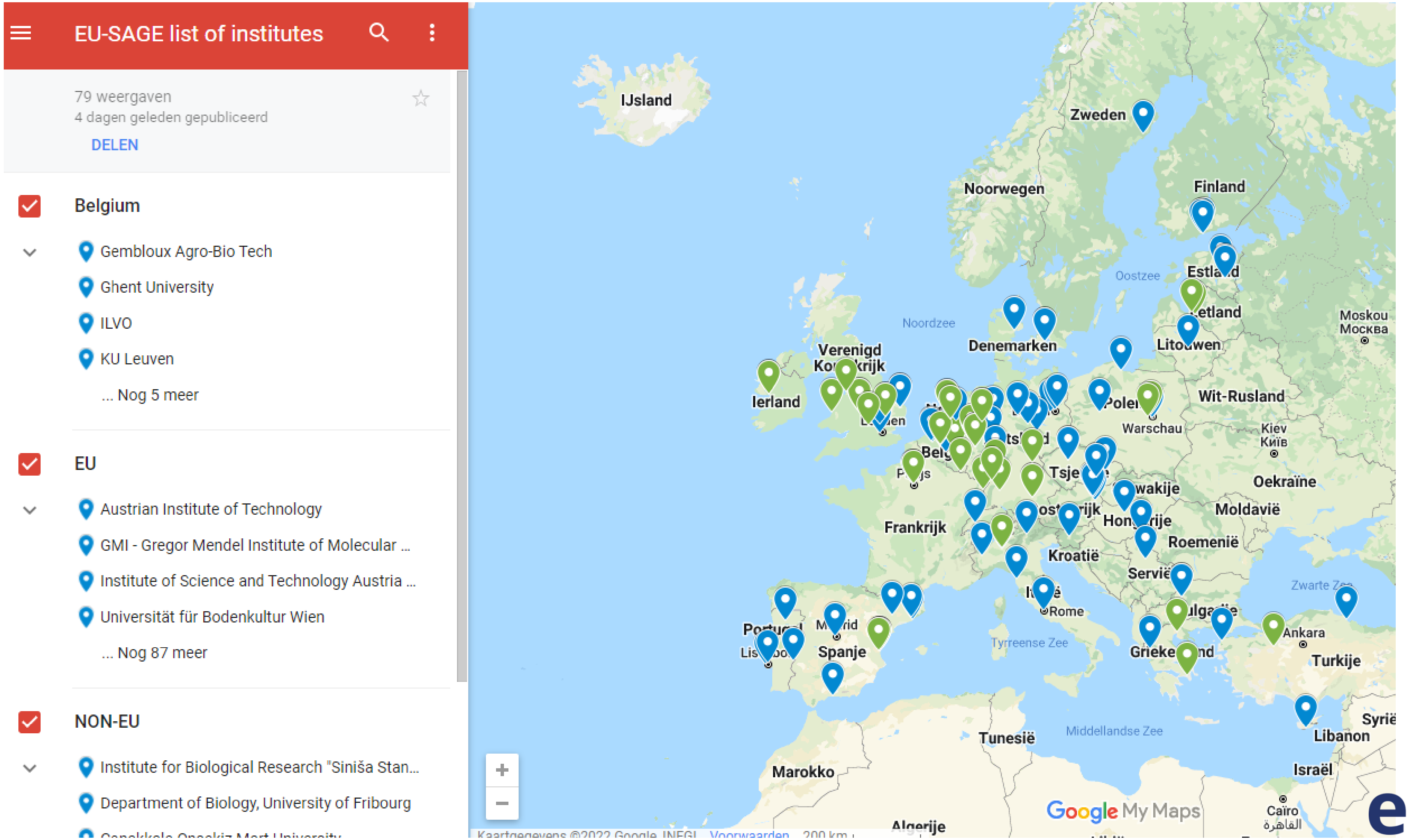
www.eu-sage.eu

- **Represent** scientists in Europe working on genome editing

- **Advocate** the potential of genome editing for agriculture

- **Facilitate** science-based policy making

EU-SAGE has 150 members from 31 countries



April 29, 2021: publication of the European Commission study

Study methodology

The study has been performed by the Commission and includes external contributions via a targeted consultation.

The study was supported by:

- An overview from the European Food Safety Authority
- Two reports from the Commission's Joint Research Centre (technology landscape and current and future applications)

In addition, it took into account expert opinions from:

- Group of Chief Scientific Advisors
- European Network of GMO Laboratories
- European Group on Ethics in Science and New Technologies

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Main outcomes of the European Commission study on NGTs

- Organisms obtained by new mutagenesis techniques that have appeared or have been mostly developed **since the adoption of Directive 2001/18** are GMOs and subject to the provisions od the GMO legislation

- Policy action on plant products derived **from targeted mutagenesis and cisgenesis** aimed at proportionate regulatory oversight

- NGTs, especially those based on CRISPR, are increasingly used in all sectors. **By 2030 a significant amount of NGTs is expected to be on the market**

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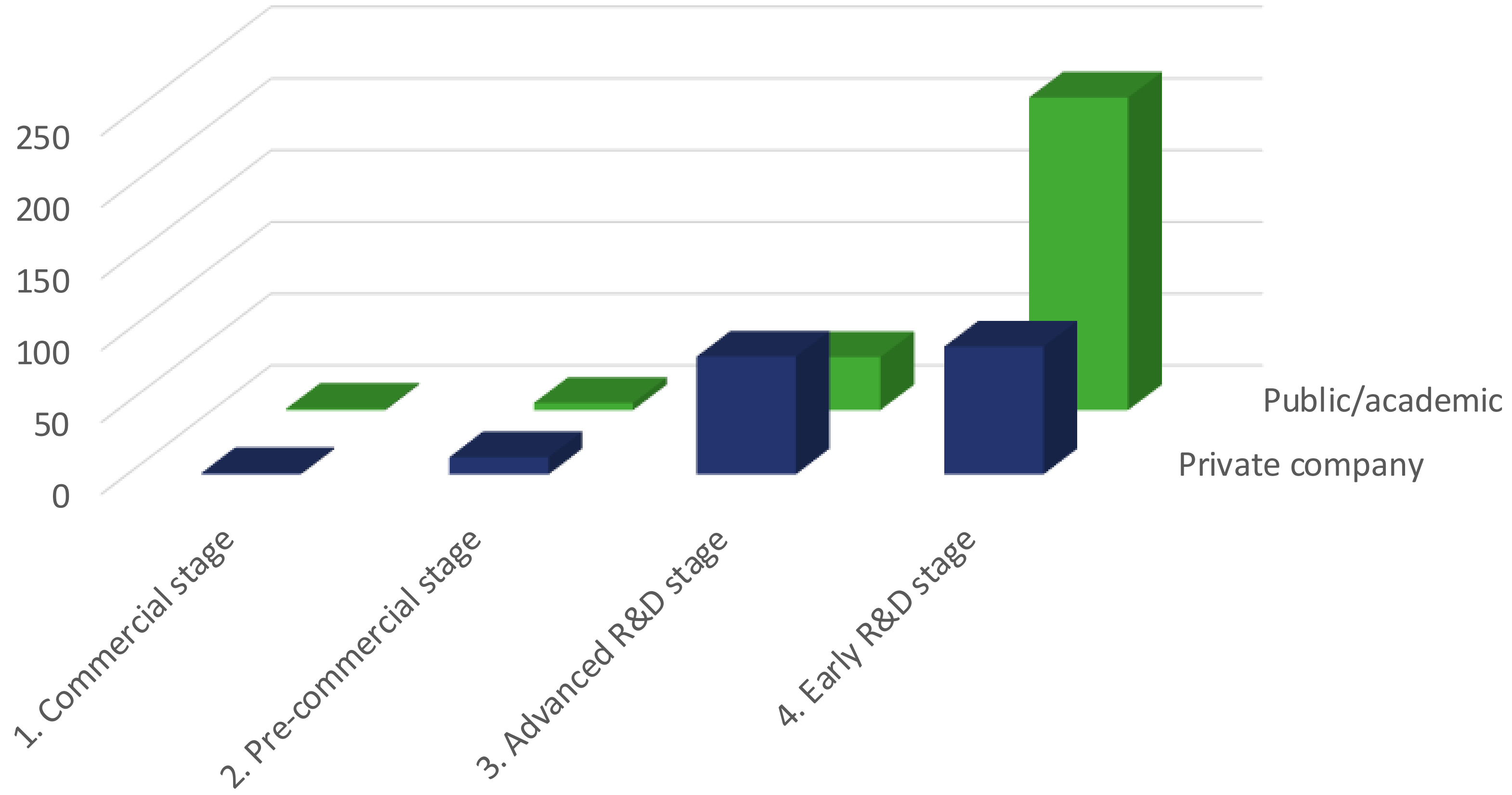
JRC study revealed that many NGT plants are in early/advanced R&D stage



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Genome-edited plants released on the market

High-oleic soy bean in the [US]

> more stable frying oil

> no trans fatty acids: healthier fried food

GABA-enriched tomato in [Japan]

> GABA lowers blood pressure: health benefit

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A nutrient-rich mustard leaf in the US

> health benefit

Waxy corn in Japan

> increased amylopectin in the corn: beneficial for food, textile and paper industries

Non-browning banana in the Philippines

> reducing food waste

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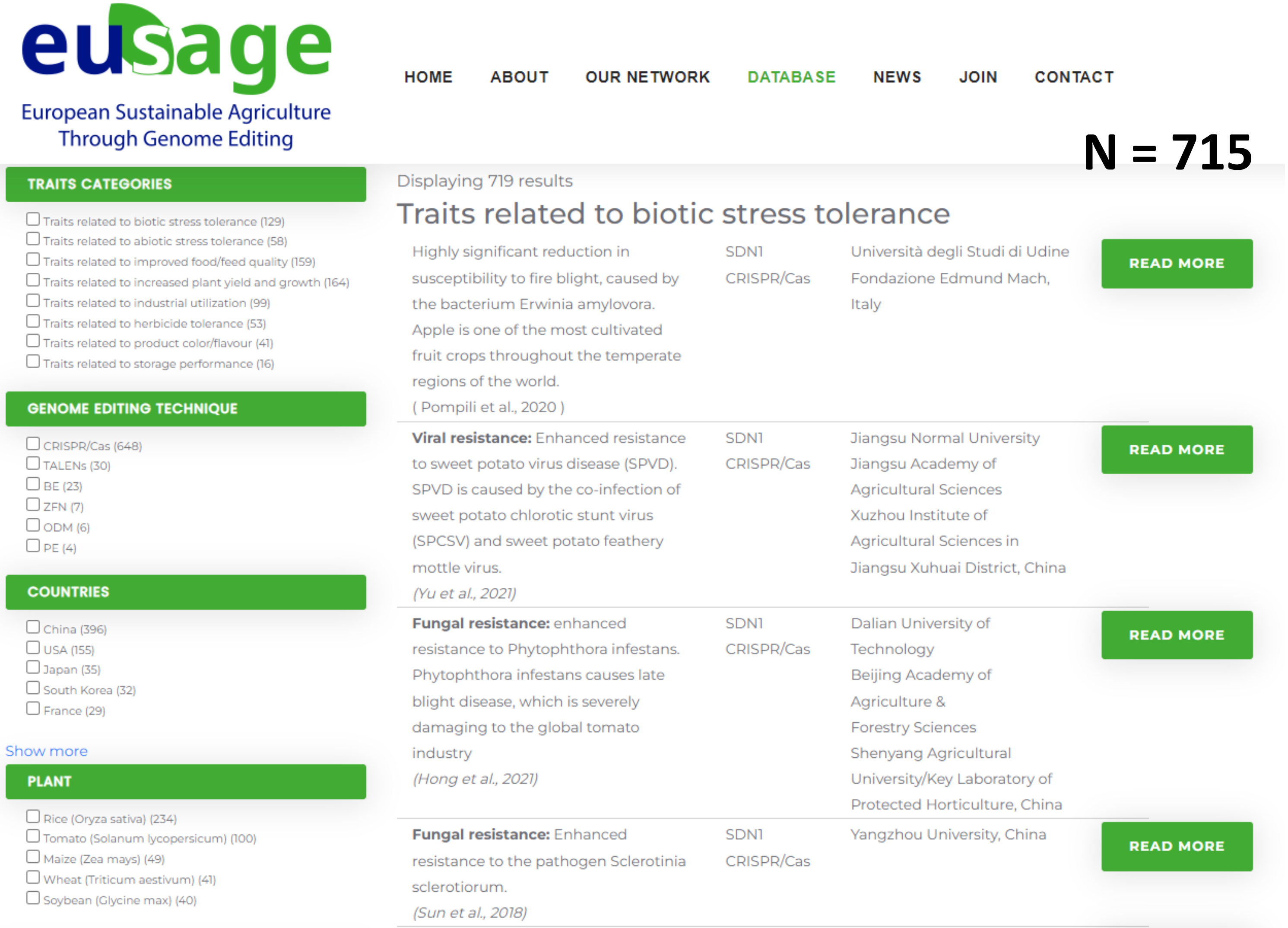
EU-SAGE database facilitates science-based policy making on state-of-the-art information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European Sustainable Agriculture Through Genome Editing

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N = 715

TRAITS CATEGORIES

- Traits related to biotic stress tolerance (129)
- Traits related to abiotic stress tolerance (58)
- Traits related to improved food/feed quality (159)
- Traits related to increased plant yield and growth (164)
- Traits related to industrial utilization (99)
- Traits related to herbicide tolerance (53)
- Traits related to product color/flavour (41)
- Traits related to storage performance (16)

GENOME EDITING TECHNIQUE

- CRISPR/Cas (648)
- TALENs (30)
- BE (23)
- ZFN (7)
- ODM (6)
- PE (4)

COUNTRIES

- China (396)
- USA (155)
- Japan (35)
- South Korea (32)
- France (29)

Show more

PLANT

- Rice (Oryza sativa) (234)
- Tomato (Solanum lycopersicum) (100)
- Maize (Zea mays) (49)
- Wheat (Triticum aestivum) (41)
- Soybean (Glycine max) (40)

Displaying 719 results

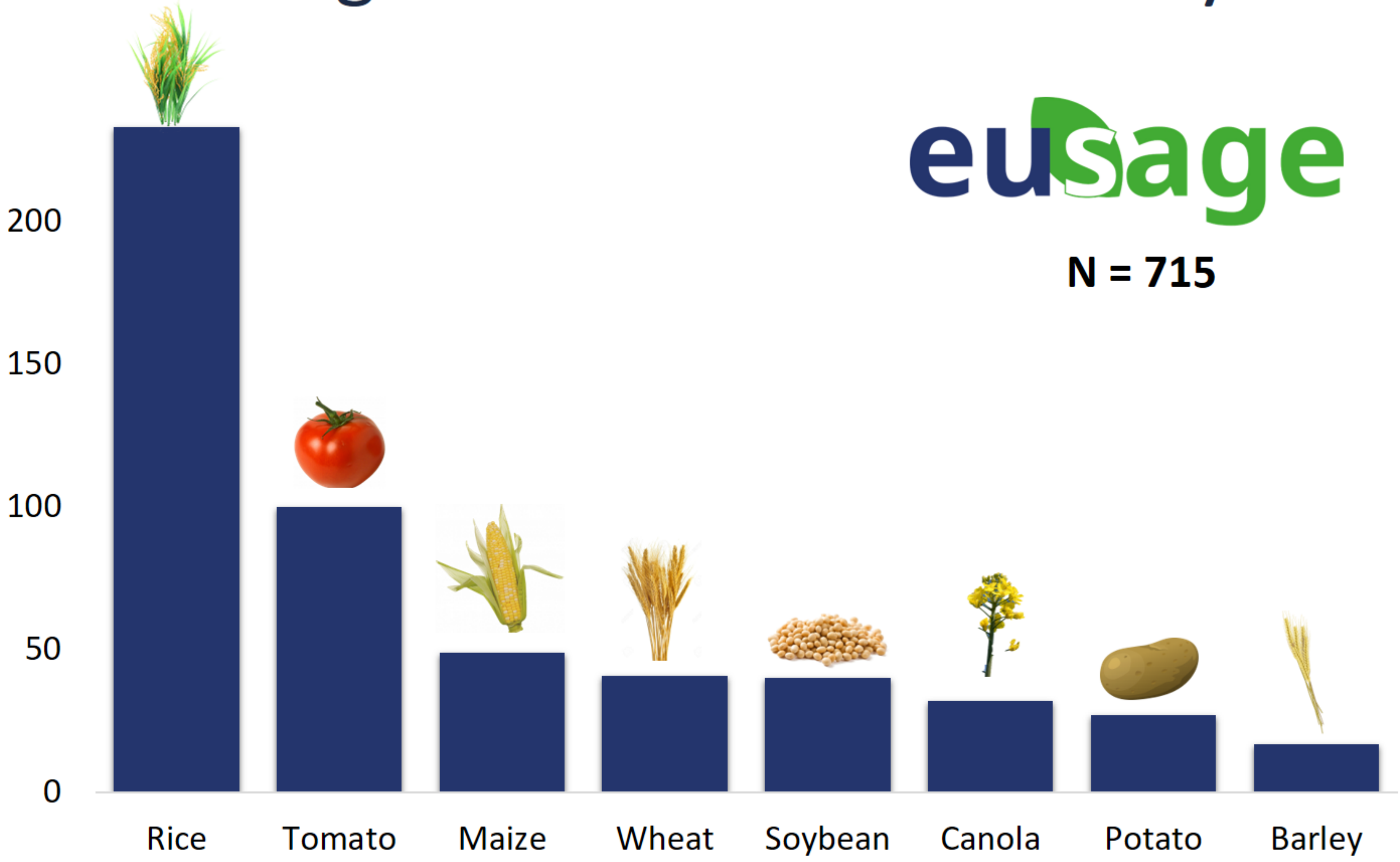
Traits related to biotic stress tolerance

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)	SDN1 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)*	SDN1 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. Phytophthora infestans causes late blight disease, which is severely damaging to the global tomato industry *(Hong et al., 2021)*	SDN1 CRISPR/Cas	Dalian University of Technology Beijing Academy of Agriculture & Forestry Sciences Shenyang Agricultural University/Key Laboratory of Protected Horticulture, China	READ MORE
Fungal resistance: Enhanced resistance to the pathogen Sclerotinia sclerotiorum. *(Sun et al., 2018)*	SDN1 CRISPR/Cas	Yangzhou University, China	READ MORE

Design of the EU-SAGE database:

- Literature search in bibliographic databases
- Peer-reviewed articles in English were screened
- A research article on any crop developed for agricultural production as a result of a genome editing was selected for the database
- Patents were not screened because inventions are far upstream of potential marketing

Genome editing is used in a wide variety of crops



Genome editing applications in crops bring benefits for producers and/or consumers

Trait category		Trait category explanation
Improved food/feed quality	**22,4%**	Modified composition of components such as vitamins, toxic substances, starch, oil, proteins, fibres, allergens, etc. to improve nutritional value.
Plant yield and growth	**22,2%**	Increased yield related to photosynthetic efficiency, to fruit size or weight or to increased number of flowers, seeds and fruits. Improved plant architecture, for example plant height and shape, growth pattern and fruit shapes.
Biotic stress tolerance	**18,2%**	Resistance to plant diseases caused by bacteria, viruses, fungi, pests, pathogens, or nematodes.
Industrial utilisation	14,0%	Applications of industrial interest such as breeding tools, bio-fuel production, nitrogen use efficiency etc.
Herbicide tolerance	7,4%	Tolerance of plants to various types of herbicides.
Abiotic stress tolerance	8,1%	Resistance to abiotic stress factors such as drought, heat, cold, salt, water excess and UV radiation.
Product flavour/colour	5,6%	Modified flavour or colour.
Storage performance	2,2%	Improvement of storage characteristics such as increased shelf-life, altered storage requirements, non-browning properties and reduced black spots.

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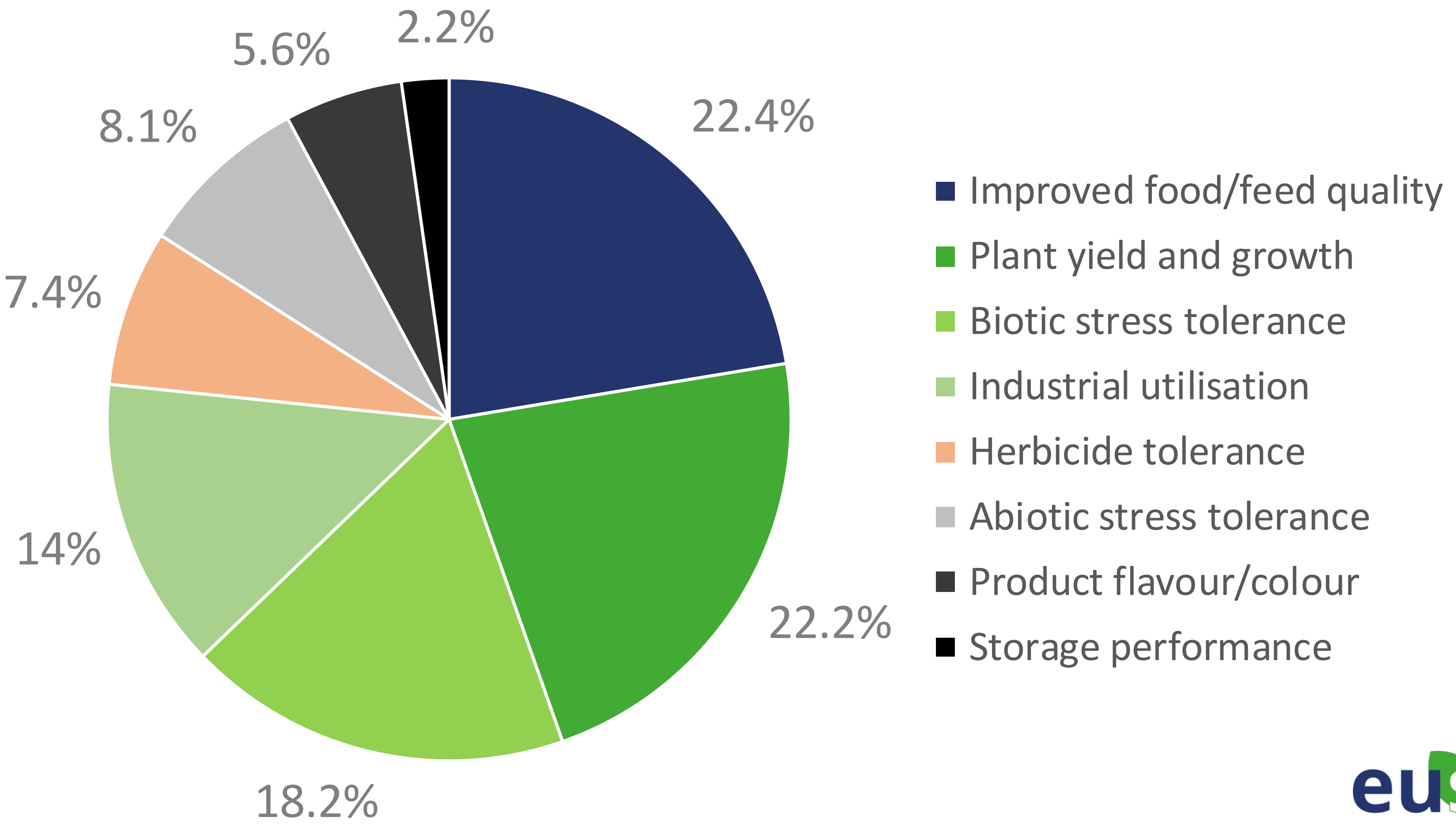
Genome editing applications in crops bring benefits for producers and/or consumers



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Examples of genome edited-crops and their potential benefits in the context of EU agricultural challenges

CROP	INTRODUCED PROPERTY	POTENTIAL BENEFICIAL EFFECT IN THE CONTEXT OF EU AGRICULTURAL CHALLENGES
Grapevine	Increased resistance to fungus *(Erysiphe necator)*, causing powdery mildew	Reduced dependency on the use of chemical or organic fungicides
Wheat	Resistance against fungus powdery mildew	Avoidance of the use of chemical or organic fungicides to combat powdery mildew
Potato	Resistance to potato virus X	Reduction of yield loss following potato virus X infection
Citrus fruit	Resistance against bacteria *(Xanthomonas citri)* causing citrus canker	Reduction of yield loss
Wheat	Drought tolerance	Reduction of yield loss under dry conditions
Tomato	Enhanced tolerance to heat stress	Better performance under heat stress
Maize	Drought tolerance	Reduction of yield loss under dry conditions

Examples of genome edited-crops and their potential benefits in the context of EU agricultural challenges

CROP	INTRODUCED PROPERTY	POTENTIAL BENEFICIAL EFFECT IN THE CONTEXT OF EU AGRICULTURAL CHALLENGES
Rice	Enhanced salinity tolerance	Enhanced yield under salinity stress conditions
Oilseed rape	Improved pod shattering resistance	Reduced seed loss during harvest, thereby increasing yields and reducing volunteer plants
Maize	Increased total kernel number or kernel weight	Higher yield per unit of land
Lettuce	Enhanced photosynthesis and decreased leaf angles for improved plant architecture and high yields	Higher yield per unit of land
Tomato	More fruits and bigger fruits	Higher yield per unit of land
Barley	Increase in plant height, tiller number, grain protein content and yield	Higher yield per unit of land and increased quality

Most genome-editing applications are crops with small genetic changes

	Point mutations (insertions, substitutions or deletions)	or	Long DNA sequences inserted („transgenes")
Conventional breeding	Spontaneous mutations mutagenesis		
Genome editing	SDN-1* SDN-2* **99,3%**		**0,7%** SDN-3*
Transgene technology „classical GMOs"			Inserting transgenes

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***SDN**: genome editing with **S**ite-**D**irected **N**ucleases e.g. CRISPR

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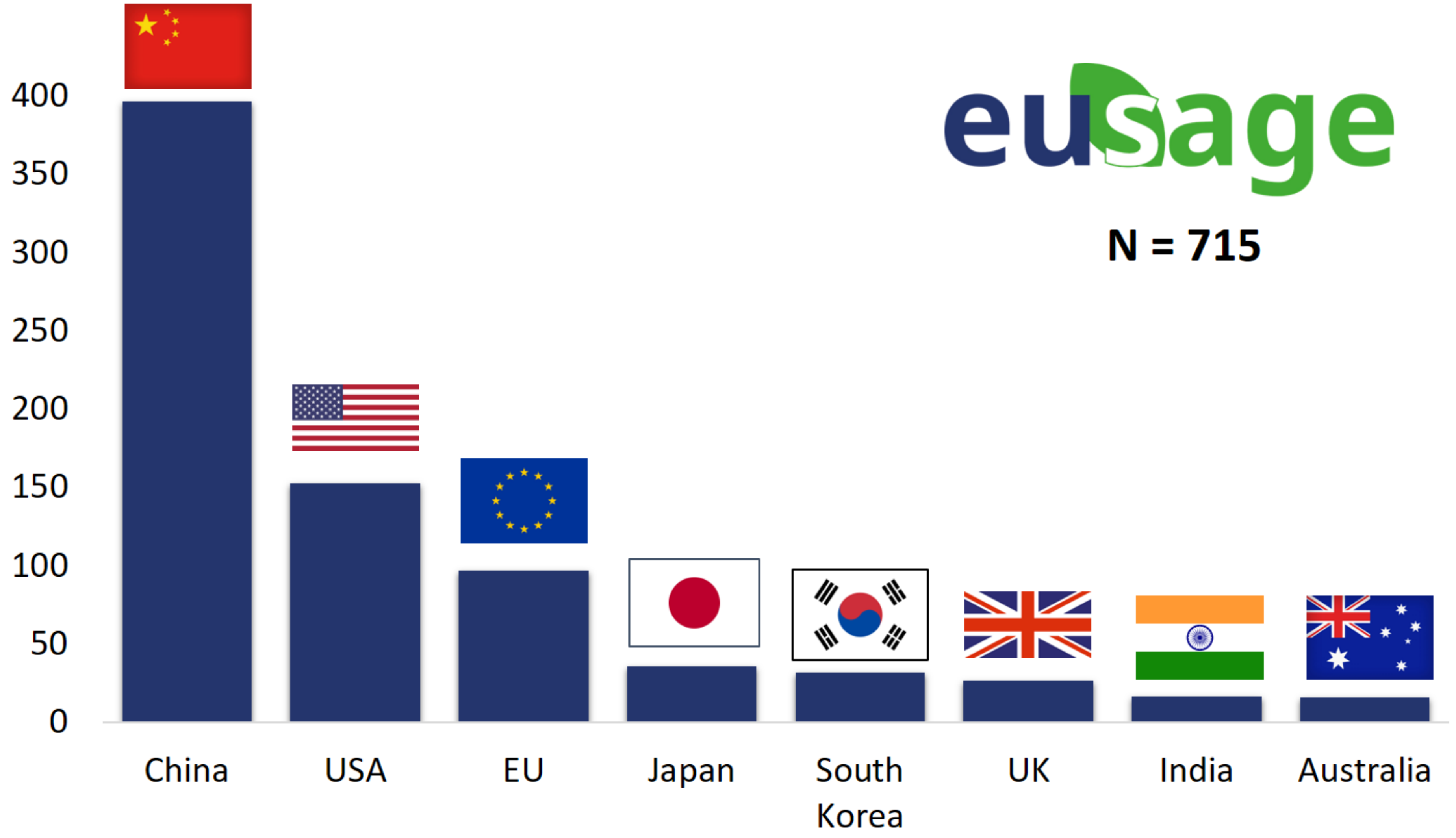
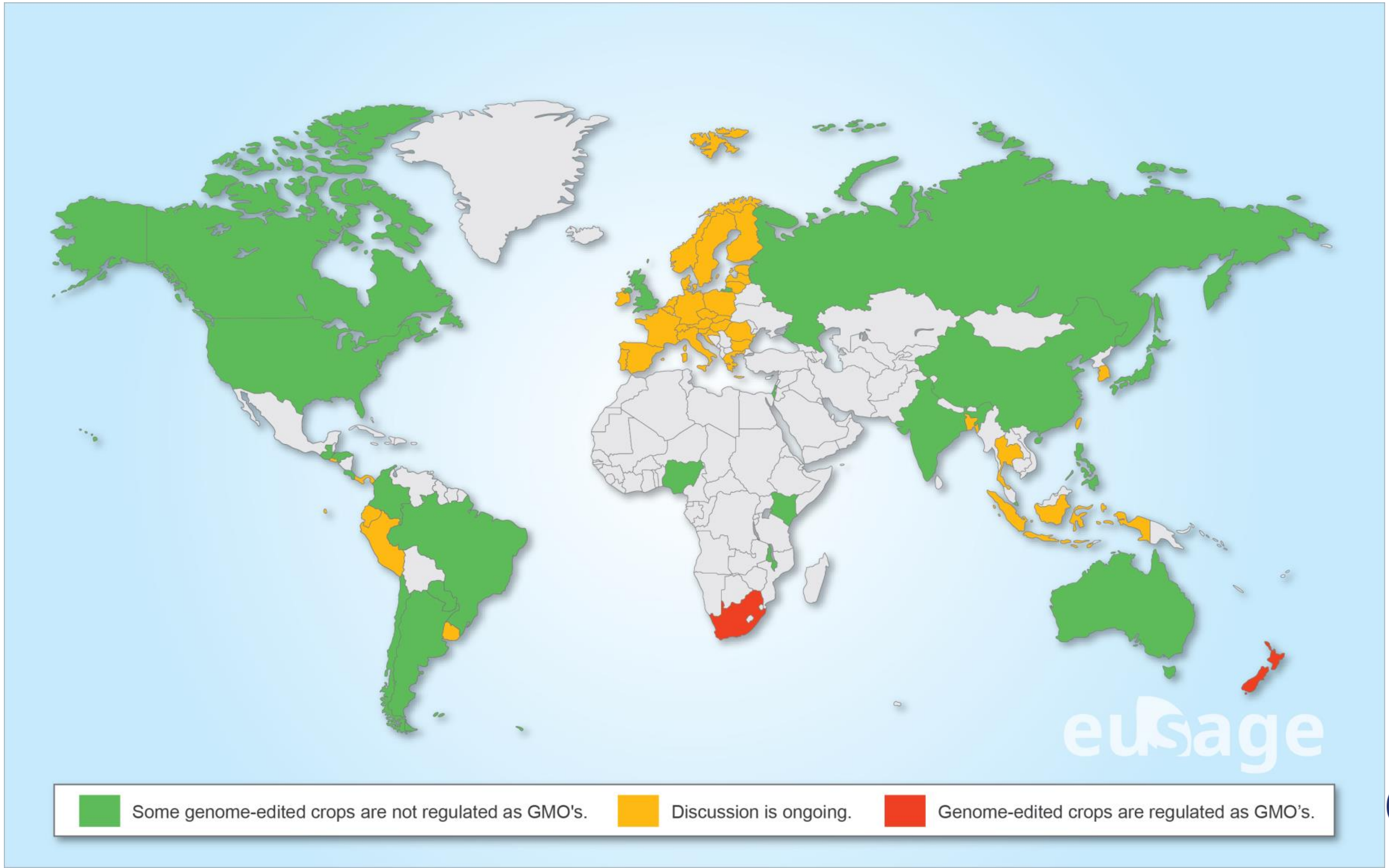
Main conclusions of the database

- Genome editing applications were identified in **65 different crops** with the vast majority in rice, tomato, maize, soybean, and wheat
- The traits of the crops are diverse and relevant for **farmers** (e.g., agronomic value) as well as **consumers** (e.g., nutrition)
- Most of the genome editing applications are crops with targeted, **small genetic changes**
- The applications in the database demonstrate that genome editing can contribute to the **‘EU Green Deal’ and the ‘Farm to Fork’ strategy**

The EU is lagging behind in the development of genome-edited crops compared to China and USA



There is currently **no differentiated approach** for the regulation of genome-edited crops in EU



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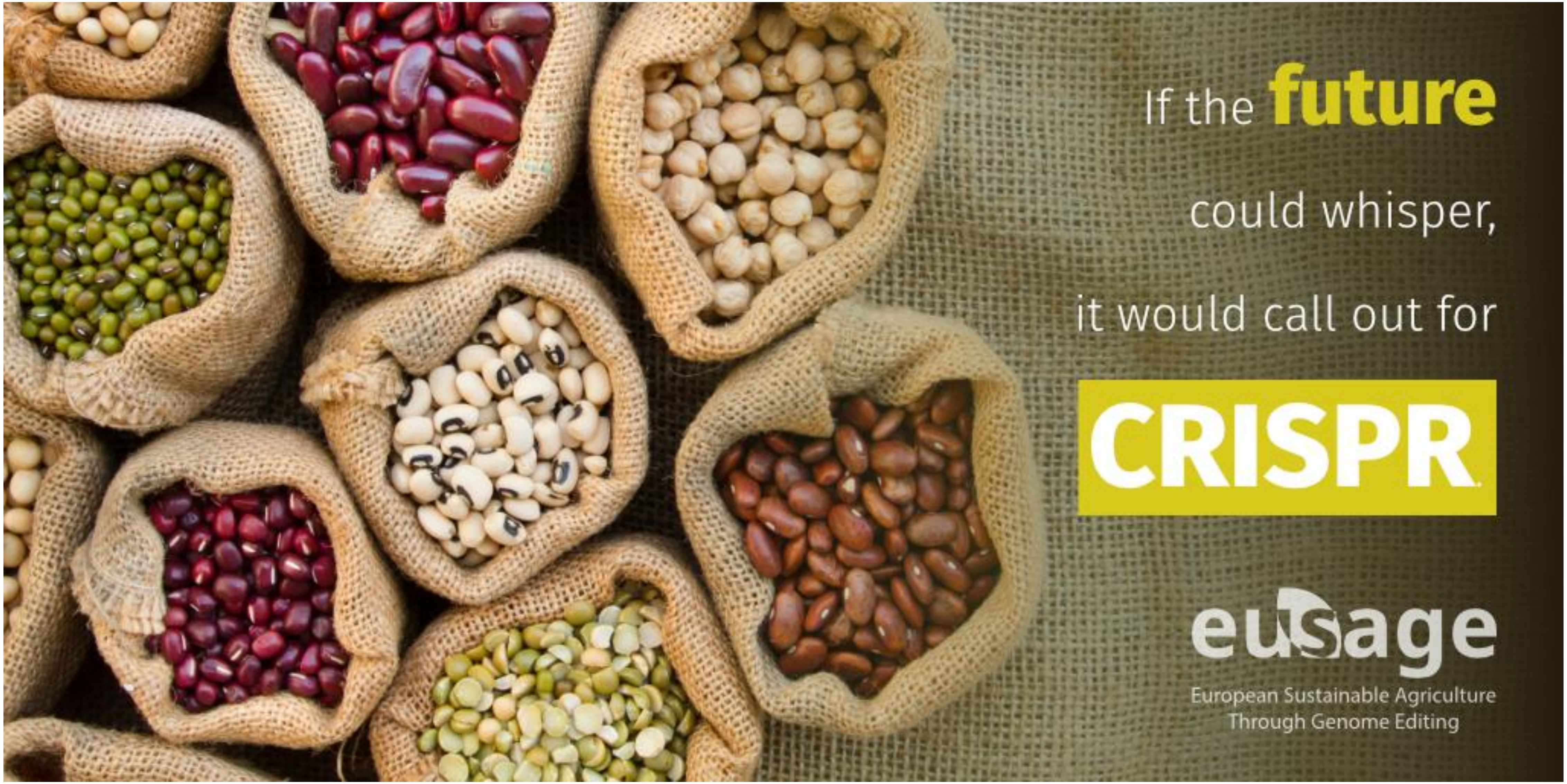
Will the EU follow a similar path as the UK and other regions in the world?

Genome edited vitamin D tomato

Wild-type tomato


EXHIBITION
EUROPEAN PARLIAMENT - STRASBOURG
What's new in the farmers' market?
Visit our market from
12th-15th June
At the entrance of the restaurant
(Flower carpet area)
The role of plant breeding in helping farmers build a sustainable, diverse and resilient European food system



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