SUSTAINABLE DEVELOPMENT GOAL 2

# ZERO HUNGER

## CONTRIBUTIONS OF EMBRAPA

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Chapter 6

# Genetic diversity and the eradication of hunger

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## Introduction

This chapter addresses the contributions of Embrapa to target 2.5 of Sustainable Development Goal 2 (SDG 2):

> By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed. (United Nations, 2018).

The modernization model of agriculture based on agricultural mechanization, the use of industrial inputs and genetic uniformity led to the substitution of varieties adapted to traditional farming systems by varieties, which meet the needs of intensive agriculture. This has contributed to the disappearance or loss of genetic variability of species that coevolved with the environment and with the cultural diversity of peoples for hundreds of years.

According to the statements of Zakri Abdul Hamid in 2013, quoted by Alisson (2013, our translation), about 75% of the genetic diversity of agricultural crops has been lost in the last century. According to Hamid:

> [...] there are 30,000 species of plants, but only 30 crops are responsible for providing 95% of the energy supplied by foods consumed by humans. Most of them (60%) are rice, wheat, corn, millet and sorghum.

Regarding the animals, the author states "approximately 22% of the bovine breeds in the world are in danger of extinction by the lack of recognition of their quality to meet the current demands of cattle breeders" (Hamid, 2013 quoted by Alisson, 2013, our translation). However, many of these native breeds are means of subsistence for many poor families in the world, since their management and maintenance are simple when compared to genetically improved breeds. The diversity of these agricultural and livestock species is important for breeding programs and local production because of their adaptation to unfavorable environmental conditions, being more resistant to droughts, extreme heat and tropical diseases. In this way, they are more appropriate to deal with climate change.

In the context of the diversity of agricultural and breeding systems, agrobiodiversity is a broad term that includes all the components of biodiversity that constitute the agroecosystem and are relevant to agriculture and food. Associated with agrobiodiversity is a range of knowledge of indigenous peoples and traditional communities that, through selection, domestication and acclimatization of native species in various socio-historical contexts, allows local and global adaptation of genetic resources to environmental adversities. The conservation of genetic resources and the promotion of the sustainable use of agrobiodiversity are crucial strategies for ensuring the eradication of hunger.

Concerned with the challenge of conserving the genetic diversity of domesticated and non-domesticated farm plants and breeds, and also with the fair and equitable sharing of benefits arising from the use of these genetic resources and associated traditional knowledge, Brazil has signed and ratified important international treaties, such as the Convention on Biological Diversity (CBD) (Convention on Biological Diversity, 1992) and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (Tratado..., 2009).

The CBD defines two strategies for biodiversity conservation: ex situ and in situ/on farm and it is based on three pillars: conservation of biological diversity, sustainable use of components of biological diversity and fair and equitable distribution of benefits arising from genetic resources use.

In accordance with CBD, ITPGRFA aims at the conservation and sustainable use of plant genetic resources for food and agriculture, as well as the fair and equitable sharing of the benefits derived from its use. It recognizes the sovereignty of States over their plant genetic resources and establishes a multilateral system for facilitated access and sustainable use of these resources. It also recognizes the right of farmers and the contribution of local communities, indigenous peoples

and farmers in all regions to the conservation and development of plant genetic resources, which form the basis of food and agricultural production throughout the world.

Embrapa carries out several actions that contribute to the implementation of these international agreements in Brazil. In relation to the CBD, Embrapa has been operating since 2002 with several programs linked to the agricultural sector related to agrobiodiversity, the conservation of pollinators and the Cartagena protocol on biosafety. Regarding ITPGRFA, the Company developed a project that resulted in a strategic action plan to promote food security in a context of climate change for crops of rice, corns, beans, wheat and cassava in Brazil, Paraguay and Uruguay. This action plan was financed by the Benefit-Sharing Fund of the International Treat and built by the Latin American Network for the Implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture (Laniit) (Strategic..., 2016).

Regarding the fair and equitable sharing of benefits from the use of genetic resources and associated traditional knowledge, the focus of both international agreements, CBD and ITPGRFA, Embrapa has contributed since 1997 to national and international discussions and the implementation of Law 13,123/2015 (Brasil, 2015) of Genetic Heritage Access and of Decree 8,772/2016 (Brasil, 2016), which regulates, at the national level, the access and use of native genetic resources and associated traditional knowledge and guarantees the fair and equitable sharing of benefits.

All the initiatives carried out by Embrapa aiming at the implementation of international agreements added to the strategies adopted to promote research, exchange and knowledge construction actions, supporting public policies, contribute to the achievement of SDGs, but especially to target 2.5. We highlight some initiatives related to the conservation of plant genetic resources and the sustainable use of agrobiodiversity that contribute to the food and nutritional security of populations.

## Ex situ conservation of genetic diversity

The conservation ex situ of genetic diversity relates to the maintenance of genetic resources outside their place of origin, being preserved in the short, medium or long term. It includes enrichment activities (by collection or exchange), documentation and conservation of these collections. It guarantees germplasm

for genetic improvement programs and for the restitution of traditional varieties lost or missing from local farming or breeding systems (Figure 1).

Photo: Paulo Luiz Lanzetta Aguiar

**Figure 1.** Genetic diversity.

Embrapa is the main responsible for ex situ conservation in Brazil and maintains the ninth largest collection of genetic resources in the world. There are about 140 germplasm banks of different products and a collection of about 200 thousand accesses of more than 700 species of cultivated plants and their wild relatives. These genetic resources are being conserved in 29 Units of Embrapa, including the Base Collection (Colbase), in Embrapa Genetic Resources and Biotechnology, which has about 110 thousand accesses and 1,019 species. The largest banks are: rice (about 30 thousand accesses); beans and soy (about 18 thousand each); wheat (about 15 thousand); and sorghum (7,200). Functional microorganisms are also maintained in this system and there are about 33 thousand accesses.

In relation to animal genetic resources, the ex situ conservation bank has 85,000 semen samples and 450 embryos. In general, the most productive animals used today in national livestock are the result of work developed by breeders, often associated with researchers. Throughout the selection process, many lineages are discarded by breeders, and Embrapa manages to preserve them

in the form of frozen semen and embryos at 196 °C below zero. These lineages may prove important for future breeding programs. In addition to this strategy, animal diversity is also maintained in conservation centers, in partnership with associations, universities and other institutions.

It is important to emphasize that all these materials are documented and arranged in the Sistema Alelo which is a portal of information on plant, animal and microbial resources that enables the exchange and use of germplasm between institutions in different countries.

## In situ/on farm conservation of genetic diversity

It covers the conservation, management and restoration of species populations and of its associated ecosystems. In situ conservation is also included on farm conservation, related to populations of species under cultivation, generally domesticated, as well as ethnovarieties (local varieties) conserved in agricultural areas (Clement et al., 2007). In situ/on farm conservation ensures that natural evolutionary processes and changes resulting from interaction with the landscape and cultural environment are maintained, allowing the accumulation of genetic variability, adapted to environmental and social changes.

Embrapa has developed several actions related to in situ conservation, such as biological inventories and geographic analyzes for conservation planning; evaluation and development of management techniques for the sustainable use of biodiversity; ecological restoration in degraded landscapes; and also to the analysis and promotion of the conservation of genetic resources by local communities and farmers. Emphasize the actions with the indigenous peoples, in which Embrapa operates in different territories, such as: Krahô, in Tocantins; Kaxinawá and Kulina, in Acre; Kayabi, in Mato Grosso; Tumukumaque, Oiapoque, in Amapá; Guarani and Kaigang, in Rio Grande do Sul, where there are activities with corn, cassava, fava beans, peanuts, beans, pumpkins, acai and even native bees.

One relevant experience refers to the support given by Embrapa to the farmers who conserve and use the Sementes da Paixão (seeds of passion, name given to the creole seeds in the state of Paraíba). Several participatory trials have been carried out to evaluate and select traditional varieties, aiming to compare their quality to other materials from breeding programs. In addition, research has contributed to improve seed production and to identify storage techniques that extend its shelf life (Santos et al., 2012).

Related to the strategies to promote in situ/on farm conservation, we highlight the banks or seed houses, the agrobiodiversity guardians and the seed fairs, actions that have been supported by Embrapa for more than 20 years.

Seed houses and socio-culturally territorialized genetic collections are local strategies for the dissemination of agrobiodiversity performed in learning spaces where families have access to new species and varieties. Seed houses are directly related to local farmers associations or technical schools. Embrapa has been an important partner of these actions by providing seeds that are included as part of the collection of these houses and are used in agroecological systems of local production.

Agrobiodiversity guardians are farmers and breeders who maintain a range of species and varieties in their farming and breeding systems, thus contributing to their conservation and adaptation to climate change. Embrapa participates in guardians' networks composed of family farmers, *quilombolas* and indigenous people in partnership with other institutions. In some cases, it supports participatory genetic improvement, training farmers and technicians, and thus strengthening the autonomy of communities. Only in Rio Grande do Sul, more than 230 individual or organized guardians were identified, and a significant part of the agrobiodiversity conserved by them was inventoried (Bevilaqua et al., 2014). These initiatives, which also include the network of junior guardians, have achieved international recognition by being nominated as a "sustainable practice" by the Food and Agriculture Organization of the United Nations (FAO) in 2016.

Agrobiodiversity fairs or seed fairs aim to foster community management, enable access to locally missing components of agrobiodiversity, introduce new crops into local systems, and promote the exchange of experiences. They are also spaces for the commercialization of family farming products. Embrapa has been supporting numerous fairs, especially in indigenous territories (Dias et al., 2015). The Krahô indigenous land, for example, has already held 10 agrobiodiversity fairs (Figure 2), which had 6,000 farmers from more than 20 ethnic groups (Dias et al., 2014). The initiative has multiplied to other indigenous territories such as Xerente, Pareci, Kayapó, indigenous peoples of Roraima and of Médio Purus, in Amazonas, and has been incorporated into public policies. Along with other publics, Embrapa supported, in Rio Grande do Sul, the holding of 12 fairs in 2017, with the participation of more than 10 thousand people.

Among the experiences of rescue and repatriation of genetic resources from the germplasm banks, there are 4 varieties of indigenous corn, 12 of sweet potato,

Photo: Terezinha Dias

**Figure 2.** *Krahô Fair of Traditional Seeds*: indigenous farmer exposes seeds for exchange.

27 of rice for the indigenous people Krahô (TO); several corn varieties for the Xavante (TO), Guarani (RS) and Maxacali (MG); fava beans for the Xavante (TO); and wheat varieties that resulted in the distribution of seeds to family farmers in Chapada dos Veadeiros (Dias et al., 2013; Rangel; Dias, 2016).

An important action was carried out from seeds of open pollinated varieties, mainly provided by the Germplasm Bank of Vegetables (Embrapa Vegetables), which allowed the reproduction of the seeds of the varieties selected locally by farmers. Through training activities and field days, more than 20 community local banks of traditional vegetable seeds were established along with farmers and traditional communities in the various regions of the country.

Several participatory evaluations of materials provided by germplasm banks have been carried out in partnership with farmers and local institutions, such as varieties of cassava, corn, pumpkins, peanuts and beans. In Rio Grande do Sul state, farmers' participation resulted in the transfer of 140 creole bean varieties and 30 varieties of other species through Partituras da Biodiversidade[2] – a collection of creole varieties for evaluation and possible adoption (Villela et al., 2014). Annually, 30 seed collections are available, among cultivars and creole varieties of beans, corn, vegetables and dual-purpose legumes to guardian farmers who, through a process of participatory genetic improvement, identify those with the greatest potential for selection of new varieties adapted to several social and ecological systems.

## Final considerations

In close relation with target 2.5 for more than 4 decades Embrapa has been developing actions for the conservation of the genetic diversity of seeds, plants and domesticated animals and their wild relatives. Its collection and exchange actions have brought together the sixth largest collection of germplasm in the world and the largest in Latin America. Added to this, pioneering actions of genetic resources availability to society, from ex situ conserved accesses, have allowed the repatriation of scarce and locally missing materials, contributing to the strengthening of in situ/on farm conservation and to a qualified approach between the two conservation systems (ex situ and in situ/on farm). At Embrapa, several projects and initiatives to strengthen the conservation of genetic

[2] Translation note: It is a mechanism for promoting biodiversity increase. It assembles creole varieties and makes them available to farmers who evaluate and select the varieties considering new uses.

resources, carried out locally by farmers, are underway, broadening the global perspective of conservation of the agrobiodiversity

This chapter has highlighted some of the initiatives that Embrapa has undertaken to promote the conservation of genetic resources and the sustainable use of agrobiodiversity. There are countless efforts by curators, breeders, researchers, family farmers, traditional peoples and communities who conserve seeds and insert them into food production systems. However, the challenge of mitigating hunger in the world requires corporations such as Embrapa to unite with government institutions and civil society in the search for joint solutions to strengthen these initiatives, either by expanding and structuring the germplasm banks of research institutions and of farmers, either by creating innovative systems for shared management or by creating and implementing appropriate public policies to achieve the goals of sustainable development.

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