No-Till Notes:
Understanding Your Soil: Part I
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Soil, and in particular soil health, has been the most neglected aspect of my farming operation. As farmers we have become very good at management decisions involving a wide array of choices when it comes to crop production. We also tend to overlook one of our most important resources, the soil. Most of our decisions on soil involve sticking a probe in the ground to determine how much commercial fertilizer to apply for a chosen crop we intend to produce. We don't look at how this soil functions, the characteristics of the soil, and how our management decisions affect the performance capabilities of the soil we work with.

Looking back over time, our soils have gone through some dramatic changes since the days when there was native prairie grass covering the acres we now farm. The most significant change has come in the amount of organic matter now contained in our soil. The native prairie land contained an estimated 3 % organic matter in our region. Our soils don't have high organic matter due to our semi-arid environment. We are in an area of a short grass prairie system. The eastern part of the state is in a tall grass prairie system, where original levels of organic matter were considerably higher, in the range of 6% organic matter.

Through years of tillage we have "mined" the organic matter from the soil. Our tillage systems through the years have used this degradation of organic matter to produce crops by using the nutrients stored in the organic matter. This production practice worked well over the years until we reached a point where the organic matter was depleted and the higher use of commercial fertilizers was needed to replenish the nutrients no longer available due to the loss of soil organic matter.

The loss of this organic matter over the years has led to significant changes in the ability of our soils to perform in terms of crop production. The lack of organic matter has led to decreased nutrient availability, less soil microorganism activity, poor water infiltration, less water holding capacity, and poor soil structure.

Understanding Your Soil: Part II

I would like to continue discussion of soil organic matter and why it is so critical that we manage our soils to increase the amount of this important component of our soil to improve crop production and yields.

Dwayne Beck, manager of Dakota Lakes Research Farm at Pierre, SD states "Reducing soil organic matter by 2 percent is the same as shipping one 80-car train load of coal from

each half section of land." That's a lot of organic matter and it's not easy to replace that much organic matter in a short amount of time. Soil organic matter and soil health can't be bought, but has to be a changed in management practices to improve upon soil health and overall crop productivity.

On our farm we began a utilizing a complete continuous no till crop production system in 1994. Prior to this time we did some no till farming on some of our dry land acres. At the time we began using a no till production system the organic matter in our soils had been depleted through years of cultivation to .6% on our dry land acres and .8% on our irrigated acres. After 14 years of no till farming we have increased our organic matter to 2.3% on our dry land acres and 2.8% on our irrigated acres.

The first step in increasing soil organic matter and improving soil health is to stop tillage practices. A no till crop production system is the best system for improving our soils and increasing the productivity of our soils. There is more to a no till farming system than just stopping tillage practices. Dwayne Beck puts it simply: "No till is not about a lack of tillage, it's about carbon management. Not doing tillage is only the beginning." Cropping rotations and intensity, residue management, introduction of cover crops, and the use of no till crop production practices all play a significant role in improving soil health.

The benefits to a crop production system by improving soil organic matter are significant. Michigan State University states that a 1% increase in organic matter equates to a 12% increase in crop production potential. The University of Nebraska notes an increase of 25 pounds of Nitrogen per acre for each 1% increase in soil organic matter.

Understanding Your Soil: Part III

In my last article I mentioned carbon management as a key focus point in no till farming. Carbon is a significant element in soil organic matter. Carbon is in the soil organic matter in much larger quantities than the other nutrients which make up soil organic matter. Increasing the amount of carbon in the soil will promote a more rapid increase in building soil organic matter.

As farmers we can manage the amount of carbon produced in our farming operation by choosing proper crop rotations which facilitate large amounts of carbon. Crops such as winter wheat, proso millet, and corn have high amounts of carbon in their residue compared to the amount of nitrogen in the residue, or a high C/N ratio. Crops such as dry edible beans, peas, chickpeas, soybeans or other legume type crops have a low amount of carbon in the residue compared to N, or a low C/N ratio. Forage crops also affect the amount of organic matter we are able to produce as we are removing the carbon from the field as we harvest the forage. Removal of residue from the high C/N fields, such as baling wheat straw or corn stalks will have a detrimental effect on soil organic matter.

As a result, our cropping rotations play a significant role in the amount of organic matter we are able to produce. Cropping rotations with high C/N ratios will build organic matter much faster than cropping rotations with too many low C/N ratio crops or forages in close proximity during the rotation.

In a corn-soybean rotation the planting of a low C/N ratio crop, the soybeans, 50% of the time does little to increase soil organic matter. Even under a no till farming system this type of rotation may even deplete soil organic matter because of the lack of carbon produced by growing the soybeans every other year.

On our farm on our dry land acres we typically plant winter wheat, followed by another crop of winter wheat, followed by proso millet or corn, followed by a legume such as chickpeas or field peas. In the rotation we are growing 3 years of high carbon crops followed by a low carbon crop with the legume. Our irrigated acres are planted in wheat, corn, edible bean rotation. In this rotation we have two years of high carbon crops followed by one year of a low carbon crop with the edible beans.

Growing high C/N ratio crops such as winter wheat, corn, proso millet and leaving the residue in the field is essential in increasing the amount of organic matter in the soil. Crops with low C/N ratios, such as legumes, or removing the carbon with a forage crop, should only be done every 3-4 years in a cropping rotation. Plan your cropping rotations to improve the organic matter in your soils. This increase in organic matter will be very beneficial in overall crop production. Adding cover crops in the rotation, particularly cover crops with high C/N ratios, will also increase the rate of organic matter production.

Understanding Your Soil: Part IV

Improving soil organic matter is critical to improving potential crop production yields because higher organic matter content in the soil improves the nutrient availability to the crop, promotes increased water infiltration and water holding capacity in the soil, and improves the amount and diversity of soil micro organisms.

In our semi-arid climate, water is almost always the limiting resource in crop production. On our irrigated acres water management is becoming more critical each year and everything we can do to conserve water is worth doing. Crop rotations which add more carbon into the soil improving soil organic matter are an important part of this management decision. High amounts of residue on the soil surface and improved organic matter content in the soil will improve water infiltration, water holding capacity, and reduce soil surface evaporation.

An example of how high amounts of residue improve yields has been studied at Dakota Lakes Research Farm. A long term study on crop rotations and the effects on crop yield have been conducted. Two rotations in this study were compared on dry land acres.

One rotation used a winter wheat, corn, pea, winter wheat rotation. The other rotation used was winter wheat, soybeans, corn, pea, winter wheat rotation.

The rotations were studied to determine the effect of these 2 rotations on winter wheat yields. In examining these two rotations, the WW-C-P-WW rotation has two high carbon crops grown, the winter wheat and corn, followed by one low carbon crop with the peas. A low carbon crop is produced one out of every three years. In the second rotation of WW-SBS-C-P-WW there is a low carbon crop grown every other year with the soybeans and peas grown two out of the four years. It is also important to note that the two prior years before winter wheat is produced are identical, with corn and peas grown prior to the winter wheat crop. The only difference in these two rotations is the WW-C-P rotation produces more carbon and residue compared to the WW-SB-C-P rotation.

Winter wheat yields in these two rotations varied dramatically. In 2002, a relatively dry year, the W-C-P rotation had a wheat yield of 56 bushels per acre, while the WW-SB-C-P rotation had a winter wheat yield of 28 bushels per acre. The high carbon rotation doubled the yield of winter wheat compared to the low carbon rotation. In 2005, a good moisture year for wheat, the high carbon rotation yielded 92 bushels per acre compared to 57 bushels per acre for the low carbon rotation. In 2006, another low moisture year, the high carbon rotation yielded 60 bushels per acre compared to 29 bushels per acre for the low carbon rotation.

Crop rotations which produce high amounts of residue and carbon do a better job of capturing and utilizing all the moisture provided to the crop. High amounts of residue in the fields allow moisture to infiltrate into the soil and store the moisture more efficiently, resulting in improved water management and improved yields. High amounts of residue on the soil surface on our irrigated acres will help to conserve our surface and ground water and lower our pumping costs.