Climate-adapted plant breeding

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At various locations in Europe with different climatic conditions, the researchers in Prof. Chris-Carolin Schön's team have cultivated old maize varieties to investigate their genetic potential. Credit: Tom Freudenberg/pict-images

The famous seed vault in Spitsbergen and national gene banks retain hundreds of thousands of seed samples to preserve old varieties of crop plants and the genetic diversity associated with them. Are these seed

banks gold mines or seed cemeteries?

Researchers around the globe are investigating whether retained samples contain genes that have been lost through breeding which could be beneficial in counteracting climate change. A research team led by Chris-Carolin Schön, Professor of Plant Breeding at the TUM, is now presenting a solution to harness the genetic potential of old varieties, so-called landraces.

Have good plant characteristics been lost through breeding?

Since the 1960s, maize has been grown in Europe's fields mainly in the form of hybrid varieties. Hybrid varieties are developed through a specific breeding scheme and, for example are 'trimmed' for high yield per hectare or low susceptibility to pests. In order to breed the best variety, a kit of characteristics is needed that could be relevant both today and in the future. Thus, genetic diversity is the basic prerequisite for breeding improved crop plants.

Hybrid varieties, however, carry only a small selection of traits compared to old varieties, the landraces. The question then is whether in addition to undesirable traits, beneficial traits have been lost in the course of many breeding generations. Therefore, the call for landraces has recently been revived, as they are characterized by high biodiversity and are considered a natural source of new genetic variation for breeding. Genetic variation reflects different variants of a gene and can be recognized by differences in the plant's appearance.

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Cold-tolerant varieties: Are they the winners in times of climate change?

The early development of young plants is of particular importance in times of climate change. Drought and heat are the conditions most damaging to crops, such as maize, when they occur during flowering. When a plant can be cultivated early in the year because it can cope with cold, it has already left its flowering period behind when temperatures are particularly high in summer. This means that it is less damaged and yield losses can be avoided.

Professor Schön and her colleagues have been examining landrace varieties for cold tolerance characteristics. For this purpose, they have developed a genome-based method of identifying and making targeted use of beneficial gene resources. After a preliminary study, in which the researchers identified the genetic differences of individual varieties, the researchers selected three landraces for cultivation in different locations with varying climatic conditions within Europe.

Landraces provide advantageous genes for crop improvement

The research team focused on traits related to early plant development and also took into account the stability of the plant (How well does it withstand wind?) and the growth form (straight or bushy?). Using molecular methods that scan the entire genome, they were able to link the data from the field trials to genes relevant to the specific traits.

"We have shown how to find new genetic variation for important traits in agricultural production. The variation in these traits is determined by many genes and is not sufficiently available in current breeding material," says Manfred Mayer, lead author of the study. "This opens the door to the development of improved climate-adapted hybrid varieties."

More information: Manfred Mayer et al, Discovery of beneficial haplotypes for complex traits in maize landraces, *Nature Communications* (2020). DOI: 10.1038/s41467-020-18683-3

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