



Evaluation of New Plant Breeding Techniques for organic agriculture

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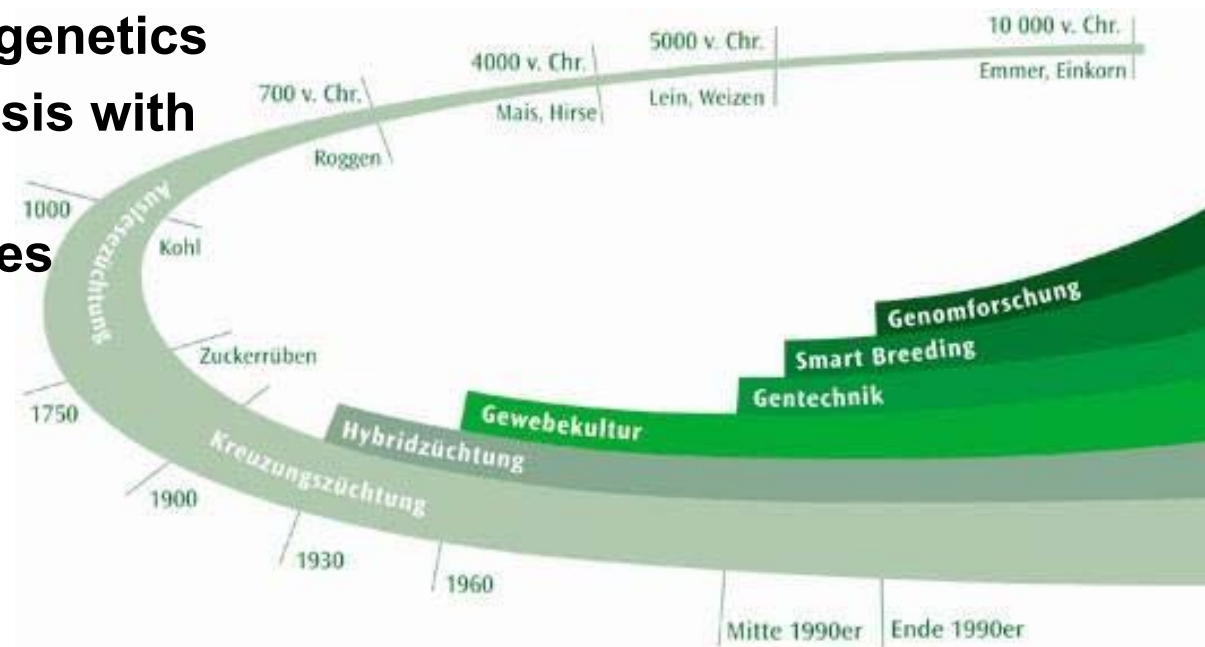
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New breeding techniques



- › **Smart Breeding**
 - › marker based selection (MAS, MBC)
 - › double haploids, cell fusion
- › **Tilling & eco-tilling**
- › **RNA Interference (RNAi)**
- › **Cisgenetics & intragenetics**
- › **Targeted mutagenesis with oligonucleotides**
- › **Zinc finger nucleases**
- › **Reverse breeding**
- › **Minichromosomes**
- › **Synthetic biology**
- › **Metabolomics**



Mönch, K., 2010. Green gene technology

Diskussionspaper on evaluation of new breeding techniques for EU commission



- › Are new gene combinations created?
- › Are new nucleotides introduced?
 - › How many (>20b)?
 - › Are they rekombinant Nucleotides?
- › Are they permanently or transistently introduced?
- › Are the modifications heritable?
- › Are the modification traceable
- › Can diese modifications occur in nature or by conventional breeding techniques?
- › What is the difference between these cultivars and the conventionally bred cultivars?

No final conclusions for all techniques

Summary presentation of each technique



for
Breeding

Technique	Nature of sequence used	Insertion in genome?	Targeted/random insertion	Heritability	Probable opinion of European experts
Transgenesis	Transgenesis (Promoter + gene of interest from sexually incompatible organism + terminator)	Yes	Random	Yes	GMO already recorded
Cisgenesis	Cisgenesis (Promoter + gene of interest from sexually compatible organism + terminator)	Yes	Random	Yes	GMO but outside scope of law
Mutagenesis via oligonucleotides	Oligonucleotides	Yes	Targeted	Yes	GMO or not GMO but outside scope of law
Mutagenesis via meganuclease	Oligonucleotides	Yes	Targeted	Yes	
Mutagenesis via zinc finger nuclease	Oligonucleotides	Yes	Targeted	Yes	GMO but outside scope of law (except if complete gene is inserted)
DNA methylation	Transgene	Yes	Random	Yes	GMO or not GMO but outside scope of law
Grafting (GM rootstock)	Transgene / Cisgene	Yes	Random	No	GM plant / fruits, non-GM seeds (if scion is not GM)
Grafting (GM scion)	Transgene / Cisgene	Yes	Random	Yes	GM plant
Agro-infiltration	Transgene in an independent construction of the genome	No (except if viral DNA + transgene)	No insertion	No	GMO / Not GMO
Reverse breeding	"Natural" mutant or transgene	Yes	Random	No	GMO / Not GMO

Inf' OGM (Hrsg.) 2012: New techniques for the alteration of the living. For whom? Why? Collection émergence (Pour l'Émergence d'une Université Du Vivant/PEUV).

The IFOAM NORMS for Organic Production & Processing Version 2012



Requirements:

4.7.1 To produce organic varieties, plant breeders shall select their varieties **under organic conditions** that comply with the requirements of this standard. All multiplication practices except meristem culture shall be under certified organic management.

4.7.2 Organic plant breeders shall develop organic varieties only on the basis of genetic material that has not been contaminated by products of genetic engineering.

4.7.3 Organic plant breeders shall **disclose the applied breeding techniques**. Organic plant breeders shall make the information about the methods, which were used to develop an organic variety, available for the public latest from the beginning of marketing of the seeds.

The IFOAM NORMS for Organic Production & Processing Version 2012



Requirements:

4.7.4 The **genome is respected as an impartible entity**.

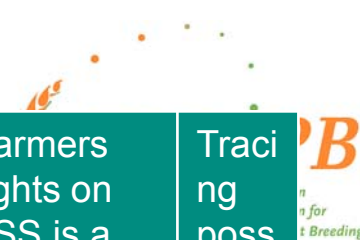
Technical interventions into the genome of plants are not allowed (e.g. ionizing radiation; transfer of isolated DNA, RNA, or proteins).

4.7.5 The **cell is respected as an impartible entity**. Technical interventions into an isolated cell on an artificial medium are not allowed (e.g. genetic engineering techniques; destruction of cell walls and disintegration of cell nuclei through cytoplasm fusion).

4.7.6 The **natural reproductive ability** of a plant variety is respected and maintained. This excludes techniques that reduce or inhibit the germination capacities (e.g. terminator technologies).

~~4.7.7 Organic plant breeders may obtain plant variety protection, but organic varieties shall **not be patented**.~~

Breeding technique	Interference on Genom level	Interference on cell level	Ability of Propagation is affected	Breeder's privilege is affected	Overcoming crossing barriers	Farmers rights on FSS is affected	Tracing possible
Marker assisted selection	No	No	No	No	No	No (Patent?)	No
Double haploids	?	Even.	No	No	No	No	No
Protoplast fusion	?	YES	possibly (Triploids)	possibly (CMS)	possibly	possibly	?
Cytoplasm fusion	No	YES	No	possibly (CMS)	possibly	possibly	?
Chemical mutagenesis, irradiation	YES	YES	No	No	No	No	No
Tilling	YES	YES	No	No	No	No	No
Eco-Tilling	No	No	No	No	No	No	No
Oligonucleotide directed mutagenesis	YES	YES	No	No	No	No	No



Breeding technique	Interference on Genom level	Interference on cell level	Ability of Propagation is affected	Breeder's privilege is affected	Overcoming crossing barriers	Farmers rights on FSS is affected	Tracing possible
Zinkfinger Nucleasen I + II	YES	YES	No	YES (Patent)	No	YES (Patent)	No
Zinkfingernucleasen III (plus Gen construct)	YES	YES	No	YES (Patent)	possibly	YES (Patent)	YES
Cisgenetics	YES	YES	No	YES (Patent)	No	YES (Patent)	?
Transgenes	YES	YES	possibly	YES (Patent)	YES	YES (Patent)	YES
RNA Interferenz (RNAi)	YES	YES	No	YES (Patent)	No	YES (Patent)	No
Reverse Breeding	YES	YES	No	No	No	No	No
Minichromosomen	YES	YES	No	YES (Patent)	YES	YES (Patent)	YES

Consequences for Organic Farming



- **ban on genetically manipulated varieties, incl. cisgenetics** - soybean, maize, cotton, wheat, rape, apple, .
- **ban on varieties from protoplast fusion**
 - CMS hybrids of cauliflower, broccoli,...
- **Clear declaration and transparency needed**
- **build up alternative breeding programmes** for crops, where these techniques have conquered markets
e.g. cotton, soybean
- **Securing GMO-free and cell fusion-free varieties and breeding material** for future breeding
- Define demand for **specific cultivars for organic farming**
- **Coordination and Cooperantion** among different stakeholders needed to tackle the breeding goals

Motion 61: Replacement of Cell Fusion Varieties



The IFOAM G.A. urges the IFOAM World Board to:

- Develop a strategy for the replacement of varieties derived from cell fusion, including protoplast and/ or cytoplasm fusion from organic farming practices.
- Define guidelines for the socio-economic implementation of such strategies.
- Promote alternative breeding programs like organic plant breeding to foster the development of cell fusion free varieties.
- In order to achieve these goals by the next G.A. in 2017, a working group should be established

Motion 62: Guidelines for New Breeding Techniques



The IFOAM G. A. urges the IFOAM World Board to define guidelines for the use of varieties derived from new breeding techniques. This implies:

- evaluating the compliance of new plant breeding techniques using the principles of Organic Agriculture,
- promoting the legally bound declaration of breeding techniques that do not comply with the principles of Organic Agriculture, and
- developing a strategy to prevent varieties derived from such breeding techniques from entering the organic sector.
- In order to achieve these goals by the next G.A. in 2017, a working group should be established

Thanks a lot for your attention

