The Land Stewardship Letter

Keeping the Land and People Together

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Biodiversity & Agriculture: A House Divided

EDITOR'S NOTE: This is the first of a two-part series on the loss of biodiversity in our agricultural systems. This installment examines the problems simplified cropping systems have created in the Red River Valley and other parts of farm country.

By Brian DeVore

KISS, short for "Keep It Simple, Stupid," has a nice, no-nonsense ring to it. But for residents of the Red River Valley these days, such a phrase leaves a bitter taste on the lips. For more than a century, replacing complicated biodiversity with a handful of crops made the region the stuff of agricultural lore. Soils deep enough to bury a man upright in helped make this 300-mile flattened trough of former tallgrass prairie a world class wheat and barley producer.

But five years ago, this simplified system proved to be the perfect environment for a fungus called *Fusarium graminearum* — wheat scab — to thrive in. Year after year of the same crops planted to contiguous sections of farmland have made it easy for the fungus to survive and spread. That's no surprise to University of Minnesota ecologist David Tilman, who has studied the effects of replacing biodiversity with monoculture.

"When we set out a huge part of the landscape to a single plant species, the pathogens have it easy. If we want agriculture to survive, we have to outsmart pathogens," he says. "We're not outsmarting them right now. We're playing the dumb game."

It's proving to be an expensive game as well. Small grains growers in the region have lost $4.2 billion worth of income since 1992, mostly because of the scab. About one-fifth of the Valley's farmers went out of business in 1997, and 1998 doesn't look much better, even though favorable weather conditions late in the growing season headed off another huge scab outbreak. On the Minnesota side of the Red River of the North, wheat plantings were down almost 30 percent in 1998. The region — it covers parts of Canada, North Dakota, South Dakota and Minnesota — is no longer one of the most productive small grains producers on the planet. In fact, some agronomists are beginning to wonder if cereal grain crops will have any role to play in this region's future. "The ideal situation is that wheat and barley don't disappear from this

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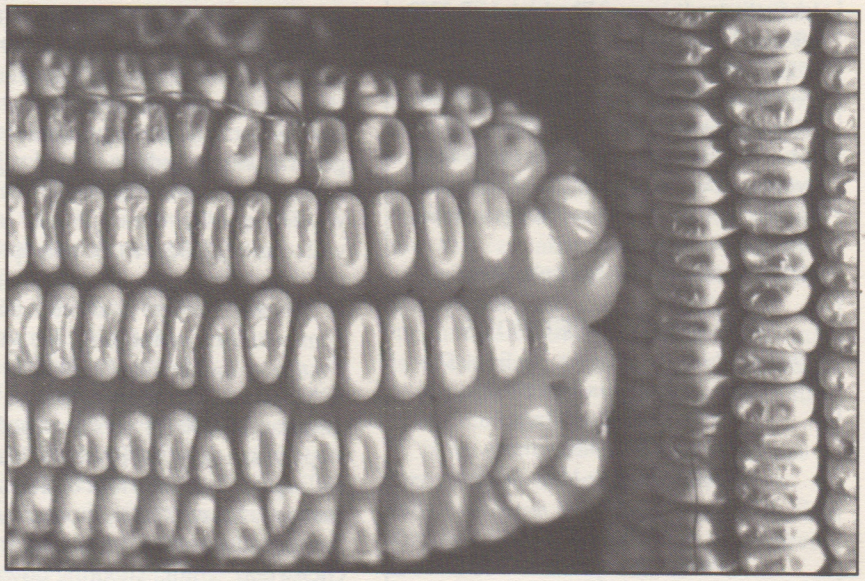

Uniformity in crops such as corn has made modern agriculture incredibly productive. But ecologists and agronomists are concerned that such a simplified production system is leaving the land and its farms more vulnerable to failure.

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rea," says one small grains expert, mustering all the optimism he can.

The Red River Valley entered the 20th Century a prime example of the good that can come from focusing a plant ecosystem's energies; manipulating it so that instead of producing a little of everything, it produces a large quantity of just a few things. But it will depart this millennium with a different legacy: as an example of the bad that results from destroying all that biodiversity.

And as reports of crop failures, disease outbreaks and super-pests begin emerging from other parts of farm country, agronomists and ecologists are expressing concern that the Valley's dire situation is not an anomaly. Rather, it's a harbinger of the disastrous, widespread consequences of simplifying plant biodiversity out of the picture. These consequences are not limited to agronomic or even ecological failures, by any means. As the bankruptcies mount and Main Streets shut down, it's become clearer than ever that biodiversity and human well-being are intricately entwined.

This spring, a 60-member task force consisting of Minnesota farmers, as well as representatives of agribusiness, public agencies and nonprofit organizations, concluded that the crisis in the Red River Valley was a prime example of technological fixes failing to make up for a lack of biological and genetic diversity.

"Our current agricultural cropping systems have less biological diversity than at anytime in history," the task force report concluded. "The cause is continued simplification of farming leading to production of a few crops over large acreages. It is increasingly clear that simplified farming is causing a crisis in rural Minnesota."

"It isn't just an environmental tragedy that's developing," says Don Wyse, a weed scientist and director of the Minnesota Institute for Sustainable Agriculture (MISA). He is one of the coordinators of the task force. "It's also an economic, family, quality of life thing as well. The resilience is being lost in terms of the environment, but it's also being lost in terms of the people. It's fragile all the way through."

Bio-diverse universe

"Biodiversity, " a combination of the words "biological" and "diversity," is a term tossed about pretty loosely these days. On a simple level, biodiversity is defined as the number of species present in any given area. But biodiversity is also measured in terms of how much genetic diversity is present within a given species.

Discussions about agriculture's relationship with biodiversity usually center around how much damage farming inflicts on the number of species present in the environment. There's little doubt that food and fiber production are by far the biggest contributors to loss of biodiversity. For example, being the buckle on the Corn Belt has made Iowa, once the home to tallgrass prairie lands containing hundreds of species of plants, the most changed landscape in the United States, according to a recent World Bank report. Until recently, scientists have neglected to apply the principles of biodiversity back in the other direction: How does farming (and farmers) suffer from lack of diversity in the system?

Within the past four years or so, some excellent studies on the complicated relationship between biodiversity and agriculture have been done. What these studies have shown is that to be sustainable long into the future, agricultural production must be *quite* dependent upon a biodiverse environment.

For example, for a dozen years ecologist David Tilman and his colleagues studied 207 grassland plots under varying conditions. Their research showed a direct correlation between the stability of a plant system, and the amount of diversity present. That may come as a surprise to anyone who associates increased biodiversity with a teeming Technicolor jungle supposedly ruled by chaos. But think about it this way: If you have a plot of land planted to all the same species of plants, they will all react to, let's say, dry weather in the same way. What if that species is not drought tolerant? When a season of adequate moisture comes, all the plants in the plot thrive. And when the rains stops, all the plants suffer. Such a lack of diversity exposes that plot to extremes in productivity: it's feast or famine time, no middle ground.

But if there are a variety of plants present in that plot — some drought tolerant, some that thrive under wet conditions — there aren't as many extremes overall. Individual plants may suffer depending on the weather that year, but the plot as a whole does well. In a sense, it's a plant's version of team work.

Just how much diversity is enough is still a mystery. In Tilman's case, he found when a plot had fewer than 10 species of plants present, it was six times more susceptible to drought than when it had 10 or more species. In a year of normal precipitation, having up to 20 species in a plot made that plot twice as stable.

Productivity of the plots, measured by how much biomass could be harvested off them, also increased with diversity. Tilman's research showed that diverse plots of up to 24 species had a 60 percent greater biomass yield when compared to simplified monocrop systems.

This study tells us a lot about the advantages of increasing biodiversity in a grassland ecosystem, says Tilman. He concedes that an acre of corn — an annual row crop harvested for its grain — is quite different from a patch of perennial plants that measure productivity in terms of biomass. Row-crop agriculture's drive to optimize yields of specific commodities can't tolerate a system that produces something as general as "biomass." Weeds may add diversity — and thus biomass — to a grain field, but they can also dramatically reduce the bushels of wheat, corn or soybeans produced on that acreage.

But the ecologist maintains that such research holds an important message for all of agriculture, from wheat production to raising hogs: diversity can take many forms, and in the end it spawns stability and strength.

Dunce caps

That lesson is being taught in many real-world ways in farm country:

◆ Although record yields of corn are still common, there is some concern that the peaks and crashes of crop yields are becoming more extreme. In Minnesota, for example, corn yields have experienced sharper highs and lows during the past two decades than ever before. Agricultural economist Philip Raup concluded in an analysis of these yield cycles that they can only be partially explained by weather patterns.

◆ The cyst nematode disease now infects more than half the soybean crop in states like Minnesota.

◆ A soil-borne fungus that causes "sudden death syndrome" in soybeans was reported in 13 states this summer. At one point, it was estimated that 90

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percent of Illinois soybean fields were infected with the disease. Missouri experienced its worst ever outbreak of sudden death syndrome this year.

◆ Herbicide resistant weeds are throwing a monkey wrench into many farmers' production systems. In some years, more than 100 percent of Midwestern crop acres — when one considers replanting situations — are sprayed with weed killers. But weeds such as giant foxtail seem worse than ever, say farmers and researchers. In addition, farmers are finding they have to switch to newer pesticides more often in a desperate horse race to stay ahead of quickly-adopting super pests.

◆ Destroying tropical biodiversity by clearing rain forests for cocoa plantations has put the worldwide chocolate industry at the mercy of pests and disease. The problem is so bad that the world's major chocolate processors met with conservation groups earlier this year to figure out ways of promoting sustainable cocoa production that preserves biodiversity.

Mono-genetics

In recent memory, the most infamous example of a simplified cropping system going awry occurred in 1970, when southern corn leaf blight wiped out 15 percent of the nation's corn crop at a cost of $1 billion. That resulted from two kinds of biodiversity problems: the planting of too much of one species — corn in this case — that allowed the pathogen to travel long distances unfettered, and the planting of too much of one variety of that species.

That latter problem is of concern to Don Duvick, who for four decades worked as a plant breeder for Pioneer Hybrids. He says the lack of genetic diversity within crop species has been a problem since the first hybrid corn varieties were introduced in the 1940s.

"The farmers all switch to one variety and that variety works great. And all of a sudden you have fields and fields of that one great variety that are susceptible to one pest adapting to that one variety."

Until recently, people like Duvick and Tilman have worked in parallel worlds on a problem that has common roots. In fact, the Center for Agriculture, Science and Technology, a think tank based at Iowa State University, recently sponsored a paper on the subject. As a sign of the political/disciplinary/philosophical boundaries this problem crosses, it was co-authored by Tilman and Duvick.

Dumb luck

In many ways, the incredible biological diversity present when row crops were first introduced to this country has helped stave off a major agronomic collapse. Consider corn and soybean country for example, which could be considered even less diverse than the Red River Valley (in addition to small grains, Valley farmers grow potatoes, sugar beets and oil seeds such as sunflowers and canola).

One wall of a large meeting room at the Southwest Minnesota Experiment Station tells, in graphic detail, the story of a region becoming one of the least biologically diverse areas on earth within a span of a few decades. Fifty sheets of blue paper use computer-generated charts and graphs to show a two-crop monoculture of corn and soybeans methodically replacing a system that at the turn of the century included wheat, oats, barley, rye, alfalfa and pasture in the rotation.

By the time one finishes looking at this wall of agronomic history, it's not a shock to learn that 91 percent of the cropped acreage in a nine-county area of Minnesota is now planted to either corn or soybeans. Sixty-seven percent of the region's total land area is growing one of those crops. This wall of statistics also tells the story of how diverse cropping systems stopped being a key farming tool and evolved into a modern farming liability. After World War II, it was assumed by most farmers that synthetic fertilizers and chemical pesticides made the fertility-building, pest-killing abilities of diverse cropping rotations superfluous. At the same time, the government was paying farmers to plant corn and wheat, not alfalfa, rye and pasture. As the diversity declined, it became easier to farm more acres. This also tracked a trend of livestock being taken off crop farms and being raised by specialist producers, sometimes in other regions. Gradually crops like hay and oats had little use in corn and soybean country.

The rich soils of the Red River Valley have their origins in a vast tallgrass prairie that consisted of hundreds of species of plants at its peak.

"What we really have here with corn and soybeans is a two-crop monocultural system, because both are row crops, even though one is a legume," says Elizabeth Dyck, a weed ecologist who does research at the Experiment Station's Elwell Agroecology Farm. "The idea of a non- legume teamed up with a legume crop is excellent. But corn and soybean are both row crops, you can't deny that."

But this two-crop monoculture has remained amazingly viable all these years, mostly because of a soil system that can withstand an incredible amount of abuse while still responding to applications of petroleum-based fertilizers. Agronomists express amazement at the amount of abuse prime Corn Belt soil can take and still be productive. Crop yields may have deeper valleys than ever, but when they peak, they really peak.

"We can show there's been a drop in organic matter all across the Midwest and yet at the same time look at our yields and consider the trend," says Paul Porter, another researcher at the station. "It's not obvious that we are plateauing yet. This soil is just too good."

Even so, Dyck, Porter and other scientists are concerned that the lack of diversity in the area is eventually going to wear on the system in other ways. After all, the soil a couple of hundred miles north in the Red River Valley is still relatively deep and fertile, and consider what's happening there. Corn still seems to be thriving, but numerous recent disease problems in soybeans — cyst nematode, white mold, etc. — have researchers concerned about the stability of that crop.

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Monocropped mortgages

And even if the rich loam could continue producing monocultures of corn, soybeans and wheat in perpetuity without signs of going biologically bankrupt, Main Streets in farm country are a different story. Record low prices for just about every commodity produced in the Midwest is a sign of yet another danger of forcing the ecosystem to produce one or two plants at the exclusion of all others: overproduction of those one or two plants. A financial crisis descended upon rural America in 1998. The Red River Valley is showing the worst of it, but corn and soybean country is in trouble too. Small town economies throughout the Midwest are in a tailspin. A Federal Reserve survey released in October showed that agricultural bankers in Minnesota, Wisconsin, Montana, North Dakota and South Dakota are concerned the farm economy is headed toward a full-blown crisis a la the 1980s. More than 40 percent of the 107 banks surveyed said their farm customers had reached their credit limits. Some 80 percent reported that farmers they worked with had incomes below normal levels. The accrual net income for the average member of the Southwest Farm Business Management Association dropped more than 140 percent between 1997 and 1998 to negative $16,230, according to agricultural economist Kent Olson.

Anti-simplicity movement

What can be done? Agriculturists — perhaps mindful of the mess simple answers have gotten farming into — say it will have to be a combination of things.

"To bet on one horse at this point in the game is stupid," says Jochum Wiersma, a small grains specialist at the Northwest Experiment Station, which is located in the heart of the Red River Valley.

The fight against wheat scab provides a microcosmic look at the futility of betting on one horse. The fungus has been documented in this country for at least 100 years. In 1917, the disease was found in 31 of 40 wheat producing states surveyed. But in the Red River Valley during the past five years, the disease has evolved from a controllable concern to a devastating nemesis as a combination of factors came together to take advantage of lack of biodiversity in the region.

Cool, wet weather that moved into the region in the early 1990s is given as one reason the scab got such a solid foothold in the first place. In addition, the popularity of soil-saving tillage practices that leave a lot of crop residue on the ground through the winter has also been blamed. Because of the short growing season that far north, plant residue in general does not break down easily. That residue serves as a perfect home for the fungus. And in recent years more corn has been grown to maturity in the Valley, thanks to some unusually late frosts in the fall, shorter season hybrids and less demand for silage in the area (due to a loss of dairy and beef operations). Corn, it turns out, is a prime carrier of the fungus.

In addition, wheat varieties bred to resist the scab are proving to be vulnerable to a leaf disease that can be just as devastating. Wiersma is telling farmers in the Valley to spray fungicides on their small grains every year in an attempt to keep the scab in check. But he concedes spraying isn't a cure-all, and it adds more expense to raising a crop already selling for less than what it costs to produce.

Some agricultural scientists and policy makers are treating wheat scab as an isolated disease problem to be "cured" with technology. For example, couldn't we just develop a super strain of wheat resistant to disease? The Minnesota legislature apparently thinks so. It has provided millions of dollars for research into using bioengineering to battle wheat scab.

But any breakthroughs in this area are at least 15 years off. And veteran plant breeders like Duvick say bioengineered plants may be just as prone to being ambushed by super-pests. In fact, because biotechnology is so precise, it may limit the number of genes a pathogen or insect has to adapt to.

"This fast solution that may be offered by biotechnology is a great big step forward," he says. "But at the same time, it's much easier for the [pest or disease] to make a great big step forward as well."

Diversity, diversity, diversity

The bottom line is that biodiversity-friendly efforts which take a big picture view of the situation must be a major part of any strategy to make our cropping system more resilient, say agronomists and ecologists. No one is suggesting that the Midwest be returned to wall-to-wall tallgrass prairie. But diverse rotations — planting different crops on the same land in subsequent growing seasons — are a good place to start. Simply rotating corn and soybeans (both row crops), or wheat and barley (both small grains) won't cut it, say agronomists. Even rotating corn and wheat, very different crops in many ways, seems to have only exacerbated the scab problem in the Red River Valley.

And in Illinois, farmers have made the troubling discovery that certain western corn rootworm beetles are able to survive a season in a field planted to soybeans. That's not suppose to happen: as their name implies, these beetles normally die when fed anything but corn. In fact, soybeans rotated with corn every other year has traditionally been used as a way of breaking up the breeding cycle of this pest. It appears that strategy is failing. Thanks to the fact that corn and soybeans are planted on literally hundreds of miles of land beyond the Illinois border, this new super-beetle is expected to move north and west into other parts of the Midwest. Scientists say situations like this point to the need for complicated rotations that put different crops on the same land three or four years in a row and beyond.

A lot of this is old news. Pre-World War II farms were relatively diverse, making it more difficult for pests to hightail it from one end of a region to another without being tripped up by varying plant habitats. But that type of diversity has been made unprofitable, due to the loss of an infrastructure that supported a variety of crops. Raising a crop like flax as part of a rotation does little good for today's farmer if there's no place to sell it. There's a reason corn, soybeans and wheat are still planted, even in the midst of price and agronomic disasters: once they're harvested, these crops can be hauled into town and sold at the local elevator. In short, a cropping system based on a few crops has produced a transportation, processing and marketing system based on a few crops.

"Wouldn't it be better if you have more than just corn and soybeans in Iowa or wheat and barley in the Red River Valley?" Duvick asks. "The answer is yes it would — if you could find someone to buy these other new crops." ❐

The next issue of the *Land Stewardship Letter* will describe how a dismal farm economy, environmental concerns and new opportunities are prompting farmers to seek ways of bringing diversity back into their cropping systems.

The Land Stewardship Letter

Keeping the Land and People Together

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Changing the Land's Complexion

EDITOR'S NOTE: This is the second of two articles on the biodiversity crisis in farm country. The last issue of the *Land Stewardship Letter* examined the problems lack of diversity is causing in our agricultural systems. In this issue, we report on farmers and researchers who are attempting to bring diversity back to farming.

By Brian DeVore

It's late September in northwest Minnesota, a time when a post-harvest hue of monochromatic browns begins to dominate the landscape. But one of Jaime DeRosier's fields stands out like a patch of green velvet that's been tossed into the middle of a parking lot. A three-week-old stand of hairy vetch and winter rye is growing like crazy in this field. A walk across it finds the ground to be soft enough to take a nap on. A small leopard frog wrestles its way through this miniature jungle as DeRosier pulls up a few strands of vegetation.

Quack grass, the bane of crop farmers, isn't going to like this at all.

"If I can keep it green in the fall, I'm going to screw up the weed system," says DeRosier. "The weeds get freaked out."

But what may be an unstable situation for a weed pest translates into just the opposite condition for DeRosier's farm as a whole. Rye and vetch are two of more than half-a-dozen plant species he uses in a complex rotation-cover crop system on the 1,500 acres of land he farms near Red Lake Falls. DeRosier's soil has responded by building up its own nutrient-making and pest-fighting abilities. Such a variety of crops makes him less vulnerable to drought and pest outbreaks, as well as soil erosion. And a reliance on natural pest-control means DeRosier doesn't have to worry whether chemical failures will make or break his crop. All this means more stability in his bank account at a time when many of the 33-year-old farmer's peers are calling it quits.

"The local farm business instructor wants to work with me to compare my finances to other operations — now that it looks like I'll be around for awhile."

Jaime DeRosier's complex rotation-cover crop system has helped his diverse farm stand out in an area where monocropping dominates.

Adding a little color

DeRosier is one of a growing group of farmers who are working to bring a little colorful biodiversity back into a mundane Midwestern crop farming system ruled by corn, soybeans and wheat. Ecologists and agronomists say such efforts are coming

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none too soon. Our agricultural system is less diverse than at any time in history and it's paying a price in lost resiliency. Dramatic swings in yields, disease outbreaks that can't be controlled and chemical-resistant pests are just some of the warning signs. Studies are emerging in respected scientific journals that show agriculture needs biological diversity if it is to continue producing food and fiber well into the next century.

For real-world evidence of that, just drive a few miles west of DeRosier's farm near Red Lake Falls past a weather-beaten "Welcome to the Red River Valley" sign. This legendary agricultural production region serves as a harsh example of what happens when a diverse ecosystem is forced to produce a handful of crops for too long. A mono-crop loving disease called *Fusarium graminearum* is wiping out the small grains industry, taking farmers and Main Streets with it. In early 1998, the Red River Valley crisis, along with emerging problems in corn-soybean country to the south, prompted a coalition of farmers, agribusiness leaders, environmentalists and scientists to surmise that our monocropping system is on the verge of collapse — environmentally, agronomically and economically (*see sidebar, page 10*). Even mainstream plant breeders are concerned that a lack of genetic diversity within species such as corn is making these row crops more vulnerable to weather and pest calamities.

Suddenly "biodiversity," a term long relegated to the ecological sciences, has become a buzz word in the halls of agricultural academia. Agronomists — many of whom promoted mono-cropping in the past — have joined forces with ecologists to harangue farmers into being more diverse. Don't plant so much corn and wheat, say these experts in an updated version of the don't-put-all-your-eggs-in-one-basket message.

The ideal system

Biodiversity needs to be returned to farm country in a couple of different forms. First of all, a greater variety of plants should be planted on individual operations. The more different these plants are from each other, the better, say plant ecologists.

"Be careful when you're talking about diversity," says Don Wyse, a weed ecologist and director of the Minnesota Institute for Sustainable Agriculture. "A series of grasses that are really annuals, I say, is that really diversity? I'm thinking a deeper diversity than that."

Research has shown that in many cases two very different plants growing side-by-side can work to create a more stable overall ecosystem. Some of the reasons behind why some symbiotic relationships work remains a mystery to scientists and farmers. In other words, it's become clear that diversity is not simply a numbers game: it's also how those plants interact and compete with each other that is key.

The importance of biodiversity in farm fields even extends below the surface. The roots of crops like corn and sunflowers are gigantic when compared to their hair-like counterparts in small grains and legumes. Just adding a root structure that provides more surface area for biological activity to take place on could help the soil cook up its own natural fertility while fighting off pathogens.

Ecologists are also promoting diversity on a regional scale. Perhaps one farmer could still raise all corn one year, while a neighbor produces alfalfa, small grains or pasture. When looked at on a big picture level, that landscape would then be more diverse, helping to disrupt pathogens that thrive on contiguous plantings of mono-crops. If markets allow, it could also diversify the economic base of that region.

Ideally, scientists worried about lack of biodiversity would like to see a farming system that more closely resembles natural processes; a prairie ecosystem made up of hundreds of species of plants, for example. University of Minnesota ecologist David Tilman's research has shown that increasing diversity in plots of perennial grasses results in more resiliency and biomass productivity. But grain crops can't be produced in such an environment on a large scale — at least not yet.

There have been some recent advances in the field of "perennial polycultures," food crop systems that combine the grain output of annual monocrops like wheat with the stability and ecological health of diverse perennial systems like tallgrass prairies. However, even researchers at the Land Institute in Salina, Kan., a pioneer in this area of study, say we may be 25 or more years away from any practical breakthroughs. By that time, the Red River Valleys of the world may not have the human, agronomic or ecological infrastructure needed to adapt such a system. Something must be done sooner if there is any hope of maintaining a core of family-sized independent farmers who can implement these more diverse methods. There has to be a way to meet nature half-way for the time being.

Can something be done in the short term?

A better row to hoe

Yes, say people like Rick Exner, who works with a group called the Practical Farmers of Iowa (PFI). PFI is a pioneer in conducting on-farm research into methods of bringing more diversity back into agricultural systems. Farmers involved with the group are experimenting with using alternative crops in rotations, planting cover crops to build soil between growing seasons and establishing flowering plants near fields to serve as hosts for beneficial insects.

"In general, we're trying to make our agroecological system more complex, because it's the lost diversity that's causing us problems," says Exner. "There are ways to increase diversity on some of these operations without completely turning them over to something else."

Diverse rotations — growing alfalfa and oats on a field once in a while instead of just planting it to corn every year, for example — were a mainstay of farming before World War II. But chemicals made it possible to replace the soil building and pest-fighting attributes of diverse rotations. It turned out to be a temporary replacement.

Recent long-term crop trials in Wisconsin, Minnesota and North Dakota show that diverse rotations not only suppress weeds and disrupt the breeding cycles of insect pests; they can also produce better yields when compared to mono-crop systems reliant on chemical inputs. How much diversity is needed to return ecological health to farm fields? Researchers and farmers aren't sure. What agronomists are certain of is that adding just one more plant to a one or two-crop system won't accomplish much — economically, agronomically or ecologically.

"People have a mind-set there is one magic third crop. It's more like third *crops*," says weed ecologist Elizabeth Dyck. "It's like the *Monty Python's Life of Brian* movie where a guy yells out: 'You're all individuals,' and the crowd yells back, 'Yes, we're all individuals!'

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It's laughable to talk about diversity if everyone is raising alfalfa as their third crop. The idea is to introduce new crops in the plural."

One problem with implementing rotations is the current state of land ownership economics in agriculture. In a region like the Red River Valley, where a lot of land is cash rented, many farmers can't afford to build up soil and break pest cycles by allowing a field to go fallow or to be planted to a non cash-crop plant for a season. They must pay the rent every year, regardless of whether that land produces a commodity that can be sold at the local elevator. Most landlords and lenders get nervous when farmers they deal with start planting crops that may not have an immediate, visible payoff.

Hairy vetch growing in between rows of corn stubble on the Winfred "Wimpy" Schmidt farm near Marietta, Minn. Schmidt says he likes using the legume to add diversity to parts of fields that would normally be bare and sterile. "I'm looking for a soil builder," says the farmer.

And so many crops that work well in a long-term rotation — forages, oats, etc. — only pay off if they can be fed directly to livestock. The same September day that Jaime DeRosier was checking out his new stand of rye and vetch, a local newspaper story about yet another dairy farming family going out of business competed with the Red River Valley crop crisis for headlines. It's no accident the demise of livestock as a major part of the region's economy is being followed by a major collapse of the cropping system.

Is there a way to introduce some sort of diversity into a cash crop system on an even shorter term basis?

Sharing the same row

"Boy oh boy," says Hans Kandel excitedly as he rolls his squeaky chair across the floor in the basement of the Red Lake County courthouse, frantically digging out charts and data. "You're *really* going to be glad you asked about this."

Kandel is an Extension crop specialist in Red Lake County, which is the heart of northwest Minnesota's wheat growing country. He likes to show visitors a beautifully symmetrical graph that starts high at one point, dips low in the middle, and ends up high again at the end. It represents the amount of sunlight that makes it down to the ground level of a stand of sunflowers during the growing season. In this case, planted at that ground level is hairy vetch, the same fern-like legume that farmer Jaime DeRosier uses in his cover crop system. Studies Kandel and others have done at North Dakota State University and on farms in northwest Minnesota show that the vetch is just shade tolerant enough to put up with low sunlight in the middle of the growing season. Once the sunflower (or corn) leaves dry up, sunlight returns to the ground and the vetch can start thriving — just in time to become a biologically active winter cover crop. Ten farmers in the area, including DeRosier, tried the method on sunflowers last year, and had no reductions in oilseed yields (as long as they planned the seeding so that the vetch didn't overtake the sunflower early in the season). They ended up with a plant system that suppressed weeds, fixed atmospheric nitrogen in the soil and, when plowed up, served as a green manure source of nutrients. This is an example of intercropping: planting two crops in the same field at the same time. Because of different growing schedules and resource needs, the crops can coexist, even thrive, on the same piece of real estate.

Kandel is particularly excited about intercropping's ability to build the structure of the soil while growing a cash crop. Since the tallgrass prairies were plowed under, the soil in his part of northwest Minnesota has had short term fertility added to it only through fertilizer and sometimes manure. These "flushes" of nutrients are difficult for the soil and plants to make efficient use of. Fertilizer applications may boost yields in the short term, but they don't create the long-term environment needed for soil to manufacture its own ecological health.

"Organic matter is probably half what it was when this area was prairie. With artificial fertilizer, we have kept up fertility from year to year, but there is no long-term building of the soil's organic matter," says Kandel. "Our system has basically been running on credit in my opinion."

Research that examines ways of making new, sustainable deposits in the ecosystem's bank account is going on across farm country. Tilman, the Minnesota ecologist, has done some breakthrough research of his own. He says in many cases farmers are ahead of researchers in seeking innovative ways for bringing diversity into cropping systems.

Some innovative farmers are starting to show that diversity can be brought back into the system in a profitable manner on a shorter-term basis. Their incentives and methods may differ dramatically, but their ultimate goals are the same: toss a little complexity into a simplified world. It won't bring about an ecological Eden by any means, but for now it will have to do.

Where's the incentive?

But the reality is that mono-cropping still rules the day in American agriculture. Theoretically, farmers should have good opportunities to diversify. After all, more than 200 different species of crops are produced in the United States. But 80 percent of this total production is accounted for by only four species: hay, wheat, corn and soybeans, according to the U.S. Department of Agriculture. Now, a 60-year-old government system that penalized farmers for planting anything but a handful of row crops is being eliminated under the auspices of the Freedom to Farm law. However, that system has left behind an infrastructure that makes raising anything other than corn, soybeans and wheat a logistical

Complexion, *see page 10...*

... **Complexion,** *from page 9*

nightmare. Don Duvick, a retired plant breeder for Pioneer Hybrid, says this infrastructure has been self-perpetuating even down to the research level.

"It just happens to be that corn and soybeans are the crops that make money for farmers and so they are the crops that make money for seed companies" so that's what gets researched, he says.

The phrase "make money" should be put in the past tense these days. This fall, corn and soybeans were selling for prices well below what it cost farmers to produce them. But as a testament to the vice-grip hold these commodities have on farmers, seed companies and industry analysts are predicting as much of those two crops as ever will be planted come spring, according to the *Wall Street Journal*.

"People ask, 'what's it going to take to get us out of the corn-soybean rotation?' I could stand here until I'm blue in the face and tell farmers it's not good, it's not ideal, there are better options. But that's not going to cut it," says Paul Porter, an agronomist at the Southwest Minnesota Experiment Station.

Freedom through limitations

Ironically, sometimes limiting one's choices can help shuck the shackles of a system that in the end was a prison. In some areas, it's the demand for a chemical-free fertility and pest control system that's bringing diversity back to parts of monocropping land. Because they cannot turn to quick fixes like chemical fertilizers and pesticides, organic farmers have to rely on diverse cropping systems to add fertility to the soil and disrupt weed, insect and disease cycles.

In recent years, crops like chemical-free soybeans have brought two to three times over the price paid for their conventionally raised counterparts. This has caught the attention of some keen "pencil pushing" farmers who are tired of losing money on monocropping, says Kandel, the Extension educator. In the past, lenders dismissed organic production as untested and on the edge of hocus-pocus, he says.

"This past year it was the banker who told some growers, 'You've been raising wheat and barley and you haven't made money the past few years, so why don't you look at these organic soybeans?' "

As another sign of the interest in a system that demands diversity, in August the Southwest Minnesota Experiment Station hosted 120 people during an organic crops field day. That's a phenomenal turnout for a region where 70 percent of the land is planted to either corn or soybeans. Researchers at the facility are hoping to put together a group of 25 farmers interested in converting at least part of their acreage to organic. They want to bring in established organic farmers to serve as mentors for making the transition. And in a holistic strategy that would have been unheard of just a few years ago, agronomists at the station are not just focusing on how to raise those crops; they are also looking at what financial incentives exist, or can be created, to encourage their production.

"As an agronomist, I really have to extend my research to the marketing stage," says Dyck, who does research at the station. "For example, flax is a crop that grows well here. But then the problems of marketing come up. Feeding flax to chickens can produce eggs that have more polyunsaturated fats. So there's a health food niche possibility."

A public good

All of this brings up an important point: In the long term, what guarantee do we have that diversity will become a major part of agriculture in time to save it from collapse? There's a lot to overcome: Having many diverse species on one piece of land is in direct conflict with farming's bread and butter: maximizing the production of one single plant.

Organic premiums or health food niches can help diversity pay financially, but it's still a difficult system to adopt and manage. Even farmers who are proving diverse cropping can be viable concede they are still learning as they go, and are constantly in need of more information.

This is also a system that will require a reversal of the current trend of fewer and larger farming operations.

"You get into questions of equipment here, of time and labor," says Dyck. "Is there an upper limit to size on a diverse cropping operation? Probably."

And what happens if price premiums disappear? The farmers who are turning to diversified, chemical-free production out of financial desperation may not have the deep ecological roots needed to stick with it through thick and thin. What incentives are there for the individual farmer to increase diversity then?

Not many, say economists, agronomists and ecologists. Although the argument can be made that increasing diversity on a region-wide basis benefits all farmers, it's difficult for an individual farmer to see an immediate pay-back. If the market is demanding corn, but it would be better diversity-wise if some farmers in the county raised hay, how do decisions get made as to who raises the profitable crop and who produces the one that's good biologically? The bottom line is that increasingly it's the market that makes such decisions. In the new book *Biodiversity in Agroecosystems*, economists Douglas Gollin and Melinda Smale argue that crop diversity is a "public good" that can't always be established and promoted via the free market (*see review, page 12*).

Tilman says ultimately American consumers may have to find a way to support this public good via subsidies.

"The benefit to society in the long term may have to be weighed against the benefits to the individual farmer in the short term," he says. "Society may have to look at helping that farmer establish an infrastructure for growing more than one crop." ❐

Agrobiodiversity creating a stir

Early in 1998, a 60-member task force concluded that more plant diversity is needed to avert a growing crisis in Minnesota. This task force is one of the first shots in the battle to publicize the problems monocropping has created in our agricultural system. For more information on the "Program for Enhancement of Landscape, Human, and Animal Health," contact the Minnesota Institute for Sustainable Agriculture; phone: 1-800-909-6472; web site: <http://www.misa.umn.edu/>.

In addition, the Council for Agricultural Science and Technology (CAST) has recently published a paper on the importance of biodiversity in our cropping systems. This is significant: CAST is often criticized for being dominated by pro-industrial ag interests. In fact, the think-tank has often used "science" to dismiss efforts to bring more sustainability into American farming. To obtain a copy of the Donald Duvick-David Tilman "plant diversity" paper, call 515-292-4512 or check out the CAST web site: <www.cast-science.org>.

Putting plants to work

One farmer is mixing it up in his northwest Minnesota fields

When Jaime DeRosier began looking for a low-cost way to transform his hay and hybrid poplar tree growing operation into small grains and other crops in the early 1990s, he was appalled at how reliant many farmers were on pesticides and artificial fertilizers.

"Farmers were borrowing 30, 40, 50 bucks an acre just for chemicals," DeRosier recalls. "And sometimes the chemicals didn't even work."

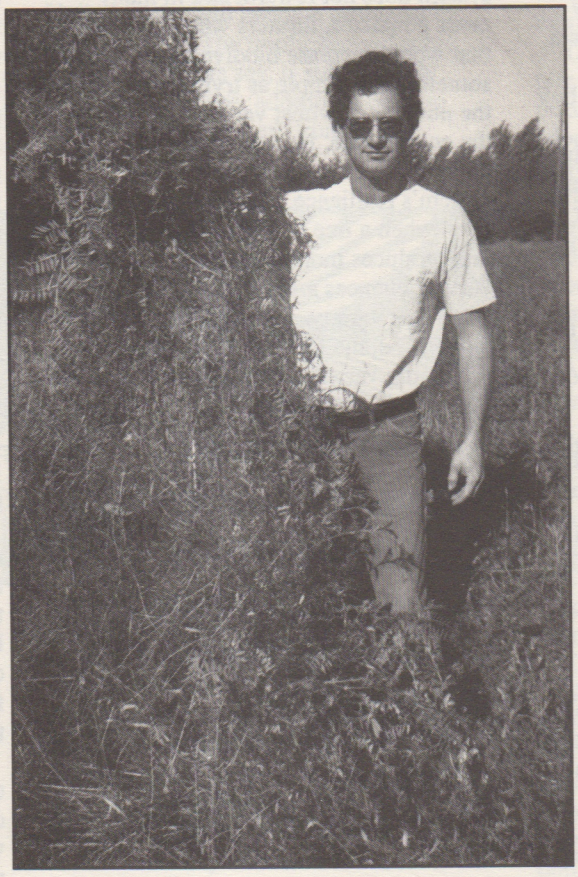
So he started experimenting with raising crops without chemicals. What became clear early on was that to do so would require a complex rotation system using cover crops, green manures and summer fallow. Even the best soils lose their ability to fend off pests and manufacture natural fertility after years of chemical inputs. Suddenly replacing chemicals with diversity without a transition doesn't work — agronomically or economically.

Today, of the 1,500 acres that DeRosier farms, more than 1,000 acres is certified organic. He's done it through a combination of weaning crop acres off chemicals using cover crops and rotations, and renting or buying land that formerly laid fallow in the 10-year Conservation Reserve Program. He's used old, pre-chemical age methods (a grandfather introduced him to the wonders of rye as a cover crop) and new ideas (he has gotten information from Appropriate Technology Transfer for Rural Areas and the now defunct *New Farm* magazine). DeRosier markets certified organic corn, soybeans and sunflower through brokers, sometimes at premiums that are two to three times the conventional market price. He's looking into raising other specialty organic crops like edible beans, sugar beets or even potatoes.

DeRosier says his yields are competitive with crops raised conventionally in the area. Although he hasn't done any direct comparisons, he knows his cost of production is much lower when compared to the average in the area. For example, he figures he can control weeds using hairy vetch for about $15 an acre — a fraction of the price of chemical control. And herbicides don't build soil or provide erosion control.

In fact, a lot of the crops DeRosier grows pull double, or even triple, duty on the farm. For example, buckwheat crowds out weeds and reduces erosion. But its flowers also serve as good habitat for beneficial insects like the ladybug (it loves to dine on lygus bugs and sunflower beetles) and the predatory wasp (it eats corn borers).

But one of DeRosier's favorite crops these days is hairy vetch. This legume is a good example of something that is not considered a "cash crop" in the conventional sense, but it still earns its keep in a variety of ways. For one thing, it can "fix" atmospheric nitrogen in the soil, providing a free source of fertility. In the spring he can plow vetch under to serve as a green manure form of fertilizer for the new crop being planted. It can also be grazed by cattle or cut for hay. Finally, DeRosier raises vetch to sell as seed to other farmers looking for a way to add diversity to their farming operations.



Jaime DeRosier with an arm load of what he calls the "queen of cover crops" — hairy vetch. DeRosier's 39-page booklet, My Cover Crop Rotation Program, *takes the reader step-by-step through how to establish a diverse system that improves soil quality, reduces weed and insect problems and in general makes it possible to raise crops without chemicals in the short growing season of northern Minnesota. For a copy, send $15 to: Jaime DeRosier, Rt. 1, Box 310A, Red Lake Falls, MN 56750.*

DeRosier has gained such a reputation for his successful use of cover crops and rotations that he recently wrote a how-to guide for other farmers (he also works as an organic cropping consultant). He's still willing to talk to farmers about how to establish diverse cropping systems, but hopes the booklet, *My Cover Crop Rotation Program*, will serve as a foundation for getting started. One section of the guide gives a snapshot history of a field. It provides a glimpse into the complexity of a system he says is constantly being refined:

1993: Spring wheat on last year's alfalfa green manure.
1994: Barley harvest with alfalfa under-seeded.
1995: Alfalfa green manure; planted buckwheat for harvest; fall seeded vetch/rye.
1996: Green manure vetch/rye; planted sunflowers for harvest with vetch inter-seeded for fall green manure.
1997: Strip cropped corn and soybeans.
1998: Plant flax or summer fallow.

DeRosier says the key to getting a diverse cropping system established is to observe closely and note what works — as well as what does not.

"People are always watching me pretty closely because they know that a field I'm transitioning out of chemicals will once in a while fall flat on its face," he says. "Every year I think I have my rotation down, until the next year comes."

But chances are such a fall is more like a temporary, character-building stumble, rather than a complete collapse. ❐