Science Societies

Perennial, dual-use Kernza for food and forage

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Professor Valentin Picasso stands in a Kernza field. Photo courtesy of the lab of Valentin Picasso, University of Wisconsin–Madison.

- Kernza is a commercial variety of intermediate wheatgrass—a perennial grain that both animals and humans can consume.
- New *Crop Science* research tested the impact of nitrogen and forage harvest on belowground biomass and nonstructural carbohydrates.
- Their findings indicate that Kernza could be suited to widespread perennial growth, with summer grain harvest and winter forage.

The concept of a perennial forage grass for livestock is far from new, and the same goes for the idea of annual crops for human consumption. But the possibility of a dual-use system where a single perennial crop can provide both forage and grain is new—and has the potential to advance sustainable agriculture, protecting the environment and providing food at the same time.

Enter Kernza. It is intermediate wheatgrass, a cool-season perennial forage grass, that produces a grain commercialized in the United States as Kernza and developed by The Land Institute. In a recent article in *Crop Science* (**https://doi.org/10.1002/csc2.20239**), researchers detail a proof of concept for the perennial grass as a dual-use system for grain and forage. Scientists investigated how nitrogen and forage harvest affect the belowground biomass and nonstructural carbohydrates of the grass.



The roots and rhizomes of Kernza. The researchers evaluated their biomass and amount of non-structural carbohydrates. Photo courtesy of the lab of Valentin Picasso, University of Wisconsin–Madison.

“This is the first perennial grain crop in the world,” explains Valentin Picasso, a professor of agronomy at the University of Wisconsin–Madison and senior author on the paper. “It’s been undergoing breeding for about 10 years. Researching and gathering information on the production of this grain like we did here is very important. The possibility of growing perennial grains would address many issues and change the way we do agriculture.”

Most crops grown for human consumption, such as corn, soybeans, wheat, barley, and rice, are all annual crops that must be planted and fully harvested each year. This means that the soil is left bare for a part of each year, with potential for environmental degradation from soil erosion. Soil washed off fields, and the nutrients it contains, can pollute waterways, for example. There are a lot of environmental problems associated

with annual grain crops, Picasso says.

A perennial grass like Kernza offers the best of both worlds. Similar to other common perennial forage grasses, it covers the ground all the time and is good for the environment. But rather than being solely forage for livestock, Kernza is different because it also offers a grain to harvest. Kernza grain is grown for human consumption. Similar to wheat, it can be made into a baking flour although it contains very little gluten. Currently, the main product is beer made from fermenting the grain.

“Producing both grain for people and forage for animals from the same crop would improve the efficiency of food production from that crop,” says Mary Beth Hall, a scientist at the U.S. Dairy Forage Research Center who was part of the research team. “Animals and humans then aren’t in competition for the resource.”

The researchers’ proposed dual-use system allows a farmer to harvest grain and forage in the same year. A farmer would plant Kernza and harvest the grain in the summer and then the forage in the fall, repeating this year after year. Their recent study looked at two management practices—nitrogen fertilization and forage harvest—and their effects on this proposed system. Specifically, it measured the effects on belowground biomass accumulation and non-structural carbohydrates in the plant.

“We looked at nitrogen application and at forage harvesting in terms of whether you just harvest grain versus harvesting grain and forage,” Picasso says. “Belowground biomass and the type of carbohydrates present are very important for perennialization of the plant, meaning its ability to survive into the next year.”

Carbohydrates in plants fall into two broad categories: structural, such as cellulose, and non-structural. Non-structural carbohydrates contain both water-soluble carbohydrates, such as glucose and fructose, and starch. These types of carbohydrates are stored in rhizomes and roots and help plants survive winter and supply the energy needed to regenerate and regrow in spring.

The group's experiments were done in two locations: Arlington, WI and St. Paul, MN. They established Kernza one fall, did appropriate harvesting and applied experimental treatments, and then sampled rhizomes and roots the second year.

Their findings showed that water-soluble carbohydrates account for the vast majority, 97–99%, of the non-structural carbohydrates in the roots and rhizomes. This is in line with most cool-season grasses, which generally have more water-soluble carbohydrates than starch. They measured both the total amount of the carbohydrates and the concentration. While the roots had a higher total amount of carbohydrates compared to the rhizomes, the rhizomes actually had the higher concentration due to their differences in biomass. They concluded that both rhizomes and roots play an important role in carbohydrate storage.

"We also found that nitrogen and forage harvesting did not affect the concentrations of non-structural carbohydrates or the belowground biomass," Picasso says. "The main implication there is that we can harvest forage and grain and not really negatively affect the persistence of this grass. It was a real proof of concept for this dual-use system."

He adds that this does not mean the forage can be harvested or grazed whenever a farmer wants because that could result in a reduction of the grass's ability to persist. The researchers want the grass to remain strong and perennial so that it can

continually provide essential ecosystem services, such as preventing erosion and nutrient runoff.

While the harvested forage can be sold, Picasso says the system is most suited for farmers who have their own dairy or beef cattle. The relatively new crop is still in its experimental phase. It is currently grown on about 2,000 acres across the United States, mostly in the Midwest but also in states like New York, New Mexico, and California.

In areas like the upper Midwest, this dual-use system could be operationalized by planting the grass in the early fall to become established. After winter, it continues growing in the spring, and the grain is harvested around late July or early August. After the grain is harvested, there is a lot of valuable forage left that can be harvested and baled for purposes like cattle feed or bedding. The grass then regrows in the fall, when can be grazed again, starting the cycle over.

“In this dual-use system, the finding that forage harvest wasn’t detrimental to the belowground plant resources needed to grow further supports the potential for Kernza intermediate wheatgrass to provide both grain and forage,” Hall says. “This expands the products that farmers can sell or use from this crop without compromising it.”

Both Hall and Picasso give caveats about the current state of Kernza. They are still studying other variables and factors—such as looking at spring harvesting, other nutrients besides nitrogen, and intercropping—and breeders are working to increase the grain yield of the grass. They also say that Kernza will not be the only solution to the challenges associated with annual grain crops.

In the short term, Kernza is not meant to replace all corn fields but instead be grown on cropland that is more susceptible to erosion or is near an important watershed. The researchers' long-term vision is to have Kernza as an option with other perennial grains currently being developed, such as perennial sorghum, rice, sunflower, and legumes.

"I see this research as really a way of transforming the way we do agriculture and the way humans relate to the environment," Picasso says. "The birth of agriculture is arguably what created human civilization and culture. I think this is a comparable revolution in terms of human history, to grow food in a way that doesn't destroy the environment as we've been doing the last 10,000 years. This is really exciting and hopeful to me."

Dig Deeper

Check out the *Crop Science* article, "How Does Nitrogen and Forage Harvest Affect Belowground Biomass and Nonstructural Carbohydrates in Dual-Use Kernza Intermediate Wheatgrass?" at **https://doi.org/10.1002/csc2.20239**.

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