

How year-round crops could reduce farm pollution in the Mississippi River

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Don Wyse's field of winter barley used to be mostly empty in the spring.

Eight years ago, just a tenth of the grain would survive the winter in this

experimental field in St. Paul. But this year, after repeatedly refining the plant's genetics, the field was flush with swaying, pale yellow grain heads.

The winter is the first hurdle that researchers at the University of Minnesota's Forever Green Initiative must clear as they attempt to breed new crops that can cover farm fields year round—and in the process, help [water quality](#) across the state.

For years, Minnesota has struggled to reduce farm pollution from fertilizers and other sources that runs into streams, lakes, the Mississippi River and, eventually, the Gulf of Mexico.

Wyse, a crop scientist who founded and now co-leads Forever Green, said he watched for years as all the funding for farm pollution research went into describing the problem. "There wasn't a very big investment in solutions."

So [crop breeders](#) at Forever Green are working on 16 perennial and winter annual crops to suck up that nutrient pollution before it escapes. Food scientists and marketers with the program are trying to develop uses for these crops and hopefully provide new revenue for farmers.

Perennial crops are not a new idea—groups like the nonprofit Land Institute, in Salina, Kansas, have been promoting the concept for decades. It holds the trademark for Kernza, a perennial grain it is developing in partnership with Forever Green scientists.

But challenges remain in the chicken-or-egg problem of developing a market for these crops. For the crops to be used in large-scale products, there needs to be a lot of production; but for farmers to bet on them, they need to be convinced there's a market.

Carried in the water

In the fertile fields of the Midwest, corn and soybeans dominate: The two annual crops covered 63% of Minnesota's 25 million farm acres in 2021, according to the U.S. Department of Agriculture. In other states, the proportion is even higher—they cover 76% of farmland in Iowa and 80% in Illinois.

In these row crop operations, typically, farmers are tilling and planting seed in the spring, harvesting in the fall and leaving that ground bare until the next growing season.

Falling rain easily washes nutrients out of these fallow fields and into nearby waterways. Phosphorus that flows with eroding farm soils feeds algae in Minnesota's lakes; nitrogen seeps down into groundwater, fouling rural water wells.

"It's this wicked problem that's choking our rivers," said Whitney Clark, executive director of Friends of the Mississippi River. There are "too many acres of leaky, annual row crops."

Nitrogen travels down the Mississippi River to the Gulf of Mexico, where it helps fuel an annual algae explosion and die-off that saps oxygen from the water, causing a massive "dead zone." This year, the National Oceanic and Atmospheric Administration forecast that the dead zone would be 5,364 square miles, nearly the size of Connecticut.

The latest action plan to shrink this dead zone, from 2008, recommended each state along the river basin reduce its nitrogen and phosphorus pollution by 45%. But the levels remain high.

David Wall, a research scientist with the Minnesota Pollution Control Agency, said the state has shrunk phosphorus amounts between 20 and

35%, mostly from improving [sewage treatment plants](#) and some cropland management measures.

But [nitrogen levels](#) have stayed the same, or in some cases, increased, Wall said.

One solution is to keep [plant roots](#) in the ground longer, where they will stabilize the soil and suck up nitrogen before it escapes.

Kernza—a thick, grasslike plant—produces well for about three years, popping out of the ground each spring and maturing for harvest by late summer or fall. By staying in place year-round, peer-reviewed research from Forever Green has shown that it captures 99% of the nitrogen that would otherwise escape compared to annual corn.

"The only way to keep nitrogen from flushing through the soil is to have roots intercept that nitrogen," said Lee DeHaan, the lead scientist for Kernza domestication with the Land Institute.

But Kernza plants are producing just 20% of what wheat plants do on the same acreage in Kansas field tests, DeHaan said.

In the field

On the U's fields in St. Paul, breeders are working to solve that problem. Scientists painstakingly collected pollen from perennial plants and applied it to traditional, annual wheat. The hybrids are growing now, and the hope is that they will have both the perennial qualities of Kernza and the higher grain amounts of regular wheat.

Success or failure won't be apparent until next spring, Wyse said. Only if they emerge again will breeders know whether the plants are truly perennials.

Take pennycress, a common roadside weed that plant biologist and breeder David Marks is trying to make into a major winter staple crop. Marks is so optimistic about the potential for pennycress to produce edible seeds that he has the plant's light-green likeness tattooed on his left forearm.

Marks has plenty to do to make the crop ready for market. The flat, circular seed pods have to be made more durable so they don't shatter open before harvest; thick seed coats must be thinned, so errant seed doesn't survive in the soil longer than a farmer might want them there; and unsafe-to-consume erucic acid has to be eliminated from the seed oils.

Marks said the crop's potential as a winter annual is not only stopping fertilizers from entering the water, but also expanding the growing window, at a time when the pandemic and war in Ukraine have unsettled the globe.

Marks said he worries that the next disruption "will be a threat to our food security. I'm thinking of the future of what's coming next."

Building the market

Of all Forever Green's crops, Kernza is perhaps the best known—and the closest to being made into [consumer products](#).

For these crops to make a difference, they need to be adopted on a grand scale, Wyse said.

"We have to have big markets to get enough of these plants on the landscape to protect the Mississippi River," Wyse said.

There are a few products on the market right now, like a Kernza cereal

sold in Whole Foods stores by Cascadian Farm, a General Mills brand.

But farmers said the Kernza they grow isn't selling as fast as other crops.

Some state money has recently been budgeted to help with this scale-up. In addition to \$763,000 in funding for crop breeding, a bipartisan group of Minnesota lawmakers this year allocated \$500,000 to help fund the supply-chain businesses that take the grain from fields to store shelves.

Developing the supply chain has required intense work, said Christopher Abbott, the president of Perennial Pantry. The startup is focused on selling foods that use perennial and cover crops.

Kernza has to go through extensive cleaning after harvest, which takes about 10 times longer than conventional wheat, Abbott said. After that, his company had to experiment with how to use the grain, which has a higher bran-to-starch ratio than other wheat.

One of Abbott's favorite products is a Kernza cracker, which he described as buttery and flaky. It took 80 iterations to get right, he said.

Early adopters of the crop are eager to make the plantings work.

Anne Schwagerl, a farmer in western Minnesota near Beardsley, said her Kernza crop has required some adjustments. Schwagerl, who planted 40 acres of Kernza in 2020, said harvesting now takes two passes; the wheatgrass must be cut a foot off the ground and then dried in the field for a few days before it can be collected.

Schwagerl said the novel grain fits well in her organic operation which also grows soybeans, corn, rye, oats and another Forever Green crop, winter camelina.

But because of the new market, she wasn't able to sell the grain she first harvested in the fall of 2021 until the following spring.

"The Kernza, we had to store a lot longer than with our corn or soybean or oats crop," she said.

There have been benefits, too. This spring, farmers struggled to get their seed into the ground in much of the state, as the cold, wet season delayed planting.

Schwagerl didn't have to worry about planting; her Kernza grass was already there, with roots several feet deep.

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