Throughout the world, crops are being modified in a number of ways to produce new superior traits *(characteristics of interest)*.

Some of these techniques include:

Sexual hybridization (used in Conventional Breeding)

Combining two sexually compatible species by cross pollination to create a variety with the desired traits of the parents.

The Honeycrisp Apple gets its famous texture and flavor by blending the traits of its parents.

Mutagenesis (used in Mutagenic Breeding)

Use of physical or chemical mutagens to induce random mutations, creating the desired trait.

Radiation was used to produce a deeper colour in the red grapefruit.

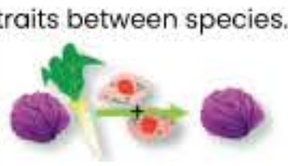
Transgenesis (used in the production of genetically modified (GM) crops)

Addition of genes from any species to create a new variety with desired traits.

The Rainbow Papaya is modified with a gene that gives a resistance to the Papaya Ringspot Virus.

Protoplast Fusion

Fusion of cells or cell components to transfer traits between species.



Male sterility is transferred from radishes to red cabbage by fusing their cells. Male sterility helps plant breeders make hybrid crops.

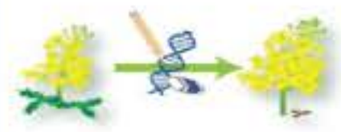
Polyploidy

Multiplication of the number of chromosomes in a crop to impact its fertility.

Seedless watermelons are created by crossing a plant with 2 sets of chromosomes with another that has 4 sets. The seedless fruit has 2 sets.

Genome Editing

The use of an enzyme system to modify DNA directly within the cell.



Genome editing was used to develop herbicide resistant canola to help farmers control weeds.

Adapted from www.biofortified.org

SASRI has pursued three such techniques in our breeding programme in order to improve sugarcane varieties for growers. They include:

- Cross pollination within our conventional breeding programme;
- Mutagenesis; and
- Transgenesis.

Conventional breeding

Conventional breeding at SASRI involves the selection of parents, managing pollination when the cane flowers in climate-controlled glasshouses, followed by field-based selection over many years until a superior new 'N' variety is released.

Mutagenic breeding

e.g. N12 Zapyr = imazapyr tolerant

Mutagenic breeding involves exposure of sugarcane cells in the laboratory to a chemical mutagen. This is followed by a protocol to select mutated cells and plants, and eventually field-based evaluation. This technique was used to create N12 Zapyr which is tolerant to the herbicide Arsenal ® (active ingredient imazapyr).

The recommended application of Arsenal® (as per the herbicide label) is to soil prior to planting, following a waiting period as the herbicide has a high residual soil activity. The advantage of N12 Zapyr is that it can be planted directly into treated soil without compromising germination.

Transgenesis

(Genetic modification or "GM")

e.g. Bt eldana resistant cane currently under development

Genes coding for a protein that acts specifically against lepidopteran insects such as eldana, have been transferred from a soil bacterium *Bacilus thuringiensis* (Bt) into sugarcane via microprojectile bombardment.

Genetically modified (GM) sugarcane is being evaluated in eldana bioassay trials and a high level of protection is being observed. Extensive testing will be carried out over the next five years including field trials in different part of the industry, before applying for a General Release permit for commercial cultivation from the GMO Registrar (DALRRD) as per the GMO Act (Act 15 of 1997).