GMO Technologies:

Transferring specific genes to crop plants

--Precise and efficient;
--Most powerful;
--Expensive for deregulation
--Publically less acceptable;
--Possible gene flow.
GMO plants are not monsters.
Some Impact of GMO Crop Plants

--We have consumed GMO food since 1997.

--Near 100% soybean, cotton and corn planted in the US are GMO.

--Up to 80 percent of packaged foods contain GMO ingredients.

Near 100% Soybean, Cotton and Corn Planted Are GMO

Credit to: https://www.beefmagazine.com/crops/gmo-crop-prevalence-nearly-100
Bt corn uptake and insecticide use in U.S. corn fields

Adapted from Malakof D. and Stokstad E. Pesticide Planet. Science Magazine. 16 August 2013.
Fundamentally the same:

Traditional and GMO breeding methods both are involved in gene transfer.
Effectiveness and public acceptance of three major plant breeding technologies

- GMO
- Gene editing
- Traditional breeding

Effectiveness:
- Most
- Least

Acceptance:
- Most
- Least
We need to use all possible tools to improve crop yield to feed the World.

Source: FAO, United Nations, WHO
Improving crop yield also reduces impact on precious natural resources.

Thank your attention!
**Gene editing technologies**

**Modify native genes in plants**

-- Precise and efficient;
-- No foreign genes in plants;
-- Limited to native plant genes;
-- Less powerful than GMO;
-- Similar to conventionally bred, not regulated in US.

**Figure:**
- **Gene editing technologies**
- **Cas9/sgRNA**
- **Editing native genes to create drought tolerance. No foreign genes moved in**
- **New drought tolerant and high seed yield corn variety**
- **The modification may create drought tolerance**
USDA greenlights gene-edited crops

Agency says techniques like CRISPR are equivalent to traditional plant breeding.
Timeline of selected traits modified by genome editing in plants, animals and for medical applications (red)

- Herbicide resistance in var. crops
- Blight-resistant rice
- Powderly mildew-resistant wheat
- High yield waxy corn
- Potatoes with altered starch
- Non-browning mushroom
- Virus-resistant cucumber
- Gluten-free wheat

2012
- Hornless milk cows
- TALENs used to fight leukemia in two infant girls

2015
- Soybean with reduced trans-fats

2016
- Herbicide resistant canola
- High yield waxy corn
- CRISPR clinical study to cure lung cancer in China
- In vitro CRISPR trials to cure HIV
- Tuberculosis-resistant cattle

2017
- Non-browning mushroom
- Virus-resistant cucumber
- CRISPR clinical trials to cure var. cancer in the US

2020
- High yield rice
- High yield waxy corn
- Non-allergenic apples and peanuts
- Improved abiotic behaviour
- Cancer treatment
- Farm animals with var. resistances against virus and bacterial diseases
Traditional Breeding technologies:

Transferring tens of thousands of genes from one plant to another.

--Most currently used crops were bred using this approach;

--Publically acceptable;

--Not precise and inefficient.

**Diagram:**

- **P1** - High yield but drought sensitive
- **P2** - Drought tolerant but low yield
- **F1** - Drought tolerant but low seed yield
- **P1 x P2**
- 6-10 generations of backcrosses and selections
- New drought tolerant and high seed yield corn variety
Traditional breeding techniques have played an important role in crop yield increase in the last 70 years. Most traits in major crops were bred from the traditional techniques.
Using traditional breeding techniques, we have developed low mowing frequency lawn grasses and non-invasive burning bush.

Sterile, non-invasive burning bush (Euonymus alatus)

Conventional lawn grass, mowing once a week

Low mowing frequency lawn grass, mowing once a month
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