New Breeding Methods
More than just a “test-tube scenario”

Climate change represents a challenge for all, for citizens and for any actor in the agri-food chain, starting with the breeders. The need to produce in a sustainable way to the benefit of the environment is not the only challenge. Our eating habits and modern lifestyle lead to the emergence of pathologies that need to be treated – starting with food. In some regions of the world, the access to affordable and nutritious food continues to be a major issue. To cope with these challenges, innovations are needed. Advanced breeding methods offer additional and more efficient possibilities for breeding, and the targeted development of desired characteristics in plants.

In the following overview, we have accumulated some application examples of new breeding methods and their intended or proven benefits. Using the reference links, you can always access the source directly for further insights and information.

Potato

Benefits
Reduced use of chemicals.
Natural starch storage stable: it can absorb water and keep it over time so that it does not have to be processed with chemicals. Savings on process chemicals are important, 60.000–75.000 T at EU level on 300.000 T of starch.

Method applied
Targeted mutagenesis

More info available here:
Genome editing in potato via CRISPR-Cas9 ribonucleoprotein delivery

CRISPR Potato Infographic

Benefits
Improved quality-food safety.
Potatoes contain no detectable reducing sugars, are light brown and, after processing, contained lower levels of acrylamide. Acrylamide is a chemical that is present in some foodproducts as a result of high-temperature cooking processes such as frying, roasting and baking. EFSA confirms that acrylamide is a carcinogenic substance and food business operators have to reduce its presence.

Method applied
Targeted mutagenesis

More info available here:
Prospects for Genome Editing of Potato

Benefits
Improved quality-food waste.
Potato varieties with reduced enzymatic browning in tubers that could prevent food waste.

Method applied
Targeted mutagenesis

More info available here:
Reduced Enzymatic Browning in Potato Tubers by Specific Editing of a Polyphenol Oxidase Gene via Ribonucleoprotein Complexes Delivery of the CRISPR/Cas9 System

Benefits
Reduced use of chemicals.
Fungi-resistant potato varieties that require less fungicide use during potato production in the field.

Method applied
Targeted mutagenesis

More info available here:
Mutations introduced in susceptibility genes through CRISPR/Cas9 genome editing confer increased late blight resistance in potatoes

Wheat

Benefits
Reduced use of chemicals.
Multiple and durable fungal disease tolerance in wheat to reduce the use of plant protection products.
10–15% of wheat per year is lost due to fungi infections. Plant breeding innovation can develop fungi resistant wheat varieties.
If these were cultivated on 50% of EU wheat cultivation area, 25 million applications of fungicides in wheat could be avoided.

Method applied
Targeted mutagenesis

More info available here:
PILTON

The socio-economic and environmental values of plant breeding in the EU and for selected EU member states

Benefits
Improved quality-food safety.
Durum wheat edited for the production of safer, less allergenic wheat variety.

Method applied
Targeted mutagenesis

More info available here:
Frontiers | CRISPR-Cas9 Multiplex Editing of the α-Amylase/Trypsin Inhibitor Genes to Reduce Allergen Proteins in Durum Wheat | Sustainable Food Systems

Benefits
Improved quality-food safety.
Low gluten wheat suitable for people suffering from Coeliac Disease (a chronic immune disorder triggered by gluten ingestion).

Method applied
Targeted mutagenesis

More info available here:
Low-gluten, nontransgenic wheat engineered with CRISPR/Cas9 (nih.gov)

Tomato

Benefits
Nutritional values.
Tomato with increased GABA (Gamma- Aminobutyric acid) content. GABA is a natural component that provides benefits to human health such as lowering blood pressure.

Method applied
Targeted mutagenesis

More info available here:
[Follow-up] First Genome Edited Tomato with Increased GABA In the World

Benefits
Improved quality-food waste.
Tomatoes with longer shelf life to combat food waste.

Method applied
Targeted mutagenesis

More info available here:
CRISPR/Cas9-induced Targeted mutagenesis and Gene Replacement to Generate Long-shelf Life Tomato Lines

Benefits
Reduced use of chemicals.
Approximately 7% of harvestable tomatoes get lost due to Phytophthora infestans, one of the most devastating fungi. Disease resistant varieties can prevent yield loss and reduce pesticide use. Plant breeding can help save more than 300,000 hectare-based fungicide applications throughout Europe by developing Phytophthora-resistant tomato varieties.

Method applied
Targeted mutagenesis

More info available here:
The socio-economic and environmental values of plant breeding in the EU and for selected EU member states

Corn

Benefits
Nutritional values.
Reduced phytate content (compounds found in certain crops like corn) resulting in better absorption of proteins and minerals and with that increasing the nutritional value due to improved digestibility and/or bioavailability.

Method applied
Targeted mutagenesis

More info available here:
Minimally altering a critical kinase for low-phytate Corn

Benefits
Climate adaptation – drought tolerance.
Even if affected by only moderate drought, an average EU farmer will envisage a yield reduction in corn cultivation of approximately 3%.
A drought-tolerant variety developed through new plant breeding methods would help the farmer avoid a profit loss of 25%.

Method applied
Gene editing

More info available here:
Noleppa-The socio-economic and environmental values of plant breeding in the EU

Oilseed Rape

Benefits
Prevention of yield loss, reduction of seed dispersal before harvest.
A major challenge in oilseed rape production is the natural seed dispersal (pod shattering), which causes yield losses of up to 25%.
Genome Editing can avoid pod shattering thus reducing yield loss, and potentially leading to land savings of up to 500.000 ha in the EU, thus lowering the pressure on existing land-use and supporting the mitigation of negative GHG emission.

Method applied
Targeted mutagenesis

More info available here:
Noleppa-The socio-economic and environmental values of plant breeding in the EU

Soybean

Benefits
Nutritional values.
High oleic acid soybean oil that provides benefits to human health as these fatty acids are known for their cholesterol-lowering effect as well as frying stability.
It has up to three times the fry life and extended shelf life compared to commodity soy oils, providing a more sustainable product.

Method applied
Targeted mutagenesis

More info available here:
First Commercial Sale of Calyxt High Oleic Soybean Oil on the U.S. Market

Grapevine

Benefits
Reduced use of chemicals.
Fungi-resistant grape varieties result in less spraying: from 10–20 applications to 2 or 3 per season.

Method applied
Targeted mutagenesis

More info available here:
Towards grapevine (Vitis vinifera L.) mildews resistance: molecular defence mechanisms and New Breeding Technologies

Is Italy’s agriculture ready for CRISPR?

Innovation to preserve tradition fungi resistant grape vine Infographic

Mushroom

Benefits
Improved quality-reduced food waste.
Reduced enzymatic browning to prevent food waste.

Method applied
Targeted mutagenesis

More info available here:
A CRISPR Mushroom

Banana

Benefits
Reduced use of chemicals.
Gene-edited variety (Cavendish) to boost the resilience against the fungus known as Fusarium wilt tropical race 4 (TR4).

Method applied
Targeted mutagenesis

More info available here:
CRISPR might be the banana’s only hope against a deadly fungus

Peanut

Benefits
Improved quality-food safety.
Gene-editing technique used to remove the major allergens and obtain allergen-free peanuts.

Method applied
Targeted mutagenesis

More info available here:
How Scientists Are Engineering Allergy-Free Wheat and Peanuts

Euroseeds
Embracing Nature