The Land Stewardship Letter

Keeping the Land & People Together

LAND STEWARDSHIP PROJECT

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Soil Health, Profits & Resiliency

Feeding the subterranean herd

How putting soil at the center could help revitalize farmland...& farming

By Brian DeVore

On a crisp morning in September, North Dakota farmer Gabe Brown held two handfuls of soil and searched for signs of life—theoretically not a difficult task considering one teaspoon of humus contains more organisms than there are humans in the world. But many of the bacteria and invertebrates that lurk in the dark basement of our farm fields exist visually only in the world of high-powered microscopes. So Brown, a compact ball of energy who can somehow combine references to soil biology, farm policy and animal husbandry in the same sentence, uses a less scientific assessment method to compare and contrast the two handfuls—one from his field, the other from a neighbor's.

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"When you grab this soil there is no structure," says Brown, referring to his neighbor's soil. Indeed, it has a slabbed, compacted look to it, indicating there isn't much room for worms and roots to facilitate transfer of water and nutrients. It's also a lighter color than Brown's darker soil, which is the consistency of cottage cheese. "If you have this dark color, you know you have organic matter. I look at it as an investment."

It's an investment in a good crop—just a few feet away stands a field of corn that's emerged from Brown's rich soil, and it's thriving, a rarity this year in a part of North Dakota that has been hit especially hard by drought. But to Brown, that healthy soil represents more than more bushels in the bin. It's also an investment in his farm's long-term viability and the future of his entire community—human and natural.

The idea that healthy soil is an investment, not just one of many tools, has led Brown and his neighbors to develop a farming system that combines some of the most exciting advances in sustainable production systems—conservation tillage, multi-species cover cropping, mob grazing and frequent rotations. This system, which is evolving, combines cutting-edge soil science with the desire on the part of natural resource professionals to no longer accept a Band Aid approach to conservation. It also shows how teamwork fueled by a holistic, big picture view of agriculture can produce a farming system that benefits land, farmers and communities.

"What Brown and the others he is working with are doing is one of the most exciting and revolutionary in-the-field developments in agriculture today," says Richard Ness, a Land Stewardship Project staff member who has worked with sustainable farmers throughout the Midwest and who has spent time in south-

Farmers in Burleigh County studied the soil profile in a corn field during a recent field tour. Farmers, conservationists and scientists working in that region believe soil's potential to develop its own fertility has yet to be fully tapped. *(LSP photo)*

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central North Dakota, where Brown farms. "They're pushing scientists, conservationists and sustainable agriculture in general to a new level."

Getting at the root of the matter

At the core of this story is a change in attitude toward soil—perhaps one of the most taken-for-granted resources around. Consider, for example, how Jay Fuhrer used to do his job. Fuhrer is the Burleigh County district conservationist for the USDA's Natural Resources Conservation Service (NRCS). Burleigh County lies near the section of the Missouri River where it passes through the south-central part of North Dakota. Here the flatness of the state gives way to a more rolling landscape—a landscape known for wheat, "wild" pastures that contain native species such as big bluestem, hay ground and, in the past decade or so, corn. This part of the state receives on-average 16 inches of rain a year, making water a dear resource. So for many years Fuhrer and other resource professionals focused on short-term efforts to get more water into the soil profile and keep it where plants could use it.

"We had accepted a degraded resource," Fuhrer recalls as he sits in his office in Bismarck, just a few miles from Brown's farm. "And when you accept a degraded resource you generally work from the viewpoint of minimizing the loss. And so we would apply a lot of practices."

Fuhrer's specialty during the 1980s and early 1990s was putting in grassed waterways in an attempt to keep water from running off so quickly. It helped, but didn't get at the core of the issue: why was that water not infiltrating the soil in the first place?

"In retrospect very few of those waterways were actually needed," he concedes.

What farmers like Brown and soil scientists in the area were starting to figure out was that the production system that had come to predominate—extensive tillage, low crop diversity, no cover crops, livestock kept out all-season long on overgrazed pastures—was compacting the soil to the point where little water could make its way beneath the surface. It was also sharply reducing the amount of soil organic matter, which drives the entire soil food web. Unbroken prairie soils can have as much as 10 percent to 15 percent organic matter. But because of intensive tillage, Midwestern soil organic matter levels have plummeted to below 1 percent of total soil volume in some cases. This means the soil has little opportunity to cook up its own fertility via the exchange of nutrients, making it increasingly dependent on applications of petroleum-based fertilizers.

Learning from failure

There is a photo that has acquired almost legendary status in Burleigh County. It shows one of Gabe Brown's fields after 13 inches of rain fell in 24 hours. The picture shows no standing water on this low-lying field, even though plots on neighboring land are inundated. Brown has created a soil profile that allows water to infiltrate quite efficiently. And unlike a field that's been drained through artificial tiling—sending water at rocket speed through the profile and eventually downstream—Brown's fields retain that moisture in the system, meaning plants can access it during drier periods. Such a healthy water cycle requires a healthy biological food web.

Soil conservationist Jay Fuhrer: "We had accepted a degraded resource." *(LSP photo)*

Kristine Nichols, a soil microbiologist at the USDA's Northern Great Plains Research Laboratory in Mandan, N. Dak., says this photo is a prime indicator that farmers like Brown are able to increase their organic matter to the point where it is able to, for example, make better use of water. As soil organic matter increases from 1 percent to 3 percent, soil's water holding capacity doubles. During the past decade or so, Brown has more than doubled the organic matter in some of his fields, raising it from less than 2 percent to nearly 5 percent.

Nichols says that as a soil scientist she was taught that a farmer couldn't have a positive impact on soil organic matter in a typical lifetime.

"We were told this was something we couldn't change, except in a negative way. Now we realize we can change organic matter," she says while sitting in her office across the Missouri River from Bismarck. That's important, Nichols adds, because in the case of organic matter, "You have something that's less than 5 percent of the soil, but it controls 90 percent of the functions."

Brown came to his own realization that he could have a positive impact on organic matter somewhat by accident. He and his wife Shelly bought their farm from her parents in 1991, and in 1994 they went 100 percent no-till as a way to save moisture in their cropping system, which produced mostly small grains like wheat. Brown liked the no-till system, but bad weather produced a string of crop failures during the late 1990s.

It made things extremely difficult financially, to the point where the Browns were having a hard time borrowing enough money to purchase fertilizer. This forced them to start planting more legumes such as field peas, triticale and hairy vetch that could fix nitrogen and provide more homegrown fertility while feeding their cattle herd.

"I was using cover crops but I didn't really grasp soil health," recalls Brown. What he did grasp was that his wheat often did better when planted into ground that had just produced a cover crop. His soil color and texture was improving, organic matter levels were rising and water seemed to infiltrate the soil profile, rather than simply running off.

"So we had four crop failures in a row, and I tell people today that was absolutely the best thing that could have happened to me and my family, although we didn't think that at the time," Brown says with a laugh as he guides his pickup past beef cattle grazing a cocktail mix of warm season cover crops.

Fuhrer and other soil conservation experts in the region were impressed with Brown's results and began talking about ways of combining cover cropping, livestock impact and no-till agriculture in a way that soil quality could actually be improved, not just maintained at a high enough level to grow a stand of wheat. For Fuhrer, taking such proactive steps couldn't have come at a better time—he had grown frustrated with applying practices that simply maintained the status quo, if that.

Diversity is strength

Frankly, cover crops are nothing new. The NRCS has long promoted planting a soil-friendly crop like rye in the fall after corn or soybeans are harvested as a way to reduce erosion. Such cover crops are often seen as having no immediate economic

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value, making them a tough sell in row crop country.

But in Burleigh County, the cover cropping concept has been taken to whole new level, and farmers have begun to see them as an integral part of their long-term financial viability, as well as the land's ecological health. Again, this breakthrough on cover crops came at failure's doorstep.

In 2006 Fuhrer was examining eight different species of cover crops planted on test plots. In one plot each species had been planted as a monoculture, and the other plots contained various combinations: two-way mix, three-way, etc., all the way up to where all eight species were planted together.

"And then we had one of the driest years on record," recalls Fuhrer. "And then I just thought, oh, everything's failed and we're just not going to learn anything this year. And I was so wrong."

What Fuhrer and his colleagues learned was that the monocultures failed, and the mixes involving just a few species didn't fare much better. But the eight-way mixture didn't seem drought stressed at all, and in fact yielded quite well.

"It really taught us a lot from the viewpoint of how plants won't necessarily compete with each other—they can actually help each other," says Fuhrer.

Long-term studies done in Minnesota, among other places, show that increasing diversity in prairie systems produces a similar positive synergy, making them much more resilient. Fuhrer and his colleagues started thinking that maybe it was a lack of carbon below the soil that was the problem. The difference between soil and dirt is soil produces life, and it can do that because it contains carbon. And socking away that carbon for a rainy day (or a very dry one) pays big dividends.

Those eight species of plants growing above ground may appear to be in competition, but all the while they are creating an incredibly diverse subterranean ecosystem. Soil scientists say a diverse root system can create a soil that is resilient, less erosion prone and able to develop its own fertility.

"We figured out we wanted to stimulate soil biology through nutrient cycling and through roots," says Brown. "Well, let's have something really diverse and try it."

These days most of Brown's cover crop mixes contain as many as 20 species. The goal is to keep the soil covered and spider-webbed with roots year-round, and to extend the subsoil's active biological season as long as possible—the greater variety of species above ground, the greater diversity of species below ground. In a typical year, Brown will do this by planting four crop types: warm season broadleafs such as alfalfa, buckwheat, chick pea, cowpea and sunflower; warm season grasses such as corn, millet, sorghum and Sudan; cool season grasses such as barley, oats and triticale; and cool season broadleafs such as canola, flax, vetch and sweet clover.

A growing season may consist of Brown planting winter wheat, harvesting it in June or July and planting a cocktail mix of warm season crops. Once they've grown up by late summer, these crops can be grazed well into the fall and even into early winter, producing good cash flow through the animals. The manure and urine deposited by the cattle, plus the trampling they execute while browsing, builds nutrients and carbon in the soil while supercharging biological activity, providing the basis for planting another cash crop like corn the following spring.

What must be kept in mind is that this isn't strictly a no-till system, or strictly a grazing system. No-till—planting crops in ground that's been disturbed as little as possible—is better for the soil than heavy tillage, but it doesn't take full advantage of the nutrients and biological activity present deep in the soil profile, says Brown. He points out that the neighbor's soil that's lower in organic matter than his has actually been under a no-till regime since the late 1990s.

And grazing perennial grasses, again a more soil-friendly system when compared to tillage, isn't the final word. Hal Weiser, a soil health specialist with the Burleigh County Soil and Water Conservation District, estimates that some of the season-long grazed land in the area has water infiltration rates of only a quarter inch. "Which is simply unacceptable," he says.

Several years ago farmers in the region began switching from simply turning cattle out into large pastures for the entire season, to breaking them up into rotated paddocks. This provided extended rest periods for grass, and pastures responded with healthier stands that provided forage longer.

But more recently livestock producers have taken that rotational grazing concept one step further by utilizing mob grazing—a system where a lot of animals are placed in a paddock for sometimes only a few hours. The animals browse the most palatable part of the plants and generate a lot of biological activity, but don't compact the soil. This system comes with the assumption that the cattle won't make the most efficient use of all the forage—in fact they may trample a good amount of it, which is not only acceptable, but may be preferable in some cases. All that trampling just puts carbon underground and generates biological activity, in effect feeding the soil.

Making soil the focus

Nichols says the key to this system is accepting that soil is at the center of one's farming system—not just another input that can be plugged in. That "dirt" is much more complex than we once thought is becoming increasingly evident as new advances in electron microscopes (thanks to medical technology) and DNA testing offer unprecedented glimpses into this fascinating world. But Nichols points out that in a way soil is a "big black box" that's just becoming "blacker" as science churns up new information about what goes on beneath our feet.

"The chemistry happens the way the chemistry happens. But when you throw biology into the mix, it gets complicated," she says while flashing microscopic images of soil organisms on her computer. "In some ways it's a step backwards—we thought we knew 10 percent of the organisms in soil, now we realize it's less than 1 percent."

But that may not necessarily be a bad thing. It's when farmers begin seeing soil as the heart of an extremely complex, oftentimes mysterious, system that they can start taking steps to get at the problem, rather than just treating the symptoms.

Nichols, who grew up on a southwest Minnesota crop farm, says a prime example of treating symptoms without getting at the core of the problem is what's happening in the Minnesota River Valley with erosion. There are indications that field-level erosion in the Valley has gone down, thanks to the adoption of conservation farming techniques, among other things. However, studies show that sedimentation of the river continues at an alarming rate.

"What is going on with the soil now where we can't get the infiltration of water?" Nichols asks. "We addressed some of the symptoms, which was great, but did we address the bottom line?"

An example of the bottom line being addressed is when microorganisms do something called "habitat engineering," which has huge implications for not only cutting erosion, but also making sure soil can cook up its own fertility while staying in place. When soil does not have good aeration and plenty of pore space, it loses its ability to stick together and form strong aggregates.

"The water coming in can actually cause these aggregates to explode with air pressure," says Nichols of a typical soil erosion situation in compacted soils.

But soils with more carbon feed themselves, and extra "food" goes into devel-

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oping a waxy glue that holds aggregates together, creating a habitat where water can't build up explosive pressure.

"They've actually engineered an environment that's safe, that has food and has the ability to produce carbon to self-perpetuate," she says. "The more of these aggregates there are, and the larger they are, the less susceptible to erosion the soil is. We've found management can impact this."

Investing in the soil bank

Being able to improve soil's ability to engineer its own healthy environment has huge implications on and off the farm.

Soil provides at least $1.5 trillion in services worldwide annually, according to the journal *Nature*. For example, soil stockpiles 1,500 gigatonnes of carbon, more than the Earth's atmosphere and all the plants on the planet. And it's the organic matter that does the heavy lifting: it can hold 10 to 1,000 times more water and nutrients than the same amount of soil minerals.

In recent decades, great strides have been made in reducing soil erosion to "T", or "tolerable" loss rates—that's the rate at which soil can be lost and still replaced. This is thanks to conservation tillage and structures such as grassed waterways and terraces.

But it's become clear even bigger strides in conservation could be made by increasing soil carbon content, or managing for "C." One NRCS estimate is that if all of our country's cropland was managed for T, soil erosion would decline by 0.85 billion tons annually. If cropland was managed in such a way that C was increased, erosion levels would drop by 1.29 billion tons per year. In financial terms, managing for T is worth $16.5 billion annually; managing for C almost $25 billion per year.

But the health of soil on an international or even national level means little unless those dollars can come home to roost on the farm.

Brown says in his case, they already have. He farms around 5,400 acres—1,300 of that is cropland and most of the rest is pasture. The Browns own about 1,400 acres and rent the rest, so maintaining a regular cash flow is important. The main cash crops are corn, spring wheat, triticale and vetch. They run 400 cow-calf pairs and anywhere from 300 to 800 yearlings, depending on the year

Increasing organic matter on his farm has allowed Brown to reduce the use of commercial fertilizer by over 90 percent, and herbicides by 75 percent, and that's paying off big time. Sitting on a four-wheeler near one of his corn fields, Brown shows a printout that outlines the financials for his 2011 crop. At today's fertilizer prices, each 1 percent of organic matter contains $751 worth of nitrogen, phosphorous, potassium, sulfur and carbon, he estimates. That means Brown's 5 percent organic matter content is worth $3,775 per acre. When he figures in his expenses for the 2011 corn crop—seed, herbicide, planting, storage, etc.—his 2011 return to labor, management and land was $5.38 per bushel of corn.

Gabe Brown standing in a field containing a 20-species cocktail mix of cover crops. Much of it will serve as fodder for his cattle, but a significant amount will also feed organisms in the soil. *(LSP photo)*

Still, cover crops and grazing aren't attractive to producers farming high-priced land and gunning for bin-busting yields.

"There's such an emphasis on yield and unfortunately with a lot of these systems, there is not an increase in yield," says Nichols of soil building farming techniques. "But if you can afford to buy an input, then you can afford the cover crop seed or the yield drag. You have to look at your goals: yield or long-term viability?"

Brown says he sees planting cover crops and letting cattle graze/trample them as no different than forward-pricing his fertilizer. But he concedes that in these days of record corn prices, planting a cocktail mix of forages, many of which will end up as worm food, may appear financially foolish.

"And now we're going to mob graze this with cow-calf pairs probably starting next week," he says while standing in a former Conservation Reserve Program field he is renting. It was planted to some 20 species of warm season plants on July 20; on this day in early September, the crop is up to his chest. "I've got to pay cropland rate on it but I'm going to seed it back to native grasses next year. Everybody thinks I'm crazy seeding good cropland back to native grass but that's what we want to do. To us, the resource comes first. The cattle can still gain on this and we're still making money."

Given the great strides he and other farmers have made in building soil health while improving profitability, Brown is a little perplexed that more producers aren't focusing on treating the problem, rather than the symptoms. Some of the hesitation may be the result of the "inputs in-results out" model of agriculture that predominates.

Invariably, when Nichols talks to farmers about how fungi can improve soil quality, someone will ask, "Where can I buy them?"

"We are in the mindset that we can always go out and buy something to fix a problem, which may not be a problem, but a symptom," says Nichols.

Brown says government programs like federal crop insurance don't help matters any, since in many ways they reward farmers for raising crops in a way that is risky, but not sustainable. Remember: he credits failure for pulling his operation out of its monocultural rut.

"Adversity drives change," he says.

Without that adversity, farmers aren't forced to take a closer look at whether their system is just a series of reactions to symptoms, or whether it's getting at the root of the problem. And without such a reexamination of systems, the true potential of soil, land and farms may never be reached.

"Gabe did something I thought was impossible and instead of telling him, 'Good job,' I said, 'What more can you do?' " Nichols says. "I don't know how far we can take it, but I like the idea of not putting limitations or constraints on a system. Can we take it a little further?" ❒

The next issue of the Land Stewardship Letter (see page 5) *will describe how Burleigh County's team approach and use of Holistic Management has helped farmers build soil health, increase profitability and create more opportunities for young farmers.*

Teaming with microbes

It's not just about the bugs beneath the surface—it's also the people above

EDITOR's NOTE: The No. 3, 2012, edition of the *Land Stewardship Letter* described innovative work being done in Burleigh County, N. Dak., to create farming systems that integrate soil health with environmental and economic sustainability. In this issue, we look at how a team effort involving farmers, conservationists and scientists is helping perfect those systems while pushing the envelope further.

2nd of 2 parts

By Brian DeVore

Talking about the importance of feeding soil microbes is fine. Speaking with your feet is even better.

"Take a closer look—anything you tramp down is just carbon in the soil," quips soil conservationist Jay Fuhrer on a Friday afternoon in early September. As he says this, he's beckoning some 120 farmers and others to follow him into an impressively diverse, chest-high stand of warm season plants: cowpea, soybean, sorghum sudan, pearl millet, graza radish, rape and sunflower.

This was the first stop on the Soil Health Tour, an event that brings farmers, scientists, students and conservationists from across the Midwest to south-central North Dakota's Burleigh County at the end of each summer. As the name of the tour implies, they come to see thriving soil, and the land does not disappoint on this particular day. Spadefuls of fragrant humus are unearthed, the results of impressive biological and chemical tests are shared, and crop fields and pastures thriving on that soil are put on display. At one stop at a cornfield, a large jar of water sits next to a six-foot deep soil profile trench. Suspended at the top of the jar in a wire cage is a fist-sized clump of soil that came from the cornfield. Even though it's been immersed in the water as part of this "slaking" test for several hours, the clump is intact and the water remains free of dissolved sediment—a sign that the soil's quality is so high that it's able to engineer its own stability. All of this points to a clear-cut conclusion: the farms on this tour are home to some mighty healthy soil.

What makes this tour special is how this soil got this way. A combination of cover crops, livestock grazing and no-till planting techniques has created soil that not only cooks up its own fertility, but naturally resists erosion and makes better use of available moisture. This means healthy crops and grasses even in an area with a short growing season and an average annual precipitation level of just 16 inches.

What this tour showcases is a farming system that puts soil health at the center. Such a system works with the soil's natural ability to maintain a healthy balance, rather than just treating the symptoms of degraded quality with an ever-revolving array of petroleum-based fertilizers and chemicals.

And by the last stop of the day, it's clear that putting soil at the center of farming is about more than which combination of methods will create the healthiest humus—it's also about blending the ideas and goals of farmers, natural resource professionals and scientists who are breaking new ground in sustainable agriculture. The farming innovations being generated by this group are noteworthy, but just as exciting is the team effort that's arisen in Burleigh County. New farming techniques come and go, but Burleigh County's Soil Health Team is a model for creating the kind of environment needed to ensure the roots for creating innovations in the future will always be deep and thriving.

A team effort

To understand why this team effort is so important, one needs to consider Gabe Brown, a Burleigh County farmer whose success with building soil health has been so significant that one would be forgiven for thinking he's an anomaly.

During the past decade or so on his 5,400 acres, Brown has put in place an innovative system for building soil health utilizing extremely diverse mixes of cover crops—as many as 20 species at times—no-till cropping, and a type of rotational grazing, called mob grazing, where cattle are put in pasture paddocks for short bursts of intense feeding.

Brown has more than doubled the organic matter in some of his fields, raising it from less than 2 percent to nearly 5 percent. He has also improved the health of his water cycle, meaning water infiltrates the soil profile instead of running off the surface.

And it's paying off financially. Brown's use of commercial fertilizer has dropped by over 90 percent, and herbicide use by 75 percent. At today's fertilizer prices, each 1 percent of organic matter contains $751 worth of nitrogen, phosphorous, potassium, sulfur and carbon, Brown estimates. That's the main reason his 2011 return to labor, management and land was an impressive $5.38 per bushel of corn.

Brown has arrived at his current system through a combination of trial and error and consulting with scientists and experts like Fuhrer. He's not afraid to get ideas from people far from Burleigh County who are working on soil health. Brown recalls with excitement when he and Fuhrer were both at a conference and saw a presentation about intense cover cropping systems given by a Brazilian scientist.

"I turned to Jay and said, 'That's the next step,' " Brown says.

Walking Gabe Brown's farm or viewing one of his PowerPoint presentations on soil health and profitability can generate a lot of excitement about the potential for linking long-term financial sustainability and soil health. But Brown knows it means little in the bigger picture if farms like his are seen as isolated examples.

"There are people all over doing this. They just don't have the mouth I have," he says with a laugh while giving a tour of his crop fields and pastures. "Now most of my cover crops are close to 20 mixes. I wouldn't recommend a real diverse mix right off the bat—it can be overwhelming. The longer I'm in this, the more questions I have."

That's why Burleigh County is focusing on helping show soil-minded farmers they are not alone in questioning agriculture's conventional wisdom that the land is just a plant stand for the next crop.

New thinking

"Soil biology is like us—it has to eat," says Fuhrer as he churns up a spadeful of North Dakota earth and holds it up for the participants in the September tour to see. And one way to feed it is to allow cover crops to be stamped into the soil while cattle are feeding on them, or while participants in a field tour are taking a closer look.

That plants can serve an important role as food for microbes and aren't only useful if they can be harvested by machines or animals is just one of the counter-intuitive messages emphasized by the Burleigh County Soil Health Team. There are other head-scratchers: planting corn may not always be the best bet financially and agro-

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nomically; cattle don't need to spend a long time in grazing paddocks; you don't need as much moisture as you once thought to raise a decent crop; no-till cropping systems alone don't save soil; fields with more varieties of plants, not less, are more resilient in the face of drought.

Fuhrer says he identifies with farmers and others who may have to change their worldview to comprehend a farming system that puts soil health at the center. Fuhrer is the district conservationist for the Natural Resources Conservation Service (NRCS) in Burleigh County, and by the 1990s it was becoming clear to him and some farmers that conventional conservation "fixes" weren't the ultimate answer to saving soil.

compacted fields, and the quality of crops and grasses being grown kept deteriorating.

What was needed was a way to test out new approaches to building soil health while spreading that information among farmers as quickly and effectively as possible.

One way the District does that is through experiments at Menoken Farm, a 150-acre educational site started in 2009. Replicated trials on cropping and grazing practices that build soil health are done at Menoken and the District shares the results through field days, workshops and a website (www.bcscd.com). It was this kind of research, for example, that helped show that diverse cover-cropping mixes were more drought tolerant than monocrops because of all the biological diversity created below ground.

But Fuhrer and others know that farmers need to see these practices put into action on real working farms, ones that share the same soil type, geography, weather and even economic conditions. So a few years ago the District promoted "25-acre grants" for seed. The farmers used the grants to establish cover crops, which are generally plantings of low-value species such as small grains. In general, these plantings protect the soil between the growing seasons for more high-value crops like corn. In return for receiving the free seed, the farmers would serve as one of the stops on the annual Soil Health Tour. Those 25-acre test plots were popular, with the District overseeing 30 to 40 a year from 2006 to 2008. With the price of cover crop seed being between $30 to $35 an acre, it was a bargain in terms of the harvest of real-world results it produced.

"So part of the bargain was a willingness to speak at the tour stop—what worked, maybe what didn't work, their observations," says Fuhrer while going over test plot results in his Bismarck office. "And then at the same time it gave people like myself the opportunity to take a look at those soils, maybe do a slake and infiltration test on them. It allowed us to kind of ride along and monitor that and really kind of look at the benefits."

That created a whole lot of on-the-ground results with a relatively small financial risk on the part of the farmer. It also developed an environment where farmers were comfortable sharing their experiences—both good and bad.

A combination of results from the Menoken Farm and the fields planted using the 25-acre grants showed that cover cropping could build soil health year-round, not just during the spring and fall. The Soil Conservation District and the farmers also learned that diverse seed mixes that went beyond the traditional cover crop plantings of small grains such as rye built up an impressive amount of carbon while feeding microbes. This makes soil naturally fertile and less reliant on chemical inputs. It is also increasingly erosion and drought proof. In other words, the soil is more resilient. And this

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Give it a listen

Farmers, conservationists and a scientist talk about improving soil health on episode 121 of LSP's *Ear to the Ground* podcast: www.landstewardshipproject.org/posts/podcast.

Burleigh County's annual Soil Health Tour in south-central North Dakota attracts farmers, natural resource professionals and students from across the Upper Midwest who are seeking information on how to combine sustainable soil management and profitability. (*LSP photo***)**

The Burleigh County Soil Conservation District's supervisors eventually formed a team that consisted of farmers and conservationists. Over the years, this team has promoted no-till, crop diversification and simple cover crop mixtures. It has also worked to get farmers to replace the traditional technique of turning cattle out into large pastures all season long with rotational grazing systems. These farming techniques have been a vast improvement over intense tillage, monocropping and overgrazing. And thanks in part to the Burleigh County Soil Conservation District's soil health work, 70 percent of the county's farmers are now using no-till cropping systems. But Fuhrer and others were finding that even with these conservation improvements, soil was still lost, precious water ran off of increasingly

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resiliency can be attained relatively cheaply by seeding cover crops—plants that, by the way, can serve double duty as livestock forage.

"This isn't a situation where someone is trying to sell a concept," says Fuhrer. "It's based on information and education. And as we share that with each other, we've learned how to build that soil back. You can't help but become excited."

That excitement was on display during the recent Soil Health Tour. The first stop was a field owned by Sanford Williams, who, along with his son Seth, operates a crop and livestock operation. The 68-acre field grew alfalfa from 2006 to 2012. One cutting was taken earlier this year and then on June 22 it was seeded to an eight-species mix of warm season plants. Timely rains before drought set in during the summer helped produce a good stand, which has resulted in a huge amount of biomass and a build-up of fertility. The Williamses plan on letting their cows calve in the small pasture next to the field, and then turning the animals out to graze—and stamp biomass.

Sanford Williams says it's hard to plant cover crops in a field that he knows would grow a good stand of high-priced corn, but that diversifying gives him more flexibility in dealing with issues like drought. (*LSP photo***)**

The farmers on the tour seem to be aware that this is a long-term investment in their land's, and farm's, overall health—a tough sell at a time when a quick applications of fertilizers and chemicals can produce an extremely profitable crop in short order.

"I want to plant corn—you can probably guess why," says Sanford while standing in the mix of cover crops. "Seth wanted to plant cover crops. With crop commodity prices where they are, I'm probably the hard one to convince to do that."

But even the elder Williams concedes that this investment is paying off in ways high corn prices never could—tests show organic matter and fertility are being built up to impressive levels in the field, all without adding extra fertilizer. Later in the tour the father and son show off pastures that have been mob grazed. Sanford explains that a lot of his pastures had been full of unpalatable gumweed before.

"Now I can't believe the grass that's growing there," he says. "I'm not a guy who knows his grasses, but I'm seeing species that are producing more feed. But it didn't turn around right away."

Fuhrer backs up that last point by talking about how although diverse cover cropping and mob grazing can rev up the biology of the soil considerably, farmers must take the long view.

"We didn't get poor soils in one year and we won't solve this in one year," he tells the tour participants.

Out of the lab

To Kristine Nichols, the fact that farmers are having a positive impact on such things as organic matter at all is a major triumph, given that when she was a grad student studying soil science such changes were talked about in terms of geological time—not something that could be impacted in a matter of years.

Nichols is a soil microbiologist at the USDA's Northern Plains Research Station in Mandan, just across the Missouri River from Bismarck. For a scientist in a specialized field, Nichols has a refreshing attitude that appeals to practical-minded farmers

"I'm less concerned about what soil organisms are, and more about what they do," she says. "We could really learn a lot more about functionality of these organisms."

Sitting in her basement office, Nichols is noticeably energized by the fact that farmers in Burleigh County are, for example, creating soil aggregates that engineer their own stability. This kind of self-perpetuating health maintenance is an exciting field of study in microbiology—and now it's being used in the real world.

What these farmers are doing is also causing Nichols to "go back to the textbooks" when questions come up on the land that she's never confronted before. For example, farmers like Brown seem to be able to raise a good crop of corn with less rainfall than one would expect. Why? Nichols has been poring over plant physiology texts looking for clues. Situations like this make it difficult to determine who is pushing who in terms of cutting-edge innovations in building soil health.

"Just like they challenge me to ask questions, I challenge them," says Nichols. "These guys are so innovative, and they so have the desire for challenge that I don't want them to stop, and I don't want them to allow me to stop. Innovations on the part of farmers are forcing us to come at this from a systems approach and ask deeper questions."

Something for everybody

And that's another key to success here—everybody gets something out of this team effort. People involved in the Burleigh County Soil Health Team like to say that if you put soil at the middle, then everything else will follow. It's like giving control over to a powerful, somewhat mysterious force. And ideally, under the general umbrella of improving the life in our land's basement, everyone gets a takeaway.

In simple terms, Fuhrer and his colleagues can say they are reducing erosion and Nichols gets to see scientific theory and research put into practice while she is given new questions to ponder. But just as importantly, farmers who are involved in improving soil health also benefit in some very significant ways. In a sense, it's a very

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community-based approach to an issue that touches on everything from environmental protection and economic viability to the future of rural communities and quality of life.

A lot of the impetus for this team approach comes from the popularity of Holistic Management in the region. Developed by Allan Savory over three decades ago, this is a decision-making framework that has helped farmers, ranchers, entrepreneurs and natural resource managers from around the world achieve a "triple bottom line" of sustainable economic, environmental and social benefits. This framework is built upon the idea that all human goals are fundamentally dependent upon the proper functioning of the ecosystem processes that support life on this planet—water cycling, energy flow (conversion of solar energy) and community dynamics (biological diversity).

Holistic Management's emphasis on "community dynamics" plays a big part in how the Soil Health Team operates.

"The Holistic model has helped get family members and business team members on the same page, helping them all pull in the same direction," says Joshua Dukart, a Holistic Management certified educator who also works as a technician for the Burleigh County Soil and Water Conservation District. He is also a field representative for the North Dakota Grazing Lands Coalition.

Another important fringe benefit to Holistic Management is that it puts producers in the driver's seat, providing more, for want of a better phrase, creative control, over what they do out on the land.

"When you look at it from the approach of restoring the soil, it's a whole different thing for the farmer," says Fuhrer. "It's a much more positive approach."

Flex farming

What's striking about the farmers who are working on soil health in Burleigh County is that in a way doing things in service of microbes has given them a type of flexibility not present on conventional farms. At each tour stop, host farmers were invariably asked about future plans for this crop field or that pasture. The majority were not set on one concrete choice. They were open-minded—willing to see what nature throws their way before deciding.

For example, Seth and Sanford Williams talked about the future of their cover-cropped field. After the cattle mob graze it, then what?

"We don't have a definite plan," says Sanford, adding that it depends on how much moisture the area receives in the next several months—adequate precipitation may mean corn will be a good fit for the field next spring, while droughty conditions could call for a small grain like wheat. Either way they've gotten cheap cattle (and microbe) feed out of the current stand of cover crops at a time when dry weather has made forage dear.

A version of that think-on-your-feet attitude about the next planting season is heard more than once on the tour.

Cattle and crop farmer Darrell Oswald: "Raising annual crops is exciting for us now." (*LSP photo*)

More on Burleigh County & soil health

For more information on efforts in Burleigh County to improve soil health, see www.bcscd.com or call 701-250-4518, extension 3. The Burleigh County Soil Conservation District is sponsoring a soil health workshop Jan. 8 in Bismarck.

"It gives you flexibility when dealing with drought," says cattle producer Ron Hein while standing next to a 37-acre field that used to be all one pasture—in recent years he's broken it up into 20 grazing paddocks. He points out that while one paddock is being grazed, 19 others are resting and rejuvenating, which is particularly important when moisture is short. "It keeps me from having to sell cows."

Fuhrer says farmers who are actively building soil health don't so much look at specific crops as much as they do at the four major crop *types*—warm season broadleaf, warm season grass, cool season grass and cool season broadleaf—needed in a given year to keep the soil covered and biologically active as much as possible. Within those types there can be dozens of choices.

Such flexibility cannot only pay off agronomically and economically, it can make farming more interesting.

The last stop of the Soil Health Tour is the Darrell and Jody Oswald farm near the tiny town of Wing. Using a combination of cover crops, no-till and mob grazing, the organic matter on the Oswald operation has been raised to a respectable 4 percent. Darrell, a long-time cattleman, talks about how working on soil health has made something he never really enjoyed—cropping—interesting for his family.

"Pretty much everything we do and the decisions we make are based on improving the resource," he says while standing near one of his cornfields, just across the fence from the farm's pastures. "Raising annual crops is exciting for us now."

The next generation

Farmers are results-oriented, and during the tour many mention it's exciting, and even fun, to see positive changes on the land and in the bank account as a result of focusing more on "the resource," as they refer to soil.

That positive energy is infectious and can

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help attract and keep a younger generation in farming. Gabe and his wife Shelly are thrilled that their son Paul recently joined the farming operation after finishing college. He's helping perfect their integration of crops and livestock while experimenting with enterprises of his own, such as a pastured poultry business.

Seth Williams likes machinery and raising crops, skills integral to his family's goal of improving soil health through diversity. After attending a grazing conference, he

"Slaking" tests involving clumps of soil and jars of water help farmers see firsthand the benefits of building healthy, stable soil. (*LSP photo*)

became convinced animals play a key role in building healthy soil, and he talked his dad into sharing their cattle enterprise with Ron Hein, who is a cousin

Dukart, the Holistic Management educator, says this kind of teamwork has allowed the Williams and Hein families to concentrate on individual strengths and interests, while contributing to the overall goal of improving the base resource: soil.

"Any given acre, Seth would like to crop it, Sanford would like to hay it, and Ron would like to graze it," says Dukart. "But they are able to concentrate on their interests and talents and abilities in certain areas and they're able to complement each other with those. They don't segregate themselves from any other parts of the operation and still stay very involved with the decision making as a whole, but basically take the leadership in one area or another."

A word for the resource

Burleigh County is far from having the ultimate soil-friendly farming system finalized. Nichols, the soil microbiologist, is constantly challenging farmers to push things even further and shoot for organic matter levels that rival native grasslands in the area.

Brown thinks a lot of these practices will stay limited in scope until farmers learn to observe the land closely and not rely on cookie-cutter solutions such as chemicals.

"One of the problems I see is a lot of the farmers and ranchers today —and I'll just be blunt—they're disconnected from the land. They oftentimes hire crop consultants, and the farms are so large and the equipment so big they don't get off the tractor and feel the soil and see what's happening," he says while holding a handful of his own soil.

Fuhrer says a lot of progress has been made—he estimates the NRCS field office in Bismarck works with 200 to 300 farmers on various conservation projects that support soil health one way or the other. But more needs to be done to provide as many options as possible for farmers. The day after the tour, which is one of dozens of soil health-related events put on in the county each year, Fuhrer was back in his office going over the results of Menoken Farm trials involving 98 varieties of cowpea, a warm-season, drought-tolerant legume. Six varieties were chosen for further planting.

Fuhrer is also seeking ways to get the "soil health is important" message out to the non-farming public. After all, non-farmers also benefit from healthy soil in terms of a more resilient food system and a cleaner environment. Getting the average citizen to talk about dirt in a positive way may sound far-fetched, but Fuhrer points out that a number of farmers "spoke for the resource" in a passionate way during the September field tour, something they may not have been so comfortable doing just few years ago.

"It was a good day for the resource," says the conservationist as he and other participants enjoy barbecued sandwiches at a park after the tour.

He was referring to the soil, but he could just have easily been talking about the people who work it. ❒

New LSP 'Soil Health, Profits & Resiliency' web page

On Sept. 21, the Land Stewardship Project helped bring the "Soil Health, Profits & Resiliency" video conference to over 270 farmers, crop consultants and resource conservationists from across Minnesota. Participants heard about new cover crop and livestock management practices, as well as ways of connecting soil health with profitability. Featured presenters were people involved in Burleigh County's soil health improvement initiative.

LSP's new **Soil Health, Profits & Resiliency** web page features video and presentations from that conference, as well as other resources related to soil quality on the farm. It's at www.landstewardshipproject.org/stewardshipfood/foodsystemslandstewardship/chippewa10/soilquality.

Cover cropping in western Minnesota

By Julia Ahlers Ness

The Chippewa 10% Project— a joint initiative of the Land Stewardship Project and the Chippewa River Watershed Project—hosted a cover crop field day in late October at the farms of Dan Jenniges and Jess Berge near the western Minnesota communities of Glenwood and Sunburg. Both are livestock farmers whose interest in cover crops comes from their desire to provide high-quality, low-cost feed to their animals. As the article on pages 20 to 26 show, cover crops can do that and so much more.

Upon first arrival at Jenniges' field, the three-dozen attendees might have been a little confused. There wasn't much green cover crop to see at first glance. As the participants' followed Jenniges into the field, however, they started to see green shoots of turnip and rape here and there under or poking through the corn residue. A careful glance across the field revealed other spots with definite green cover crop growing. The reason for the lack of much green cover across the field: the drought.

Jenniges' seeded the cover crop mix into standing corn at the end of June. In a normal rainfall year, the turnips and rape would have gotten established enough to keep them alive until the corn canopy started to lessen in late summer or early fall, when they could start to grow again and then take off after harvest to provide additional green forage for Jenniges' beef cattle.

Despite the challenges Jenniges experienced in trying to establish a cover crop in standing corn during a drought year, he is willing to try again next year.

"If I can postpone having to feed stored feed even by just a couple of weeks or even a month, it's worth the effort and investment," he said.

At the Berge farm, the tour participants saw— and smelled— a successful establishment of a cover crop of turnips and rape on a 40-acre field, which Berge had seeded in July after harvesting a stand of oats and field peas for silage. The abundant, high-quality forage of the cover crop is providing the Berges with inexpensive feed for their 300-head ewe flock and eventually for their cow-calf pairs. "This is ideal feed for those calves," Berge told the mixed group of farmers and natural resource agency staff.

In addition to providing the farmers with low-cost, quality animal feed, cover crops fit with the overall goals of the Chippewa 10% Project. Our belief is that there are economically viable ways for farmers and landowners to get diversity and more living cover on acres in the watershed. That diversity is what will make our soils more resilient and our water cleaner while putting more money into the pockets of farmers. ❐

Dan Jenniges (*right*) helps attendees of a cover crop field day at his farm hunt for green growing plants in the corn residue. Jenniges seeded turnip and rape in the standing corn in late June. (*photo by Julia Ahlers Ness*)

Julia Ahlers Ness coordinates the Chippewa 10% Project out of LSP's office in western Minnesota. She can be contacted at 320-269-2105 or janess@landstewardshipproject.org. Details on the initiative are at www.landstewardshipproject.org.

'Farming for Soil Health' class this winter in west-central Minnesota

The Land Stewardship Project is helping coordinate a two-part "Farming for Soil Health: Setting the Foundation for Success and Profitability" class this winter in Glenwood, Minn.

The first part of the class will be held Jan. 15-17; the second part is Feb. 5-6. All sessions will run from 9 a.m. to 5 p.m. The instructor will be Joshua Dukart (*pictured*), a Holistic Management certified educator who also works for the Burleigh County Soil Conservation District in North Dakota and is a field representative for the North Dakota Grazing Lands Coalition.

For more information, including details on fees, class location and registering, see www.landstewardshipproject.org or contact LSP's Julia Ahlers Ness at 320-269-2105, janess@landstewardshipproject.org. (*LSP photo*)