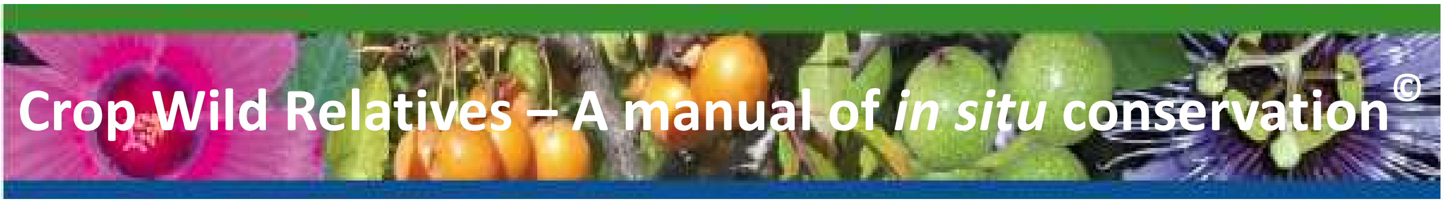


Complementary *ex situ* conservation actions

The Message

Though it is essential to maintain species' evolution and promote diversity through natural selection processes, *in situ* conservation has significant limitations. It is therefore important to complement *in situ* conservation activities with *ex situ* actions (in genebanks or botanic gardens) in order to ensure the maximum genetic diversity of target species is safely conserved.

IN SITU VERSUS *EX S*ITU CWR CONSERVATION

Advantages

In situ conservation

- Avoids storage problems associated with field genebanks and recalcitrant seeds.
- Allows evolution and enhancement to continue through exposure to pest and diseases and other environmental factors.
- Indirect benefits, including ecosystem support.
- Sustainable use by local people.

Ex situ conservation

- Rescue of threatened germplasm.
- Requires limited space to conserve large numbers of accessions.
- Conserves an adequate representative sample of CWR populations.
- Ease of accessibility and exchange of germplasm.
- Evaluation facilitated.
- Ease of documentation.
- No exposure to pests, disease and other hazards (except for field collection and Botanic gardens).
- Indefinite maintenance of germplasm.
- More cost effective.

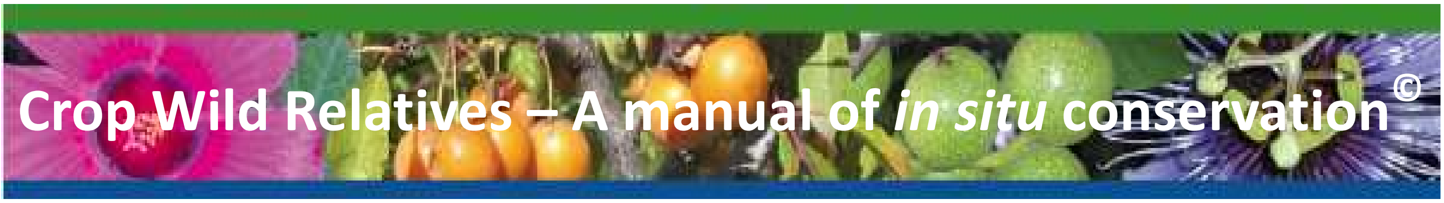
Disadvantage

In situ conservation

- Requires extensive areas for effective conservation.
- Generally has a limited coverage of the genetic diversity of the target species.
- Exposes natural populations to wide range of natural catastrophic events.
- Materials cannot be readily used and may be difficult to access.
- Subject to conflict with management by landowners.
- Expensive to maintain.

Ex situ conservation

- Freezes the evolutionary process.
- Difficult to ensure adequate sampling (intra-specific variability).
- Total genetic integrity cannot be ensured due to human error, selection pressure during regeneration.
- Only limited accessions can be conserved in field genebanks.
- Natural catastrophes in field genebanks.
- In vitro-somaclonal variation and loss of totipotency (capacity for tissues to differentiate into organs).



CWR COMPLEMENTARY CONSERVATION STRATEGY

A complementary conservation strategy involves **the combination of different conservation actions (*in situ* and *ex situ*)**, which together lead to an optimum sustainable use of genetic diversity existing in a target genepool [1].

1 - Dulloo, M.E., Ramanatha Rao V., Engelmann F. and Engels J.. 2005. Complementary conservation of coconuts. In P. Batugal, V.R. Rao and J. Oliver, (eds.) *Coconut Genetic Resources.* IPGRI-APO, Serdang. Pp. 75-90.

Key activities for implementing *ex situ* conservation actions

1. Gathering of relevant information on the species to be collected, including seed storage behavior, plant phenology and ecogeographic data.
2. Liaising with relevant stakeholders and organizing a stakeholder network.
3. Undertaking a gap analysis to identify the population most in need of collecting.
4. Obtaining the necessary regulatory authorization for collection.
5. Devising a sampling strategy for collecting that optimizes the highest level of genetic diversity. It is suggested to collect five populations across the species' range and from at least 50 plants (but preferably 200 plants) per population. However, the actual number to collect will depend on local circumstances.
6. Collecting seeds and other materials in the field, including taking a herbarium specimen to verify taxonomic identity.
7. Proper handling of the seeds in the field, including seed processing.

Guidelines for seed collecting

Collecting seeds or other propagules is the first activity for establishing an *ex situ* collection.

Targeting selected priority sites for collecting samples which contain the highest species and genetic diversity may be required. In this instance, predictive tools based on geographic information systems (GIS) can help to identify potential collecting sites. Many GIS methods use climatic variables as the principal drivers of geographic distribution and can be used to predict sites of high species diversity.

Useful Resources:

- The Millennium Seed Bank website: http://www.kew.org/science-conservation/conservation-climate-change/millennium-seed-bank/
- Documentary on chickpea seed collecting by Ken Street: http://www.seedhunter.com/.
- The "GapAnalysis" website is a useful tool to enable plant collectors to target areas containing traits and taxa under-represented in *ex situ* collections: http://gisweb.ciat.cgiar.org/GapAnalysis/

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EX SITU CONSERVATION METHODS

Seed genebanks

Involves drying seeds to low moisture content and storing them in moisture-proof containers at a low temperature.

Tissue culture

Involves the maintenance of plants in a sterile, pathogen-free environment with a synthetic nutrient medium. Different *in vitro* conservation methods are available:

1. slow-growth conservation by limiting the environmental conditions and/or the culture medium;
2. synthetic seed technique, which aims to use somatic embryos as true seeds by encapsulating embryos in alginate gel, which can then be stored after partial dehydration and sown directly.

2 - Engels, J.M.M, Maggioni L., Maxted N., and Dulloo M.E. 2008. Complementing in situ conservation with ex situ measures. In Iriondo, J., Maxted, N., and Dulloo, M.E. (eds) (2008) *Conserving Plant Genetic Diversity in Protected Areas*. CABI Publishing, Wallingford Chapter 6, pp. 169-181.

Pollen storage

Pollen can be stored in the same way as seeds and used as a conservation method for genetic resources, especially for perennial species of fruit and forest trees. It has a relatively short viability when conserved under classical storage conditions (partial desiccation followed by storage at sub-zero temperatures) and has, therefore, only been used to a limited extent in germplasm conservation.

Field genebanks

Consists of growing live plants in a field or in a screen or greenhouse. This method offers easy access to plant material for characterization, evaluation and subsequent utilization, but is often difficult and expensive to maintain.

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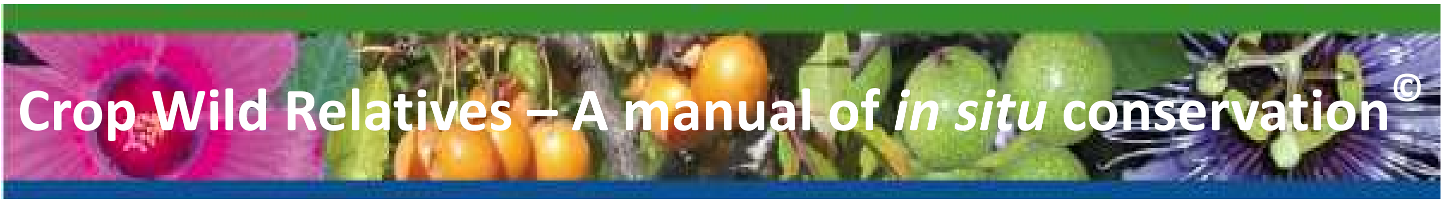
Botanic Gardens

Involves the maintenance of live plants in a garden landscape. Since botanic gardens have limited amounts of space, the number of accessions of individual species is limited and thus their value for genetic diversity conservation is often questioned.

Cryopreservation

Involves the storage of a range living tissues, including cell suspension, calluses, shoot tips, embryos and even whole seeds, at extremely low temperatures in liquid nitrogen. Material must be able to survive the freezing procedure before storage and the thawing procedure after storage. The Millennium Seed Bank Kew has developed protocols for cryopreservation of wild plants. See: http://www.kew.org/ksheets/pdfs/K31_cryopreservation.pdf



Crop Wild Relatives – A manual of *in situ* conservation©

USING *EX SITU* COLLECTIONS TO SAVE CWR POPULATIONS

Ex situ collections may be used to **re-introduce a species** that has disappeared from its natural environment. Accessions collected in the past and conserved in genebanks or in botanic gardens can provide valuable materials for restoration. The re-introduction of *ex situ* materials to the wild is a complex activity and needs to undertaken with careful consideration. One must ensure the stock or accessions introduced are, in fact, native to the site, that plants are free of diseases and that they have adequate genetic diversity.

Ex situ collections may also be used in **enrichment planting** or re-enforcement for threatened CWR populations and those which are not regenerating in the wild. New plant material can be obtained from *ex situ* collections and planted to reinforce the population at the site.

Challenges of *ex situ* conservation

- Storage conditions established mainly for major crops may not be well adapted for some CWR.
- Seed storage behavior can vary among and even within species.
- Protocols may not exist for specific CWR for *in vitro* or cryopreservation conservation.
- Restraints in accessing germplasm from genebanks may exist due to government policies relating to germplasm exchange, property rights, access and benefit-sharing regulations or phytosanitary regulations.
- The cost of maintaining a genebank can be prohibitive and financial shortcomings can threaten collections.

Steps for an *ex situ* recovery plan

1. **Site assessment** - A thorough examination of the site should be conducted, documenting the status of the target population and any threats affecting it. The site assessment determines the strategy to adopt for re-vegetation.
2. **Re-vegetation method** - Include direct seeding, planting using naked-rooted seedlings, potted seedlings, or planting under nurse crops.
3. **Identification of source material** - The source of the material from the *ex situ* collection must be chosen carefully. Accessions from the same site, or one as close to it as possible, should be selected.
4. **Sampling to ensure genetic diversity** - Samples from the genebank accession(s) must represent maximum genetic diversity.
5. **Propagating of materials** - The planting of materials (seeds or cuttings) should be multiplied in a nursery and an equal number of plants from each accession grown for the required number of plants needed for the re-vegetation.
6. **Site preparation and replanting** - The success of the reintroduction depends on good site preparation. Competing factors and threats must be controlled prior to planting.
7. **Post planting treatment** - Once planted, seedlings should be monitored to ensure their survival. If they die, they must be replaced with the nursery stock.

FURTHER INFORMATION

- ***ENSCONET Seed Collecting Manual for Wild Species***, ENSCONET. 2009. ISBN: 978-84-692-3926-1. http://www.ensconet.eu/Download.htm
- **IUCN/SSC Guidelines for re-introduction. SSC Re-introduction Specialist Group**, IUCN, 1995. International Union for the Conservation of Nature. http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Policy_statements/Reintroduction_guidelines.pdf
- **Plant cryopreservation**, IUCN (2002) Kew 2006. Information sheet K31. http://www.kew.org/ksheets/pdfs/K31_cryopreservation.pdf