📄 Cheat Sheet 1 – Plant Breeding: Definition, Scope & Aims 🌾

🔹 Definition

- **Plant Breeding** = the **art and science of improving plants** by altering their heredity for human benefit.
- Combines **traditional methods** (selection, hybridization) and **modern tools** (biotechnology, genetic engineering).

🔹 Scope of Plant Breeding

- **Yield improvement** → e.g., high-yielding wheat, rice.
- **Resistance to stresses** → biotic (disease, pests) & abiotic (drought, salinity).
- **Quality traits** → protein-rich pulses, vitamin-enriched rice (Golden rice).
- **Adaptability** → varieties suitable for diverse soils & climates.
- **Industrial use** → cotton (fiber), sugarcane (sugar), oilseeds.
- **Conservation** → preservation of crop genetic resources.

🔹 Aims of Plant Breeding

1. High yield.
2. Biotic stress resistance (diseases, insects).
3. Abiotic stress resistance (drought, heat, salt).
4. Improved quality (nutrition, flavor, storage).
5. Early maturity (short-duration crops).
6. Better adaptability (wide cultivation).
7. Economic traits (fiber length, oil %, sugar content).

🔹 Domestication

- Conversion of wild plants into cultivated crops.
- Selected for **larger seeds, non-shattering, uniform maturity**.
- Examples:
    - Wheat & barley (Fertile Crescent).
    - Maize (Mexico).
    - Rice (India/China).
    - Cotton (India, America).

◈ Plant Introduction

- Transfer of plant varieties across regions.
- **Intercontinental**:
  - Groundnut (South America → India).
  - Rubber (Brazil → Asia).
  - Mexican wheat (to India during Green Revolution).
- **Interstate**: crops moved across Indian states.
- Requires **acclimatization** for success.

◈ Mnemonics 💡

- **Aims of Plant Breeding = "Y-QEAR"**
  - **Y**ield
  - **Q**uality
  - **E**arliness
  - **A**daptability
  - **R**esistance

◈ Exam Capsule 🎯

- Plant breeding = genetic improvement of crops.
- Scope: productivity, resistance, quality, adaptability.
- Aims: yield ↑, quality ↑, stress resistance ↑, maturity ↓.
- Domestication & plant introduction supply raw material for breeding.

📄 Cheat Sheet 2 – Agencies & Risks in Plant Breeding 🏛️🌾

◈ Major Agencies in India

1. **IARI (Indian Agricultural Research Institute, New Delhi)**
   - "Pusa Institute."
   - Pioneered crop improvement research in India.
   - Key role in Green Revolution (wheat & rice).
2. **FRI (Forest Research Institute, Dehradun)**

- Works on forest trees & medicinal plants.

3. **BSI (Botanical Survey of India, Kolkata)**
    - Maintains national herbarium & plant biodiversity records.
    - Helps in documentation of wild relatives of crops.
4. **ICAR (Indian Council of Agricultural Research)**
    - Apex body for agricultural education & research.
    - Coordinates breeding programs across India.
5. **NSC (National Seeds Corporation)**
    - Produces & distributes high-quality breeder & foundation seeds.
6. **SSC/SSCA (State Seed Corporations/State Seed Certification Agencies)**
    - Handle certification, multiplication & distribution at the state level.

◈ Risks of Plant Introduction

- Along with useful traits, **undesirable traits may spread**:

1. **Diseases**
    - Example: Late blight of potato introduced to Europe.
2. **Pests**
    - Example: Cotton boll weevil in America.
3. **Weeds**
    - Example: *Parthenium hysterophorus* (congress grass) introduced accidentally in India.

◈ Precautions

- Quarantine checks at ports.
- Screening & acclimatization before large-scale introduction.
- Controlled trials in experimental fields.

◈ Mnemonics 💡

- **Agencies → "I Fix Better National Seeds"**
    - **I**ARI
    - **F**RI
    - **B**SI

- **N**SC
- **S**SC

🔹 Exam Capsule 🎯

- Agencies: IARI, FRI, BSI, ICAR, NSC, SSC.
- Risks: introduction may bring diseases, pests, weeds.
- Example: *Parthenium* weed, late blight of potato.
- Solution = quarantine + acclimatization.

📄 Cheat Sheet 3 – Steps in Plant Breeding & Selection Methods 🌾

🔹 Steps in Plant Breeding

1. **Collection of Variability**
   - Germplasm collection from native & exotic sources.
2. **Evaluation & Characterization**
   - Study useful traits (yield, disease resistance).
3. **Selection of Parents**
   - Best varieties chosen for hybridization.
4. **Hybridization**
   - Crossing of selected parents.
5. **Selection in Progeny**
   - Desirable recombinants selected.
6. **Testing & Evaluation**
   - Multi-location trials for adaptability.
7. **Release & Multiplication**
   - Superior variety released for cultivation.

🔹 Selection Methods

1. **Mass Selection**
   - Plants with desirable traits chosen & seeds bulked.
   - Merits: simple, cheap, maintains variability.
   - Demerits: less uniform, not useful for self-pollinated crops.
   - Example: Improvement in wheat, maize.

2. **Pure Line Selection**
    - Selection from progeny of a **single homozygous plant**.
    - Produces highly uniform varieties.
    - Merits: uniformity, stability.
    - Demerits: narrow genetic base, less adaptable.
    - Example: Many improved rice & wheat varieties.
3. **Clonal Selection**
    - Used for **vegetatively propagated crops**.
    - Superior plants cloned → propagated by cuttings, tubers, grafts.
    - Merits: uniformity, easy to maintain.
    - Demerits: no new variation.
    - Example: Potato, banana, sugarcane, mango.

🔹 Mnemonics 💡

- **Steps = "Cool Elephants Select Happy Small Tame Rabbits"** 🐘🐇
    - **C**ollection → **E**valuation → **S**election → **H**ybridization → **S**election → **T**esting → **R**elease

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🔹 Exam Capsule 🎯

- Plant breeding steps = collection → evaluation → selection → hybridization → testing → release.
- Selection methods:
    - **Mass selection** (bulk seeds).
    - **Pure line** (single homozygous line).
    - **Clonal** (vegetatively propagated crops).

📄 Cheat Sheet 4 – Hybridization Basics 🌸🌿

🔹 Definition

- **Hybridization** = process of **crossing genetically different plants** to combine desirable traits into one genotype.
- Produces **hybrids** with improved yield, resistance, or quality.

🔹 Objectives of Hybridization

1. Combine traits of two or more parents.
2. Develop disease- and pest-resistant crops.
3. Improve yield & quality (nutrition, fiber, oil content).
4. Introduce earliness, adaptability, stress tolerance.
5. Create novel variations for further selection.

◈ Basic Steps in Hybridization

1. **Selection of Parents** – superior plants chosen.
2. **Emasculation** – removal of stamens from bisexual flowers before anther dehiscence (to prevent self-pollination).
3. **Bagging** – covering emasculated flowers with paper/plastic bags.
4. **Artificial Pollination** – transfer of pollen from chosen male parent.
5. **Re-bagging** – to prevent contamination.
6. **F_1 Generation** – shows **hybrid vigor (heterosis)**.
7. **F_2 Generation** – segregation, recombination, variation.

◈ Types of Hybridization (Basic Classification)

- **Intraspecific** – between varieties of same species (wheat × wheat).
- **Interspecific** – between two species of same genus (sugarcane).
- **Intergeneric** – between different genera (triticale = wheat × rye).

◈ Features of Hybrids

- **F_1 generation** → uniform, vigorous.
- **F_2 generation** → shows segregation (useful for selection).
- **Commercial hybrids** often maintained only at F_1 level (e.g., maize).

◈ Mnemonics 💡

- **Hybridization Steps = "Every Boy Always Re-bags Flowers"** 🌸
  - **E**masculation
  - **B**agging
  - **A**rtificial pollination
  - **R**e-bagging

- F_1 generation

🔹 Exam Capsule 🎯

- Hybridization = crossing genetically different plants.
- Steps: emasculation → bagging → pollination → re-bagging → F_1 → F_2 .
- Objectives: combine yield, resistance, adaptability, quality.
- Produces hybrids with **heterosis** in F_1 and **variation** in F_2 .

📄 Cheat Sheet 5 – Hybridization in Self- & Cross-Pollinated Crops 🌾🌸

🔹 In Self-Pollinated Crops

- Aim: combine useful characters into one homozygous line.
- Common methods:

1. **Pedigree Method**
    - Selection of superior plants in F_2 .
    - Maintains pedigree record for successive generations.
    - Example: wheat, rice.
2. **Bulk Method**
    - Large population advanced without selection up to F_5 –F_6 .
    - Natural selection operates.
    - Selection done later.
    - Example: barley.
3. **Backcross Method**
    - Repeated crossing with **recurrent parent**.
    - Used for transferring a single trait (disease resistance).
    - Example: wheat resistant to rust.

🔹 In Cross-Pollinated Crops

- Aim: exploit heterosis (hybrid vigor).
- Methods:

1. **Single Cross**
    - Cross between two inbred lines.
    - Example: maize hybrids.

2. **Double Cross**
    - Cross between two single crosses.
    - Produces more variability.
3. **Three-Way Cross**
    - Cross between a single cross and another inbred line.
4. **Top Cross**
    - Inbred line × open-pollinated variety.
    - Used for testing combining ability.
5. **Synthetic Varieties**
    - Produced by intercrossing several selected genotypes.
    - Example: fodder crops.

◈ Key Differences

- **Self-pollinated crops** → methods stabilize homozygosity.
- **Cross-pollinated crops** → methods maintain heterozygosity & exploit heterosis.

◈ Mnemonics 💡

- **Self-pollinated → "PBB"**
    - **P**edigree
    - **B**ulk
    - **B**ackcross
- **Cross-pollinated → "SDT-S"**
    - **S**ingle
    - **D**ouble
    - **T**hree-way
    - **S**ynthetic

◈ Exam Capsule 🎯

- Self-pollinated: pedigree, bulk, backcross.
- Cross-pollinated: single, double, three-way, top crosses.
- Self → stabilize lines; cross → exploit heterosis.

📄 Cheat Sheet 6 – Types of Hybridization 🌾🌿

🔹 1. Intraspecific Hybridization

- Cross between two varieties/strains of the **same species**.
- Aim: combine desirable traits within a species.
- Example:
  - Rice variety (IR8 × Basmati).
  - Wheat high-yield × wheat rust-resistant.

🔹 2. Interspecific Hybridization

- Cross between two **different species** of the same genus.
- Produces hybrids that may be fertile or sterile.
- Example:
  - Sugarcane (*Saccharum officinarum* × *S. spontaneum*) → high sugar + hardiness.
  - Potato (*Solanum tuberosum* × *Solanum demissum*) → late blight resistance.

🔹 3. Intergeneric Hybridization

- Cross between species of **different genera**.
- Often requires chromosome doubling (polyploidy) for fertility.
- Example:
  - **Triticale** (*Triticum* × *Secale*) → wheat × rye hybrid, combines yield + hardiness.
  - **Raphanobrassica** (Radish × Cabbage) – Heterogeneous result, not commercially successful.

🔹 Key Outcomes

- Intraspecific: easy, stable, fertile hybrids.
- Interspecific: useful for disease resistance, stress tolerance.
- Intergeneric: novel crops, often artificial polyploids.

🔹 Mnemonics 💡

- **Types = "S-I-I"**
  - **S**ame species → Intraspecific.

- **I**nterspecific → Different species (same genus).
- **I**ntergeneric → Different genera.

🔹 Exam Capsule 🎯

- Hybridization types:
  - Intraspecific → within species (wheat × wheat).
  - Interspecific → between species (sugarcane).
  - Intergeneric → between genera (triticale).
- Used to combine yield, resistance, adaptability, or novelty.

✅ That's **Cheat Sheet 6**.

👉 Do you want me to continue with **Cheat Sheet 7 – Mutation Breeding (concept, mutagens, examples like Norin-10, rice, barley, chlorina tobacco)?**

You said:

continue

ChatGPT said:

Alright 👍 Let's now go into **Mutation Breeding**.

📄 Cheat Sheet 7 – Mutation Breeding ⚡🧬

🔹 Definition

- **Mutation breeding** = creating **new crop varieties** by artificially inducing mutations using **physical or chemical mutagens**.
- Objective: develop traits not found in natural variation (disease resistance, dwarfness, early maturity).

🔹 Mutagens Used

1. **Physical Mutagens**
   - X-rays, Gamma rays, Neutrons, UV radiation.
2. **Chemical Mutagens**
   - EMS (Ethyl Methane Sulfonate).
   - Mustard gas.
   - Sodium azide, nitrous acid.

◈ Procedure

1. Select parent material.
2. Expose seeds/cells to mutagen.
3. Grow M_1 generation (mostly heterozygous).
4. Select mutants in M_2 generation (stable lines).
5. Evaluation & release.

◈ Examples

- **Norin-10 Dwarf Wheat** (Japan → introduced into India during Green Revolution).
- **Rice**: “Sharbati Sonora,” “Jagannath,” “Pusa Basmati-1.”
- **Barley**: disease-resistant mutants.
- **Chlorina mutant in Tobacco** (classic example in teaching).

◈ Advantages

- Quick method to develop new traits.
- Creates variability where none existed.
- Can improve both cross- and self-pollinated crops.

◈ Disadvantages

- Most mutations harmful or sterile.
- Requires screening of huge populations.

◈ Mnemonics 💡

- **Mutation = “Man-Made Magic”** → New traits appear suddenly.

◈ Exam Capsule 🎯

- Mutation breeding = induction of mutations by radiation/chemicals.
- Mutagens: gamma rays, EMS, sodium azide.
- Examples: Norin-10 wheat, rice mutants, barley, chlorina tobacco.
- Useful for dwarfness, resistance, quality improvement.