Evolutionary breeding — Improving the performance and stability of winter wheat

Can the UK wheat industry adapt to climate change and reduced inputs?

The **Adaptive Winter Wheat** project, conducted by the Organic Research Centre—Elm Farm, aims to improve the stability and performance of winter wheat. Research in the project has investigated if a wheat crop with high genetic diversity shows greater resilience in the face of climatic variability and a reduced dependence on the use of agrochemicals. Rather than developing a new pure line wheat variety, this project has developed a novel approach to wheat breeding, known as *Evolutionary Breeding*.

The wheat crop we have developed is being trialled at 24 farms which are participating in the project, and at a further four sites where more in depth scientific analysis is taking place.

The Wheat Breeding LINK project is funded by Defra and industry partners.

defra Department for Environment Food and Rural Affairs

LINK COLLABORATIVE RESEARCH

The problem

Monocultures— the one trick ponies

Conventional UK wheat crops are typically composed of single varieties that have been bred to achieve optimal yields when grown under specific conditions, typically in high input systems. Consequently these modern wheat varieties tend to perform poorly in the absence of high agrochemical inputs.

As prices for synthetic inputs are predicted to rise and concerns over their environmental impacts become more apparent, a reduction in their use is becoming more and more inevitable. This presents the need for developing varieties of wheat that are specifically suited to low-input and organic production systems.

Surviving environmental variation

Predictions for the future UK climate suggest increased climatic variability and higher frequencies of extreme weather events. Coupled with a reduction in the use of agrochemical inputs, this means that conditions for growing winter wheat in the UK are likely to become increasingly unpredictable and uncontrollable.

The cereal industry is therefore under pressure to supply farmers with wheat varieties that are able to cope with climatic variability, be competitive against weeds, pathogens and pests, and be able to utilise soil-bound nutrients efficiently without depending on synthetic inputs.

How do we develop a wheat variety that can cope with such a wide range of growing conditions?

The solution—Genetic diversity

Plants can best cope with variable growing conditions when they posses a diverse set of genes that enables them to survive and adapt to changes in their environment. Think of these genes like items of clothing. Imagine you're going on a summer camping trip. The unpredictable weather of the British summer means you wouldn't want to pack only shorts and sunglasses. Instead it would be safer to pack equipment and clothing to suit all possible weather conditions (including a rain coat for the inevitable rain showers!). Similarly, a plant will be best equipped to survive unpredictable weather conditions when it has high genetic diversity.

At the Organic Research Centre we have used this principle to create a wheat crop, known as a Composite Cross Population (CCP), that is resilient and can provide stable yield and quality both in variable, low-input systems and high-input systems.

Composite Cross Populations

The CCPs have been developed by crossing 20 parent wheat varieties in every combination possible. Normally a breeder would just select and grow a single cross. For the CCPs however, the entire offspring from all of the crosses were grown together. In principle, the wheat populations growing in the field then possess the characteristics of all 20 of the original parents including,, for example, high yield potential from Deben, good disease resistance from Claire and good baking quality from Hereward. The farmer can thus achieve a high yielding milling wheat that can cope with disease outbreaks.

The benefits—Adaptability = Stability

Results of test baking: CCPs produce flour suitable for bread making

The enormous range of characteristics that exist in the CCP means that, like the well prepared camper, the wheat has the ability to cope with whatever conditions it encounters in the field. This means the farmer achieves greater stability of yield and quality, without the need for agrochemicals.

A Wheat variety that's tailored to your farm

The high genetic diversity of the CCP also allows the wheat to adapt to the particular soil and climate of the farm as well as to the farmer's management system. As the farmer uses farm-saved seed over successive years, natural selection takes place in the field and is expected to lead to a wheat crop that is more suited to the specific conditions at any farm.

Reduced costs

Growing a wheat crop that has the natural ability to perform well in a range of conditions also means the farmer can reduce the use of synthetic inputs, saving both economic costs to the business and costs to the environment.

For more information please contact: Dr Thomas Döring: thomas.d@organicresearchcentre.com