Public Research, Public Benefits

Kernza & Other Forever Green Innovations Show the Power of Ag Policymaking that Looks Beyond Corn & Soybeans

By Brian DeVore

Publicly funded agricultural research can sometimes take decades to show clear-cut, practical results, the kind that are evident to the naked eye. But on a hot July afternoon in western Minnesota, Carmen Fernholz was able to vouch for a significant return on investment in a relatively short amount of time when it comes to breeding a more farm-friendly form of perennial grain.

"When I planted that seed the first year, I could hardly see it, it was so small," said Fernholz. "And when I got the seed last fall and took the husk off it, it was double in size. I said, 'That's what they did in six or seven years?' That tells me we're moving quickly."

He said this while standing in a field on the more than 350 acres he and his wife Sally farm near Madison in western Minnesota. Growing in that 15-acre field was a lush, thick stand of a variety of wheatgrass with the trademarked name "Kernza." As the chest-high plants bent to the breeze, they bore a strong resemblance to annual wheat. In fact, intermediate wheatgrass is a perennial grass that is a genetic cousin of common wheat, and in the Fernholz field grain kernels were maturing on the ends of the stalks. Carmen explained that what sets this stand of grain apart is that it won't have to be replanted next year. In other words, this field represents a key step in developing the world's first commercially-viable perennial grain.

Gathered around the edges of the field were more than 70 farmers, plant breeders, natural resource agency personnel, and people involved in the food industry. It was fitting that such a wide spectrum of the farm and food system was represented on this particular day. After all, from the time University of Minnesota scientists like Dr. Don Wyse started developing this form of wheatgrass back in 2011, they made it clear that research related to it wouldn't just focus on improving agronomic characteristics like seed size and harvestability. Through the U of M's Forever Green Initiative, researchers have also been examining what impacts this deep-rooted plant can have on building soil health and keeping contaminants out of water, as well as how well it lends itself to being milled into flour and utilized for everything from baked goods to beer. They've even been studying its use as a source of livestock forage.

As a result of public investment in the Forever Green Initiative, Kernza's practical potential to produce grain, forage, and ecosystem services in corn country is emerging. (*LSP Photo*)

The U of M got its first Kernza seeds from the Land Institute in Kansas, which has been working on developing perennial grain for decades. Wyse and other researchers have spent the past eight years developing a line of the wheatgrass that is adapted to a more northern climate. The 15 acres growing on the Fernholz farm represents the first Minnesota variety of the plant. This will be the first of many U of M Kernza varieties, according to Dr. Jake Jungers, a perennial cropping systems ecologist in the university's department of agronomy and plant genetics. Seven more varieties are in the pipeline, ready to be rolled out in the next several years. Minnesota-born Kernza is now being raised on around a dozen farms—some as far north as the Canadian border and some in the southeastern and southwestern regions of the state.

"This is the honeymoon period for Kernza research," said Jungers as he examined the stand, which he and wheat breeder Dr. Jim Anderson said was the best they'd seen yet. They were particular impressed by the stand considering that it, along with the rest of the land the Fernholzes farm, is certified organic. "Things are happening fast and furious," added Jungers.

Over the past five years or so, the U of M's success in doubling seed size has increased productivity of the grain kernel. Increased size also has a practical benefit for farmers come planting time. "If you're not used to planting light, fluffy seed, you can lose your religion quite quickly," quipped Fernholz.

Another critical improvement is Minnesota Kernza stalks are shorter—tall, rangy wheatgrass tends to fall over and lodge when the seed size is increased. Researchers have also been working on improving the grain's ability to separate from the hull during harvest without sticking. As was made clear during the field day, this "fast and furious" activity is not restricted to seed size and harvestability; results are emerging as to its environmental benefits as well—it can keep nitrates out of groundwater while helping soil better manage runoff in general (*see the sidebar on page 16*). The fact that it is a perennial with an extensive root system also means it can build soil organic matter, which, among other things, sequesters greenhouse gases.

In addition, the food company General Mills had samples of a Kernza-based cereal on-hand at the Fernholz farm, while the Birchwood Café and Bang Brewery offered

Kernza, *see page 16…*

Give it a Listen

On **episode 229** of LSP's *Ear to the Ground* podcast, farmer Carmen Fernholz and researcher Dr. Jacob Jungers talk about the agronomic, economic, and ecological benefits the world's first commercially-viable perennial grain could produce: www.landstewardshipproject.org/posts/1215.

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up baked goods and beer, respectively, that were produced with the perennial grain. Finally, feed trials show that it compares well to pasture grass as a source of forage for cattle.

Kernza still faces plenty of roadblocks before it is commercially feasible—yield and harvestability are just two issues scientists and farmers are struggling with. But in just a few short years, intermediate wheatgrass science has shown the sweet spot publicly funded agricultural research can fit nicely into: while providing public goods like environmental sustainability, products can be created that benefit a specific group, in this case the farmers who derive economic value from raising a soil-friendly crop.

A Public Investment

The research on Kernza is being coordinated by the Forever Green Initiative, a U of M program that is working to develop a variety of crops that can provide an alternative to annual plantings of corn and soybeans. Besides Kernza, Forever Green is working with, for example, pennycress and winter camelina, oilseeds which can be grown alongside soybeans as a kind of relay crop.

During the past several years, the Land Stewardship Project has worked with other groups to procure funding from the Minnesota Legislature for Forever Green to the tune of $1.5 million to $2 million for two-year budget cycles. In the 2019 legislative session (*see page 10*), $4.3 million was secured for the biennium, and LSP plans to push for $10 million in funding during future sessions.

Kernza and the other plant systems being studied by Forever Green represent a slight change in attitude on the part of policymakers. By helping to fund this research, members of the Minnesota Legislature are acknowledging that the future of agriculture does not need to be completely wed-

Kernza, *see page 17…*

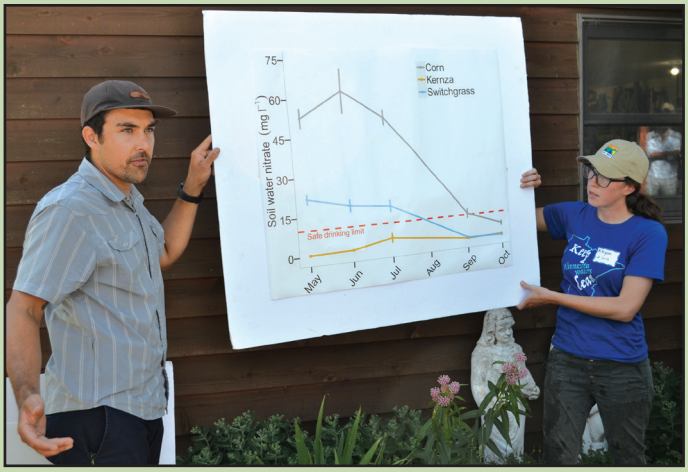
The Power of Perennial Roots

Because Kernza is a wheatgrass, it has the deep, curtain-like root system so characteristic of perennials. In fact, University of Minnesota researchers say Kernza roots often extend deeper than they are able to dig with a shovel. That's good news when it comes to water quality, since having a living root system present in a farm field 365-days-a-year helps build the soil's ability to manage and store water runoff, while soaking up contaminates.

Kernza's knack for taking up nitrates is of particular interest in farm states like Minnesota, where nitrogen fertilizer used in the production of crops like corn has become a major pollutant in many rural communities. Since 1994, the Minnesota Department of Health has found 51 community wells drawing water with nitrate levels near or above federal safety standards. Some communities have had to install water treatment systems, while others have simply drilled new wells in an attempt to bypass contaminated aquifers. And then there are all the private wells on farms and other rural properties that have been contaminated with high levels of nitrates, making the water unsafe for drinking, particularly for infants. All of the options for procuring safe drinking water in an area where nitrate contamination is prevalent are expensive.

"An alternative approach here is to prevent the contamination from happening in the first place, and that's by making changes on the landscape," says Dr. Jake Jungers, a perennial cropping systems ecologist who is researching Kernza at the University of Minnesota.

Jungers, along with other researchers at the U of M and the Kansas-based Land Institute, recently conducted a study where they compared the amount of nitrates escaping fields planted to three different plant systems: corn, switchgrass, and Kernza. According to the study, which was published earlier this year in the journal *Agriculture, Ecosystems & Environment*, the amount of nitrate leaching in the Kernza field was two orders of magnitude lower than it was in corn (it was one order of magnitude lower when compared to switchgrass, which is also a perennial). During a July field day at the Carmen and Sally Fernholz farm (*see page 15*), Jungers displayed a chart showing that during the entire growing season, nitrate leaching under a Kernza field was well below the federal drinking water standard. The ability of switchgrass to keep nitrates below the standard kicked in by July, while corn produced unsafe levels of leaked nitrates all the way until September. Michigan State University research found nitrate leaching beneath Kernza was 86 percent less when compared to wheat.



Research by the U of M's Dr. Jake Jungers, shown here with Rhyan Schicker of the Lac qui Parle Soil and Water Conservation District, indicates Kernza's extensive root system helps keep nitrates from leaching into groundwater. (*LSP Photo*)

Such results have caught the attention of municipalities. In southeastern Minnesota, where karst geology makes groundwater particularly vulnerable to contamination, officials in Chatfield are growing Kernza on a few acres to protect their city's well field. It's hoped a pilot program will provide more communities a chance to utilize the perennial grain as a water quality protector.

During the Fernholz field day, a "one inch rainfall" simulation was applied to a chunk of soil that had been dug out of one of the farm's fields. The soil sample was sprouting Kernza that had been seeded into the field in 2018. In comparison, soils dug up from cornfields utilizing various tillage practices were also soaked with the faux precipitation. When compared to the corn, the wheatgrass retained more of the moisture in the soil and had less runoff, and the water that did percolate through the Kernza roots and down into a jar below was clear.

As she examined the aftermath of the artificial rainfall, U of M soil scientist Dr. Jessica Gutknecht was impressed by a plant that was going to be providing such ecological services for years to come.

"It's amazing what we saw in only one year of Kernza," she said.

…Kernza, *from page 16*

ded to ever-increasing corn and soybean production, and that there are advantages to borrowing from a plant's wild side when creating a viable agricultural crop.

The experience the Fernholzes are having with Kernza offers a glimpse at how publicly-funded innovation can prime the pump for widespread innovation on the land.

A Hoof in the Door

Trials show that after year three, Kernza's productivity drops off significantly. Carmen Fernholz likes the fact that after planting the wheatgrass, he will have at least three years of continuous living cover on a field, which will build organic matter with its deep roots and biomass, eliminating the need for tillage and other means of weed control. Because he is organic, Fernholz relies on tillage for weed control more than he likes, and a perennial grain like Kernza can help deal with that issue while producing cash flow year-after-year.

"I've really become sensitized to tillage," the farmer said. "With things like Kernza, through a natural system we can suppress our weed seed banks, and then we have a much greater opportunity to eliminate this tillage we are so dependent upon now. Kernza is its own cover crop."

Since a conventional field must be chemical-free for three years before it can be certified organic, Kernza is the perfect transition crop for farmers looking to go organic, said Fernholz.

And Kernza's ability to be grazed makes it a multifunctional crop. Jungers laid out a scenario where a grower with cattle could plant Kernza in the fall and then graze it early the following spring—trials show that grazing in the spring typically does not reduce grain yield; in fact, it may improve stand longevity. In mid-August, the grain could be harvested and the straw baled. Later in the fall, it could be grazed again.

"Hey, if we can produce a revenue-generating perennial grain on our farms while improving soil health, let's do it, let's move forward," says farmer Carmen Fernholz, shown here describing his farm's Kernza plot during a recent field day. (*LSP Photo*)

"So, there could potentially be four sources of revenue in one season: spring grazing, grain harvest, straw removal, and a fall grazing," said Jungers.

That potential for utilizing livestock in such a system has Fernholz excited. He and Sally started farming in 1972 and have been certified organic since 1975. Recently, they have been working with a beginning farmer, Luke Peterson, who is interested in carrying on the land's organic legacy. As part of that plan, Peterson wants to integrate livestock into the operation, something the Fernholzes have not done. Carmen feels Kernza could provide that entry for animals. In fact, this summer the Fernholzes and Peterson signed a contract with the USDA Natural Resources Conservation Service that qualifies them for cost-share funds to put in rotational grazing infrastructure.

All of this is exciting stuff for Carmen, a longtime pioneer in organic and regenerative agriculture who has been doing joint, on-farm research with the U of M since the mid-1980s. When he was first approached by Wyse about planting a few acres of intermediate wheatgrass, the farmer agreed to it quickly—mostly, he said, because he already had a good working relationship with U of M researchers and was used to them "tossing things" at him. But it soon became evident that this research could have deeper implications, from an agronomic, environmental, and economic point of view.

"Hey, if we can produce a revenue-generating perennial grain on our farms while improving soil health, let's do it, let's move forward," said Fernholz. "It's exciting." ❐

For more information on the U of M's Forever Green Initiative, see www.forevergreen.umn.edu.