Topic:

Strategies for the Domestication and Preservation of Economic Plants

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Strategies for the Domestication and Preservation of Economic Plants

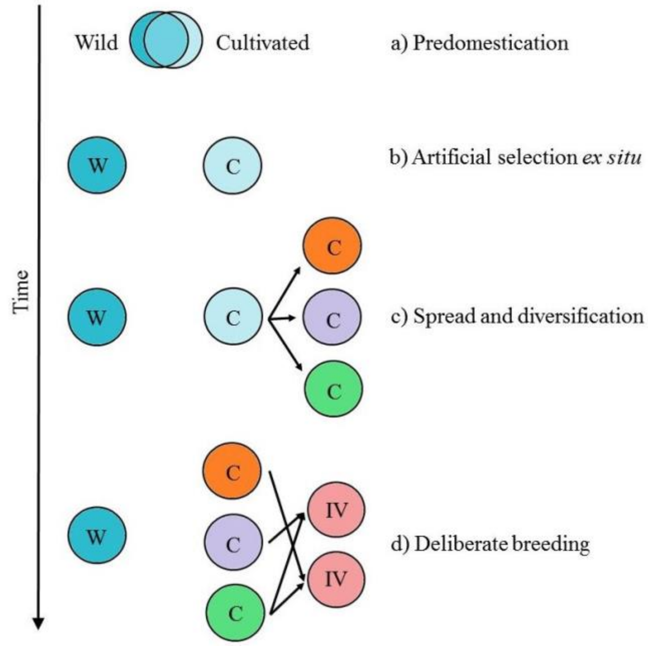
Domestication:

Plant domestication is the process whereby wild plants have been evolved into crop plants through artificial selection. This usually involves an early hybridization event followed by selective breeding.

Domestication is an evolutionary process, in which humans promote the adaptation of wild species to agro-ecological niches and to local preferences. The evolutionary trajectory from wild to domesticated population is a complex multistage process, that involves several steps:

1. **Predomestication:** humans begin to purposely plant and look after wild plants with favorable traits.
2. **Artifcial selection in environments created by humans:** at this the stage, human selective pressures promote alleles related with domestication traits.
3. **Spread and diversifcation**: propagation and local adaptation to different agroecological and cultural environments. In this stage, cultivated and wild populations diverge and domesticated traits diversify.
4. **Deliberate breeding**: this last stage has been practiced intensively in the last century. In classical breeding, controlled crosses between inbred lines are made and then individuals with desirable traits are selected. In the last decades, molecular and genetic tools have been integrated to breeding practices.

Figure 2. Evolutionary stages of domestication. W represents wild populations, C cultivated populations and IM improved lines. **a)** Predomestication; **b)** Management in environments created and controlled by humans; **c)** Spread and adaptation of cultivated populations; **d)** Deliberate breeding. It is important to notice that these stages are not mutually exclusive and can occur in presence of wild progenitors, increasing the probability of gene flow. Modified from Meyer & Purugganan (2013).



Effects of Domestication:

While the domestication process has varied in different plant groups depending on the mating system, growth form, harvested plant parts and economic importance there are several aspects that have been identifed to be common to most domestication processes. These include loss of genetic diversity, the genes associated with the domestication process, an accumulation of deleterious variants, the relation between the cultivar and its wild relatives and the possibility of phenotype convergence and its molecular basis in different domestication processes.

- **Genetic Diversity Reduction:**

  One of the most important determinants in crop evolution is the level of genetic diversity contained in the domesticated accessions, especially with reference to the wild ancestral gene pool. Genetic diversity is important as a necessary condition for further evolution in response to selection pressures, not only in the wild but also in breeding programmes. Genetic diversity reduction has been widely described in some of the most important crops. It is due to genetic drift resulted from population bottlenecks, and to artifcial selection and the consequent selective swee. The domestication process itself, the spread from the center of origin and modern breeding practices, involve population bottlenecks because only some genotypes are selected, promoting a genetic diversity reduction.

- **Mutations in genes under domestication:**

  The most frequent functional changes occur in alleles involved in function loss and gene expression. These mutations promote major effects in phenotypes, which usually distinguish domesticated and wild populations. Mutations can have several effects on ftness that range from lethal to neutral and advantageous, but most of these new variants in coding regions are expected to be deleterious, because they may alter phylogenetically conserved sites or can cause loss of protein function.

- **Gene flow between domesticated plants and their wild relatives:**
  Gene fow between crops and their wild relatives is common, since these two types of population coexist in sympatry, and in most cases, crops and their wild progenitors belong to the same biological species. Despite gene fow, wild and domesticated plants remain phenotypically distinct, at least with respect to domesticated syndrome traits, probably because of human selective pressures on cultivated populations, and natural selection of wild forms.

The domestication process and breeding have modifed the genomes of the plant species that we consume on a daily basis. The recent development of massive parallel sequencing tools allows us to access to information from whole genomes, accelerating identifcation of genes affected by domestication and to correlate domestication syndrome traits with their molecular basis.

Figure 1 Examples of wild and domesticated forms of crops. The frst image of each row is the wild relative. a) teosinte and maize (Zea mays); b) chilli pepper (Capsicum annuum); c) common bean (Phaseolus vulgaris); d) cotton (Gossypium hirsutum). Images taken from CONABIO.and CIAT and CIAT.

Preservation:

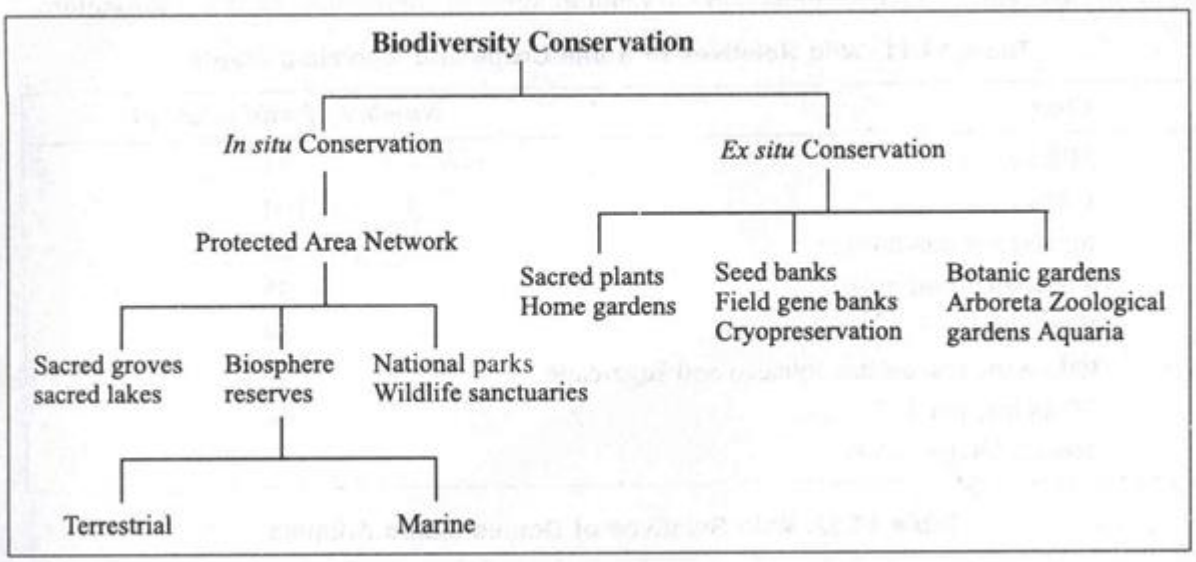
It is the the act or process of preserving, keeping safe or kept from injury, destruction, or decay. Preserved plant specimens provide us with important information about plant diversity and distribution, in a relatively permanent, and verifiable form that serves as evidence of a plant's existence in time and space.

Seeds and plant tissue contain all kinds of genetic information in their cells. This genetic information is called germplasm. Storing this genetic information–all the traits and characteristics of a plant–for future use is important. Unique characteristics in a species may provide the key to solving future breeding challenges. Germplasm scientists research how crop genetic diversity can best be conserved and made available for plant breeding.

There are two major approaches to conservation of plant genetic resources: ex situ conservation and in situ conservation, including farming. The two approaches complement each other.

In-situ Conservation: Conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in the surroundings where the species have developed their distinctive properties. large ecosystems may be left intact as protected reserve areas with minimal intrusion or alteration by humans. It includes national parks, sanctuaries and biosphere reserves.

Table 14.10. In Situ and Ex-situ Biodiversity Conservation



Ex-situ Conservation:

Ex situ conservation is defined as "the conservation of components of biological diversity outside their natural habitats." It involves the sampling, transference, and storage of target taxa from the collecting area and is generally used to safeguard species or populations that are at present or are potentially in danger of physical destruction, replacement, or genetic deterioration. The techniques for ex situ conservation used today include seed banks, field gene banks, in vitro storage, pollen banks, DNA storage, and botanic gardens.

- **Seed and ultra-dry seed storage:** Seed storage in gene banks is the most researched and usually the most efficient and effective form of long-term storage of plant germplasm of orthodox seeded species. With regard to temperature, the effects on longevity from changes in seed storage temperature are very similar among diverse orthodox species. The relative benefit of a given reduction in temperature becomes less below a certain temperature.

- **Botanic garden conservation:** Botanic gardens have traditionally focused on maintening species diversity, particularly on wild species that are endangered in their natural habitat. Botanic gardens generally preserve their plant material as living collections consisting of only one or a few individuals per species. Those species that cannot be stored as dried seed at low temperature are retained as tissue cultures.
- **DNA storage:** DNA banking is an emerging technique in genetic resources conservation. DNA extracts and DNA and RNA sequences are considered genetic resources, and they are now routinely extracted and conserved in DNA banks. The advantage of storing DNA is that it is efficient and simple and overcomes many physical limitations and constraints that characterize other forms of storage.
- **Field gene banks:** Many plant species, especially of tropical origin, produce recalcitrant or intermediate seeds. Recalcitrant or intermediate seed-producing species are not as numerous as those that produce orthodox seeds, but many of them are economically important, e.g., oil palm *(Elaeis guineensis),* rubber *(Hevea brasiliensis),* durian *(Durio zibethinus),* coffee *(Coffea arabica),* cacao *(Theobroma cacao),* and coconut *(Cocos nucifera).* In field gene banks, plant genetic resources are kept as live plants. Many species such as banana (*Musa* spp.), pineapple *(Ananas comosus),* sugarcane (*Saccharum* spp.), potato *(Solanum tuberosum),* and taro *(Colocasia esculenta)* reproduce mainly through vegetative means such as tubers, roots, suckers, and crowns. They rarely produce seeds and are highly heterozygous and therefore of limited utility for the conservation of particular genotypes. For these species and for species producing recalcitrant seeds, field gene banks have traditionally been the method of choice.
- **IN VITRO techniques:** Plant tissue culture and in vitro techniques are being refined particularly for vegetatively propagated crops, crop species with recalcitrant seeds, wild species that produce little or no seeds, and species with long life cycles. The basic aim is to introduce explants, i.e., small tissue pieces, from the donor plants into sterile culture and maintain them in a pathogen-free and controlled environment in a synthetic medium. The cultures can be stored under conditions of either slow or suspended growth. The slow-growth technique serves short- and medium-term conservation needs. For long-term storage of germplasm, in vitro cultured material is introduced to ultra-low temperatures so that virtually all cell activities are suspended. This is the cryopreservation technique.

Ex-situ conservation	In-situ conservation
In this, the animals and plant are placed in a special care unit.	In this, the animals and plants are not placed in any special care unit.
The animals and plants are separated from their natural habitat.	The animals and plants are not separated from their natural habitat but are protected in their natural habitat only.
It helps in recovering populations or preventing their extinction under stimulated conditions closely resembles their natural habitats.	It helps in recovering populations in the surrounding where they have developed their distinct features.
Ex-situ conservation method includes protective maintenance of threatened species.	In-situ conservation method includes protection of endangered species.
Examples are zoological parks, botanical gardens, wildlife sanctuary, in vitro fertilization, etc	Examples are biosphere reserves, national parks and many sacred groves.

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