Samples from the Millennium Seed Bank in the UK

WOLFGANG STUPPY © RBG KEW

# PRESERVING THE HARVEST

Brazil is participating in an international project to conserve frozen seeds from wild relatives of 28 agriculturally important crops

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The underground coolers of the Millennium Seed Bank, a facility at the Royal Botanical Gardens in Kew just outside London, store approximately 2.5 billion seeds of 40,000 plant species from all over the world at -18 degrees Celsius (ºC), with a relative humidity of 15%. The vault is designed to withstand explosions, flooding, and radiation and is expected to preserve the ability of the seeds to germinate for over a century. Most of the collection is made up of genetic material from wild *plants* not domesticated by humans that are threatened with extinction, live in highly specific places, or are useful to humanity—or could be in the future. Within this frozen wealth

of biodiversity from over 100 countries (including Brazil), a small group of samples serves as an emergency reserve in case climate change puts global food security at risk.

Seeds from species that are wild relatives of 28 crop are kept as part of an international effort to ensure viable plants with diverse genetic material are available to facilitate adapting crops to different climates. In addition to wild relatives of the three crops that provide half of all calories consumed by humans (corn, wheat, and rice), the list includes varieties of other well-known crops, such as beans, bananas, and carrots, as well as other less popular crops, such as grass pea and vetch.

Brazil is one of 25 countries taking part in the initiative, which is designed to ensure the sustainability of agriculture in the face of climate change. To date, the country has contributed seeds of nondomesticated ancestral species of four crops: rice, potato, sweet potato, and millet (a small-seeded cereal that resembles maize). Seeds from five wild sweet potato species, four wild rice species, two wild potato species, and two wild millet species were sent to the UK. "Wild plants can be more resistant to pests, disease, and adverse environmental conditions and could be extremely useful for agriculture in the context of climate change," explains Marília Burle, an agronomist from Embrapa Genetic Resources and Biotechnology in Brasília who is Brazil's representative in the international project Adapting Agriculture to Climate Change that is, led by a team from Kew. There is no loss of biodiversity for countries participating in the project. "We also keep seeds of the same plants that we ship to the UK in our own bank. The Millennium samples function as a backup of the seed of these wild species that we preserve at Embrapa," says Burle.

Between 2013 and 2018, Brazilian researchers made 16 field trips, collecting seed samples from wild relatives of rice, potato, sweet potato, and millet from every biome in the country—from the Amazon to the Pampas—except the Caatinga (semiarid scrublands) in the northeast. Only three other countries from South America participated in the initiative: Peru, Chile, and Ecuador.

In an article published in the scientific journal Plants in July of 2022, the leaders of the wild crop species conservation project outlined the results achieved over the past 10 years. Seeds from the wild relatives of the 28 selected crops were all successfully obtained. In total, nearly 4,600 samples from 345 species were sent to Kew. The crops whose genetic diversity was best covered by the survey were alfalfa, wheat, bambara groundnut (a relative of peanuts), and grass pea (which can be cooked like beans). Potatoes, rice, and eggplant were also highly sampled, according to the study.

"Some of the so-called exceptional species—groups of plants that cannot be stored using traditional seed drying and freezing methods—are the most difficult to conserve," Kew Gardens biologist Chris Cockel, leader of the wild crop relatives project, said in an interview with *Pesquisa FAPESP*. There are usually no major problems storing the seeds of the nondomesticated species of the nearly three dozen crops included in the initiative by drying them and refrigerating them at subzero temperatures. "However, some seeds of rare species and tropical crops, such as mango and avocado, cannot survive this process. The same is true of oak," says Cockel.

Orchid varieties are probably the least conserved plants in the Millennium Seed Bank, according to British scientists. Orchid seeds are very fine, almost like sand, and difficult to handle.

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Entrance to the Svalbard Global Seed Vault in Norway

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Wild species related to millet (*top left*) and sweet potato (*left*). Seed germination test at Embrapa (*above*)

Alternative means of preservation, such as the expensive process of freezing plant parts at -196 ºC in liquid nitrogen, have been implemented over time.

Modern agriculture tends to homogenize the genetic material of crops to maintain or increase productivity. When a crop variety or species adapts well in a given region and produces a high yield, farmers tend to then fill their fields with more plants that have the same biological characteristics. The forms of these crops that produce low yields or are difficult to manage, whether domesticated or not, are abandoned. It is not uncommon to find thousands of crop specimens with practically identical DNA on large farms. The United Nations Food and Agriculture Organization (FAO) estimates that 75% of the genetic diversity of cultivated plants has been lost over the last century.

Brazil has one of the world's largest national germplasm banks for agricultural crops, started by Embrapa in Brasília in the 1970s. Germplasm is the technical term for genetic material that can be preserved and used to propagate a crop. In the vast majority of cases, the seeds are dried and frozen at negative temperatures. The germplasm bank at Embrapa, which receives contributions from the company's research units and partner institutions and universities, holds 118,000 seed samples from approximately 1,100 species, most of which are cultivated plants, such as rice, beans, wheat, and soy.

"We store 1,500 seeds of each variety," says Juliano Gomes Pádua, an agronomist from Embrapa Genetic Resources and Biotechnology and supervisor of the bank. Every 15 to 20 years, the seeds are tested to check that at least 85% of them are able to germinate. The material kept in the nation's capital serves as a backup of the state agricultural company's "active" germplasm banks located at branches around the country. These active banks provide seeds for research and agricultural extension work. "Almost everything in these active banks is also stored in the germplasm bank," explains Pádua.

The Svalbard Global Seed Vault, located on a Norwegian archipelago in the Arctic circle, is another international partner that participates in national plant diversity preservation programs. Excavated into a mountain approximately 130 meters above sea level, Svalbard was created in 2008 and holds nearly 1.2 million seed samples at -18 °C. The material covers 6,000 species from 91 seed banks in 68 countries. Brazil has sent the project three shipments, totaling approximately 5,000 samples of corn, soy, onion, pepper, pumpkin, rice, beans, melon, watermelon, cashew, and passion fruit. "The seed vault at Svalbard is only opened three times a year," says biologist Rosa Lía Barbieri from Embrapa Temperate Climate in Pelotas, who was Latin America's representative on the scientific council of the Norwegian project for three years (2019–2022). "The location is remote, and access is tightly controlled." ■

## Scientific article

EASTWOOD, R. J. *et al.* Adapting agriculture to climate change: A synopsis of coordinated national crop wild relative seed collecting programs across five continents. **Plants**. July 13, 2022.

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