

1 In the past, selective breeding of corn was done by choosing seeds with features such as the ability to grow well in different climates, soil types and produced the most seeds. This means that only the best or most suitable seeds will grow and reproduce.

Planting a seed from a corn plant that appears to have one or more desirable features is not always reliable. Even though its phenotype may seem to be suitable, the genotype (and therefore phenotype) of its offspring may not be suitable. If the original plant had a recessive gene in its genotype there would be a chance of the seed being homozygous recessive. This would mean that the particular phenotype expressed in the original corn plant would not be expressed in the new plant. 2

1 The offspring of selectively bred corn plants will inherit similar genes from its selectively bred parents. Farmers can now deliberately cross two members of the same species that both possess either homozygous dominant or homozygous recessive genes and almost guarantee a purebred offspring. The first way was by using a test cross. By crossing one organism that is showing the dominant form of a trait with another of the same species that is homozygous recessive for the same trait; it is possible to determine the other organism's genotype from the traits expressed in the offspring. Another method is marker assisted selection (MAS). MAS can be useful for traits that are difficult to measure or are expressed late in development. The process for MAS includes mapping and then using this information for marker assisted selection.

When crop plants like corn are artificially bred by selective breeding, there is a noticeable decrease in their genetic diversity. The plants share similar genes with each other which then increases the risk of genetic disease. Similarity within a species means that if the species comes into contact with a disease, there is a high chance of the whole species being wiped out. This will have implications on other things. For instance, it could have detrimental effects on ecosystems if one species is removed from a food chain. 2



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3 Genetic cloning of whole corn plants is another way to produce crops with desirable features. Humans have manipulated the genetic transfer of cloning of plants and animals to meet human demands, particularly those of today with modern culture and living. The genetic modification of an organism is a human manipulation. Bt-corn is a type of genetically modified organism (GMO). The modification of an organism to result in a GMO may involve either, altering an existing gene, adding a foreign gene or modifying an existing gene's expression. This is done to overcome selective breeding and its limitations, as selective breeding is the selection of particular plants and animals to be bred under domestication. Since the development of agriculture, the techniques of modifications resulting in a GMO were developed, but they too just as selective breeding also have their own limitations.

3 A genetically modified organism is a plant (or animal) that has been genetically modified through the addition of a small amount of genetic material from other organisms through molecular techniques. A gene that produces a feature of interest is identified and separated from the rest of the genetic material from a donor organism. Most organisms have thousands of genes; a single gene represents only a very small part of the total genetic makeup of an organism.

3 A donor organism can be a bacterium, fungus or even another plant. With Bt corn, the donor organism is a naturally occurring soil bacterium, *Bacillus thuringiensis*, and the gene of interest produces a protein that kills Lepidoptera larvae, in particular, European Corn Borer. This protein is called the Bt delta endotoxin. The Bt delta endotoxin was selected because it is highly effective at controlling Lepidoptera larvae, caterpillars. It is during the larval stage when most of the damage by European Corn Borer occurs. The protein is very selective, generally not harming other insects such as beetles, flies, bees and wasps). Genes from *Bacillus thuringiensis* (Bt) are inserted into corn crop plants to make them capable of producing the insecticidal toxin and therefore resistant to certain pests. Delta endotoxins rapidly affect the insect's digestive system, so damage to the plant stops soon after the insect is exposed to the toxin. Mortality may take several days, so the effects of delta endotoxins are very different from what can be expected from conventional insecticides. 4

There are many different Bt corn hybrids available. Some experimental transgenic plants have caused allergic responses in humans. There are no known serious human health effects associated with Bt corn. However, a biological implication of Bt corn is the possible negative effects it can have on populations other than those intended. A study done in 1999 found that Bt corn is also toxic for Monarch butterfly larvae. They suffered a significant decrease in fitness when their normal diet was dusted with Bt corn pollen. Bt corn can adversely affect non-target insects if they are closely related to the target pest, as is the case with Monarch butterfly. These adverse effects are considered minor, relative to those associated with the alternative of blanket insecticide applications. 4

A biological implication of pest resistant Bt corn is that there is less genetic diversity in the species. If all the corn plants have identical DNA they will all be susceptible to the same things, such as diseases, drought and herbicides/pesticides. Bt corn has revolutionized pest control in a number of countries, but there still are questions about its use and impact on other species. Also, the control of insects by Bt corn has many scientists worried that overuse of Bt corn could produce pests resistant to Bt toxins. The resistance to Bt corn has already happened occurred for two moth species: fall armyworm, *Spodoptera frugiperda*, in Puerto Rico, and African stem borer, *Busseola fusca*, in South Africa, so this concern is warranted. 4