



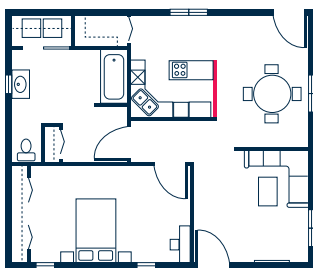
Gene Editing

A technique that allows plant breeders to make targeted improvements within a plant's existing DNA. Gene editing tools, such as CRISPR-Cas9, will help plant breeders integrate desirable traits into improved seed products with greater efficiency & specificity than ever before.

HOW: DNA is the biological "blueprint" for all living things. And similar to how an architect uses a blueprint to make changes to a house, gene editing tools allow us to make specific & targeted improvements to a plant's genome blueprint.

Deletion

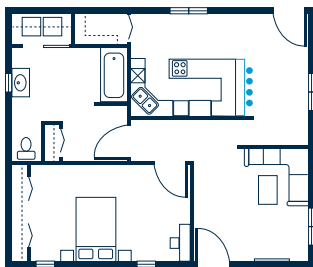
Loss of Function



Just like strategically removing a wall can improve a house by creating more open space, gene editing tools can make deletions in the DNA blueprint, or genome, to improve a plant.

Replacement

Change in Function



Gene editing tools can also make replacements in the DNA blueprint enabling new traits, like replacing a table & chairs with a kitchen bar, creating a new seating arrangement.

WHY: Gene editing tools enable plant breeders to make targeted changes within a plant's DNA that offer new solutions and benefits to consumers & farmers that support modern agricultural practices around the world.

For example, it can be used to:

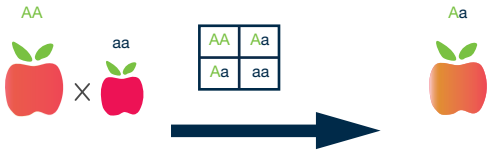
- /// Deactivate an unfavorable characteristic such as disease sensitivity or reduced gluten.
- /// Enable a beneficial characteristic such as drought tolerance or improved nutrition.
- /// Break a genetic link between beneficial & unfavorable characteristics such as between disease resistance and drought sensitivity.

Want to know more?

- (Legacy) Monsanto: Learning Lessons from Nature: Gene Editing (bit.ly/2rpgwh3)
- American Seed Trade Association – Seed Innovations (bit.ly/2kNcEmd)
- The Center for Food Integrity - Downloadable Engagement Guide to Help Communicate about Gene Editing (bit.ly/2rievU2)
- CropLife International – Plant Breeding Innovation (bit.ly/2qoMHxF)
- Best Food Facts: What is CRISPR Technology Video Series (bit.ly/2UmwPZi)

Techniques to Create Genetic Variation

Genetic diversity drives selection of desired traits and adaptation; even the earliest breeding techniques has accomplished this since the very beginning of civilization.



Breeding: Combining two sexually compatible species to create a new & improved variety with the desired characteristics of the parents.

By crossing two apple varieties with desirable traits, the University of Minnesota developed the Honeycrisp apple for ideal sweetness, firmness, tartness and shelf life. These apples have become a prized consumer commodity.



Mutagenesis: Use of physical or chemical mutagens to induce random genetic changes, activating new & desirable characteristics.

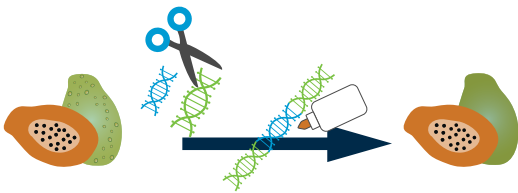
Ruby Red grapefruits were created by exposing seeds to radiation causing a mutation resulting in a deep red fruit color and today still remains the most popular grapefruit variety.

2 Sets of Chromosomes



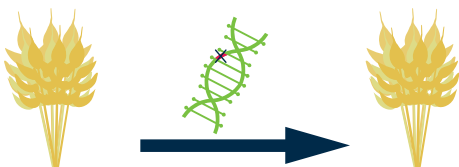
Polyploidy: An uneven pairing of chromosome sets occurring after cell division.

Seedless watermelons are a result of crossing two varieties of watermelons with a different number of chromosomes. This method results in a variety of seedless fruits, desired and valued by consumers.



Transgenesis: Addition of desirable genes from another species resulting in a plant with new & beneficial characteristics.

Papaya is a flagship crop in Hawaii and was almost completely lost to the Papaya Ringspot Virus. The University of Hawaii developed Rainbow papaya containing a gene giving this variety resistance to the virus and production has fully rebounded.



Gene Editing: Use of a DNA editing tool such as CRISPR-Cas9, to target a deletion or replacement at a specific location within the cell's DNA.

Low-gluten wheat has been developed by an international academic collaboration between the US and Spain. By making targeted deletions in the genome of specific wheat varieties, this resulted in a reduced amount of a specific gluten protein. All other characteristics remain the same. No product has yet been commercialized, but this will benefit consumers with non-celiac gluten sensitivity.