In situ and *ex situ* conservation

Two sides of the same coin

Key Messages

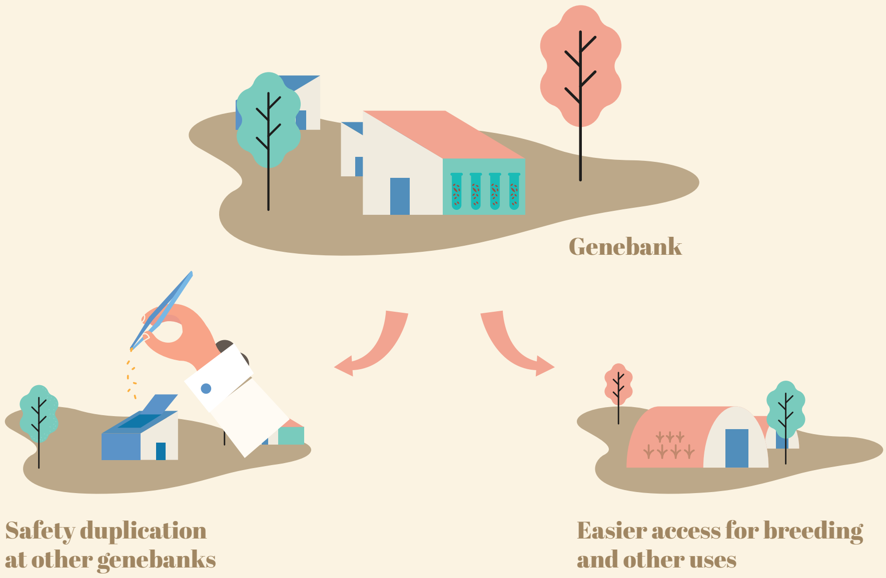
- Crop wild relatives (CWR) are wild plant species that are related to crops. CWR constitute a valuable genetic resource for crop improvement and the adaptation of agriculture to climate change.
- Many CWR species and populations are at risk, necessitating a systematic global effort to conserve and secure these valuable genetic resources, both in genebanks and in the wild.
- *Ex situ* conservation of CWR facilitates their use in agricultural research and breeding and allows diversity to be backed up in multiple locations.
- *In situ* conservation of CWR is useful for conserving genetic diversity at the population level, and also for allowing the continued evolution of new, adaptive traits.
- The complementary conservation of CWR both *in situ* and *ex situ* is the best strategy to safeguard and make available the diversity of CWR, as well as to ensure their continued evolution.

Crop Wild Relatives need to be conserved

Crop wild relatives (CWR) are wild plant species that are related to crops (typically belonging to the same genus as the crop species). CWR constitute a valuable genetic resource for crop breeding and climate change adaptation, having been used to improve varieties of rice, sugarcane, wheat, barley, tomato, sunflowers, and other crops. One study has estimated that CWR have provided traits to global agriculture worth $115 billion in one year, 1997, alone.[1]

Like wild plant species in general, of which approximately 22% are threatened with extinction according to the 2010 Sampled Red List Index for Plants, [1] crop wild relatives face a number of threats in the field. These include land use change, invasive species, and the intensification of agriculture. Climate change is also expected to modify, reduce, and in some cases eliminate the ranges of many CWR species; for example, around 16-22% of peanut, potato and cowpea CWR are predicted to go extinct by 2055,[2] while changing climatic conditions are likely to greatly diminish the potential habitat of many maize wild relatives. [3] In addition, a recent analysis of how well CWR are conserved in genebanks found that almost 30% of CWR taxa were not present in genebanks at all, with a further 24% represented by fewer than ten samples.[4]

Crop wild relatives can be conserved both *ex situ* (out of place) in genebanks, field collections and botanical gardens, and *in situ* (in place) in their natural habitat. *Ex situ* conservation of CWR is essential both to prevent the loss of CWR genetic diversity and to facilitate the use of their diversity in crop breeding. *In situ* conservation, in complement, involves the maintenance and recovery of populations in their natural surroundings, and is necessary to ensure continued evolution, including the natural exchange of genes with each other and their cultivated cousins.



Ex situ

Ex situ conservation of CWR enables their use in agricultural research and breeding efforts, makes them more accessible to breeders and other users, and allows them to be backed up in multiple locations.

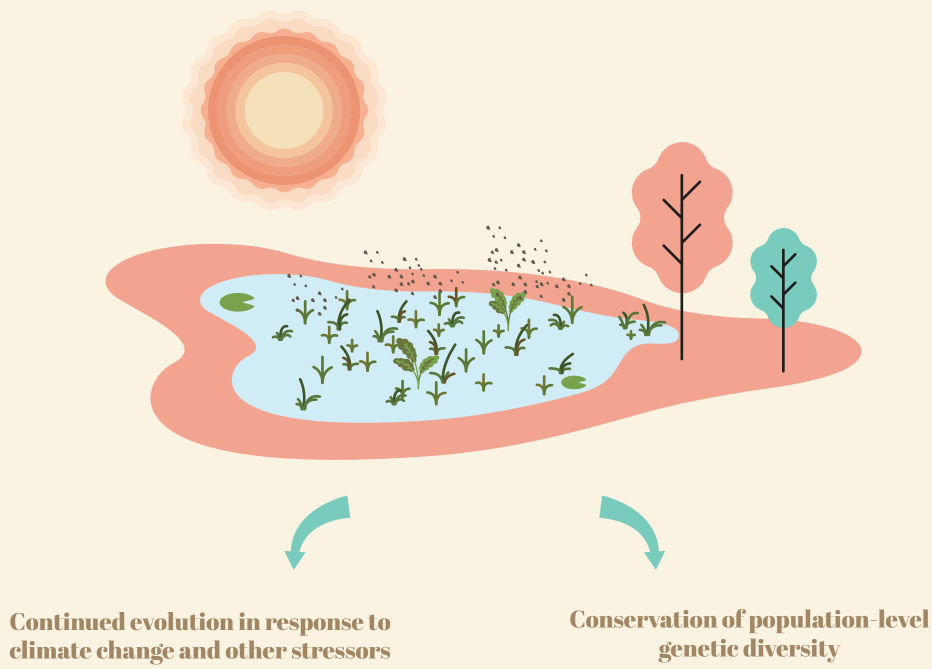
The importance of *ex situ* conservation

Ex situ conservation of CWR is what enables their distribution and use. Without *ex situ* conservation, it is difficult if not impossible to use their genetic material in breeding. Imagine having to go back to a remote location to collect seeds of a particular population every time a breeder needs it somewhere in the world. Collecting and storing CWR in genebanks makes them more accessible to breeders and enables their use in agricultural research and breeding. It also allows samples to be backed up in multiple locations, called safety duplication.

CWR are held *ex situ* in national crop diversity collections and international genebanks such as those of the CGIAR, the Millennium Seed Bank, and the Svalbard Global Seed Vault. About 700,000 CWR accessions are currently held *ex situ* in genebanks around the world, about 10% of the total holdings.[5]

In situ

In situ conservation is also important, as wild populations of CWR can contain much more genetic diversity than a single accession in a genebank, and maintaining viable populations of CWR in the wild allows them to continue evolving new, more adaptive traits.



The benefits of *in situ* conservation

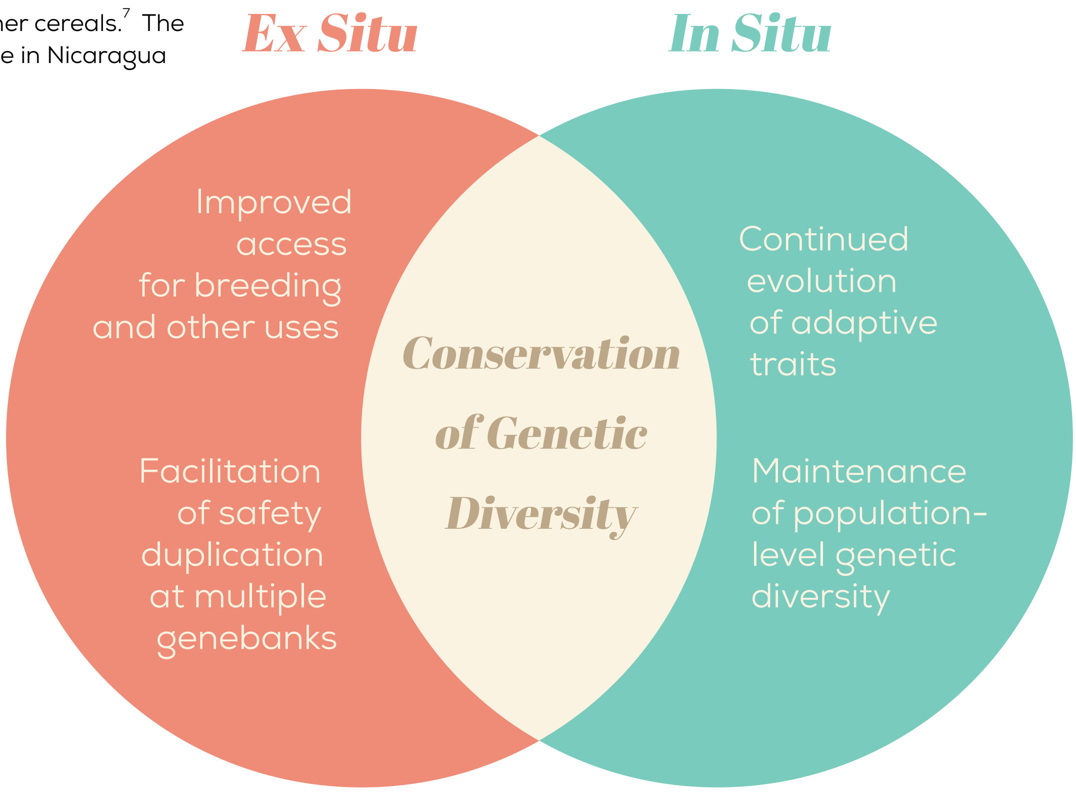
In situ conservation is also important, however, as wild populations of CWR can contain much more genetic diversity than is generally captured in an accession in a genebank, and maintaining viable populations in the wild also allows them to continue evolving, with the potential appearance of new adaptive traits. For example, wild wheat and barley populations in Israel have shifted their flowering times significantly earlier in the season from 1980 to 2008 in order to escape from the increased drought brought by climate change.[6]

In some instances, CWR are the primary target of *in situ* conservation efforts, while in others, CWR are fortuitously present in existing protected areas that were established for other purposes. Examples of *in situ* conservation of CWR include the Sierra de Manantlán Biosphere Reserve in Jalisco, Mexico, which preserves the endemic maize relative Zea diploperennis, and the Erebuni Reserve in Armenia, which helps to conserve a number of wild relatives of wheat and other cereals.[7] The Apacunca Genetic Reserve in Nicaragua was created in 1996 specifically to conserve the last existing populations of teocintle (or *Zea nicaraguensis*), a wild relative of maize that possesses resistance to salinity, pests, diseases and flooding.

The creation of a global network of CWR *in situ* conservation areas is currently under consideration by member states of the FAO Commission on Genetic Resources for Food and Agriculture (CGRFA).[8] The Secretariats of the Convention on Biological Diversity (CBD), the International Treaty on Plants Genetic Resources for Food and Agriculture (ITPGRFA), along with Bioversity International recently notified their respective Contracting Parties, together with the national focal points of the CBD Programme of Work on Protected Areas (PoWPA), of the need to strengthen *in situ* conservation of plant genetic resources through the incorporation of active CWR conservation in protected area networks, and link *in situ* conservation to sustainable use. A call for a global action for the development of a global network of 'genetic reserves' within CWR hotspots areas is urgently needed to ensure their conservation and sustainable use, for the benefit of our current and future food security.

Two sides of the same coin

In situ and *ex situ* conservation of CWR are not alternatives or perfect substitutes for each other. Each approach provides something that the other does not, as illustrated in the Venn diagram below. In particular, *ex situ* conservation is necessary for the use of crop wild relatives in breeding, while *in situ* conservation tends to maintain a greater amount of diversity and ensures the continued evolution of adaptive traits. Thus, the question conservation practitioners should be asking is not whether to focus on *in situ* or *ex situ* conservation, but rather what combination of the two approaches is optimal.



National Governments are encouraged to develop National Strategies and Action Plans for conservation and use of CWR. A strategy combining *in situ* and *ex situ* is the best approach to conserving the diversity of CWR, making it available and ensuring its continued evolution.

Endnotes

[1] (1997). Economic and environmental benefits of biodiversity. Bio-Science, 47 (11), 747–757.

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[4] Castaneda-Alvarez, N.P. et al. 2016. Global conservation priorities for crop wild relatives. Nature Plants article 16022. doi:10.1038/nplants.2016.22.

[5] U.N. Food and Agriculture Organization of the United Nations. 2010. The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture.

[6] Nevo, E.; Fu Y.; Pavlicek T.; Khalifa, S.; Tavasi, M.; Beiles, A. 2011. Evolution of wild cereals during 28 years of global warming in Israel. PNAS Early Edition.

[7] Hunter, D., Heywood, V., 2011. Crop Wild Relatives: A Manual of *In Situ* Conservation, 1st ed. Earthscan, London

[8] FAO. 2009. Establishment of a Global Network for *In situ* Conservation of Crop Wild Relatives: Status and Needs, by N. Maxted & S. Kell. Commission on Genetic Resources for Food and Agriculture. Rome. 211p. www.fao.

Further information and contact

- For more information please visit our website **www.cwrdiversity.org** or contact **cropwildrelatives@ croptrust.org**
- Keep up to date with project activities by following us on Twitter **@CropWildRelativ**
- The Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives Project is generously funded by the Norwegian government, and managed by the Global Crop Diversity Trust in partnership with the Millennium Seed Bank of the Royal Botanic Gardens, Kew.

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