

Pre-breeding of cereals, and why it is necessary for sustainable food production

Docent lecture in Agricultural science, specialization in Plant Breeding by Therése Bengtsson

To achieve a sustainable food supply under a changing climate, food production must become more resource-efficient and the environmental impact on soil, water, and air kept as low as possible while maintaining biodiversity. Today we see steady population growth in the world. We are in the midst of an ongoing climate change, with more unpredictable and extreme weather conditions such as drought and flooding. The changing climate is expected to influence which pathogens and pests will dominate in the future, and for their control today we rely mainly on chemical pesticides because plant resistance to several of them is lacking. Hence, crops that can provide farmers with a high yield despite annual and local weather fluctuations and the presence of pathogens and pests are necessary for future food security. In this docent lecture, I will summarise current challenges breeders and researchers are facing on their way to developing crops for sustainable food security, but also present what tools and plant resources are at hand.

Genetic diversity is vital for crop improvement. Low genetic variation makes a crop more vulnerable to abiotic (e.g. drought) and biotic (e.g. disease) stresses. Today, there is a vast collection of landraces (farmers' cultivars) and crop wild relatives (CWR) held at genebanks worldwide. They are considered to have a large genetic variation for resistance or tolerance to abiotic and biotic stresses. Desired genetic traits (e.g. host plant resistance to pathogens and pests) from non-adapted material like CWR can be introduced into modern domesticated material that the breeders more easily can use in their genetic improvement programs through a process known as germplasm enhancement or pre-breeding. However, when crossing with a CWR many undesired traits will be transferred. Removing those is a very long and costly process. Thus, pre-breeding is often carried out by the public sector in close collaboration with private breeding and seed enterprises.

For the last decade, I have worked closely with Nordic researchers and breeders in projects dedicated to pre-breeding of cereals for resistance and tolerance to biotic and abiotic stresses as well as other important agronomic traits. This collaboration has resulted in the development of easy-to-use DNA markers for several traits, which will facilitate cost-efficient selection at an early growth stage and in early generations in the Nordic breeding programs. Moreover, it has resulted in genetically enhanced material with resistance transferred from landraces and old cultivars to adapted material. In the lecture, I will provide an example from one of the Nordic pre-breeding collaborations, and of how we there managed to transfer and combine leaf scald resistance genes from spring barley landraces into modern spring barley material adapted for Nordic conditions.

At the end of my lecture, I will share my idea of an area I want to focus my future research on, namely pre-breeding for pest resistance. An area that has been neglected due to available and efficient chemical pest control but also because of the difficulties in phenotyping such traits since insects are mobile, influenced by the surroundings, and do not always cause visible damage to the plant. However, as a result of ongoing changes in the climate and regulations concerning pesticide use, breeding for pest resistance will become increasingly important in the coming years.