soil health matters:
ADD ORGANIC MATTER

Natural Resources Conservation Service

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If you want to build organic matter and improve your soil health, take a lesson from Mother Nature, urges Dwayne Beck, manager of South Dakota State University's Dakota Lakes Research Farm near Pierre, South Dakota.

Even after 30 years of no-till and cover crop experience, he says there's still much to learn about mimicking nature. The critical first step is to realize that the soil is living and part of a larger ecosystem.

"The diverse plants of the prairies cycled carbon back to the soil, and that slow, steady return of carbon to the soil boosted soil organic matter which continuously fed billions of microbes," Beck says. "Those microbes, in turn, broke down organic matter, making nutrients available to plants. This cycle produced the high levels of active organic matter in virgin prairie soils that accounted for the astounding yields sodbusters enjoyed in past generations."

Half the organic matter is lost through cultivation

Constant cultivation of farmland has taken its toll on organic matter. On average, about half the organic matter content of most agricultural soils in the Midwest, for instance, has been lost since the land was first cultivated. Plots established on the oldest continual agricultural research fields in the U.S. bear that out.

The Morrow Plots on the campus of the University of Illinois indicate starting soil organic matter content in prairie grass borders was 5.5 to 6.5 percent in 1876. Organic matter had dropped to 4.1 percent on the continuous corn plot by 1904, while the corn-oats rotation plot dropped to 4.5 percent. As expected, a rotation system did better; the three-year rotation of corn, oats and hay still had an organic matter level of 5.9 percent in 1904. Oxidation of organic matter from continuous tillage on the corn plot has reduced organic matter levels to between 2 and 3 percent today.

Benefits Beck has seen

After at least 30 years of no-till and just as many years of crop rotation and cover/forage crop use, Dwayne Beck has seen advantages of combining the practices first-hand. They include:

1. With no-till and diverse rotations, we use up to 30 percent less irrigation water.
2. We have no runoff with irrigators applying 2 inches of water in 9 minutes. With tillage and no rotations, pivots produced 50 percent runoff and more.
3. Soil with high organic matter holds more water—this means it does not become either saturated or too dry as quickly as the same soil with less organic matter.
4. Crop residues from no-till help hold soil particles, nutrients and pesticides in the field.
5. Depending on residue amounts, no-till cuts soil erosion by up to 90 percent.
6. Weeds can be controlled with less herbicides.
7. Diverse rotations reduce weed, disease and insect pressure, and spread the workload.
8. More profitability and stability to the farming system.

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Those drops are significant for crop yields. Research at Michigan State University indicates that a 1 percent increase in organic matter offers a 12 percent increase in crop production potential.

Tillage is the culprit

The latest research shows that the less you till, the more carbon you keep in the soil to build organic matter—living and dead plant roots, microorganisms, insects and earthworms.

"In tillage-based systems, mineralization is 'boom and bust.' Booms occur after tillage with busts following shortly after. In contrast, mineralization in no-till soils is more evenly spread over the season," Beck says.

"No-till changes the size and diversity of the community of organisms living in the soil," he says "Tilled soils contain relatively more bacteria than no-till soils. These bacteria rapidly decompose organic matter, giving a quick release of plant nutrients. In contrast, no-till soils house relatively more fungi, which decompose residue slowly. The result is more gradual nutrient release."

"Carbon in the soil accounts for about half of the organic matter, and you can't optimize carbon cycling unless you continuously no-till," Beck says.

"The active fraction of organic matter, the part that's either alive or rapidly decomposing, greatly increases with no-till."

Earthworms, whose presence in large numbers are a sign of healthy soil, benefit from no-till. Earthworms improve drainage, increase soil aeration, and aid in crop residue decomposition. But any soil disturbance is harmful to them. No-till soils support several times more earthworms than tilled soils.

And once you start no-till, it's very important to stick with it, Beck says. "The biggest key to aeration, infiltration, drainage, and resilience is the formation of excellent soil structure and macro-pores," he says. "These are cut or destroyed by even light tillage. Once you cut or cap a macropore, it fails to function properly. It's just like holding your thumb over the top of a soda straw. Nothing flows in it."

Think about the way you farm

"An engineer friend of mine who builds roads asked me why farmers still tilled their fields," Beck says.

"I told him that I really didn't know—maybe it was because they thought they were breaking up compaction. The engineer thought about it a while and replied, 'I disk and drive on a roadbed to make it hard…one of us is wrong.'"

Rotate varied crops

Just as the prairies weren't tilled, they also weren't made up of single species of growing plants. A variety of growing plants with their roots below the soil surface produced a balanced carbon source for soil microorganisms that resulted in high organic matter content.

"Once you realize the soil is living, it makes sense that the living organisms in the soil need a balanced diet, just as your livestock [need a balanced diet]," Beck says. "You can't provide that diet with a continuous crop. That's where cover crops and crop rotations come in; they're needed to give that variety of food to the soil."

No-till, crop rotation combination

No-till and crop rotations are the cornerstone of Beck's farming philosophy. The only way to rebuild soils and increase organic matter is to continuously no-till a varied rotation of crops that best manage residue. No-till and diversity have to go together–they complement each other," he says.

Rotating crops and using a no-till process retains organic matter in soil.

"That could mean cover crops after wheat harvest, winter cover crops between corn and beans, and rotations that factor in both grass and broadleaf plants as well as warm-season and cool-season crops.

"Cover crops create a canopy that in turn yields a microclimate ideal for microbes that break down stubble. As a result, organic matter increases, and soils are warmer and drier at the surface. Corn planters don't have to struggle through dense residue, and weed management is a big benefit."

Taken together with intensive rotation, no-till becomes a comprehensive program—there's no need to fall back on occasional tillage, Beck says. "And you don't want to till occasionally, because one year of tillage destroys that environment for microorganisms you've been building for years."

The absolute best way to build soil, he believes, is to no-till several years of annual crops in rotation, followed by a perennial crop like grass for grazing or biomass.

Dwayne Beck's Research

Beck's research emphasis for more than 30 years has been on developing no-till systems for irrigated and dryland areas in central South Dakota, but his expertise has been sought and utilized throughout the world. His identification of the extremely important role of crop rotation in minimizing weed, disease, and insect problems while increasing potential profitability has allowed producers to profitably adopt no-till techniques in the Dakotas and elsewhere.

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