Rethinking Cropping Systems: A Case for No-Till

The current production paradigm for annual cropping systems such as corn and soybeans has many challenges resulting from weather variability, water and soil quality problems and the narrow margin of economic sustainability. Yield is largely controlled by three fundamental factors: genetics, environment (weather and soil) and management. Two of these factors, namely the genetics (the choice of crop cultivars) and the management systems we implement, can be influenced to a certain degree. These management systems, which include practices such as tillage, crop rotation and cover crops, are major components when dealing with the uncertainty of the environment. Therefore, the choice of tillage and crop rotation systems significantly affect production sustainability, soil health and environmental quality.

Corn yield reductions in parts of Iowa during the 2012 drought exceeded 40% in conventional tillage systems compared to 15% with no-till.

Management and tillage decisions are among several decisions farmers make every year. However, a number of factors need to be considered when selecting a specific tillage system for any given field or region within a state. These factors include the soil type, soil slope, soil drainage and topsoil depth (or the A-horizon of the soil solum). Other equally important decisions in crop production include cultivar selection, crop rotation, fertilizer management, residue management equipment, planting and harvesting equipment, compliance with conservation plans, the economics of a particular tillage system and the timing of tillage operation, which is dependent on soil moisture condition.

The choice of conservation agriculture systems such as no-till (NT) has economic and environmental benefits. There is a positive impact of NT on soil productivity and profitability, especially under extreme weather conditions. In addition to the capital costs, corn and soybean production input costs with conventional tillage systems can average $25 to $33 more per acre than the NT system. Aside from the economic value, NT and other conservation systems also protect soil quality, conserve energy and improve soil health and soil organic matter.

Tillage Causes Significant Organic Matter Losses

Tillage affects soil conditions and destroys soil organic matter by accelerating organic matter loss through oxidation, resulting in a weak soil structure and significant surface runoff and soil erosion. In many long-term studies in the Midwest and elsewhere, organic matter loss has exceeded 50% since the breaking of sod more than 150 years ago. The destruction and loss of organic matter is well correlated with the intensity of tillage (Figure 1).

In addition to the degradation of soil quality due to organic matter loss and lack of sustainability from inadequate soil conservation measures, there are economic consequences of soil loss. It is very difficult to assign the

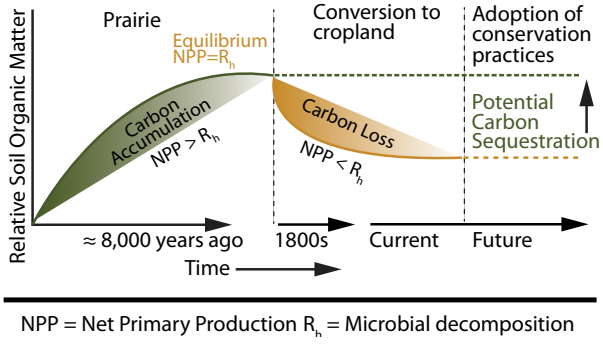

Figure 1 – Soil organic matter change as influenced by land use and management practices.

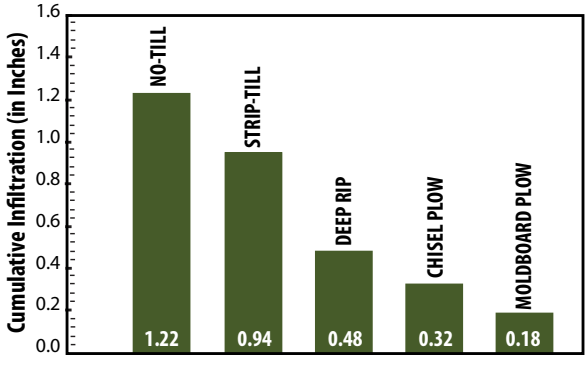

Figure 2 – Soil recharge as influenced by tillage system. No-tillage and strip-tillage increased subsoil profile water recharge by 50% to 70% over other conventional tillage systems.

exact economic value of lost soil in terms of nutrients and productivity. However, it is possible with reasonable assumptions to determine the economic cost of nutrients and productivity loss. This loss represents nutrients such as N, P, K and other macro- and micronutrients and, most importantly, the long-term loss of soil productivity.

The organic matter that is lost through the destruction of soil structure and subsequent soil erosion cannot be replaced as quickly as one may think. Organic matter recovery in row-cropping systems is slow if tillage continues to be practiced. However, implementing NT, the use of cover crops and other conservation practices can minimize such losses and rebuild organic matter over time. The increase in organic matter with NT and cover crops is slow but steady.

The benefits of increasing organic matter with NT can be translated into yield savings, especially in times of drought. An increase in water recharge in the soil profile was found to be 50% to 70% with NT (Figure 2) compared with conventional tillage systems such as chisel plow and deep rip. This increase in water storage during severe dry conditions as experienced in 2012 can have significant effects. During the 2012 drought, corn yield reduction in parts of Iowa under conventional tillage systems exceeded 40%, compared to 15% with NT. The benefits of NT in improving the biological, physical and hydraulic properties of the soil are well linked to the increase in soil organic matter. These benefits associated with NT are related to crop residue on the soil surface. Besides reducing soil erosion, crop residue has many other benefits. It works effectively by trapping soil moisture, which allows water to easily infiltrate the soil to recharge the subsoil profile. Conventional tillage of any kind damages the soil by reducing the residue cover and its effectiveness in protecting the soil from both water and wind erosion.

To gain the benefits of NT, farmers need to have a long-term commitment to NT in order to sustain the performance of the system. Adoption of NT and its benefits for soil conditions and yield improvement take time. As shown by many studies, a soil system under NT gains stability and effectiveness after five to seven years. During the conversion to NT after many decades of intensive tillage, the soil system needs time to recover from the constant assault, which destroys its physical and biological properties. Therefore, switching from NT to a conventional tillage system will be just as damaging as continued conventional tillage. Organic matter loss as a result of the oxidation of organic matter can be as high as 23% in the first two hours of a tillage operation within a 24-hour period.

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