



Soil Organic Matter and N Cycling

by Ray Ward

SCIENCE

Raymond C. Ward is a soil scientist & founder of Ward Laboratories at Kearney, NE.

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Photo by Buddy Feltner.

The author examines soil structure during the '01 Kansas No-Till Tour. During these forays, Ward is always armed with his trusty spade and his quick wit.

plant material you see on the soil surface either from the last harvest or from several years ago is crop residue, not soil organic matter. The real carbon sequestration occurs in the decomposed plant residues.

The stable organic matter in the soil has a carbon to nitrogen (C:N) ratio range of 10:1 to 12:1. One percent organic matter is the same as 10,000 pounds of OM per 1,000,000 pounds of soil. Since one inch of soil across one acre weighs about 300,000 pounds, an 8-inch layer of soil containing 1% OM is the same as 24,000 pounds of OM. This is 12 tons of OM. If a soil has 3% OM in the top 8 inches of soil then there are 36 tons per acre.

Organic matter is 58% carbon, which is almost 21 tons of carbon per acre in those 36 tons. So with a C:N of about 10:1, if there is 21 tons of carbon then there is 2.1 tons of organic N or 4200 pounds of organic N per acre in an 8-inch layer of soil. How much of this organic N is available to a crop in one year? In the days of conventional tillage we considered the following as useful guidelines for a soil with 3% OM (i.e., 4200 lbs. organic N):

for small grains: 1% release per year (42 lbs of N)

row crops: 2% release per year (84 lbs of N)

summerfallow: 4% release per year (168 lbs of N)

With tillage a considerable amount of organic nitrogen was released per year, and the variation in the above figures is due to the timing and extent of tillage and the timing of the crop's growth. One of the reasons for summerfallowing was mineralization of organic N to nitrate. As the N was released, carbon was lost as carbon dioxide

(CO₂). Therefore as we continued to cultivate the land we lost organic matter. Turnover in undisturbed grasslands is much slower, at about 0.5% release per year (21 lbs of N).

An Empty Warehouse?

Why is soil OM important? As I described, it is a 'warehouse' for N storage, as well as other nutrients, which are slowly released or 'spoon-fed' to the crop under no-till. Soil OM also improves the water-holding capacity of the soil, as well as the physical properties of the soil which will be discussed.

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As no-tillers try to build organic matter in the soil, one must remember that N has to be sequestered also. By leaving residue on the surface it is hoped that OM will build. How does this happen? When crop residues are

incorporated by tillage, the microorganism population increases very rapidly. If there is good moisture, warm temperatures, and available nitrate, decomposition is complete in a few short months. (*Editors' Note: The atmospheric oxygen introduced into the soil by tillage allows the population explosion of decomposing organisms, which need the oxygen for respiration—their 'feeding frenzy' typically oxidizes more C than what the crop accumulated during the season.*) Tillage also decreases the size of aggregates (granular clumps of soil), allowing microorganisms more access to carbon inside those aggregates. Therefore, tillage over a period of 50 to 60 years released carbon (and other nutrients) that had taken dozens of centuries to accumulate. By leaving the soil undisturbed we begin the process of building OM. However, for every 10 pounds of carbon trapped, one