Soil Health

Seeking Signs of Life

2 Approaches to Monitoring the Path to Healthy Soil

Seeing is believing, and nowhere is that more true than when it comes to building soil health in farm fields and pastures. During Land Stewardship Project field days and workshops, participants spend a lot of time discussing how they monitor whether the practices they're implementing are taking their soil, and their farms, in the direction they want. It's not always easy. Sometimes the soil is very open about how it's faring — erosion and excessive water runoff are clear indicators it is compacted and has lost good aggregate structure. Other times, it can be a bit of a silent sufferer, and it requires sophisticated testing or long-term monitoring to figure out its overall health.

During a recent series of LSP soil health workshops, two different presenters shared stories of how they gauge the progress of their soil healthy farming practices. It turns out those indicators can reveal themselves on a brightly-lit computer spreadsheet, or in the dark of night.

Homegrown Science

When Connor McCormick was in 4th grade, he conducted an experiment comparing the growth of two groups of grasses, one of which was receiving applications of Miracle Grow fertilizer. That experience hooked the farm kid from southeastern Minnesota on homegrown citizen science. And it was while studying biology and environmental science at Saint Olaf College that he saw the opportunity to combine his love of experimentation with his passion for farming.

When he was a sophomore, Connor received an assignment to study cover cropping. The project opened his eyes to the ecological and agronomic benefits of building the soil biome with diverse root systems. This led the student to do more soil health research. In fact, as part of his examination of the impact tillage systems have on soil biology, Connor was able to get his hands dirty on farms near the Saint Olaf campus.

One thing Connor was able to show through sophisticated field sampling and analysis was that, when compared to conventional tillage, the no-till system produced soil with the highest microbial activity, a key sign of a healthy biome.

When Connor graduated from college in 2016, he returned to his family's farm in southeastern Minnesota, where he now raises crops and beef cattle with his father, Kevin. He also does custom trucking. All this keeps the 28-year-old busy, but Connor still finds time to do a little on-farm science, comparing, for example, seeding cover crops with a helicopter as opposed to with a high-boy sprayer implement.

"It's what brought me back home," says Connor McCormick of his chance to combine science and farming. (*LSP Photo*)

For other farmers looking to experiment, Connor recommends attending workshops and talking to others who are implementing innovative practices. Many of these practices won't generate an immediate return on investment, so once you're ready to put your toe in the water, contact local agencies or even conservation groups about obtaining funding for, as an example, cover crop seed. The USDA Natural Resources Conservation Service, Soil and Water Conservation Districts, and even watershed protection groups all have resources available, including seeding equipment that can be rented, he says.

McCormick's on-farm soil health experiments have been encouraging and back-up what he was witnessing as a college student: armoring the soil and keeping living roots in it year-round creates resilient, productive fields that are managing moisture well and not eroding. But farming is a business, and it's just as important to monitor the monetary progress of various soil health practices. McCormick is showing that cover cropping and no-till are reducing the need for costly chemical inputs, and by grazing cover crops he has been able to provide his cattle herd two weeks of free feed — money in the bank.

Not all of his experiments have been a success. In the spring of 2021, he planted "green" into standing rye and learned the hard way that one should wait to spread fertilizer during that process. It turned out it was hard to run a planter through where the tracks for the fertilizer applicator were.

"But I wrote it down so next year I'm going to know to apply the urea after I plant," he says.

McCormick has ideas for experimenting with planting 60-inch corn and seeding cover crops in the wider row gaps, providing even more solar energy for forage growth. The young farmer has also toyed with planting rye in the fall after soybeans or corn, and then coming back in the early spring and no-tilling alfalfa in the rye.

Overall, Connor says such trials offer a way for soil health to serve as a natural meeting place for two fascinating worlds: science and farming.

"I love farming. I also want to learn new things and work with people, and for me that combination has worked out good," he says. "It's what brought me back home."

Emergent Ecology

When Mike and Dana Seifert came back to Mike's family's 100-acre farm in east-central Minnesota a few years ago, they realized intense tillage over the decades had taken a toll in the form of eroded soils. Mike's father, Big Mike, was aware of that as well. It was also evident herbicide-resistant weeds had become a major problem.

So, the young farmers —they're both 38 — worked with Big Mike to integrate soil-friendly practices like cover cropping and no-till into their production of corn, soybeans, oats, and alfalfa hay.

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Give it a Listen

On **episode 267** of the Land Stewardship Project's *Ear to the Ground* podcast, Connor McCormick talks about how a 4th grade experiment launched him down a path of researching linkages between ecology, economics, and healthy soil: landstewardshipproject.org/podcast/ear-to-the-ground-267-bringing-science-back-to-the-farm.

Episode 269 features Mike Seifert sharing how he's using cover cropping and no-till to make up for the soil damage caused by years of heavy tillage: landstewardshipproject.org/podcast/ear-to-the-ground-269-soils-stairway-to-heaven.

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They've had stumbles along the way, but some four years in, the Seiferts are starting to see better weed control, less compaction, and lowered erosion levels. Mike says that when they were first establishing cover crops, getting three years of funding and technical advice via the local Soil and Water Conservation District was key.

"When we started, I didn't quite know what I was doing, but by the end of that third year I was ready to be planting my own seed mixes and doing stuff that was beyond what they were offering us to do," he recalls. "So it was a perfect way for us to get started."

Less weed pressure and lower input costs are good indicators that the Seiferts are on the right path soil health-wise. But Mike got a particularly dramatic vote of confidence one night last August after a one-inch rain fell at the end of an extended dry period. He was walking in a recently harvested oat field to see if it was dry enough to be seeded to alfalfa the next day and got the sense the ground was actually moving.

Mike Seifert: "That was one of those rare moments where you actually had kind of a little message from nature." (*Photo by Mike Seifert*)

"It was bizarre. I bent down and I looked, and it was like a web of earthworms all across the soil, everywhere in front of me that my light pointed to," recalls the farmer.

The earthworms appreciated that oats had been introduced into a field that previously had been in a simple corn-soybean rotation. It had been one of their more marginal fields, and so the farmers thought a small grain in the rotation would benefit its biology as well as structure. They were right: all the ground cover the oats provided, combined with lots of fine root structure beneath the surface, had bolstered the biome, even during a drought.

"When you're dealing with soil health, it feels like so much of it is beneath the surface and you need a microscope to check it out," Mike says. "That was one of those rare moments where you actually had a little message from nature that said, 'You know what, you're doing the right thing here.' " ❐

The Cost of Negating Aggregation

Fixing the Dysfunctional Relationship Between Water & Soil

By Brian DeVore

Rancher Alejandro Carrillo likes to say that, "it's not how much rain you get, it's what you do with it." He should know. In the early 2000s, soon after he returned to his family's livestock operation in the Chihuahuan Desert of northern Mexico, the area got 20 inches of rain, which is double what the region normally gets in a typical year. So much precipitation would be a bonanza for the forage the cow-calf herd feeds on at the 30,000-acre Las Damas Ranch, right? In reality, all that extra rain did little good. That's because it was falling on hard, compacted soil that had been damaged by years of overgrazing.

Carrillo's story, which he shared while in Minnesota recently to present at a series of Land Stewardship Project soil health workshops, illustrates one of the key roles building healthy soil plays in creating resilient farms and ranches: its ability to absorb and store water and eventually make it available to growing plants when they need it. That capacity has become especially critical to farmers in recent years as they grapple with the extreme precipitation events wrought by climate change. Water holding capacity is a big deal when too much rain threatens to swamp the landscape, sending soil and agrichemicals racing off fields. It's also a big deal when there's too little rain, as farmers learned in many parts of the Midwest during the 2021 drought. This weather whiplash has become the new normal.

"We're preparing for a future that both has too much water and not enough water, and often those things are co-occurring in the same season," says Natalie Hoidal, a University of Minnesota Extension educator.

Fortunately, farmers have proven they can use methods such as managed rotational grazing, cover cropping, no-till, and diverse rotations to build soil organic matter — the energy-rich portion of the soil profile that's made up of plant and animal residue, along with the tissues of living and dead microorganisms. There is a direct correlation between a soil's water holding capacity and the amount of organic matter present.

Just how direct that connection is may be debatable. Up until the 1990s, many soil scientists felt the link was tenuous, at best. But in 1994, a *Journal of Soil and Water Conservation* analysis found that as the organic matter increased from 1% to 3% across all types of soils, the available water holding capacity of soil roughly doubled. The USDA's Natural Resources Conservation Service (NRCS) has widely publicized the figure that a 1% increase in organic matter in the top six inches of soil adds roughly 25,000 to 27,000 gallons of water holding capacity per acre. Over the years, that statistic has been cited repeatedly, including by the Land Stewardship Project.

To muddy the waters, in 2018 a *European Journal of Soil Science* analysis of the soil science literature tamped down the 1994 study's claims, concluding that a 1% increase in soil organic matter increases available water holding capacity by just 1.16%. The authors of that paper concluded that there are a lot of good reasons to build organic matter in the soil — it sequesters carbon, for example — but increasing water holding capacity may not be one of them. Meanwhile, this year a February *Soil Science of America Journal* study waded into the fray and concluded that in fact a deep analysis of the latest science shows the relationship between organic matter levels and water holding capacity may be vastly underappreciated.

Confused? University of Minnesota soil scientist Anna Cates says when making connections between organic matter levels and water holding capacity, it's important to take into account different soil types — finer textured soils may respond much differently than heavier soils, for example. Cates, who is the state soil health specialist with the Minnesota Office for Soil Health, calculates that in a medium-textured soil, increasing organic matter levels by 1% provides 3,400 gallons per acre of extra water at a 12-inch depth. That may not be as impressive as what the NRCS has been

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promoting, but it's still significant. The scientist says it's important to look beyond the first few inches of topsoil when measuring a field's ability to hold and manage water.

"At depth it is really clear the soil health systems are storing more water," she says.

The role soil "aggregates" play in water holding capacity should also be considered. Aggregates are groups of particles that bind to each other more strongly than to adjacent particles. The gaps between aggregates provide pore space for retention and exchange of air and water. Aggregate structure can be destroyed by intense tillage and overgrazing.

Cates says a farmer may get improvements in water holding capacity which are not directly related to changes in organic matter levels, but are linked to organic matter *function* and *structure*. The good news is that the same practices that can increase soil organic matter can also fortify aggregate structure.

"Soil organic matter is critical for forming aggregates, and aggregates are critical for holding water," says the scientist.

Improved aggregate structure can occur in a few growing seasons, while organic matter increases are measured in years or decades. A lot of quick aggregate structure can be created during those slower years of organic matter improvement.

What's Your Infiltration Rate?

Want to test your soil's ability to absorb moisture? You can learn an easy way to do this by watching LSP's "Water Infiltration Test & Comparison" video at bit.ly/3wgXqLo.

A Welcome Reception for Rain

While the science may remain a bit unsettled, farmers are nonetheless finding a direct connection between building soil health and increasing water holding capacity — that applies from the arid Southwest to the humid Upper Midwest. Alejandro Carrillo, the Mexican rancher, knew something had to be done to improve his soil's water holding capacity after a bounty of rain yielded few positive results in his pastures. "When it rains, it doesn't rain grass," he says.

Over the years, the rancher has built up his land's organic matter by implementing an intense system of managed rotational grazing. Frequent movement has allowed the grasses and other forages to recover from the animal impact and develop deep root systems that can store precipitation. Perhaps most importantly, such a system of grazing is building the soil's aggregate structure, allowing it to make use of any amount of precipitation that might be falling.

The soil at Las Damas can now soak up water at a rate of 18-20 inches per hour; a neighboring ranch has an infiltration rate of only 2 inches per hour. That generates a direct financial payoff: Las Damas now has a 550-head cow-calf herd, which is triple what the family used to be able to run on the same acres. Carrillo says net revenue has increased 350% since the early 2000s.

The roller crimper system, which the Jovaags use in conjunction with cover crops, is helping build aggregate structure on previously damaged soils. (*Photo by Paul Hunter, Mower County SWCD***)**

Minnesota farmers Jon and Ruth Jovaag have also made a direct connection between soil health and water holding capacity. But they are in an area that can get triple the annual rainfall that Carrillo sees in a typical year. They raise 500 acres of crops as well as livestock in southern Minnesota's Mower County and are transitioning all of their acres to organic production. The Jovaags are using a combination of no-till, cover cropping, and diverse rotations to reduce compaction and increase aggregate structure.

Give it a Listen

On **episode 268** of the Land Stewardship Project's *Ear to the Ground* podcast, organic cropping expert Léa Vereecke, soil conservationist Steve Lawler, and farmer Jon Jovaag talk about how the roller crimper system can help extend the benefits of a cover crop: landstewardshipproject.org/podcast/ear-to-the-ground-268-rolling-down-the-cc-river.

On **episode 270**, Alejandro Carrillo discusses how he brought his family's ranch back to life by building soil health: landstewardshipproject.org/podcast/ear-to-the-ground-270-it-doesnt-rain-grass.

One method they've been using is a roller crimper to control weeds without the use of chemicals or tillage. It creates a heavy mulch between soybean rows, which not only controls weeds but reduces the amount of moisture that leaves the surface on hot days. Staff with the local Soil and Water Conservation District have examined the Jovaags' soil and say its aggregate structure is recovering after decades of intense tillage and compaction.

That's paying off at both ends of the weather extreme spectrum. During a particularly wet spring, the Jovaags noticed one of their tile lines was not emptying water into the nearby Cedar River. That was odd, because the field it ran under was usually "notoriously wet." When they planted soybeans in the field, the farmers ran into no wet spots.

And on a hot summer day during a different growing season, Jon was surprised to see other irrigation rigs in his neighborhood running, while his stood idle. He assumed that his irrigators had failed to be activated because sensors that measured soil moisture were malfunctioning. But it turned out the sensors were right — he had plenty of moisture to spare, even if his neighbors' fields were dry.

"We were able to go about another 10 days before we ran that irrigator," recalls the farmer. "Even where the irrigator didn't hit, those soybeans still produced pretty well. And so, soil health, I mean it's just key to everything working as a system." ❐

The Soil Builders' Network

Join the Land Stewardship Project's Soil Builders' Network to get regular updates on workshops, field days, and on-farm demonstrations, as well as the latest soil health and cover crop research. For more information on joining, see the web page at landstewardshipproject.org/soil-health or call 507-523-3366.