Soil and Water Conservation District Stephenson County

Stephenson County Soil and Water Conservation District

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Organic Matter: The Lifeline of Soil

"The plough is one of the most ancient and most valuable of man's inventions, but long before he existed, the land was in fact regularly ploughed, and still continues to be ploughed by earthworms. It may be doubted whether there are many other animals which have played so important a part in history of the world as these lowly organized creatures." – Charles Darwin

By Anserd "AJ" Foster, Southwest Area Crops and Soils Specialist

Farmers are well-versed in how to select a variety and plant it; how to control weeds, pest, and diseases; and how to fertilize and water plants. So why does the ability to grow 300-bushel corn, 100-bushel soybean and 100-bushel wheat still seem outside the grasp of many farmers?

To answer this question, I will start by asking another question. How many farmers know about the health and condition of their soil? Considering that the soil is the foundation of the entire farming operation, it is not surprising that our most successful farmers, those who consistently produce high yields, are focused on growing the soil.

Why don't more farmers "grow the soil"? It is just like with our bodies — we can get by with supplements and medications without investing in cultivating a healthy lifestyle. But eventually our health declines and our demand for supplements and medication increases just for us to remain functional.

Surprisingly, we all know what to do to stay healthy, but it is not until we find ourselves in a doctor's office or in a hospital bed that we are forced to change and do what we already know we should be doing. It is the same with the soil. All farmers know or have heard many times the importance of growing the soil, improving soil health, and increasing soil organic matter.

In my opinion, organic matter is to a soil like blood flowing through our bodies. For example, if you are a blood donor and you give blood regularly, but your body does not replenish itself, donating blood will eventually weaken or kill you over time, despite your good intensions. This is what we do to our soil each time we put a plow or other tillage implement to it. Soil management practices can have a significant effect on organic matter levels in the soil.

Soil organic matter affects both the chemical and physical properties of the soil and its overall health. The composition and breakdown rate of soil organic matter affects the diversity and biological activity of soil organisms, plant nutrient availability, soil structure and porosity, water infiltration rate, and water holding capacity.

Building organic matter in a soil system is a function of numerous factors: 1) organic matter inputs (above-ground residues and roots), 2) climate (rainfall and temperature), 3) physical and chemical properties of the soil, and 4) land use and management.

Back to the question of why more farmers do not grow the soil? I think there are two main reasons:

- Building soil organic matter through appropriate farming practices may take several years, especially in dryland areas where limited moisture reduces biomass production and soil biological activity.
- Identifying soil management practices that promote soil organic matter formation and moisture retention, and that ensure productivity and profitability for farmers in the short-term can be very difficult.

Contrary to the two points above, it is not impossible to build soil organic matter, although it might be difficult and require some change in farming practices. In my opinion, cover crops, use of manure, and no-till are good starting points for anyone interested in building soil organic matter. In taking steps to build soil organic matter, do not forget that regardless of the practice used, green growing material does not build organic matter, but brown dead material does.

In sum, it may be time to start thinking about growing your soil as well as your crop. You can start evaluating your soil by monitoring soil organic matter.

The Connection Between Flooding and Farming Methods

Scientists say there is a way to at least decrease the amount of damage natural disasters can do and it all starts in the farm fields.

“We have to work with nature, we can't fight it,” Doug Hisken, a Belle Plaine, KS, area farmer said about this year’s overly wet weather leading to flooding problems across much of the state.

From rising prices at the grocery store, extra-long commutes due to road closures to the tax dollars spent repairing those flood damaged roads, this year's wet start has taken a heavy toll on all Kansans.

“Everybody took it on the chin this year,” said Darin Williams, a Waverly area farmer.

But scientists say there is a way to at least decrease the amount of damage natural disasters can do and it all starts in the farm fields.

Last year agriculture accounted for more than 40-percent of the Kansas economy. That is pretty standard. Did you know how Kansas farmers do their job also impacts our daily lives? And changing it, could change some of the problems we have seen this year from the unusual weather.

Kansas has seen it before, when a change in weather patterns in the 1930s created a natural disaster affecting all of us, the Dust Bowl.

“The dust storms and things, that's kind of the opposite problem, but it's all related, you know?” Hisken said.

Scientists agree, saying dust storms from extreme drought and this year's flooding both come back to how farmers get their crops in the ground.

“Soil acts as kind of a living sponge. and so, it takes in and filters out any contaminants that are within that, in that water system. It also holds and stores water,” said Candy Thomas, a soil health specialist with the U.S. Department of Agriculture (USDA) based in Salina, Kansas.

She says healthy soil can hold more water, meaning it is less likely to flood and get washed away during wet years. And it will hold onto that water during the drought years, helping crops keep growing.

“We're trying to bridge that gap for our crops to uptake as much moisture as they can and for the roots to stay as cool as they can,” Williams explained. “So, they can produce as much grain as possible till we can get to that next rain.”

While urbanization has paved over many areas that used to absorb water, farmers like Hisken and Williams say there is still a lot they can do to slow down flooding.

“Man has been very irresponsible through the history of mankind in terms of how they've managed their soil,” Hisken said.

Thomas spends much of her time traveling the Midwest teaching farming methods designed to better do just that.

She says better soil management may not be able to prevent flooding like we have seen this year, but it could certainly make it less disastrous.

“We were able to start holding more water,” Williams said about the difference he saw in his fields after implementing Thomas’ methods. “When these heavy rains would come, we would start getting more water infiltrated into the ground.”

They are talking about no-till farming.

The Connection Between Flooding and Farming Methods (continued from page 3)

It involves four basic steps.

One: minimize disturbance of the soil. That means no plowing or tilling between crops, leave the ground as undisturbed as possible.

“Maintaining the soil structure and keeping it in place are critical things for me,” Hisken said.

Two: keep the ground covered. Plant cover crops with deep roots in between cash crops and/or leave the remains of the last crop in the ground. This lets the plants develop deeper roots, which holds the soil in place. It also shades the ground from moisture’s natural enemies, the sun, and the wind.

Williams says not only does this make crops healthier and more drought resistant, it also makes them easier to plant. He points to a part of his field, about the size of a man’s palm, where the ground is bare. He taps it with a sharp metal pointer.

“I can't puncture through that. It is hard on top. And that is what happens with the sun and the wind. it bakes the soil out,” Williams explains.

Water cannot get through this tough soil that is almost the consistency of concrete, either.

“But if we move over here to the residue,” he adds, moving a few feet over where the ground is thickly covered in remnants of rye and corn crops, “look how easy that goes in the ground. I just pushed that in the ground 4 inches.”

Three: start working on what is in the soil. Replenish the nutrients used to feed crops by rotating what you plant, what one crop takes out of the soil, the next one puts back in.

Then, four: add the animals back into the system. That means both those that live in the soil and those that live above it.

Thomas sinks a shovel into the ground in the middle of one of Williams’ fields, pulling out handfuls of rich, dark dirt. She breaks it apart, showing all the animals living in it.

“They're living the good life here,” she said, pointing out all the earthworms encased in the handfuls of dirt. “These guys, when they get in the soil system, this is what it's all about, is building and creating this pore space. These earthworms create these channels that are entrenched with nutrients.”

Then she points to a pill bug slowly unrolling on the shovel.

“And then the isopods, the roly poly sow bugs, they're good too, cause they breakdown this residue at the surface,” she said. “Which is good food source for these worms, as well. All of these guys together create this really fantastic environment, which you can see big pores for the water to run down through. Super important.”

No-Till farmers generally enter the process one step at a time, but Williams went all in when he returned to farming nearly a decade ago.

“We saw an immediate difference early on, you know, even in the first year. But at about the fourth year, we really started seeing the ability to hold a lot more water,” he said. Though he continues to see improvement every year. “You've got to look at it as a system that builds itself every year, you know, every year you're improving it.”

Now, in this year of flooding, he is profiting from that decision.

When asked what difference he is seeing between his fields and those of his neighbors who do not practice no-till and cover crop farming, he said, “Well, number one would be the temperature of the soil.”

The Connection Between Flooding and Farming Methods (continued from page 4)

The prime temperature for growing healthy plants, Williams says, is in the mid-70s to mid-80s. When Thomas turns a heat gun on the ground in his fields, the areas with cover over them measure in the mid-70s. The few areas that are bare are already into the 100s.

And, while Williams' neighbors are repairing flood damage to their fields, he is already planting.

"You're standing in a field right here that took on five inches of rain in an hour, you know, two weeks ago," Williams said. "And we're planting it today without, you know, erosion issues."

But few farmers are as ready to make these changes as Williams.

When asked how many Kansas farmers are using these No-Till farming methods, Thomas pauses a moment before answering.

"Not as many as I would like, obviously," she eventually said. "Between five and 10% are utilizing the cover crops like Darin is using. No-Till is around 30 to 50%."

While KAKE News was unable to find a vocal, organized opposition to the No-Till movement, many Kansas farmers appear unwilling to give up methods they know work to gamble on something new.

Hisken says it is a necessity.

"You would think after the thirties, when we had drifts of soil equivalent to snow and covered up fences, that we would not have that happen again. But we still have dust clouds similar to the thirties," he said. "We can't let this keep happening the way it's been happening…We know that we have to maintain that legacy for generations to come…. We have to be willing to learn from our mistakes. We have to be willing to learn from history. And we need to be willing to change what we can change."

Meanwhile, Williams says going all in on all four steps of the No-Till/Cover Crop process has paid off in ways he had not expected. He is found the cover crop process protects his fields from weeds, letting him spend less money on herbicides while the better nutrition in the soil has increased his yields.

"I just can't see how using less chemical and fertilizer and making more money per acre is a bad thing," he smiled.

Which leads us right back to water safety concerns. Fewer chemicals on fields means what water does still run off in a rainy year like this one is less likely to cause dangerous contamination of water supplies downstream.

The Connection Between Soil Organic Matter and Soil Water

By Anna Cates, State soil health specialist

One benefit of increasing soil organic matter is to store more water in your soil. Why does this happen? Because soil organic matter creates pores in a range of sizes. Exactly how much more water is stored due to soil organic matter will depend on soil texture, though.

Soil organic matter is a busy mix of materials — fragments of last year's stalks and roots, earthworm casts, and living microbes and invertebrates, to name just a few. These materials are broken down by physical and biological processes. For example, freezing and thawing causes plant residue to lose its structure. Tiny dissolved molecules flow deep into the soil with rainwater. Hungry invertebrates, fungi, and bacteria consume complex living and dead organic material and excrete nutrients they do not need in a smaller, simpler form. These small organic molecules can stick to clay surfaces. Clay surfaces covered with organic material grow like snowballs, and soil aggregates are formed.

How soil aggregates affect soil water

Soil aggregates are critical for holding water in the soil for two reasons. First, a well-aggregated soil has large pores between aggregates to let water enter the soil profile. Second, small pores within aggregates hold water tightly enough to keep it around, but loosely enough for plant roots to take it up. It is critical that soil both let water flow through and hold water for later. If your soil does not let water infiltrate, you will have ponding, runoff and soil loss, and lower plant water supply. If your soil does not hold water, plants suffer from drought.

So, soil organic matter is critical for forming aggregates, and aggregates are critical for holding water. Because of that link, there is definitely a positive relationship between organic matter and water-holding capacity. How much water-holding capacity increases depends on your soil type.

Plant-available water capacity

We are mostly interested in the soil water as it relates to plant-available water. Plant-available water capacity is water held by soil against the pull of gravity (i.e., it does not wash through) but not too tightly for plants to draw it in. You see a bigger bump in plant-available water capacity when you increase organic matter in coarse-textured soils than finer loams or clays. This is because coarse soils naturally have larger pores between particles and really need the organic matter to develop small pores. Fine-textured soils already have small pores and aggregate more easily, so there are diminishing returns on increased organic matter. More soil organic matter means more soil pores and lower bulk density. Some of those pores are large, which is great for infiltration, but won't increase plant-available water capacity.

You can calculate how much more water holding capacity you might get from increasing organic matter, but the number varies with soil type. For example, a recent compilation of studies found that available water capacity in medium-textured soil increased by 3.1% with every 1% OM increase (Minasny & McBratney 2017). If you are starting with available water capacity of 22% (moderate for a silt loam according to NRCS), adding 1% OM would bring you up to 25.1% available water capacity (Table 1).

Article continued on page 7

Table 1. Estimates of available water capacity (AWC) increases with soil organic matter (OM) increases, 0-12" soil samples.

Soil texture*	AWC increase per 1% OM increase (%) **	AWC increase per 1% OM increase (gal.)	Initial AWC (gal.)	AWC after 1% OM increase (gal.)
Loamy sand (0.5-3%)	3.3	10,898	32,583	43,481
Silt loam (3+% OM)	3.1	10,056	71,682	81,738
Clay loam (3+% OM)	2.4	7,921	55,391	63,312

Average initial AWC by soil texture from NRCS data:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/office/ssr10/tr/?cid=nrcs144p2_074839
**Average increase in AWC per 1% OM for coarse, medium and fine soils based on Minasny and McBratney, 2017, converted from increase per 1% OC using van Bemmelen Factor (OM%=C% x 1.724)

You can estimate how many gallons that adds to a 1-foot depth of soil. Increasing OM by 1% increases AWC by about 10,000 gallons per acre for that medium-textured soil, on top of an estimated existing 71,000 gallons available water capacity. 10,000 gallons is about a 1/3-inch rainfall or irrigation event. That is 10,000 gallons in the soil, instead of lost as runoff. That water prevents drought stress and holds soluble nutrients, like nitrate, that plants will be able to access. Notice that while available water capacity increases about 10,000 gallons in both a loamy sand and a silt loam, for the loamy sand that 10,000 represents one-quarter of its new available water capacity — a much more striking increase!

10,000 gallons is just an estimate. What is important is that increasing organic matter fundamentally changes the soil structure. We cannot push soil from a loamy sand to a clay loam. But management focused on protecting soil structure and building soil organic matter, like reduced tillage and continuous living cover, can build organic matter and improve soil function.

The Importance of Pollinators

In the United States one third of all agricultural output depends on pollinators. Fruit and vegetable growers can attest to the significant role pollinators play in the production of many of our crops. Promoting pollinators' habitat on and near the farm benefits everyone who likes to eat!

Insects and other animal pollinators are vital to the production of healthy crops for food, fibers, edible oils, medicines, and other products. The commodities produced with the help of pollinators generate significant income for producers and those who benefit from a productive agricultural community. Pollinators are also essential components of the habitats and ecosystems that many wild animals rely on for food and shelter.

There is evidence that populations of native and managed pollinators are in decline, and the loss of benefits derived from them is being felt by the agricultural community. Human activity such as urbanization can lead to habitat fragmentation or destruction. Changes in agricultural practices and the use of broad-spectrum pesticides can disrupt or destroy long-established pollinator habitats. Other factors leading to pollinator decline include disease, and the spread of invasive plant species.

Whether you are a farmer or a homeowner, there are many ways you can learn about pollinators and help them to prosper by enhancing native pollinator habitats and protecting against pollinator declines.

Just type *pollinators* into any internet search engine, and you will be presented with pages and pages of links to universities, organizations, agencies, and individuals who share the desire to ensure that pollinators have what they need to do their work.

Did You Know?

- Pollinators support biodiversity: There is a correlation between plant diversity and pollinator diversity.
- The pollinator population of an area is a great indicator of the overall health of an ecosystem.
- Some crops, including blueberries and cherries, are 90 percent dependent on honeybee pollination.
- Honeybees visit five million flowers to make one pint of honey.
- To produce 150 pounds of honey, bees cover a distance equal to 13 trips to the moon and back.
- 90 percent of the nation's apple crop is pollinated by bees.
- Bees tend to prefer flowers that they can walk on to sip nectar. Butterflies and moths need a place to land on the flowers that they visit, so they prefer broad, flat-faced flowers.
- There are 4000 bee species in the U.S. There are 450 species in New York State alone.
- Increased yields and higher quality crops are benefits that growers and consumers realize from a healthy *pollinator population, native or managed*.
- Worldwide, approximately 1,000 plants grown for food, beverages, fibers, spices, and medicines need to be pollinated by animals in order to produce the goods on which we depend.
- It is estimated that there are about 2.4 million bee colonies in the U.S. today, two-thirds of which travel the country each year pollinating crops and producing honey and beeswax.
- Flowers bloom during the day and night, depending on which pollinator they need to attract. *Day-blooming flowers* are often brightly colored, while those that *bloom at night* are often pale, and may produce sweet scents or odors to attract nocturnal pollinators such as moths and bats.

Tips for Establishing a Healthy Pollinator Habitat

- Start right. Flowering plants can be started from seed; shrubs are better established by transplanting seedlings.
- Consider the soil characteristics, site drainage, sunlight, and other factors when selecting plants.
- Provide a variety of flower colors and shapes to attract different pollinators.
- Plant in clumps, rather than single plants, to better attract pollinators.
- Choose plants that flower at different times of the year to provide nectar and pollen sources throughout the growing season.
- Whenever possible, choose native plants. These plants will be better adapted to your soil type, climate, precipitation, and local pollinators.
- Avoid the use of pesticides. Practice Integrated Pest Management (IPM) to reduce damage to your plants and to protect pollinators by using less chemicals.
- Visit a plant nursery to ask about pollinator plants suited for your site conditions.
- Pollinators need water too. You can provide water for pollinators with a shallow dish, bowl, or birdbath with half-submerged stones for perches.

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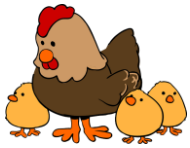

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