South Dakota Soil Health Coalition
10 Years & Growing

Soil Visions

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Growing Sunflowers for Soil Health

By Stan Wise

For an agricultural operation to thrive, producers must sometimes look at the big picture and make decisions to benefit the long-term success of their farm or ranch. Changes made on a farm now might take years to realize their positive effects, but those changes can be crucial to the farm's survivability.

Researchers at the North Central Agricultural Research Laboratory near Brookings, SD, have spent decades trying to find the information producers need to make those decisions. The lab, operated by the U.S. Department of Agriculture's Agricultural Research Service, has maintained long-running experiments that have offered useful insights into the benefits of several different crop rotations.



A field of sunflowers grows near Groton, SD, in late July 2026. SDSHC photo.

One rotation showing promising results consists of corn, soybeans, spring wheat, and sunflowers, in that order.

Sunflowers for soil health

The rotation experiment has been running at NCARL for 26 years in a no-till setting, and it has yielded results that can only been obtained through multi-year repetition.

ARS Soil Microbiologist Michael Lehman's research shows there are soil health advantages to adding sunflowers and small grains to a traditional corn-soybean rotation.

He has observed increased enzymatic breakdown of residue by microbes in the soil following sunflowers. That's an indicator of increased microbial activity, which promotes soil aggregation, the accretion of soil into stable clusters which allow for increased water infiltration rates, higher water storage capacities, and reduced erosion.

"How are we demonstrating that it's improving aggregation? We've measured the erodible fraction," Lehman said. "That decreases when you're measuring it in the corn phase following sunflower compared to soybean. So that's good. You want low erodible fraction and higher (microbial) activities. We've also looked at carbon mineralization activities. Same pattern with activities increasing in corn after sunflower."

That's not the only benefit Lehman has noticed.

"There's more arbuscular mycorrhizal fungi in the corn following sunflower that are associated with corn roots and are able to mobilize nutrients and water and protect the roots against pathogens," he

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The 2026 Soil Health School is set for Sept. 15-17 in Twin Brooks, SD!
Sign up today!
Learn more on Page 3

Test Grain for Nitrates Before Using It as Forage

By Stan Wise

With the vast majority of South Dakota in a drought and experiencing high temperatures, grain producers are having to make some tough decisions about their crops. Will those grains produce enough yield to make harvesting them a financially viable option, or is it better to use those crops as forage for livestock?

Grain crops that won't yield enough to be worth harvesting can be an excellent source of food for livestock, especially in a drought when pastures aren't producing enough forage. However, there's a risk that producers need to be aware of before haying or grazing their small grains.

Grain uses nitrogen to generate protein for growth. "In drought conditions, it's going to do everything it can to hold on to that nitrogen, and so especially in the lower two thirds of that plant, when it's droughty, we're going to see higher nitrate levels," South Dakota State University Extension Sheep Field Specialist Jaelyn Whaley said.

Those nitrates pose a problem for livestock.

"When our cattle or our sheep consume that forage, they're going to take that nitrate, and they're trying to convert it into something that the animal can actually use," Whaley said. "When the bacteria do that, one of the intermediates is nitrite, which everybody, I think, is familiar with being toxic. When the animal's blood levels of nitrite go up, their blood cells can't sequester oxygen. So, they're basically, for lack of a better term, suffocating from the inside out."

Nitrate poisoning can be fatal for livestock, but even if it doesn't lead to an animal's death, there's another risk. "Moving into the fall, especially, most of our cows are going to be bred, and so it can lead to abortions as well, even if it doesn't actually kill the cow," Whaley said.

SDSU Extension offers free nitrate testing at several locations around the state, and Whaley said that more precise testing is available at other labs for $15-$20. "I've always felt like it's fairly cheap insurance," Whaley said.

Producers should start to become concerned about nitrates once they reach 1,000 parts per million of nitrate-nitrogen in a test sample, she said. "At 1,000 parts per million, if you're feeding it to yearlings or calves or non-pregnant animals, you should be safe. But at a thousand, we start to recommend that you limit that to 50% of the ration in pregnant females," Whaley said. "We can make adjustments from there up to 4,000. If it exceeds 4,000 parts per million, that's when we start saying you absolutely cannot feed this to your livestock."

The good news is that nitrate levels in grains decrease as the plants mature, Whaley said. So if producers can wait a little longer before haying or grazing the grain crop, there should be less risk for livestock.

Haying versus grazing

Producers who plan to use a grain crop as forage need to decide whether they will cut and bale the grain as hay or allow livestock to graze it in the field.

South Dakota Health Coalition Soil Health Specialist Ryan Beer said that haying the grain can make things a bit simpler. "You can get it all at the right time. If you're going to graze it, it's going to turn fairly quickly to where the quality is just going to keep going down," he said. "You could hay it all in a short time, get it knocked down and baled, and it's all that pretty good quality."



This winter wheat is being cut for hay near Newell, SD. Producers should test grain crops for nitrate levels before using them as forage. SDSHC photo.

However, there are other advantages to letting livestock graze the grain in the field. For one thing, producers won't have to spend the time and fuel necessary to hay it. "You're also going to leave all those nutrients that those plants have there, so it's going to help the soil," Beer said.

He noted that there are options other than grazing if producers want to maintain a consistent forage quality by haying the grain and also keep the nutrients on the field where it was grown. "You can do things like feeding it back on that ground, bale grazing, or even just rolling it out and spreading it on those fields, trying to keep those nutrients there. That's going to be a benefit," Beer said.

Regardless of which method is used, Beer said it is important to leave some residue on the ground to protect the soil from erosion. Producers can cut the grain a little higher to leave some stubble as well as to avoid the nitrates which tend to concentrate in the lower portion of the plants.

SDSU Extension offers several online videos with information on the issues surrounding the use of drought-stressed crops as forage which can be accessed at bit.ly/CropsAsForage.

Producers who are looking for additional forage or have grain forage to offer other livestock producers can use the free South Dakota Grazing Exchange website (www.sdgrazingexchange.com) to find resources or list the resources they can offer.

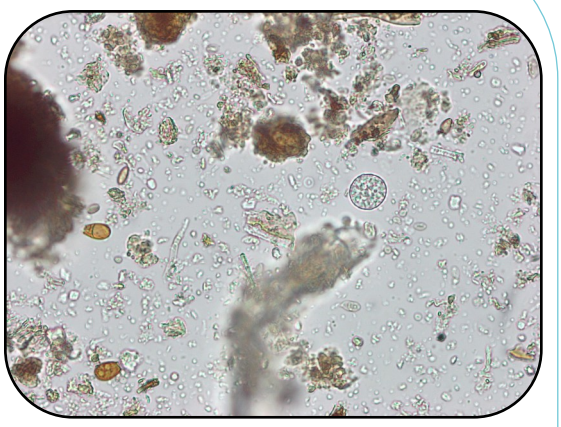
The Farm Service Agency has recently expanded its Livestock Forage Disaster Program which offers financial assistance to livestock producers who suffer eligible grazing losses due to a qualifying drought or fire. To apply for this program, producers can visit their local FSA office.

To learn more about soil health land management practices, visit www.sdsoilhealthcoalition.org or contact the South Dakota Soil Health Coalition at sdsoilhealth@gmail.com or 605-280-4190.

Microbial Resilience in a Drought

By Janét Moore
SDSHC Soil Health Technician

Drought is an increasingly prevalent climate stressor, profoundly impacting farming systems, particularly the soil microbiome. Soil microbes are necessary to build the soil structure, cycle nutrients, and generally keep plants healthy. In water-limited conditions, and/or when temperatures are high, microbial abundance declines; however, soil microbes can become dormant and later turn back into active living cells when conditions improve! Microbial dormancy is a reversible state of reduced metabolic activity that allows microorganisms to survive harsh conditions, maintain biodiversity, and form environmental seed banks. It has been estimated that at least 90% of the bacteria and fungi in soil are dormant at a given time.



The two light brown/golden oval microbes on the left are testate amoebae, with a flat side for a mouth. The grainy circle in the upper right is a ciliate cyst (single wall). SDSHC photo.

Many types of bacteria produce internal dormant structures called endospores. Endospores are used exclusively for survival rather than reproduction. Endospores have a tough multilayer coating that are highly resistant to environmental stress. In fact, scientists have successfully revived endospores extracted from ancient amber and salt crystals estimated to be 25 to 250 million years old! Now that's resilience!

A general spore is a broader term for reproductive or protective structures, mostly used by fungi. Most fungal spores are extremely resilient due to a thick protective outer wall. Some melanized fungal spores – those with dark pigment – can even survive the rigors of space travel. Fungal spores have been recovered alive from deep marine sediment cores dating back 100,000 to over 430,000 years, and scientists were able to successfully germinate and grow them in laboratory cultures!

The dormancy strategy for soil protozoa (which consist of important organisms like amoebae, flagellates, and ciliates) are to encyst – grow a cyst that encloses their body. Protozoa cysts can remain dormant but alive for up to 20 years in soil.

Nematodes are another important group. Like protozoa, they produce waste that is full of plant available nutrients. Nematode eggs are very resistant to environmental changes, also remaining viable in soil up to 20 years.

When conditions become favorable again, bacteria can double in population about every 20 minutes, fungi about every 2 hours, protozoa about every 20 hours, and nematodes about every 2 days to 2 months to 2 years, depending on the species. Some of the very beneficial nematodes are slower to mature but can live as long as 8 years and produce hundreds of eggs in every reproductive cycle!

These are just some of the many strategies Mother Nature uses to overcome adverse conditions and keep life humming along. Microbial dormancy comes in many forms, but the goal is the same: Wait it out and live to see a better day!

Sign Up for Soil Health School, Sept. 15-17 in Twin Brooks

Don't miss the Soil Health School, Sept. 15-17 in Twin Brooks, SD! This event will be held at David Kruger's Farm as well as at the nearby Abbey of the Hills. The school will feature expert instructors from across the Northern Plains, including industry professionals, researchers, and experienced producers. Attendees will experience in-depth classroom lectures and hands-on field exercises. New practices demonstrated this year will include soybeans interseeded into camelina and virtual fence grazing! This is an excellent chance to learn more about regenerative ag and network with others who can help you improve your soil!

Individual registrations for the school cost $150, and additional registrations from the same operation cost $75. Class size is limited, so early registration is recommended. For more information and registration, visit https://bit.ly/2026-SHS.



Upcoming Events

Aug. 18
Working Lands Workshop
Wagner, SD

Aug. 20
South Dakota Leopold Conservation Award Tour
Meadow, SD

Aug. 22
Prairie Fest: A Family Celebration of Dakota Grasslands
Sioux Falls, SD

Aug. 27
Woody Encroachment Management Field Demonstration
Yankton, SD

Aug. 28
Small Scale Ag Soil Health School
Huron, SD

Sept. 9
West River Research Farm Field Day
Sturgis, SD

Sept. 9-11
South Dakota Grazing School
Chamberlain, SD

Sept. 10
Southeast Research Farm Field Day
Beresford, SD

Sept. 15-17
Soil Health School
Twin Brooks, SD

Sept. 17
Woody Encroachment Field Tour
Oacoma, SD

Oct. 7
Eastern South Dakota Water Conference
Brookings, SD

Jan. 26-27
Soil Health Conference
Sioux Falls, SD

Watch for more events HERE.

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said. "And there are less pathogens on the corn following sunflower than the other crops."

All of this is good news for producers.

"The bottom line is your soil has better structure. It has better pore structure. It's biologically active," Lehman said. "So why does the farmer care? The farmer probably would like better soil structure. Better air and water infiltration. I think they would like higher soil carbon, which we've seen in those plots. I think it would be good if it had less bulk density, which we've measured in those plots."

Sunflowers for stability

A four-year rotation that includes sunflowers offers more than improved soil health. It also offers stable corn yields despite weather extremes, ARS Research Agronomist Shannon Osborne said.

"In years with adequate rainfall, we do not see a difference in corn yields between the corn-soybean rotation compared to the diversified four-year rotation," Osborne said. "In years where rainfall is limited at some point during the growing season, we see an average yield increase of approximately 35 percent when corn is grown in a four-year rotation compared to a corn-soybean rotation."

Osborne noted that the rotation experiment plots are only fertilized for 85 percent of maximum yields and that producers who apply the full rate of fertilizer may not see such a dramatic yield disparity.

The reason for the lower fertilizer rates, Osborne said, is to allow the soil to function in a productive manner. "If the plant has all the nutrients that it needs, is it going to signal to the microbes that it needs things and get the microbes to do it?" she asked.

She noted that soils at the research farm are low in plant-available phosphorous, yet the crops grown there aren't deficient in phosphorous.

"So, the soils are able to provide the nutrients that it needs. It's converting that total phosphorus into a plant-available phosphorus," Osborne said.

An economic study of the rotation experiment showed no decline in net profitability for the rotation that included sunflowers. "It was just as profitable as the corn-soybean rotation was," Osborne said.

Cover crops for more benefits

Adding cover crops to the 4-year rotation that includes sunflowers unlocks some surprising benefits for pollinators and sunflower yields.



These ears of corn were taken in 2024 from the long-running crop rotation experiment at the North Central Agricultural Research Laboratory near Brookings, SD. The ears on the left were taken from a corn-soybean rotation. The ears on the right were taken from a corn-soybean-spring wheat-sunflower rotation. This comparison shows a yield advantage for corn grown in the diverse four-year rotation that includes sunflowers. USDA-ARS photo.

"The concentration of sugar in the nectar was a lot higher in the sunflowers with cover crops by about 28 percent, which is substantial for both attracting pollinators to the plants, but also really important for development of the larva and the brood that bees are actually producing," ARS Research Entomologist Karl Roeder said. "And for the adult bees themselves, we saw about a 74 percent increase in abundance and a 33 percent increase in the number of species on sunflowers with cover crops."

Roeder said the cover crops also affected sunflower yield.

"We also saw some pretty big bumps in yield," he said. "I think it was about a 36 percent increase in the mass of the seeds that were produced on those sunflowers that had cover crops."

Making it work

Currently, sunflower production in South Dakota is concentrated in the central portion of the state.

Onida, SD, producer Chuck Todd, who is president of the National Sunflower Association and chairman of the South Dakota Oilseeds Council, thinks sunflowers can be a profitable addition to crop rotations on the eastern side of the state, which receives higher annual

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This is a visual comparison of corn grown in two different crop rotations in late July 2024 at the North Central Agricultural Research Laboratory near Brookings, SD. The corn on the left was grown in a corn-soybean rotation, and the corn on the right was grown in a corn-soybean-spring wheat-sunflower rotation. This comparison demonstrates increased height and biomass for corn in the diverse four-year rotation. USDA-ARS photo.

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precipitation.

"I think you could make 3,000 (pounds per acre)," he said. "I think the cash price for sunflowers right now would probably be in that 25-cent range per pound. That puts you at gross receipts of $750 (per acre)."

Todd said the breakeven cost for sunflowers in his area is $405 per acre, a sum that includes average land rental rates.

"We put less inputs into our sunflowers than we do corn with respect to fertilizer and seed costs. So that helps a little bit, too, on net revenue," he said.

Challenge

One of the largest challenges of growing sunflowers in South Dakota is controlling the red sunflower seed weevil.

"Because the red sunflower seed weevil is so well synchronized with sunflower production, severe infestations are common in South Dakota," South Dakota State University Associate Professor and Extension Field Crop Entomologist Adam Varenhorst said.

Those severe infestations being managed routinely with insecticides combined with sunflower production being concentrated in just a few counties in central and western South Dakota has led to the development of pyrethroid resistant weevils.

"To date, we've confirmed red sunflower seed weevil resistance to multiple pyrethroid active ingredients that are labeled for the pest in sunflowers at all of the commercial sunflower fields that were tested in South Dakota," Varenhorst said.

While there are a limited number of insecticides that are still effective, some cultural control practices have proven to be effective, both recently and in past research.

Recent research in North Dakota and South Dakota has shown that early planting dates for sunflowers reduces seed damage, increasing yields and oil content, Varenhorst said.



Onida, SD, producer Chuck Todd is the president of the National Sunflower Association and chairman of the South Dakota Oilseeds Council. He believes that sunflowers can be a profitable addition to crop rotations in eastern South Dakota. Courtesy photo.



A female red sunflower seed weevil. The weevils' bodies are dark in color but are covered with reddish-orange hairs. They have an elongated snout with antennae that originate from the snout. Photo courtesy of Adam Varenhorst.

"If we plant sunflowers early enough, in early- to mid-May, we see reduced seed damage caused by the red sunflower seed weevil," he said. "We've reduced the seed damage from somewhere in the 60 to 80 percent potential, down to the 5 to 10 percent range. Early planted sunflowers will still have infestations, but the heads are too developed for the female weevils to lay eggs successfully."

The percentage of damage in a crop determines whether it is suitable for the confection market or if it must be sold for the bird seed or oilseed markets. The confection market pays a premium for sunflower seeds, but it has been hard to meet the standards of that market for growers in central South Dakota where the resistant populations of weevils are found.

"One of the big questions is whether or not the resistant populations will exist outside of the central and western South Dakota areas, or if susceptible populations exist in eastern South Dakota and will remain somewhat isolated there," Varenhorst said.

During the 2026 season, Varenhorst has tested at least one population of red sunflower seed weevils in Brookings County and found it to be highly susceptible to four pyrethroid active ingredients. "These results are promising and suggest that red sunflower seed weevils in eastern South Dakota may be widely susceptible to insecticides," he said.

Todd is optimistic weevil populations in the eastern part of the state have not yet developed insecticide resistance. "I think the reason we have the problem with the sunflower weevil is because we have just so many acres all concentrated in a certain area," he said. "If we could spread some of those acres back to areas that have grown flowers before, I think we could get the confection market back here, and they could find acres that they need in South Dakota."

Todd said that producers wanting to start growing sunflowers will need some on-farm storage facilities for the seeds where they can wait until they are brought to market. He also suggested contacting a sunflower producer and asking lots of practical questions.

Osborne, who experienced a learning curve when first growing sunflowers for the long-running rotation study, suggested producers start small and see if sunflowers will work for them. "Incorporate a little bit. See what you think," she said. "And you know, don't give up if you have one year of failure because it takes a while for good things to happen. You can't build soil health overnight."

For more information about the benefits of diverse crop rotations visit www.sdsoilhealthcoalition.com or contact the South Dakota Soil Health Coalition at 605-280-4190 or sdsoilhealth@gmail.com.

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Small Scale Ag Soil Health School Aug. 28 in Huron

For the first time, SDSHC will host a Small Scale Ag Soil Health School, Aug. 28 at the Crossroads Hotel and Event Center in Huron! This event will feature presentations from Coalition, SDSU Extension, NRCS, and SDACD instructors and a tour of a nearby operation. Participants will learn the basics of the soil health principles and how to improve their garden or small scale operation. This is an excellent chance to learn about high tunnels, cover crops, and how to implement regenerative management techniques. This School is free for current Coalition members and $35 for non-members. Lunch is included. Learn more and register at https://bit.ly/2026-SmallScaleAg.

SAVE THE DATE 2027 Soil Health Conference Jan. 26-27 in Sioux Falls

The 2027 Soil Health Conference will be held Jan. 26-27 in Sioux Falls, SD! Don't miss our outstanding lineup of speakers, vendors, and activities! This year's conference will feature speakers Keith Berns, Erin Martin, Karl Palmberg, Chuck Rice, Tom Dykstra, and many more! The list of break out sessions is sure to offer information on a topic that interests you. This is an excellent chance to learn more about regenerative agriculture and network with people who can help you improve your land, your health, and your community! Watch for updates about speakers, activities, and registration at www.sdsoilhealthcoalition.org/soil-health-conference.