Soil Health

A Grain of Ecological Truth

What a New Twist on an Old Crop Tells Us about the Need for Ag Diversity, Livestock Integration, Public Research & Public Goods

By Brian DeVore

It's March 10th, and winter is definitely not a distant memory in this part of northeastern Iowa. Tom Frantzen navigates his pickup truck past hoop houses full of hogs, grain bins, and narrow pastures tucked between shelterbelts. A cold rain has been falling off-and-on all day and the overcast sky isn't much lighter than the black, saturated soil, creating a dreary, monochrome effect. But the weather isn't dampening the farmer's enthusiasm. As his truck bombs through mud holes full of snowmelt, Frantzen talks excitedly about what's at the end of this field road — he's convinced it has the potential to remake the landscape, not just on his farm, but throughout the Midwest. Suddenly, just past a fast running stream and a thin line of trees, a sign of spring and the source of the farmer's optimism: a green carpet splashed across 16 acres of black soil. Frantzen fords the stream with his pickup and parks at the edge of the field, which was covered in snow just a week before.

The crop growing in this field has reenergized Frantzen's faith in diversified farming to the point where he's spent the past few years evangelizing about it to other farmers in his neighborhood and across the Midwest. He's even co-authored a letter to U.S. Secretary of Agriculture Tom Vilsack, challenging him to "really change agriculture" by supporting making this particular crop a key part of the Midwestern landscape. Frantzen makes it clear that the hybrid grain rye growing on the backside of his 320-acre farm isn't just a specialty darling or a cover crop — to him, it represents a new way to think about agronomic and economic resiliency in agriculture. And others agree.

"In my 30 years in this business, I think it's the most exciting thing we've ever launched," says Mac Ehrhardt, owner of Albert Lea Seed.

But people like Frantzen and Ehrhardt make it clear this is not about one particular crop riding into town to save the day — that kind of "silver bullet" thinking has gotten agriculture into bushels full of trouble over the years. And it's not about tweaking the corn-soybean rotation to make it slightly more "sustainable." Rather, the story behind hybrid rye coming to America is a story of taking an ecological, long view approach to agriculture. Whether dealing with the scientific, agronomic, managerial, or marketing challenges of getting a new crop established on the land, to Frantzen it comes down to being guided by a key question: "I mean, do we really want a diverse agriculture?"

Farmer Tom Frantzen: "I think the people at the coffee shop would argue we were in fairly significant trouble." (*LSP Photo*)

Monsters of the Midway

Less than a decade ago, Tom and Irene Frantzen's relationship with diversity was being seriously tested. They started farming in 1974, began transitioning to organic in the 1990s, and by 2000 their crop and livestock operation was fully certified. Tom is the first to concede that they rely on the premiums they receive from their organic crop, pork, and beef production to stay profitable on their 320 acres. And since they can't use petroleum-based fertilizers or pesticides on their operation, long-term rotations are key to naturally breaking up pest cycles and building fertility. Over the years, they had developed a five-year rotation — corn, soybeans, small grains like oats, hay, and pasture — that did exactly that. The oats were the pivot point of this mix: the Frantzens can feed it to their livestock and use its straw for their deep-bedded pork production system. It also serves as a nurse crop for seedings of alfalfa and clover, which fix nitrogen in the soil while providing cattle forage. Plus, like many small grains, oats, with their extensive root systems, help build soil organic matter and disrupt weed cycles. Oats are an example of what University of Minnesota small grains specialist Jochum Wiersma calls "rotational partners" — they may not always have an intrinsic value in the marketplace, but contribute to the overall agronomic and economic success of a rotation.

But by 2012, giant ragweed, which had up until then been a relatively minor nuisance, was seriously disrupting the Frantzens' rotation. For both organic and conventional farmers, giant ragweed is now considered to be one of the most difficult to manage weeds in a part of the Corn Belt that extends from Ohio through southern Minnesota into northeastern Nebraska. It's the perfect pest: like many weeds, it has evolved a resistance to popular herbicides like glyphosate as their use becomes ubiquitous, it emerges from soil depths of up to four inches, and it has a large seed packed with stored energy, allowing it to get the jump on crops (it can grow up to five feet taller than the crop with which it is competing, blocking out the sun). As climate change produces high humidity and extreme heat, ragweed has thrived.

Frantzen calls giant ragweed an "evolutionary monster." Scientist Matt Liebman says he's not exaggerating. According to Liebman, who is an agronomist and the H.A. Wallace Chair for Sustainable Agriculture at Iowa State University, a major reason ragweed transitioned from a nuisance to a crop killer is that in the past it would emerge in March and April, making it vulnerable to being controlled by early season tillage, a cover crop, or herbicides incorporated into the soil at planting. But genotypes of the weed have evolved that extend its emergence window from early spring into the early portion of, for example, the soybean growing season.

By 2013, the Frantzens were in the midst of a major ragweed infestation. It hammered their soybean production, cutting yields in half, in some cases. But it was the small grains that really suffered. Ragweed made it almost impossible to harvest oats for the grain, and the Frantzens were having a hard

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time getting enough straw for hog bedding. With the failure of small grains, the farm was losing a key rotational partner, which impacted everything from the establishment of forages to the productivity of future corn and soybean crops. "I think the people at the coffee shop would argue we were in fairly significant trouble," says Frantzen.

Liebman visited the Frantzens when they were in the middle of their ragweed battle, and was struck by how bad things had gotten. "It was eating up their farm. It was pretty grim," he recalls. The scientist and the farmers agreed: it was an ecological problem calling for an ecological solution.

Winter Warrior

If giant ragweed was getting an early jump in the spring and then staying competitive well into the growing season, why not plant something that could duke it out with the weed during that key period? Such a strategy would require a new crop that didn't fit into the typical plant-in-spring, harvest-in-fall cycle that dominates the Corn Belt. That's why Frantzen was so excited when, in 2016, he received a call from Practical Farmers of Iowa asking if he was interested in experimenting with a form of hybrid rye that was being introduced into this country by KWS, a German seed company.

Hybrid rye is a "winter annual" — a crop planted in the fall that overwinters and then is harvested the following summer for grain and straw. If Midwestern farmers are aware of rye, it's probably as an open-pollinated cover crop with little market value. Open-pollinated rye can be planted in the fall and used to battle early-emerging weeds the following growing season (rye has allelopathic properties that fend off weeds). It's terminated with chemicals, tillage, or a roller crimper in early spring to make way for the next corn or soybean crop being planted.

But the Frantzens needed something that would produce feed and bedding for their hogs while outcompeting weeds well into summer. Since it's harvested for its grain, hybrid rye stays on the land up until July or August, providing cover for the land and living roots in the soil for much of the growing season. Cover crops are a way to make the corn-soybean system more sustainable, but they don't represent a true third crop; it's the difference between being a rotational *partner* and a rotational *participant*.

"With regular cover crops, you kill it just when it starts to become something," says Frantzen. "So the big difference with hybrid rye and soil is that I've got the full month of May, full month of June, and full month of July for the root structure to do something in biologically active soil. Instead of killing something as it comes out of the chute, we'll let the horse make some laps."

The problem posed by giant ragweed can be traced to how monocultures have come to dominate the Midwestern landscape during the past 70 years or so. Weed evolution thrives in a simple farmscape, and it doesn't get much simpler that a corn-soybean rotation. Government programs that do everything from penalize farmers for diversifying and emphasize export-driven commodity markets to promote the processing of corn into ethanol while using crop insurance incentives to narrow rotations have wiped out traditional rotations. To top it off, diversified livestock farms, which utilize a mix of crops (as well as pasture) to produce homegrown feedstuffs while providing a place to spread manure, are being replaced by CAFOs, which rely on huge quantities of corn and soybeans, and not much else.

These trends leave little room for small grains such as oats, wheat, barley, and rye, not to mention perennial forages produced on hay ground and pasture. In one Iowa watershed alone, between 1949 and 1997 the percentage of cropland used for wheat, barley, oats, alfalfa, and other forage crops was slashed from 42% to 3% while the percentage in corn and soybeans grew from 57% to 97%, according to a *Journal of Soil and Water Conservation* study. By 2017, 85% of the total harvested cropland in Illinois, Indiana, Iowa, Minnesota, Nebraska, Ohio, South Dakota, and Wisconsin was sprouting corn and soybeans. Minnesota and Iowa were once major oat producers. In 2020, Minnesota farmers harvested 160,000 acres of oats, a 97% drop from 1950. Iowa has seen a 99% drop in oat production during that same period. Even a small grain mainstay like wheat is being replaced in some places by corn and soybeans. The USDA estimates a little over 46 million acres of wheat will be grown in this country in 2021, the fourth lowest amount since records began in 1919.

With Midwestern agriculture so dominated by two annual row crops, there is little incentive for the rest of the agricultural infrastructure to be diversified. Everything — from transportation and storage to processing and livestock production — is constructed around the corn-soybean system. Even innovation is constricted by this fixation on these two plants — for the past several decades in this country, the bulk of crops research, both public and private, has been focused on improving even more all the elite varieties of corn and soybean genomics farmers have available.

In that kind of climate, there's little economic incentive or public support for developing a hybridized small grain in the test plots of universities and seed companies. So maybe it's not surprising it came from a place where corn and soybeans don't rule the land: northern Europe.

In many parts of Europe, small grains have remained a key part of cropping systems. And interest in winter annuals like rye has increased in recent years as a result of environmental rules that require farmers to keep 50% to 70% of their ground covered with a living plant throughout the year. Since commercial varieties of hybrid rye were released in Europe in the early 2000s, use has exploded there. Claus Nymand, the product manager for KWS's hybrid rye division in North America, estimates that 20 million acres of the crop are now grown from Russia to Ireland, and from Scandinavia in the north to Spain in the south.

As it did with corn back in the 1930s, hybrid vigor in rye has paid off in a number of ways. For one thing, by selecting for various traits and doing careful cross breeding, grain yield in hybrid rye can be as much as double that of its unimproved, open-pollinated counterpart. Just as importantly, the new varieties are resistant to ergot, a fungus that resembles rat droppings and is toxic for humans and animals. Ergot can cause abortions in sows and hallucinations in humans. There is evidence that the hysteria that led to the Salem Witch Trials was the result of people consuming ergot-contaminated grain.

Another advantage of hybrid rye is that its stalk is about four-feet-high, considerably shorter than the six-foot conventional rye, meaning it's less likely to lodge during storms, a significant plus in light of the extreme weather events that come with climate change. "Wow, I get a plant that stands and I get about twice as much grain," says Frantzen. "Nice work, plant breeders."

In September 2016, the farmer planted 18 acres of hybrid rye. By November, the crop was six inches tall, and when the Frantzens hosted a Practical Farmers of Iowa field day the following June, it was three-to-four feet high. A few ragweed plants could be seen, but they were significantly outmatched. By mid-July, when they harvested a bumper crop of grain and straw off a field that had previously been a riot of ragweed, the Frantzens were convinced: they had brought their rotation back from the brink.

Five years down the road, the Frantzen rotation looks like this: plant hybrid rye in September, harvest it the following July and plant a nitrogen-fixing cover crop such as peas, which is grazed off. The next spring, that field is planted to corn, and the subsequent rotation years involve soybeans, oats,

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hay, and pasture.

In a sense, a crop like hybrid rye is prying open a critical window during the growing season that is shut tight under a corn-soybean regimen that ties up the land until well into the fall. By being able to plant a nitrogen-fixing cover after harvesting the rye in the middle of the summer, the Frantzen farm is able to provide key fertility for crops grown the following year.

"What kind of planting window do you have with corn and soybeans during the growing season? None," says Tom. "With a winter annual like hybrid rye, you get to have a crop that opens that window up."

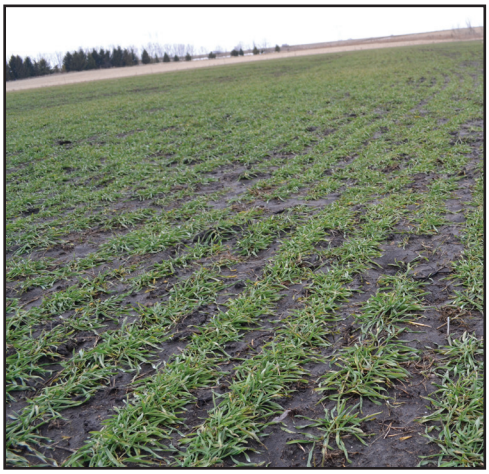
And it's not just the rye straw that benefits the Frantzen swine herd — PFI trials show the processed grain competes with corn as a feed source for their hogs. Because it can be harvested for grain, hybrid rye provides the farm with significant marketing flexibility: while the Frantzens have walked it off the farm in the form of pork, they have also sold it to a specialty miller that's less than an hour's drive away. They are also growing a forage version of hybrid rye, which provides a key feed source for the cattle herd when grazed or cut as silage. University of Wisconsin research shows the forage version of hybrid rye is highly digestible for cattle, another result of hybrid vigor.

American Inroads

KWS's Nymand estimates that 40,000 acres of hybrid rye are grown in the U.S. — a drop in the bucket compared to the almost 180 million acres of corn and soybeans planted this year. Planting it is not a minor investment — the per-acre cost of seeding hybrid rye can be almost double that of its open-pollinated, conventional counterpart. The majority of farmers who are growing hybrid rye here have contracts with specialty millers or whiskey distilleries.

One of those farmers is Richard Magnusson, who farms 11,000 acres with two nephews near Roseau in northwestern Minnesota. At the prompting of the U of M's Wiersma, he planted 60 acres of hybrid rye in 2016. He has expanded his acreage every year since — in 2021 he's set to harvest over 900 acres of the crop. He was the first to plant hybrid rye in his area, and now a dozen farmers in surrounding counties raise a total of around 5,000 acres of the crop.

"At times, it's one of our best crops," says Magnusson. Because he focuses on raising small grains in a part of the state known for such crops, managing hybrid rye was not a big stretch for the farmer. He likes that it is winter hardy and requires far less chemical inputs than other crops. At first, he had to haul his harvest several hours to the Twin Cities. But now, with more acres in the area, a local elevator is shipping it by rail. The per bushel price has ranged from $4 to $8, and Magnusson says he can make money when yields exceed 100 bushels to the acre — his yield monitor shows he's produced 140 bushels per acre in spots, over double what he's gotten with open-pollinated rye. Becca Brattain, the country manager for KWS, says the crop has a wide geographic range, doing well in Canada and from



By early March, the hybrid rye on the Frantzen farm is already getting a jump-start on weed pests. (*LSP Photo***)**

coast-to-coast (yields drop off significantly when it's planted as far south as Kentucky and Tennessee). She says hybrid rye is not competitive in areas that can produce 250 bushels of corn per acre. "But we are competitive with those guys who are getting 200 bushels to the acre of corn."

That's good news for the environment: because hybrid rye cuts reliance on pesticides, reduces nitrogen fertilizer pollution, and, in general, builds soil health, its carbon footprint is about a third that of corn, according to research in Europe.

Walking it Off the Farm

Hybrid rye grows well here, has multiple uses, and leaves a lower carbon footprint. It's ripe for a major breakthrough in American agriculture, right? This is the part of the story where many "third crops" and other innovations hit a wall. They generate a lot of excitement, and then the reality sets in: how will farmers make them consistently pay?

This is hybrid rye's fifth growing season in the U.S., and Ehrhardt's company is seeing demand for the seed increasing every year. But he estimates that the U.S. is already raising about 90% of the rye needed for the milling and distilling industries. Magnusson says it faces the same "chicken and egg" dilemma a lot of specialty crops face. "Production and use have to kinda balance each other out. You can't just produce a whole bunch and hope it sells," he says.

Everyone interviewed for this article — farmers, researchers, agronomists, and seed dealers — agreed on one thing: hybrid rye's road to mainstream success runs straight through the barn. U of M Extension crops educator Jared Goplen has crunched the numbers for corn-soybean farmers looking to diversify, and come to one conclusion. "There are ways to make small grains like hybrid rye pay, but it's going to take livestock as part of the system," he says.

Around 70% of the hybrid rye grain raised in Europe is fed to livestock, mostly hogs. Feed trials in Illinois and South Dakota reinforce what the Frantzens have discovered: it can work as a good feed source for swine that are currently being fed mostly soybeans and corn. One estimate is that it has 90% to 95% the feed value of corn.

Farmers in Iowa, Minnesota, and South Dakota are feeding hybrid rye grain to conventional and organic hogs on a trial basis. Even CAFOs are showing interest in raising it as a feed source — since it can be harvested in the summer, it provides a wider window for manure applications. Because local feed mills may not be used to processing rye as feed, the livestock farmers it works best for are those that have access to their own milling facilities. For example, the Frantzens' son, James, operates a specialty feed mill a few miles from the farm.

A Public Good

One barrier to making innovative crops a consistent reality on farms is lack of support for not only developing and adapting local varieties, but helping farmers get them established. Hybrid rye was developed by KWS working with university researchers in Europe. Tom Frantzen is thrilled that he has a new tool, but concerned that it's not based on homegrown science. "Why isn't this work being done in the Midwest?" he asks.

The 2017 Iowa Farm and Rural Life Poll asked what it would take for farmers to plant more small grains. The farmers surveyed agreed that extended rotations involving small grains were good for soil health and helped break up pest cycles, but just 28% felt that such rotations could be as profitable as corn-corn or corn-soybean rotations. Lack of viable markets for small grains was a

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major reason for the farmers' concerns. And half of the respondents said the "culture of Iowa agriculture" is not supportive of crops other than corn and soybeans. "Culture" can mean many things, including what kind of science is there to back diversification. Two-thirds of respondents rated lack of small grains varieties with "elite" genetics as a major impediment. Lack of technical support was also an issue.

"In Iowa, we haven't had a small grains breeder for 14 years and haven't had a forage breeder for 15 years," says ISU's Liebman. "It's a self-fulfilling prophecy — we can't diversify rotations because we don't provide what farmers need when it comes to elite genetics."

Minnesota is in a slightly better position. Small grains are an important part of the Forever Green Initiative, a U of M project that is developing crops that can be integrated into corn-soybean systems as "relays" for providing continuous living cover. The U of M's Wiersma, who is based out of the Northwest Research and Outreach Center in Crookston, has been doing trials on hybrid rye and his part of the state is still a major producer of small grains. Goplen, who is based out of the West Central Research and Outreach Center in Morris, is working with farmers who may be focused more on raising corn and soybeans, but would like to diversify. Goplen says there is a lot of potential to do research based on a life cycle analysis of how the crop could reduce a farm's carbon footprint.

The problem is, when one starts considering things like the carbon footprint of a cropping system, that's research related to public goods, and an agricultural public good requires public support in the form of land grant research. With the exception of initiatives like Forever Green, which has received funding from the Minnesota Legislature thanks to pressure from the Land Stewardship Project and its allies, public support for sustainable ag research is hard to come by. And in general, public plant breeding — conventional and sustainable — is in a "crisis" funding wise, according to numerous studies. The journal *Crop Science* has concluded that the field "is in a state of decline." The loss of public funding for land grant plant research is particularly troubling at a time when private seed firms are focusing on creating varieties that boost their bottom line, not providing wider societal benefits like a lower carbon footprint.

Albert Lea Seed's Ehrhardt says making hybrid rye a big part of Midwestern agriculture would require publicly-funded research and technical support that takes an interdisciplinary approach. Such efforts should go beyond involving agronomists and include economists and ecologists, among others, he says, adding that they should be guided by difficult questions such as, "What's it worth to reduce nutrient leaching in the Minnesota River Valley watershed?"

KWS's Nymand says one motivation U.S. agriculture may have to make a crop like hybrid rye a key part of its rotation is the threat of regulation. After all, the pressure to keep cover on the land in parts of Europe has made a winter annual very popular there. "And this is also coming in the U.S., I'm pretty sure," he says of such regulations.

Nymand is a native of Denmark, so he can be forgiven for not being aware of just how difficult it would be to implement such restrictions in this country. But even his American colleague, Becca Brattain, who lives on a farm in Indiana, recognizes the benefits such requirements have produced.

By summer, the hybrid rye is completely dominating the giant ragweed on the Frantzen farm. "I've got the full month of May, full month of June, and full month of July for the root structure to do something in biologically active soil," says Tom Frantzen of hybrid rye. (*LSP Photo***)**

"As a farmer, I know none of us love regulations, I get that 110%," she says. "But it certainly promotes crop diversity in Europe. It certainly promotes this concept of soil health, things like that."

Liebman says as long as agriculture is not required to pay for "externalities" like nitrogen pollution and increased use of toxic chemicals because of herbicide-resistant weeds, even the most exciting third crop opportunity may not catch on.

"Probably the biggest factor that keeps the existing corn-soybean duopoly in business is the lack of costs for environmental damage or what might be happening to human health," he says. "If you don't charge for that and you get subsidies for doing more of the status quo, it's difficult to change."

Give it a Listen

Episodes 195 and 254 of LSP's *Ear to the Ground* podcast feature farmer Tom Frantzen talking about how his struggle with giant ragweed forced him to revamp his rotation. Check out episode 195 at www.landstewardshipproject.org/posts/podcast/1006 and episode 254 at www.landstewardshipproject.org/posts/1404.

The Discomfort of Diversity

Back in northeastern Iowa, Tom Frantzen has never been afraid to disrupt the status quo. After all, he's what social scientists call an "early adopter" — someone who enjoys pushing the envelope. He knows that to make a game changer like hybrid rye part of mainstream farming, it will mean reaching farmers, who, for various reasons, do not feel they are in a position to make major changes to the way they do things. That will require operating on many fronts: locally, regionally, and nationally. As he drives his pickup near the town of Alta Vista in early March, he points out an example of a "local" effort: the fields on several small Mennonite dairy farms are sprouting hybrid rye. At Frantzen's prompting, the farmers seeded the rye after taking off corn as silage in early fall. Land that has been exposed by silage harvest is particularly vulnerable to erosion.

The farmer also talks about the letter he recently helped pen to the USDA chief, and how he hopes it will make it clear to policymakers that this is not just about hybrid rye, or any third crop, for that matter. This is about accepting the reality that agriculture must evolve if it is to stay viable. After all, for years, Frantzen thought his previous rotation was the ultimate answer — evolutionary biology said otherwise.

Paraphrasing Alan Nation, the late editor of the *Stockman Grass Farmer*, he puts it bluntly: "Comfortable people don't create change — uncomfortable people do. And people need to honestly answer a question: are you comfortable or uncomfortable?" ❐

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