Genetic Modification Hidden in Novel Breeding Techniques

Haring, M.A.[1] and Lammerts van Bueren, E.T[2]

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Abstract

Plant breeding has experienced an enormous increase in several applications of biotechnology over the past few decades. The most pronounced technology is probably genetic modification (GM). Although GM crops are planted in industrial agriculture worldwide on more than 100 million hectares, organic agriculture has decided to refrain from products using this technology. Drawing the line to keep GM crops out is based on the evaluation of the process of genetic modification and is laid down in several IFOAM statements. Because more and more novel breeding methods that rely on genetic modification techniques are being introduced to develop new varieties, organic agriculture is challenged to evaluate these methods. In this paper, we will describe the essentials of four novel breeding methods: in addition to new techniques such as reverse dihaploid breeding and cisgenesis, marker-assisted breeding and protoplast fusion will also be discussed. These techniques all harbor concepts or processes originating from genetic modification principles. Marker-assisted breeding carries in it the line of thought originating from the gene transfer principle. Breeders only want to transfer selected DNA regions from one variety to another; all other heritable information is ignored. They constantly determine the DNA marker composition of progeny plants, using DNA amplification techniques (PCR) that rely on enzymes produced by genetically modified organisms. Protoplast fusion is already recognized in legislation of several EU countries as being a GM technique. The main application is to transfer a cytoplasmic male sterility trait from one species to another species, which it cannot normally be crossed with. The end product will be a male sterile variety that harbors a piece of DNA from another species. Dihaploid plants originate from a plant tissue culture technique (i.e., anther culture) developed to quickly generate inbred lines. It has been combined with genetic modification to reconstruct parental lines from a hybrid plant with desired properties. The inventors call this approach reverse breeding. Although genetic modification is an essential part of the technique, no traces of the introduced transgene remain in the end product. Finally, the legal description of genetically modified organisms (in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination) has challenged scientists to adjust the gene transfer protocol in such a way that the legal description no longer fits. They have coined the term "cisgenesis" for this purpose. In laymen's terms, this refers to the fact that a potato gene is introduced into the potato genome by gene transfer, a situation that could also have occurred through natural crosses. The cisgenic potato would therefore carry less risk than a traditional transgenic GM plant.

Assessment based on products implies a choice for an ethical approach that only considers the extrinsic consequences of human action by making a risk-benefit analysis. It neglects so-called intrinsic ethical arguments related to the applied technology (the process) itself. The organic movement uses the intrinsic argument of "unnaturalness" against genetic engineering. Therefore, a logical conclusion would be that products of cisgenesis and reverse breeding both should be subject to the current GMO regulations in organic agriculture and should thus be banned from organic agriculture. This also holds for the described example of protoplast fusion. To evaluate molecular marker-assisted breeding we need to distinguish between two aspects: the way such markers are produced and the way they are applied.

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[1] Swammerdam Institute for Life Sciences, University of Amsterdam, Kruislaan 318, 1098SM Amsterdam, The Netherlands, e-mail: haring@science.uva.nl, Internet: www.science.uva.nl/sils

[2] Louis Bolk Instituut, Hoofdstraat 24, 3972 LA Driebergen, The Netherlands, Internet: www.louisbolk.nl