Science Societies

Safeguarding plant genetic resource collections for agriculture

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Recently, some of the facilities of the National Center for Plant Genetic Resources of Ukraine (PGRU) were damaged in the war by Russia (www.newsweek.com/fact-check-ukraine-national-seed-bank-

> **destroyed-russia-1707864**). This was reminiscent of the challenges and sacrifices made to save ICARDA's wheat collection in Syria from armed conflict only a decade earlier. Genetic resources such as PGRU are needed to ensure future food security. We asked some of the staff of the USDA-ARS National Plant Germplasm System to remind us of the reason for and importance of backing up plant genetic resources in genebanks.
>
> *— David Clay, ASA President; Ron Turco, SSSA President; and Seth Murray, CSSA President-Elect*

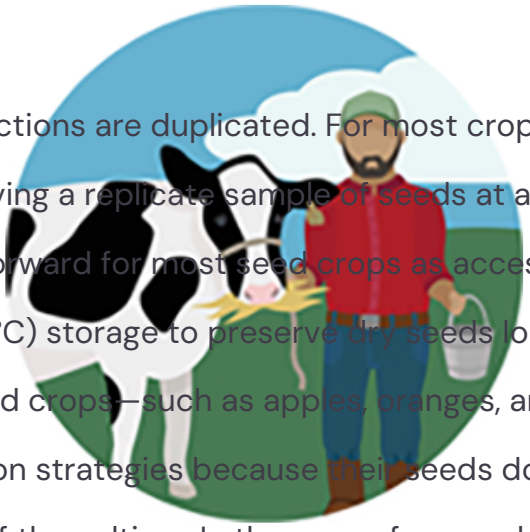
Plant genetic resources (PGR, or "plant germplasm") are the raw materials used for research and to breed higher quality, more productive, and resilient crops and restore landscapes damaged by fire, cataclysmic weather, and invasive pests. The benefit of available and effectively used PGR are demonstrated by the near tripling of grain yields worldwide since the start of the 'Green Revolution' in 1961. **1** There are hundreds of other examples of how PGR provide solutions to agricultural problems every day. Collections of PGR provide the genetic diversity needed to develop and deliver food, fiber, feed, industrial products, and attractive, functional landscapes to growing populations.**2**

Genebanks maintain collections of agricultural PGR containing a vast range of diversity for future generations. They strive to provide plant germplasm that is alive and healthy, carrying the genes needed for disease resistance, drought tolerance, nutritional

quality, or other desired traits. Genebanks also gather data about the samples they maintain to help researchers and breeders find useful traits and genes within large PGR collections.

Collections may be maintained as seeds in cold storage (with periodic grow-outs) or as herbaceous or woody plants outdoors, in the greenhouse, or in vitro (as small plants or plant tissues in test tubes). Generally speaking, actively growing plants are more vulnerable to abiotic and biotic threats than those that are quiescent, such as seeds although even stored seed collections are susceptible to failures of environmental controls, aging, or other catastrophes. Field collections are susceptible to drought, flooding, fire, heat, cold, and a constant influx of new pests and diseases. Plants in greenhouses and culture rooms can die from malfunctions of environmental controls (i.e., overheating) and from pest outbreaks. In addition, human-caused threats to PGR collections can include land development, vandalism, or armed conflict.

Duplication of PGR Collections



Therefore, it's imperative that PGR collections are duplicated. For most crops, this duplication can be accomplished by saving a replicate sample of seeds at a distant location. This can be relatively straightforward for most seed crops as accessible technologies exist for freezer (0 °F, –18 °C) storage to preserve dry seeds long term. However, cultivars of clonally propagated crops—such as apples, oranges, and avocados—require alternative duplication strategies because their seeds do not maintain true-to-type characteristics of the cultivar. In the case of some clonally propagated

crops, collection duplication can mean growing replicate trees at a distant second location. Advancing technologies enable high-density storage of clonally propagated PGR in secure facilities through cryopreservation methods that use liquid nitrogen. The long-term cost savings and lower risk of external threats make off-site freezer and cryogenic storage an effective strategy to secure PGR in genebank collections.

The USDA National Laboratory for Genetic Resources Preservation (NLGRP) in Fort Collins, CO employs both freezer and cryostorage to secure duplicate samples of PGR collections for the U.S. National Plant Germplasm System (NPGS) and several international and national PGR collections. Currently, about 80% of the samples (also termed “accessions”) of NPGS’s collections of seed-propagated PGR are duplicated at NLGRP with the ultimate goal of attaining the highly stringent FAO standards of seed quality.[3] Examples of duplicated samples of clonally propagated crops include cryopreserved dormant buds from the Geneva, NY apple collection that have been retrieved and grafted onto rootstocks to replace field trees that were lost to fire blight disease. Shoot tips of 400 citrus cultivars were recently cryopreserved, securing this valuable collection that is threatened by citrus greening disease.

Online Courses on Plant Genetic Resources from Colorado State University

Three one-credit graduate level courses will be available online from Colorado State University in fall semester, 2022. The courses will be taught by plant geneticist Dr. Geoff Morris and will deal with (1) the origins and structure of plant genetic diversity, (2) the principles and methods for conserving that diversity, and (3) strategies for identifying useful variation in genetic resources and delivering it to stakeholders. Course descriptions, costs, and registration information are available at **http://pgrcourse.colostate.edu/**.

The international genebank community collaborates to facilitate necessary duplication of valuable collections. For example, duplicate samples from other PGR genebank systems are safely stored in the NLGRP without the responsibility of actively curating those samples; they are protected and readily accessible to the genebanks that deposited the samples. The Svalbard Global Seed Vault on the Norwegian island of Spitsbergen offers this service to genebanks throughout the globe.

The security of PGR collections is increasingly important as collections age, regional weather patterns shift, and armed conflicts erupt. No national or international PGR system is immune to those dangers, making it even more important to build national, regional, and international collaborations to develop and adopt innovative, forward-thinking strategies for safeguarding PGR and optimally managing genebank collections.

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