Reverse Breeding: accelerating innovation

For many years, plant breeding has been a trial and error exercise, whereby new varieties are produced from a cross between parental plants or through self-pollination. The process is based on identifying a desired characteristic in one plant – for instance higher resistance to a specific disease – and crossing it with another plant which allows the desired trait to appear in the offspring. However, a series of unwanted characteristics is transferred as well, which requires several more breeding cycles in order to be replaced by desired traits. This form of breeding takes many years to accomplish, which represents a very long time span given the need to rapidly address issues linked to climate change and food security. In order to speed up the process and allow for more precision and efficiency, new methods are needed. Several New Breeding Techniques (NBTs) have already been developed, among which Reverse Breeding.

A new way of breeding

Reverse Breeding allows production of new hybrid plant varieties in a much shorter timeframe and ambient numbers compared to conventional plant breeding techniques. In Reverse Breeding (illustrated in Figure 1, below), an individual plant is chosen for its elite quality (Fig. 1 A). By suppressing normal genetic recombination (Fig. 1 B&C), homozygous parental lines are derived from this plant. Upon crossing, these parental lines can reconstitute the original genetic composition (Fig. 1 D) of the selected elite plant, from which the lines were derived. During Reverse Breeding, a genetic modification step is employed to suppress genetic recombination (Fig. 1 B), and thus yielding intermediate plants which fall under GMO-legislation (European Directive 2001/18/EU). However, the final selected variety and their parental lines do not contain this genetic modification and thus fall outside the scope of the GMO-legislation.

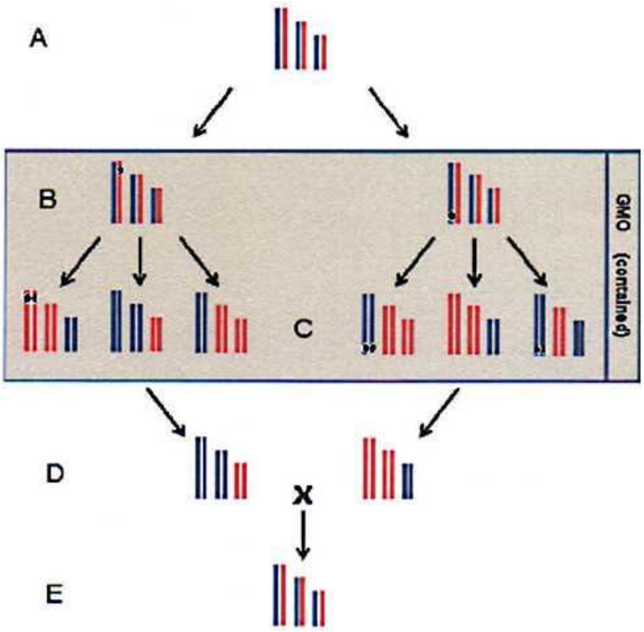

Figure 1. Schematic explanation of the steps involved in Reverse Breeding. A = Original hybrid (field); B = Transformants (intermediate organism, contained); C = Double haploids (intermediate organism, contained); D = Homozygous parental line (resulting organism, field); E = Reconstructed heterozygous offspring (field)

Benefits
Reverse Breeding accelerates the breeding process considerably and increases the number of available genetic combinations which allows breeders to respond much quicker to the needs of farmers and growers with better varieties.

Where could Reverse Breeding be applied?

Practically, Reverse Breeding creates new heterozygous hybrid plant varieties with hybrid vigour (see insert ‘Hybrid vigour’) which would be difficult and time-consuming to obtain through classical breeding. The classical heterozygous hybrids cannot be stably maintained by breeders due to the natural genetic recombination of the chromosomes. Until now, breeders create elite hybrids afresh by crossing homozygous parental lines (forward breeding). Reverse Breeding can construct homozygous parental lines, that, when mated, perfectly reconstitute the selected heterozygous hybrid plant afterwards. These homozygous parents can be propagated indefinitely by breeders.

Hybrid vigour
Hybrid vigour is essential to produce high-yielding varieties in many crops. Reverse Breeding can be used in the crops like; cucumber, onion, broccoli, cauliflower, sugar beet, maize, pea, sorghum, (water-)melon, rice, tomato eggplant and so on. *Source: Nature genetics, volume 44, 2012.*

Although the Reverse Breeding process does involve the use of recombinant DNA, the selected homozygous parental lines and their offspring are <u>non</u> transgenic. The plant varieties that are produced as a result of this application are similar to those that can be produced using conventional breeding techniques.

Reverse Breeding: added value for Europe's economy and innovative potential

Small and Medium sized Enterprises (SMEs), which represent a large part of the EU's innovative plant breeding sector, could especially benefit from Reverse Breeding to answer market demands and develop new varieties that are more sustainable or produce higher yields in a whole range of crops, including fruit and vegetable crops. Before this can happen however, EU Member States must align their position toward Reverse Breeding. If they can build on the notion that the technique creates plant varieties which could also be obtained through conventional breeding, the European plant breeding sector will be freed from expensive regulatory burden and its competitiveness will be given a strong boost. Indeed, companies, and SMEs in particular, will be able to focus their resources on research and valorisation of innovation within Europe rather than having to do so in non-EU countries – an added value for the European agricultural sector and economy as a whole. It will also level the playing field and allow the EU to effectively compete with other markets where the technique could be applied.

About the NBT Platform

The NBT Platform is a coalition of SMEs, large industry and prominent academic research institutes, which strives to bring clarity to the European debate on NBTs. Its aim is to provide policy makers and stakeholders with clear and precise information on NBTs and to generate awareness about their potential benefits for the European economy and society as a whole.

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