New (green) genetic engineering

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EU court verdict – what do we need to know?

The history of plant breeding goes way back in time. As early as 10,000 BC, emmer and einkorn wheat became the first cereal varieties to be specifically selected and cultivated. Later, these varieties came to Central Europe and many other different cereal varieties originated through genetic selection that are being cultivated even today.

Today's systematic plant breeding is based on the hybridisation experiments and observations of Gregor Mendel and the resulting discovery of Mendel's laws in 1866. Intensive cross-breeding has been carried out on this basis since 1900 and continues to be done even today. A majority of varieties available today are a result of this hybridisation and cross-breeding.

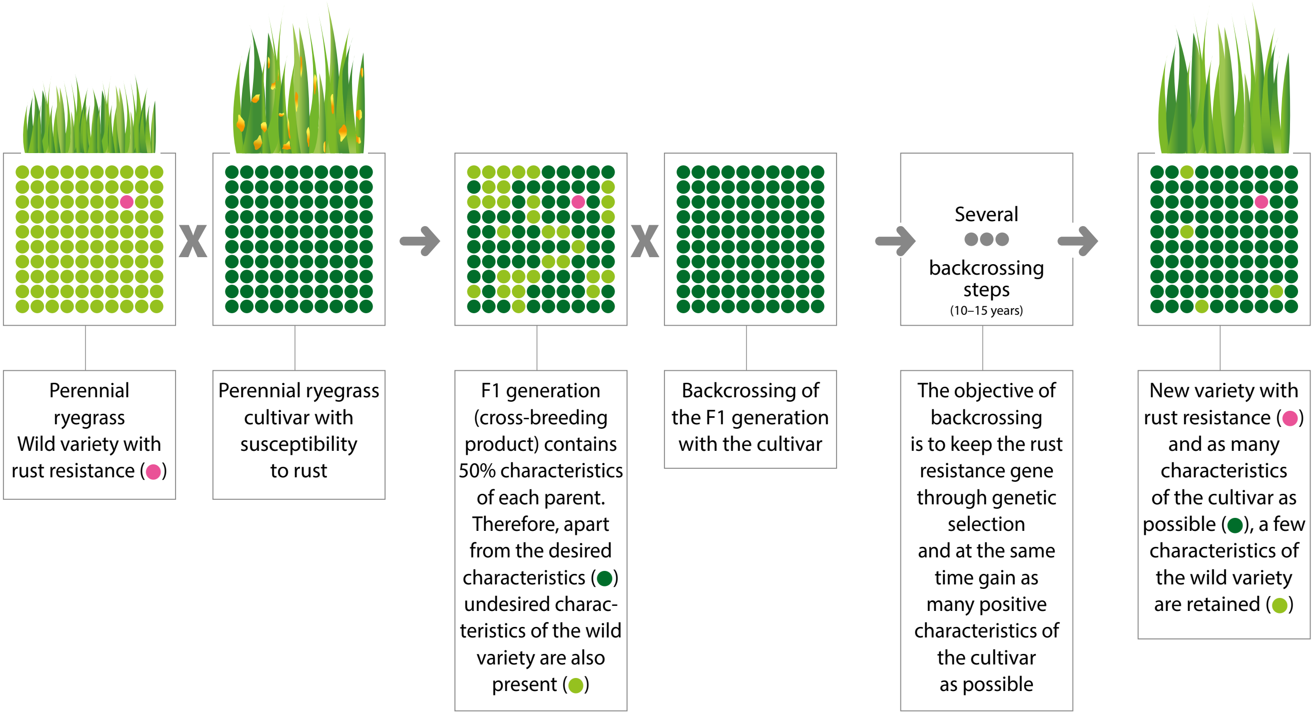
In the last century, a variety's yield was the main priority. This, however, has changed. Specifically desired qualities such as resistance to diseases and ability to adapt to different climatic factors now play a key role in the breeding.

Already existing varieties are usually crossed using the classical hybridisation technique in order to achieve new characteristics. If the desired characteristic is not present in the existing variety, or is only weakly developed, then the use of wild plants expressing appropriate characteristics can be helpful. This, however, generally results in various problems.

Firstly, it is not known whether the newly formed generation has the desired characteristic. Secondly, many other genes and expressions of characteristics are inherited which are often undesirable and existing characteristics, such as yield or quality, are significantly impaired. A new variety can come into being only after many phases of backcrossing.

Classical hybridisation is thus based on species-specific genes, is subject to random distribution of mother and father genes and takes a long time (10–15 years for every new characteristic).

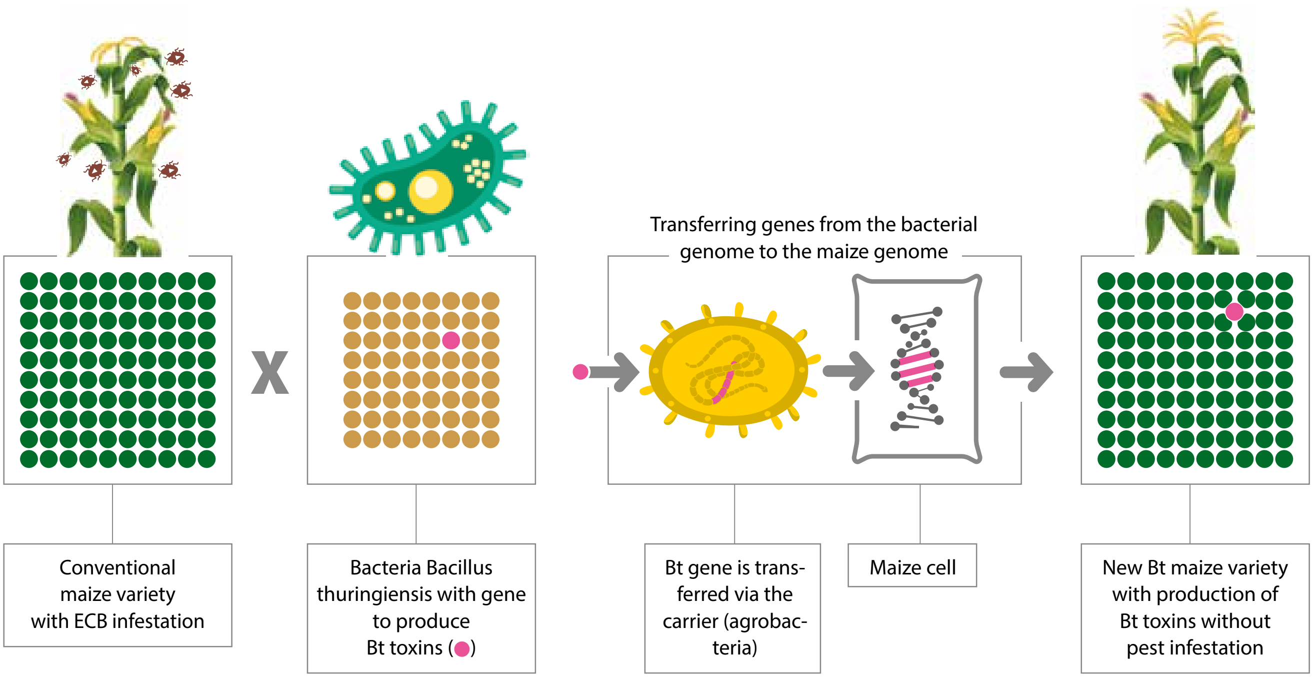
Classical cross-breeding



Classical genetics achieved a new technological breakthrough at the end of the 1990s. In this new method, a gene with the desired resistance, which could theoretically originate from any organism, is introduced into the genome of the cultivated plant. This method, however, is subject to various contingencies as well. The position the target gene will attach in the genome is generally unknown, as well as whether it will be attached multiple times, and whether the integration will damage or even destroy other genes. Laborious, expensive and lengthy tests under isolated conditions are required to control and evaluate the outcome of this genome modification.

Classical genetic engineering thus allows access to non-species-specific genes, involves enormous expenditure and effort and can be controlled only to a limited extent.

Classical genetic engineering



In recent years, an increased knowledge and understanding of cultivated plant genomes and biotechnological advances has given rise to a new (green) genetic engineering, usually known as the CRISPR/Cas system. This technology has two distinct approaches. In the first approach, the species-specific genes are modified: the prerequisites for this approach are that an appropriate resistance gene is known and that it exists in slightly modified form in the cultivated plant. CRISPR/Cas is able to slightly modify the relevant gene with the highest precision and thus "rewrite" it in the required form. This involves a breeding process within the genome of the respective cultivated plant and thus the modification of species-specific gene. The resultant new variety can also be achieved with the aforementioned classical cross-breeding, genetic selection and backcrossing technique. CRISPR/Cas, however, saves a lot of time, is significantly cost-efficient and is performed under highly controlled conditions.

On the other hand, there is a second approach where a non-species-specific gene – using the known process of classical genetic engineering – can be introduced into the plant genome using CRISPR/Cas. This also is a significantly cost-efficient and time-saving method. The process can be better controlled than classical genetic engineering. However, many groups have raised concerns about whether mixing genes from different organisms is sensible or may involve unforeseeable risks.