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Understanding the Basics of Heirloom, Hybrid, and Genetically Modified Organisms (GMO) Seeds

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Introduction

In order to make informed decisions about the seeds you want to acquire and plant, it is important to know the different types of seeds available today. In this fact sheet, heirloom, hybrid, and genetically modified seeds will be discussed. The discussion starts out with low or no intentional breeding and ends with the current state of the art technology in seed improvement.

Heirloom seeds

Heirloom plants are commonly known as "old" varieties of fruits, vegetables, and flowers with particular traits that have been grown and kept for a certain length of time, or passed on through generations from individuals or groups of growers who preserved them. Generally, they have not undergone much, if any, breeding by humans (Clemson Extension Service, 2016).

Heirloom plants are kept for their desired traits including flower color and shape, fruit and vegetable shape, color, taste, and texture (Figure 1). Although heirloom plants, particularly heirloom vegetables, are seeing a resurgence in popularity, they are still not commonly grown in modern large-scale agriculture because their yields tend to be lower than other seeds that have been specifically bred for certain desirable traits (Wikipedia, 2016).

All heirloom plants are open-pollinated. Meaning that these plants are pollinated through self-pollination and other natural mechanisms of pollination. Self-pollinating plants have "perfect" flowers; they have both male and female reproductive parts. This biological arrangement gives the plant the ability to self-pollinate. By contrast, non-self-pollinating plants are pollinated by wind, insects, birds, and other animals. When isolated properly, open-pollinated varieties will produce seeds that will breed "true." In this case, true means that the next generation of plants from these seeds will yield flowers and fruits that closely resemble traits of the parent plants. If an open-pollinated plant variety is not properly isolated from other varieties of the same or closely-related plant species, however, cross-pollination may occur and can result in seeds that will not yield true-to-breed traits. The production yield of random crossings are thus unknown and desired traits of flowers and fruits found in the parent plant may be lost. Non-self-pollinating plants are at greater risk for cross-pollination than self-pollinating plants. Some self-pollinating plants, such as beans and lettuce, do not need isolation and will breed "true" and yield seeds that will produce flowers and fruits closely identical to their parent plants (Herring, 2003).

Figure 1. Heirloom vegetables come in a variety of colors, tastes, and textures. Source: https://content.ces.ncsu.edu/extension-gardener-handbook/16-vegetable-gardening Cody Maureen, Flickr CC BY - 2.0.

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Hybrid seeds

Unlike the unpredictable behavior of open pollination, a hybrid plant is typically developed by intentionally crossing two distinct varieties of the same species. This type of precise breeding is conducted by humans in controlled environments and is known as 'selective breeding.' Hybrids are usually developed for characteristics that may include uniformity in flower and fruit development, disease resistance, temperature and climate tolerance, earlier and increased yields, higher germination rates, and overall improved plant growth and development. Seed companies choose parent varieties that produce high quality first generation offspring known as 'F1 hybrids.' If breeding work is done well, F1 hybrids (often) result in special characteristics favored by customers of seed companies (Savonen, 2008) (Figure 2). In order to get just the right combination of traits, seed companies can spend a lot of time and money breeding and multiplying seed, and, it is costly. Thus, hybrid seeds are often the most expensive seeds on the market because seed developers need to be paid for their scientific and business efforts.

Interestingly, the next generation of seeds produced by hybrid plants do not usually produce flower and fruit characteristics identical to the parent hybrid plant. This is because in the next generation, the plant's genes have combined in different combinations and thus, the most desirable traits are (most likely) lost. What this means to growers is that seeds coming from hybrid plants are of little value if predictability in the next crop is desired. Thus, seed for hybrid varieties must be purchased year-after-year from the seed companies or nurseries, unless the grower wants to gamble growing an array of offspring (Savonen, 2008).

Genetically modified organism (GMO) seeds

In the case of plants, genetically modified organisms (GMO), also known as 'transgenic plants,' are plant varieties developed by inserting a gene from another organism, typically a plant, into another plant (Herring, 2003). A genetically modified organism (GMO) is any organism whose genetic material has been altered using genetic engineering techniques (i.e., a genetically engineered organism). Development of a GMO is a step above selective cross-pollinating of hybrids because of the speed and accuracy of the technology to insert the desired genetic traits.

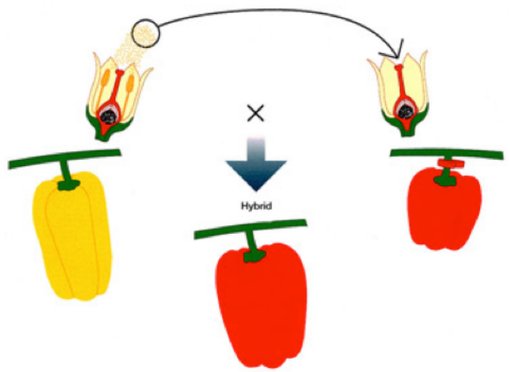

Figure 2. Illustration of hybrid fruit development from controlled cross-pollination. Source: http://www.coventrymysteries.com/wp-content/uploads/2012/09/Seed-Hybrid-Diagram-Monsanto.jpg

GMO technology also now allows for the transfer of genes between different organisms. For example, a modified tomato plant's beetle resistance relies on a gene from a harmless bacterium (*Bacillus thuringiensis*), which scientists inserted into the tomato plant's genome. This particular gene, 'cry1Ac', encodes a protein that is poisonous to certain types of insects, including the beetle. Once the new gene has been introduced, the plant can be bred to create new plant seeds that pass the gene from the current generation to the next. There are several gene transfer techniques and Figure 3 illustrates one of them, the "gene-gun" approach (Genetic Science Learning Center, 2013).

The GMO Controversy

GMO (foods) are the subject of protests, vandalism, referenda, legislation, court action, and scientific disputes. Numerous entities including government regulators, consumers, scientists, and other organizations debate GMOs. Topics of debates on GMOs include whether food containing GMO-related ingredients should be labeled, the effect of GM crops on health and the environment, the potential impact on farmers, and GMO foods' roles in feeding the world, and how the scientific techniques could be used to breed higher-yielding plants for energy production (Wikipedia, 2017).

The use and legality of GMO (crops) varies by country. There is significant scientific consensus that currently available/approved foods containing GMO ingredients are no more dangerous to human health than foods derived from non-GMO crops. There is some support, however, that each GMO food needs to be tested for real risks on a case-by-case basis before introduction. In the United States, no ill effects from GMO foods to the human population has ever been documented by credible scientists. Thus, the United States Food and Drug Administration does not require labeling, and does not recognize a distinction between approved GMO and non-GMO foods (Wikipedia, 2017).

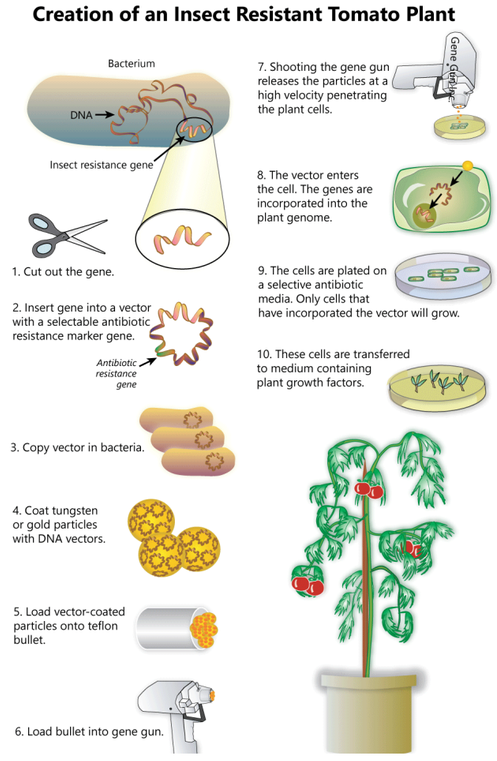

Figure 3. Generic engineering – the 'Gene-gun' approach. Source: Genetic Science Learning Center, 2013.

Key Points

It is important to know the origins of different seeds, and be able to use that information to pick the right seeds for the right task. Here is a summary of the seed types just discussed.

- *Heirloom* seeds are "old" varieties kept, preserved, and passed down to newer generations of growers. Heirlooms are preserved for desired traits, particularly taste, texture, color, and shape, and historical context. If isolated properly, seeds from heirloom plants (like all non-hybrid, open-pollinated plants) will breed "true."

- A *hybrid plant* is typically developed from cross-pollinating two distinct varieties of the same species. The seed from this selective cross-pollination will yield a flower or fruit of desired characteristics which may include color, size, shape, disease-resistance, early harvest, increased yields, and uniformity. Seeds from hybrid fruits will likely not breed "true" to the hybrid parent plant and thus seeds need to be purchased each growing season.

- *GMO* (plants, crops, foods), or transgenic plants, are derived from transferring genes of one organism to another organism by genetic engineering methods. This method is the most precise technique for developing plants with the most desired traits.

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