Flood Compaction and Soil Carbon

If you dig in the soil this year, you will notice that the soil tends to be harder and more compacted in the top 3-4 inches. This is a common occurrence in a wet year, especially when water has been standing on the soil surface for an extended period of time. Farmers may think it is the weight of water causing the soil compaction. Water weighs 8.34 pounds per gallon and there is 27,156 gallons of water in an acre-inch of water. A field with 12 inches water/acre of land is equivalent to 62.4 pounds pressure per square foot of soil ((12 inches of water * 27156 gallons/inch * 8.34 pounds/ gallon of water)/43,560 square feet per acre)). Tractors and farm equipment have axle loads that weigh 10-20 ton, so our soil scientists tell us that the "weight" of the water is not a major cause of soil compaction.

When soils are saturated for long periods of time, soil microbes, especially the anaerobic (lack of oxygen) bacteria dominate and they obtain oxygen for respiration from the soil by stripping if off other molecules. Well aerated (soils with adequate oxygen) have an earthy smell, while anaerobic soils smell musty and stale. Anaerobic bacteria convert nitrate to atmospheric nitrogen (N_2) a gas through denitrification. They also consume a majority of the "glues" and root exudates which promote good soil structure. Our corn and soybean roots do not survive or grow in standing water, so the root die back and they give off less "glues". The combination of anaerobic bacteria, lack of oxygen, poor root development, and the lack of root exudates is the cause of the poor soil structure and the soil compaction.

Many famers will be tempted to do some fall tillage to correct this problem. However, live roots improve the soil structure and to add back active organic matter to improve soil structure. The subsoil moisture is high this year and trying to till it may cause more damage than it soils. Planting a cover crop will increase the carbon content and increase the soil's natural glues to improve soil structure.

Most people probably think that the majority of carbon dioxide comes from the air for plant photosynthesis. Actually, the soil is the major source of carbon dioxide. The soil carbon dioxide concentration is 3,000-10,000 parts per million (PPM). A radish plant needs 50-100 pounds of carbon dioxide per day while 10 foot tall corn needs 400-500#/acre per day at full growth. To get 400-500# carbon dioxide per acre per day, over 13,000 cubic acres of atmospheric air or an area 1000 miles high over each acre of corn is needed. At 0.039% atmospheric carbon dioxide, this is not feasible because the volume of carbon dioxide is too low. The majority of the carbon used in corn or soybean production has to come from the soil. So carbon management is critical for good crop production.

In crop production, the big three macro-nutrients were nitrogen (N), phosphorus (P), and potassium (K) or N-P-K. Water or hydrogen and oxygen is also critical for maximizing yield and to move nutrients to the plant roots. However, carbon is the "keystone" element and may be the most limiting element in producing high yielding crops. Without adequate carbon, most of the macronutrients have no frame work for being processed.

Photosynthesis is only 4-5% efficient on average because carbon may be limiting in the form of adequate levels of carbon dioxide. With over 40-60 percent loss of carbon and soil organic matter from our soils, the efficient management of C-N-P-K is required to maximize crop yields. Keeping our soils planted to live crops year round keeps that carbon recycling efficiently while tillage is releasing carbon. The end result is a soil with less active carbon, harder denser soils, and more soil compaction.

Plants recycle carbon dioxide from the process of soil respiration (through oxidation, the release of energy). As humus and sugars in the soil are decomposed and carbon dioxide is released, the plant canopy absorbs carbon dioxide from the soil in the space or 1-2 hours. Plants will resynthesize the released carbon dioxide back into sugars through the process of photosynthesis. So this soil-plant cycle is repeated over and over again very efficiently.