FFF Review

Key To "Stashing" Carbon: Residue Management

Research and on-farm experience show that improvement of soil environment via high-yield farming greatly enhances stashing.

Not an of the assimilated carbon from residue is stashed in the organic fraction. The amount or percentage of residue that is converted into organic matter is dependent on a variety of conditions.

Soil environment. Moisture content, pH, exposure to air all affect microbial action and thus the amount of organic matter produced.

Tillage systems. The moldboard plow used in conventional tillage exposes subsoil to elements that rapidly destroy organic matter by oxidation to CO_2. Reduced tillage, on the other hand, leaves a protective cover of residue on the surface and places some residue deep enough to be converted into organic matter.

Nutrient levels. Sufficient nitrogen, phosphorus and sulfur should be present to promote conversion of residue into organic matter. Treating residue with fertilizer generally has been discouraged because it temporarily ties up or immobilizes N, P, or S instead of feeding the existing crop.

Geographic location. In the northern latitudes of the Corn Belt, shorter growing seasons reduce carbon sequestration, although cold winters will prevent destruction by oxidation. Middle latitudes appear to have a beneficial balance of a favorable growing season and cold winters that prevent oxidation loss. In the southern latitudes, warm winters can accelerate organic matter loss by oxidation.

Soil structure key

The scales can be favorably tipped on how much carbon is stashed by improving the soil structure via high-yield farming. For example, after a 300-bu/A yield of shelled corn is harvested, there are 10.6 tons of stover and roots left in the field. This residue contains about 4.8 tons of carbon and 0.1 ton of N. The carbon/nitrogen ratio is about

Table 1. CO_2 sequestered in soil organic matter, continuous corn, Varvel, 1994, Mead, NE.

Pounds of nitrogen per acre		
0	80	160
CO_2 sequestered in metric tons per acre		
-.79	+.27	+2.2
Projected sequestration*		
-58 mmt	+19.7 mmt	160 mmt

*In U.S. millions of metric tons (Assumes 73 million acres)

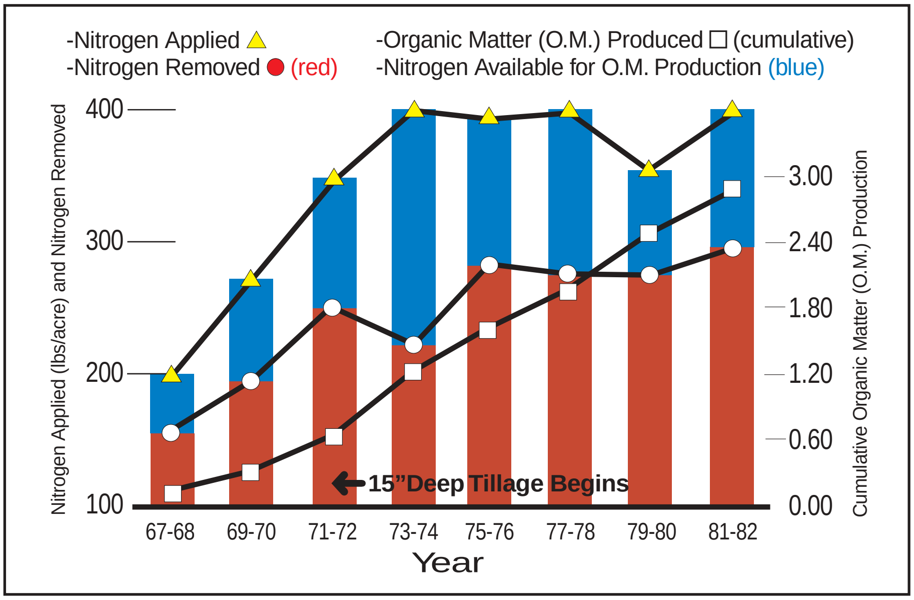

Figure 1. Nitrogen removed versus nitrogen applied and organic matter production.

50:1. The carbon/nitrogen ratio of most organic matter in the U.S. is about C/N/P_2O_5/S = 110/10/3.2/1.3. In other words, unless more N is available or added to residue, reasonable conversion to organic matter cannot occur. Adding about 20 lbs of N per ton of residue will change the ratio to about 25:1. The reaction should then tie up more carbon in organic matter. At least 200 lbs/A of N would be needed in this case to obtain a more favorable C/N ratio. Several corn farmers have shown the way.

Over 15 years, an Illinois corn grower named Herman Warsaw added both N and P as he incorporated residue (up to 15 inches deep) into the soil with a twist shank chisel (Figure 1). Organic matter increased steadily about 0.18 percent per year. Assuming 3 million pounds of soil in the top 9 inches, the increase would amount to 5,400 lbs of organic matter containing about 3,100 lbs of carbon. The organic matter also would contain about 280 lbs/A of N, which could be released to feed corn roots during summers when temperatures and moisture were favorable. In effect, Warsaw needed about 200 lbs of N to sequester a metric ton of carbon. If every farmer adopted a similar program, a total of 375 million metric tons of CO_2, would be sequestered in the U.S. each year!

In University of Nebraska trials (Table 1), it appears that about 160 lbs/A of N produced 1.93 metric tons more of CO_2, than the 80-lb/A rate. Thus, the extra 80 lbs/A allowed the sequestration of .53 metric ton more of carbon (C) than the lower rate.

Both examples are in one respect approximations because we are dealing with estimating a small amount of organic matter in millions of pounds of soil. In addition, the biochemical reaction is dependent on a great number of parameters such as pH, moisture, temperatures, P_2O_5 availability, sulfur content, soil type, etc.

The digestion system of a cow is an interesting comparison with conversion of corn residues. The rumen digests corn stover quite well if the ration contains nitrogen (from urea or soybean meal), phosphorus (from dicalcium phosphate), sulfur (from sodium sulfate) and trace elements. C/N ratio is changed to 25:1 with feed supplements. C/P_2O_5 and C/S ratios are also optimized.

Wheat is another crop that could respond to this program. After it is harvested, straw residue can have a C/N ratio of 100:1. This could be converted to a 25:1 C/N ratio with commercial fertilizer to encourage formation of organic matter.

Forests represent another opportunity. Timber production can be increased at the same time more carbon is assimilated. There are some 700 million acres of timberland in the U.S. Visualize the potential. If just 150 million acres were fertilized with 100 lbs of N (and possibly some P2O5 and sulfur), it might be possible to stash up to 250 million metric tons of CO_2 or about 5 percent of our total U.S. emissions today!