

Introduction to Plant Breeding

Introduction to Plant Breeding

Key concepts, objectives, methods, and modern tools

1. What Is Plant Breeding?

Aspect	Description
Definition	The scientific art of improving plant traits to meet human needs (food, fiber, fuel, ornamental, etc.).
Goal	Develop new varieties that are higher-yielding, more nutritious, disease-resistant, climate-adapted, and/or have desirable agronomic and quality traits.
Scope	Includes traditional selection, hybridization, mutation breeding, and modern molecular/genomic approaches.

2. Historical Milestones

Period	Milestone	Impact
Pre-1900	Early farmer selection & domestication of wild species.	Foundation of genetic variation for crops.
1900-1930	Mendelian genetics applied to crops (e.g., wheat, maize).	Systematic crossing and predictable inheritance.
1930-1960	Development of hybrid corn; establishment of national breeding programs.	Massive yield gains through heterosis.
1960-1990	Mutation breeding (radiation, chemicals) and early tissue culture.	New traits and disease resistance.
1990-2005	Marker-assisted selection (MAS) and early transgenic crops.	Faster selection, precise introgression of genes.
2005-present	Genomic selection, CRISPR/Cas genome editing, speed breeding.	Accelerated breeding cycles, multi-trait improvement.

3. Core Objectives of Plant Breeding

Introduction to Plant Breeding

1. **Yield Improvement** – increase grain, fruit, or biomass per unit area.
 2. **Stress Tolerance** – drought, salinity, heat, cold, flooding.
 3. **Disease & Pest Resistance** – durable resistance to viruses, fungi, insects.
 4. **Quality Enhancement** – nutritional content, processing traits, taste, shelf life.
 5. **Adaptation to Agronomic Practices** – mechanization compatibility, planting density, fertilizer use.
 6. **Sustainability** – reduce inputs (pesticides, water), improve soil health, support agroecology.
-

4. Breeding Methods Overview

Method	Principle	Typical Use	Advantages	Limitations
Mass Selection	Choose best performing individuals from a population.	Early-stage crops, self-pollinated species.	Simple, low cost.	Slow genetic gain, limited control of specific traits.
Pedigree Selection	Track ancestry of selected individuals across generations.	Self-pollinated crops (e.g., wheat, rice).	Precise fixation of traits.	Labor-intensive, long cycles.
Hybrid Breeding	Exploit heterosis by crossing inbred lines.	Maize, sorghum, many vegetables.	High vigor & yield.	Requires production of inbred parents, seed purity.
Backcross Breeding	Introgress a specific trait from donor into elite recurrent parent.	Disease resistance genes, quality traits.	Rapid recovery of elite background.	May retain linked undesirable genes (linkage drag).
Mutation Breeding	Induce random mutations (radiation, chemicals) and select mutants.	Novel traits not present in germplasm.	Generates new variation.	Random, may need large screening populations.
Marker-Assisted Selection (MAS)	Use DNA markers linked to target genes for selection.			