

# Wheat and Gene Editing: Breeding for Better Bread



Wheat is a staple of diets across the world. The grain is the source of close to 20-percent of the calories consumed worldwide.

Researchers at Kansas State University are using innovative methods like gene editing to breed wheat with added benefits, including lower gluten options that could allow people with gluten sensitivities to enjoy bread and other wheat-based foods.

## Gluten Sensitivities Are on The Rise

More than 18 million people in the United States have a gluten sensitivity or intolerance and one percent of the population has celiac disease. Globally, 1.4 percent of the population has celiac and in China, more people are experiencing gluten intolerance than ever before. These issues not only affect digestive tracts, but purchasing decisions, food availability, and global market trends.

In 2018, more than 730 million tons of wheat was produced around the world, the majority of which was exported by Russia, Canada, and the United States. As more people face gluten intolerance, there naturally is a higher demand for low-gluten and gluten-free products. The market for bread, tortillas, processed snacks, and even deli meat that does not contain gluten has exploded in recent years and gives those not able to handle gluten more options in restaurants and grocery stores. If gluten intolerance continues to increase in global populations, demand for wheat could go down and negatively effect the entire wheat-growing value chain.



## Adapting the Wheat Genome with Innovation

Dr. Eduard Akhunov, Professor of Wheat Genetics and Pathology at Kansas State University and his group of researchers are using innovative gene editing technology to adapt wheat to naturally produce less gluten. Specifically, Dr. Akhunov's team is trying to reduce the amount of immune reactive amino acids that trigger gluten sensitivity while still maintaining the qualities that produce an ideal loaf of bread.

Gluten is what gives wheat-based dough its elasticity and creates the iconic crunchy-on-the-outside, chewy-and-soft-on-the-inside quality of a fresh-baked loaf.

In 2017, scientists sequenced the wheat genome, effectively unlocking a wide range of potential for improvements. Because of this, Dr. Akhunov's research team knows exactly where in the genome to look for the specific traits they want to edit. They can do this with CRISPR/Cas9 technology described by Dr. Akhunov as a way to increase the rate of generation of natural variations in a genome. Scientists can use CRISPR to achieve the same result that could happen in nature over the course of millions and millions of years, within a single growing cycle. This capability speeds up the innovation time line for better quality wheat varieties that can grow in regions all around the world. Increased yields are a priority for wheat growers but unfortunately, long-term selection for increased yield resulted in a tremendous decrease in protein content in most of the modern wheat varieties.

“By using gene editing, scientists can improve the protein content and the nutritional value of the wheat itself,” says Marsha Boswell, Communications Director for Kansas Wheat.

In addition to protein content, gene editing also allows for improvements to the amount of zinc and iron in the wheat so growers can grow enough of it while preserving its quality.



**DR. EUDARD AKHUNOV**  
PROFESSOR OF WHEAT GENETICS AND PATHOLOGY  
AT KANSAS STATE UNIVERSITY

## Upping the Nutritional Value, Decreasing Land Use

Because so many people in so many places around the world depend on wheat for their daily nutrition, improving the grain's profile could be life changing for millions of people.

"Micro-nutrients are a critical part of the human diet," says Dr. Akhunov "Being able to deliver them through one of the most broadly consumed products would be the best way of solving the nutrient deficiency problem in developing countries."

In addition to changing gluten content, the team in Kansas was able to increase the protein in the wheat by 16% while also achieving a marked gain in grain size and weight. Because of that, they are optimistic that farmers can grow more, better quality wheat on less land. Santiago Bonvilla, Production Manager at Radina's Bakehouse close to the Kansas State University campus has been baking bread for almost 16 years. He says that science is the only way to keep delicious bread with natural ingredients available for a growing population.

"We are losing arable land every single year, but we have more people to feed," Bonvilla says. "It is inevitable that we are going to have to use a type of seed that is - for lack of a better term - created by science."

Bonvilla says his customers want a clean label that allows them to get the natural health benefits of wheat in their bread. Wheat is rich in vitamins, minerals, and fiber. Gene editing has the potential to allow scientists to improve that nutrition profile by increasing the antioxidant levels, increasing digestibility, and improving the glycemic index of wheat for sweeter bread with less added sugar.



## Better Wheat to Better Feed the World

“We certainly get the feeling that we’re helping to feed the world,” says Aaron Harries, Vice President of Research and Operations at Kansas Wheat. “The population of the world is growing, and our challenge here is helping farmers make a living wage in a globally competitive wheat marketplace. We have to make our product better than any other product and try to improve what we’re selling. That’s where a lot of these techniques such as gene editing are going to play an important role.”

Harries says that in nature, plants are always changing and because researchers can now do that on a scientific basis, that process has been transitioned into a laboratory and sped up. Now, there is the benefit of better specificity when dealing with precision gene editing tools. Whether the target is the immune reactive amino acids, the protein, or the micronutrients, wheat researchers have an incredible opportunity to improve wheat for the benefit of millions.

Dr. Akhunov’s team at Kansas State and the researchers at Kansas Wheat are working hard to genetically improve wheat with CRISPR/Cas9 not only to bake better bread, but to improve farmer livelihoods and improve the health of consumers around the globe.



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**SANTIAGO BONVILLA**  
PRODUCTION MANAGER AT RADINA'S BAKEHOUSE  
MANHATTAN, KS



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