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Use of Plant Genetic Resources for In Situ and Ex Situ Conservation in Crop Improvement

*R. S. Parmar[1] and Sonali B. Chaudhari[2]
[1]Associate Professor and Head, Dept. of GPB, College of Agriculture, Junagadh Agriculture University, Motabhandariya -Amreli(365610), India
[2]Assistant Professor, Dept. of Soil Science, Colleage of Agriculture, Junagadh Agriculture University, Motabhandariya -Amreli(365610), India
*Corresponding Author's email: rakeshparmar@jau.in

Conservation of plant genetic resources involves two primary strategies: in situ and ex situ conservation. In situ conservation focuses on protecting genetic resources within their natural habitats, such as national parks and biosphere reserves, while ex situ conservation involves collecting, preserving, and maintaining genetic resources outside their natural habitats, like in seed banks or botanical gardens. Both methods are crucial and complementary for safeguarding plant diversity. Conservation, evaluation and utilization of plant genetic resources (PGRs) in crop improvement are crucial for sustaining the ecology among living organisms of the planet and for being self-sufficient in crop production and improvement programmes. PGRs are a hope for the future of global food and nutritional security as these diverse germplasms are the storehouse of valuable traits, viz., yield-attributing,biotic and abiotic stress-tolerant, nutritional traits, entailed by the researchers and breeders to swiftly respond to new types or enhanced levels of biotic and/or abiotic stresses induced by climate changes and malnutrition as well (Halewood *et al*., 2018)

In Situ Conservation

Definition: Conservation of germplasm under natural conditions is referred to as in situ conservation. This is achieved by protecting the area from – human interference, such an area is often called natural park, biosphere reserve or gene sanctuary. NBPGR, New Delhi, established gene sanctuaries in Meghalaya for citrus, north Eastern regions for musa, citrus, oryza and *saccharum*. Gene sanctuaries offer the following advantage.

Examples

Protected Areas: National parks, biosphere reserves, and wildlife sanctuaries are examples of in situ conservation areas where plant species are protected within their natural ecosystems.

On-farm Conservation: This involves protecting crop diversity on farms, often by farmers continuing to cultivate traditional varieties alongside modern ones.

Sacred Groves: These are areas of forest traditionally protected by local communities for religious or cultural reasons, often harboring unique plant diversity.

Merit

Cost-effectiveness: In some cases, in situ conservation can be less expensive than ex situ methods, especially when utilizing existing protected areas.

Evolutionary Dynamics: Allows for the continued evolution and adaptation of plant populations to changing environmental conditions.

Demerit

Risk of Loss: Natural disasters, habitat destruction, or invasive species can threaten plant populations in situ.

Management Challenges: Managing in situ conservation areas can be complex and require ongoing monitoring and resources.

Ex Situ Conservation

Definition: Ex situ conservation involves conserving plant genetic resources outside their natural habitats, often in specialized facilities.

Examples

Seed Banks: Germplasm is stored as seeds of various genotypes. Seed conservation is quite easy, relatively safe and needs minimum space. Seeds are classified, on the basis of their storability into two major groups.

1) Orthodox and 2) Recalcitrant

Orthodox seeds: Seeds which can be dried to low moisture content and stored at low temperature without losing their viability for long periods of time is known as orthodox seeds. (eg.) Seeds of corn, wheat, rice, carrot, papaya, pepper, chickpea, cotton, sunflower.

Recalcitrant: Seeds which show very drastic loss in viability with a decrease in moisture content below 12 to 13% are known as recalcitrant seeds. (e.g) citrus, cocoa, coffee, rubber, oilpalm, mango, jack fruit etc.

Seed storage: Based on duration of storage, seed bank collects are classified into three groups. (1) Base collections. (2) Active collections and (3) Working collection.

Base collections: Seeds can be conserved under long term (50 to 100 years), at about -20OC with 5% moisture content. They are disturbed only for regeneration.

Active collection: Seeds are stored at 0OC temperature and the seed moisture is between 5 and 8%. The storage is for medium duration, i.e., 10-15 years. These collections are used for evaluation, multiplication, and distribution of the accessions.

Working collections: Seeds are stored for 3-5 years at 5-10OC and the usually contain about 10% moisture. Such materials are regularly used in crop improvement programmes.

Field or Plant Genebanks: This technique is traditionally useful for recalcitrant species or the type of plants which does not easily produce seeds, or seed is highly heterozygous and preferable to store clonal material. Plant species like rubber, cassava, cocoa, banana, coconut, mango, coffee, yam, sweet potato, sugarcane (Rao, 2004) and taro (Mancilla-Álvarez *et al.*, 2019) belong to this category. However, field gene banks are easily accessible for utilizing and evaluating the material being conserved but restricted interms of genetic diversity because of their susceptibility to pests, disease and van-dalism and involves extensive areas of land. It cannot reflect genetic diversity in afield gene bank.

Limitations

1. Require large areas
2. Expensive to establish and maintain
3. Prone to damage from disease and insect attacks
4. Man – made
5. Natural disasters
6. Human errors in handling

A DNA Bank is a component of ex situ conservation, which preserves genetic material outside a species' natural habitat, such as seeds, tissue, or purified DNA. These "off-site" collections provide a safety net against extinction and can be used for research and breeding. DNA banking offers an efficient, long-term method to conserve the genetic information of diverse species, ensuring its availability for future generations and for supporting the development of new varieties

Botanical Garden Conservation

Conservation on botanical gardens has the freedom to focus on wild species that may not be given sufficient priority for conservation. These gardens do not have the same constraints as institutes to focus on their activities on crop or crop-related species.

In Vitro Culture: Storing plant tissues or cells in a laboratory setting under controlled conditions.

Cryopreservation: Seed storage methods like seed banks, botanical garden and field gene bank are part of ex situ conservation. But there are some plant parts which cannot be conserved and stored by either in situ and ex situ method, so for those plants another conservation practice called cryopreservation helps in its storage. Furthermore, biological materials like plant organs and seeds like recalcitrant are used in this conservation method. In vitro conservation provides medium-term storage facility along with reducing the risk of germplasm loss from insect attack, dis -ease attack, nematode attack or any other natural disasters. It is also commonly used in vegetatively propagated plants (Ogbu *et a*l., 2010). Cryopreservation refers to the storage at ultra-low temperature with liquid nitrogen at the temperature of−196 °C. Living biological tissues can be stored through this method as the storage system can arrest the metabolic activity and cell division of the live cell. In cryo -preservation, no change in genetic make-up, vigourness and viability of the con -served material is obtained (Cruz-Cruz *et al*., 2013).

Accessibility: Ex situ collections provide readily available material for research, breeding programs, and other uses.

Protection from Threats: Provides a backup in case of loss of populations in the wild.

Controlled Conditions: Allows for precise control of environmental factors to maintain viability.

Demerit:

Cost: Establishing and maintaining ex situ facilities can be expensive.

Potential Loss of Genetic Diversity: Adaptation to the new environment may lead to loss of some genetic traits.

Ethical Considerations: Concerns about the long-term maintenance of genetic material and potential for genetic drift.

Integration:

Complementary Approaches: In situ and ex situ conservation methods are complementary and often work together to ensure the long-term survival of plant genetic resources.

Bridging the Gap: Ex situ collections can be used to reintroduce threatened species into their natural habitats, and in situ conservation efforts can inform the selection of material for ex situ conservation.

Sustainable Use: Both approaches are essential for ensuring the sustainable use of plant genetic resources for food security, climate change adaptation, and other critical applications

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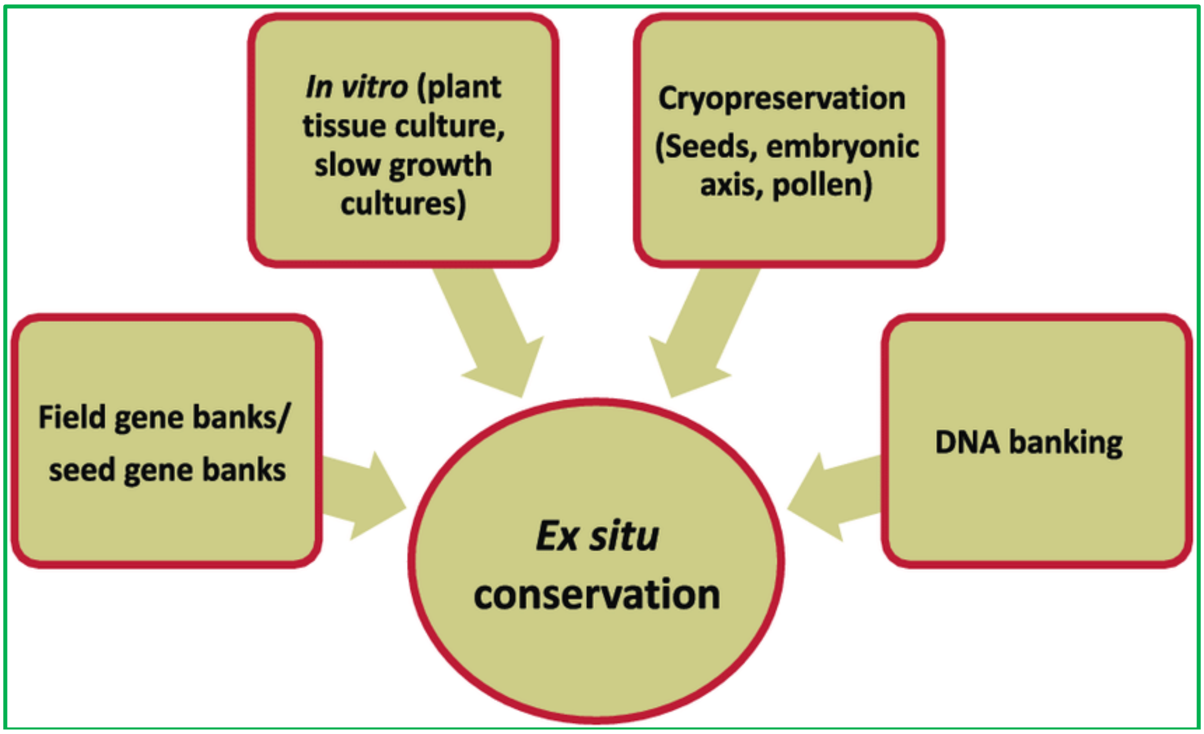
In vitro (plant tissue culture, slow growth cultures)
Cryopreservation (Seeds, embryonic axis, pollen)
Field gene banks/ seed gene banks
DNA banking
Ex situ conservation