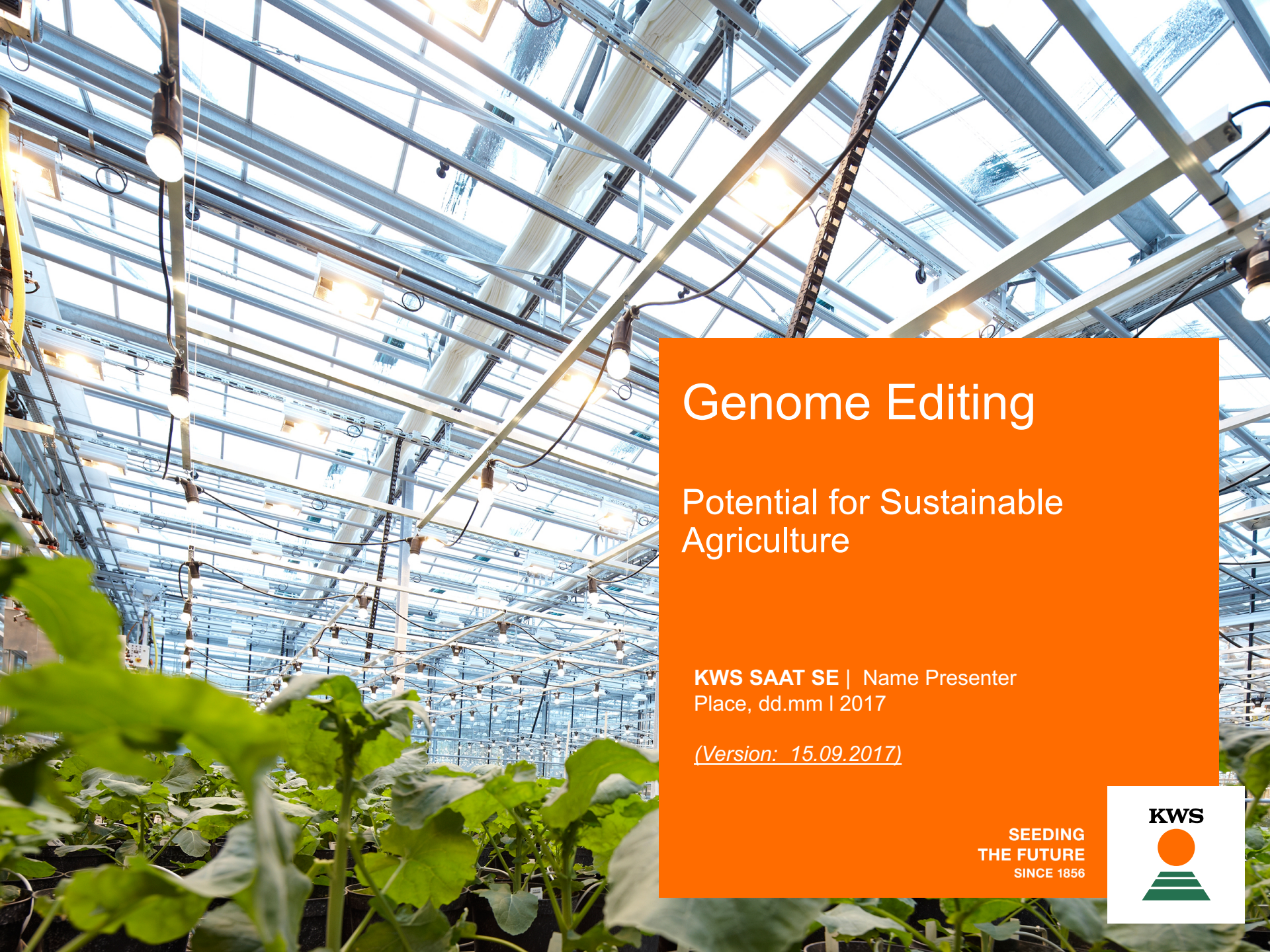

# Genome Editing

## Potential for Sustainable Agriculture

**KWS SAAT SE** | Name Presenter
Place, dd.mm l 2017

*(Version: 15.09.2017)*

SEEDING
THE FUTURE
SINCE 1856

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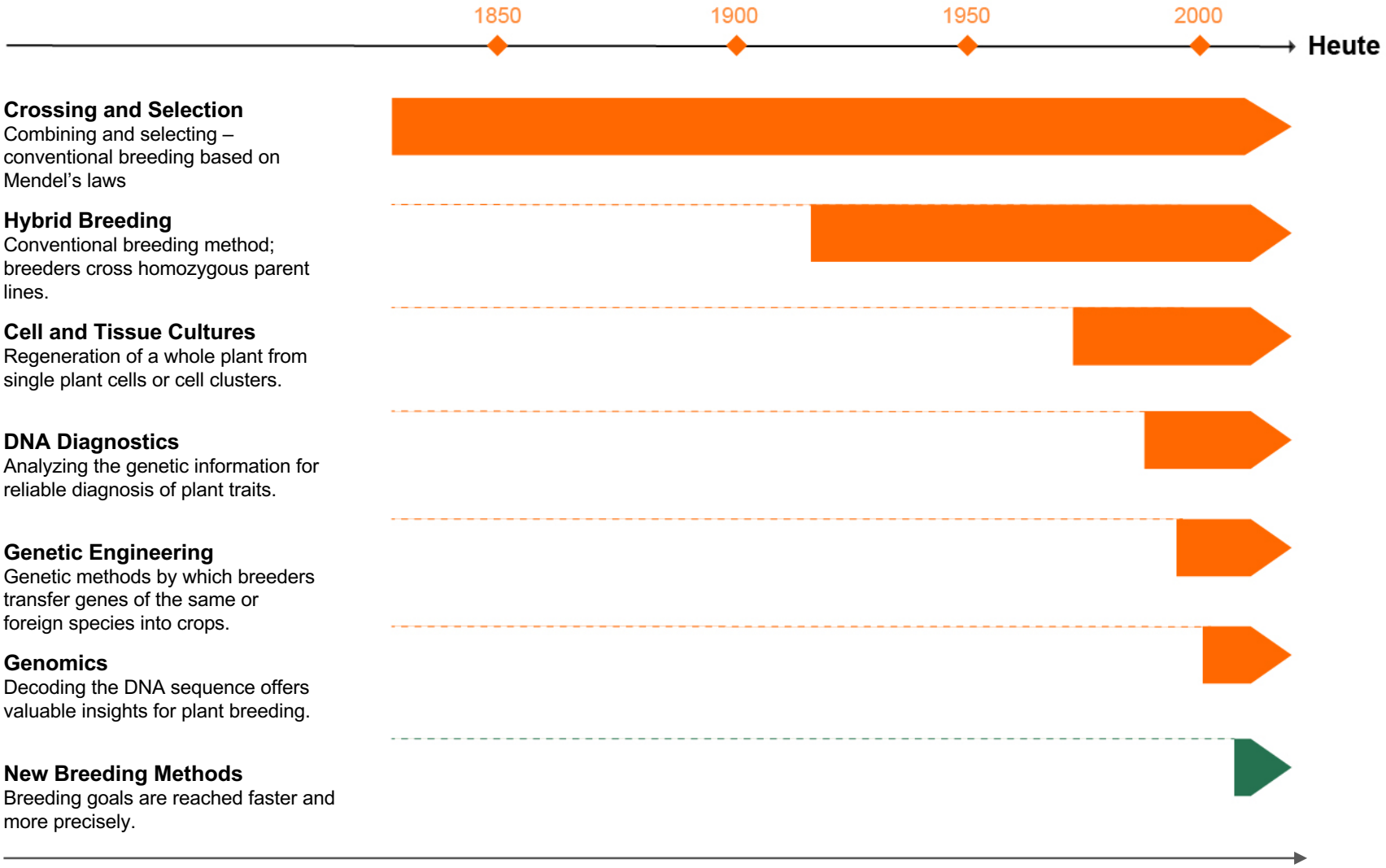
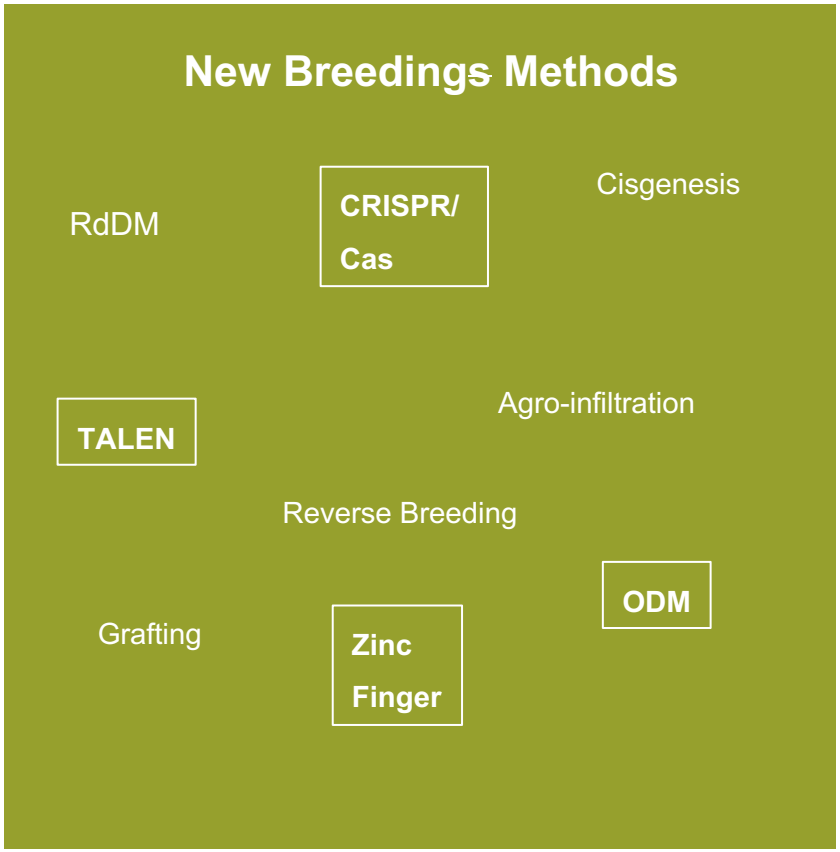
# Innovation in Modern Plant Breeding



# The next step in the development – Genome Editing

**Changing DNA by state-of-the-art breeding.**
Genetic diversity | Efficiency | Precision




**Additionally to applying Genome Editing Methods, it is necessary that:**

- relevant target genes are identified
- their biological function is understood
- the exact gene sequence is known
- the optimal mutation point is identified

**Extensive research on cell biology and gene identification is needed: not only in companies, but also in the university research environment.**

# How do the new methods work?
# Genome Editing using the CRISPR/Cas example

**Guide**
As a first step, breeders guide an enzyme (nuclease) to the desired position in the genome.

**Cut**
The nuclease splits the DNA precisely, resulting in a double-strand-break.

**Repair**
The natural existing cellular repair system reassembles the DNA. In this process, sequences can be deleted, added or edited – this is the decisive moment in the DNA modification.

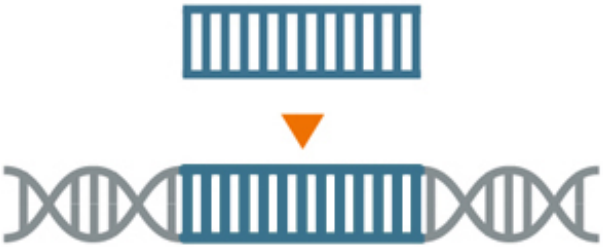
# How do the new methods work?
# Genome Editing using the CRISPR/Cas example

**Variant 1**
Deliberate random alteration of small DNA building blocks (e.g. point mutations or deletions)

**Variant 2**
Deliberate targeted transfer of DNA building blocks of the same species

OR

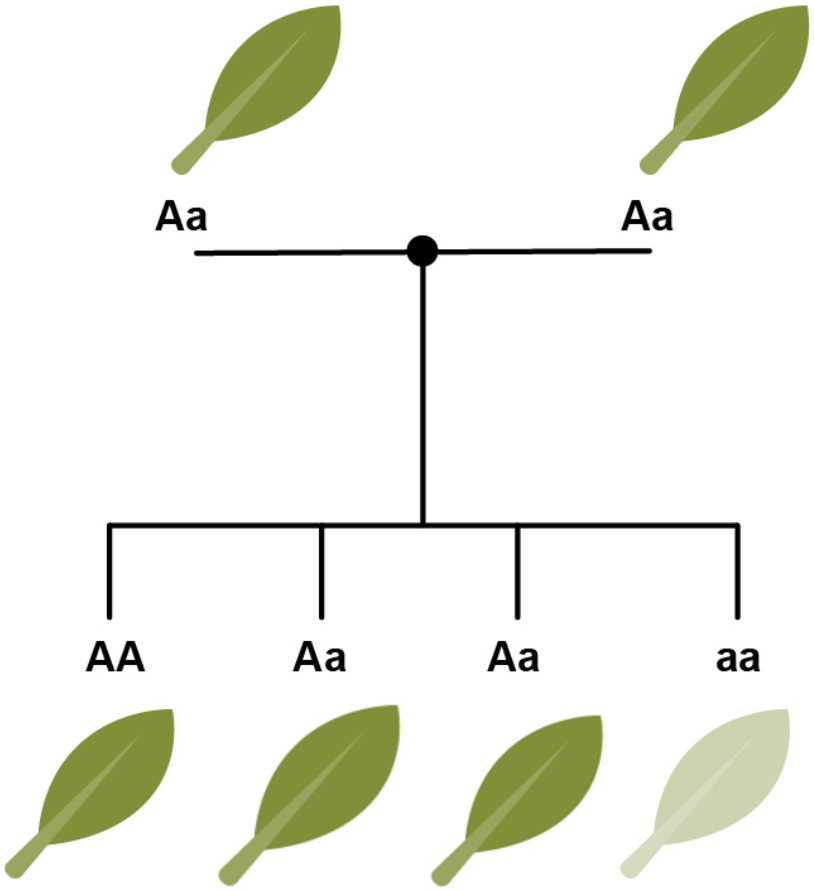
**Variant 3**
Deliberate targeted transfer of genes or gene sequences from foreign species



**Plants resulting from these methods could also occur spontaneously in nature or be produced with traditional cross or combination breeding – they are nature identical. No specific regulation is necessary.**

**Plants resulting from this variant are genetically modified and are subject to the genetic engineering law in effect in the EU.**

# The result is identical. The decisive advantage: Genome Editing is faster and more precise




**Changing DNA by traditional breeding.**

- Even in the Neolithic age, plants with certain traits were selected and propagated.
- Mendel‘s laws in mid 19th century
- Genetic theory and related insights on how genetic plant traits are transferred through crossing and combination simplify breeding.
- Scientific progress leads to faster and more effective breeding methods.
- Breeding goals remain the same: to improve the genetic characteristics of plants.
- Traditional breeding achieves this. The new methods considerably accelerate the breeding process with more precision.

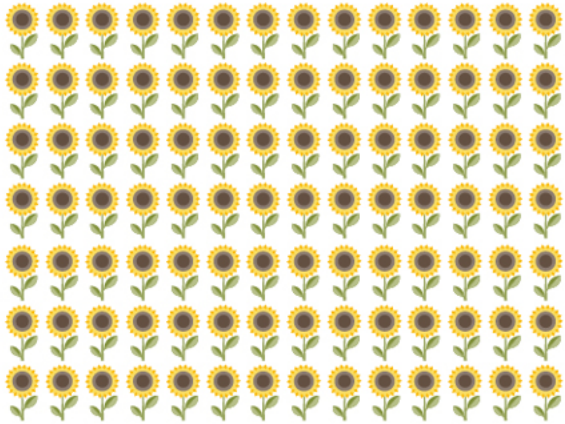
# The result is identical. The decisive advantage: Genome Editing is accelerating the breeding process.

**Crossing and Selection**

High-performance variety

Wilde type with desired trait

**7 generations / about 1000 plants**



**Improved high-performance variety**

**Genome Editing**

High-performance variety

**2 generations / about 20-50 plants**

# Possible applications of Genome Editing

- **Trait development**
  - Pest and disease resistance
  - Abiotic tolerances
  - Herbicide tolerance
  - Optimized composition of plant components
  - …
- **Speeding up innovation for the benefit of sustainable agriculture**
  - Securing yield progress and stability
  - Improved pest and disease resistance
  - Reducing the use of inputs (water, fertilizer, chemicals)
  - Improved energy and nutrient content
  - Orphan crops can also benefit from genome editing, provided sufficient resources are dedicated to research and breeding

# Genome Editing: a precise process with a result that is identical to nature.

- New methods allow for faster and more precise plant breeding.
- Genome Editing methods need to be judged in a differentiated manner.
- Methods used without a transfer of foreign genes or gene sequences equal traditional breeding methods from a regulatory standpoint.
- The resulting plants are identical to those derived from conventional breeding, or could occur naturally.
- The new methods are practicable also for small and medium-sized enterprises.

# Alternative slide

# How do the new methods work?
# Genome Editing using the example CRISPR/Cas

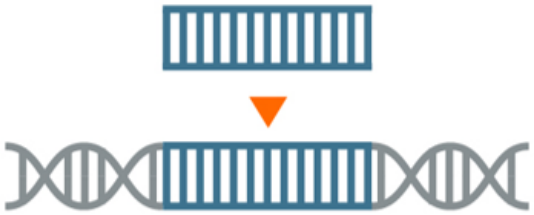
**Guide:** As a first step, breeders guide an enzyme (nuclease) to the desired position in the genome.

**Cut:** The nuclease splits the DNA precisely, resulting in a double-strand-break.

**Repair:** Natural existing cellular repair system reassembles DNA. Sequences can be deleted, added or edited.

Deliberate **random** alteration of small DNA building blocks (e.g. point mutations or deletions)


Deliberate **targeted** transfer of DNA building blocks of the **same species**



Deliberate targeted transfer of genes or gene sequences from **foreign species**

**Nature identical - no specific regulation is necessary**

**Gene technology law in the EU**

# Advantages of Genome Editing in Plant Breeding

- **Improving the efficiency in breeding**
  - One-step introgression of native traits from genetic resources without linkage drag
  - Multiple founders/avoiding genetic sweep
  - One-step introgression of traits instead of back crossing
  - Increasing recombination rate
  - Increasing allelic variation
  - …