Genebanks – treasures of biodiversity

More than 10,000 years ago, men began cultivating animals and crops as food sources. This agricultural revolution led to the domestication process, in which the early 'plant growers' consciously or unconsciously selected among wild germplasm the material that was best adapted for human use and cultivation, i.e. increased storage organs, even germination, reduced dormancy and early maturation. These so-called landraces were passed from growing season to season and included materials that were adapted to various environmental conditions such as drought or altitude. Landraces could thus produce stable but not outstanding yields under varying conditions.

The early 20th century saw a shift away from mass selection towards crossbreeding, which allowed for the targeted incorporation of specific agronomic features from parents into progeny. Although these adaptations were associated with dramatic alterations to plant morphology, the genetic control of these traits is often relatively simple involving only a few genes, each of them exerting large phenotypic effects. Together with developments in cultivation techniques and protection of plants, the new cultivars improved the yield substantially; yield of winter wheat more than tripled between 1930 and 1993. Along with these developments, a concentration of cultivated crops and cultivars has been recognised – about 70 percent of the overall acreage of winter barley in Germany is covered by eight cultivars only.

Already in the 1920's plant specialists in several countries recognised the risk of losing the genetic variability of cultivated plants in response to changing environmental conditions and cultural practices and initiated collection missions in order to accumulate and store genetic resources in *ex situ* (not at the original site) seedbanks. Nikolai I. Vavilov, founder of the first seedbank, developed theories regarding the origin of crops, their evolution, regional and evolutionary variability that formed the scientific basis for the collection, exploration and preservation of plant biodiversity. Today about 6 million records of plant material are kept worldwide in about 1,000 institutions, which differ both in size and the variety of the material. Three different methods for preserving plants are being employed:

Storage facilities of the Genebank at IPK Gatersleben.

Photo: IPK

1. In seedbanks seeds are stored under cold and dry conditions and are reproduced in certain intervals to 'harvest' new viable seeds. Depending on the longevity and the viability of the seeds, these can be kept for several years or in the case of wheat or barley even for few decades. Seedbanks account for about 90 percent of the worldwide preserved plant material.
2. Field genebanks (*in vivo*) or *in vitro* storage are used primarily for species that are either vegetative propagated or that have non-orthodox seeds, which cannot be dried and stored for long periods. The preservation in fields covers about 9 percent and *in vitro* less than 1 percent of the worldwide resources.
3. Another method uses ultra deep temperatures for long-term storage of vegetatively propagated plant species. To this end, very small parts of the shoots, termed „meristems", are frozen in liquid nitrogen at -196°C. In case the sample is needed, meristems can be regenerated into intact plants by tissue culture.

For the future, it will become more and more important not only to preserve the accessions but also to characterise the stored germplasm at the genetic as well as at the trait level. This will be achieved by deploying high-throughput analytical tools that allow for the systematic analysis of large numbers of samples for the discovery of rare variants and features that further improve plant performance with respect to a sustainable production of food, feed or renewable resources. First promising examples in this direction are the identification and meiotic transfer of resistance genes from wild barley into cultivated barley varieties. Similar attempts were successfully performed in potato and sugar beet. Thus, genebanks provide the genetic resources to increase genetic diversity, which in turn forms the basis to further adapt crop plants to the requirements imposed by a growing world population, an increasing demand for renewable energy and the unknowns of a global change.

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