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COOPERATING FOR NEW VARIETIES

Shaping Wheat for the Future

Global demand for wheat is set to outpace production.

To accelerate the development of more efficient and robust varieties, Bayer CropScience has set-up a broad network of breeding facilities and partnerships with leading international research institutions.

The golden ears are iconic: Since the dawn of civilization, wheat has been a symbol of health and prosperity around the world. Today, it occupies more area than any other commercial crop and ranks among the top-three staple foods together with rice and maize. Cultivation of the wheat we know today began thousands of years ago and developed from the domestication of certain grass types. "Over time, these grasses evolved into the high performance varieties that feed our modern day society", says Steve Patterson, Bayer CropScience's Global Crop Manager Cereals. But recent environmental changes are putting wheat to a very hard test.

Of the major crops, wheat is the most vulnerable to climate change, due to its geographic spread and adaptation as a cool season crop. Around the world, shifting climate zones are causing greater fluctuation and increasing

incidence of severe weather conditions such as droughts and heavy rains. "We are facing the twin challenges of how to increase intrinsic yield and adapt current wheat varieties to cope with these environmental challenges", says Patterson. Some climate models even show, that a temperature rise of two degrees by 2050 will lower wheat yields by an average of 20 percent. In light of these threats, the wheat team around the world is working to get wheat into shape for the future.

Plants and animals have had millions of years to adapt to changing environmental conditions. "What is happening today is occurring in such a relatively short period of time that it creates huge challenges for the development of the needed varieties adapted to the changing conditions", Patterson says. Every day a plant undergoes millions of mutations. It is nature's key to survival. And a relentless



Despite the enormous quantities of wheat being produced around the world, meeting the global demand will become more challenging in the future.

TOP-TEN CROPS BY ACREAGE IN 2012

(in millions of hectares)



Wheat is by far the largest crop in terms of acreage. About 25 percent of the global arable land is used for cultivating wheat.

Source: FAOSTAT



battle is waged inside each and every organism: Plants and animals are constantly exposed to harmful fungi, viruses and other environmental factors. A plant's genetic information can even be altered just by sunlight. Although only very few mutations become a fixed part of an organism's gene pool, in the long term it is only thanks to these mutations that new and more robust species arise in nature. "If we succeed in breeding ever more robust varieties, we can

improve productivity and have the potential to meet the environmental challenges, allowing us to recover or even open up areas of land that currently cannot be effectively used for wheat growing", Patterson says. "This is the only way to meet the growing demand in the long term." At Bayer CropScience's breeding facility in Gatersleben, one of the research priorities is to combine traditional wheat varieties that are no longer grown in agriculture

with today's high performing types.

"Some older heritage varieties have properties that make them more resilient", Patterson says.

Speeding-up Trait Development

But Gatersleben is just one of seven breeding facilities engaged in Bayer's research into enhancing wheat. All over the world, nearly 400,000 head rows and about 8,000 genotypes have already gone into field and yield trials since the start of Bayer's breeding program a mere two years ago. Despite ideal growing conditions, the development of a new wheat variety takes as long as the development of new pharmaceuticals: 8-12 years. So the specialists at Bayer CropScience are pursuing several paths in their strategy to develop new varieties with better traits.

"Our ability to understand and manipulate the genetics of wheat has transformed dramatically over the last decade. This means we can do new things that we couldn't do in the past", says Patterson. Next to traditional breeding approaches with native traits, Bayer CropScience is also collaborating with leading research institutions around the world to find GM and non-GM solutions for enhancing wheat. The most recent collaboration is with the Netherlands-based biotech company KeyGene. "We have developed a very efficient method to speed up trait development", says Edwin van der



Steve Patterson, Global Crop Manager Cereals, leads Bayer CropScience's global research network into wheat and related crops.

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At KeyGene in Wageningen, Edwin van der Vossen (left) and his fellow researchers (above)

use cutting-edge technology to analyze thousands of genes in short time.

Vossen, Vice President Field Crops at KeyGene in Wageningen. KeyGene's unique discovery pipeline first identifies key genes associated with novel traits such as drought tolerance or herbicide resistance. Then, by inducing so called point mutations, they can modify these genes to create more beneficial variants. But because wheat has several copies of its genome, this is not an easy task, typically requiring mutation of multiple gene copies. "But we have the capacity to screen thousands of gene sequences in a very short time to find out if a mutation has occurred in the multiple copies of a selected target gene", explains van der Vossen. The scientists in Wageningen then grow plants from this material and analyze them with a digital phenotyping machine. There, each plant is automatically transported into a large chamber where it is photographed from all sides. The machine also records parameters such as leaf surface and root density. It even waters the plants and provides them with nutrients according to a predetermined schedule. "It is the biggest phenotyping system in Europe. And it helps us find out which plants have best acquired the new traits", says van der Vossen.

New Varieties around the Corner

After KeyGene has found the lines with desired mutations, John Jacobs and his colleagues at Bayer CropScience's Innovation Center in Ghent receive packets of seeds. These are then grown at greenhouse facilities in Ghent. "We do a number of crossing steps to eliminate any background mutations and end up with a new and clean variety containing only the desired

mutation for field trial evaluation", says Jacobs. The collaboration with KeyGene has already generated a large collection of mutants during the pilot phase and is geared for success. And the non-GM method has helped with major agricultural accomplishments in the past: "The varieties that led to the green revolution in the 1960's were also developed in a similar way", says Jacobs. For example: newly introduced varieties with a high nitrogen uptake had the tendency to fall over just before harvest because their heads would become too heavy. So scientists activated a gene that causes dwarfism to make the stem stronger and more robust.

The collaboration with KeyGene is just one example of Bayer CropScience's efforts to provide farmers with agricultural innovations. The wheat mutant screening pipeline is just one component of a large multi-year agreement between the two companies to improve traits in a number of agricultural crops including not only wheat,

but also oilseed rape, rice and cotton. Patterson: "Although this specific project has only just begun, the first results of our integrated wheat strategy are already around the corner". Bayer CropScience's first new wheat varieties are expected to hit the markets in 2015. And the already strong network of partnerships will help to ensure the demand for man's oldest staple crop can be met for many years beyond.

For new varieties, Bayer scientists are collaborating with several international institutions, such as KeyGene in the Netherlands and CSIRO in Australia.

