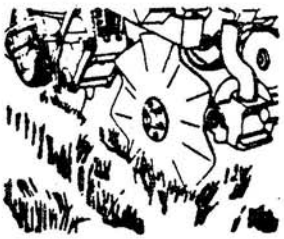
TECHNICAL NOTES

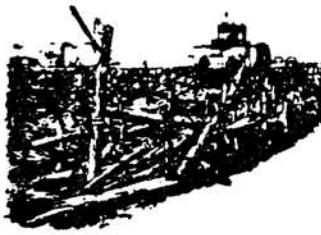
U. S. DEPARTMENT OF AGRICULTURE Portland, Oregon SOIL CONSERVATION SERVICE

AGRONOMY - Technical Note No. 19 July 1984

THE IMPORTANCE OF SOIL ORGANIC MATTER AND ITS INFLUENCE ON SOIL PROPERTIES AND CROP PRODUCTION

Tillage Talk





Subject: Organic Matter Influence
File in Section No. I. SOIL MGT.
Date: June 21, 1984

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The Importance of Soil Organic Matter and Its Influence on Soil Properties and Crop Production

Perhaps no soil component offers as wide a range of benefits to overall so health and productivity as does organic matter. Highly significant advantages are found in water infiltration, erosion control, and cation-exchange improvements. Improved soil structure allows more extensive root development and, therefore, more efficient utilization of the root bed.

Studies in the United States have shown that organic matter content was the variable most closely associated with runoff from moderately sloping soils encompassing a broad range of textures. On 44 different soils of varying texture, the organic matter content influenced the infiltration of 2.5 inches of rain per hour more than did the soil texture and topography. A summary of 678 plot-years of corn at 9 locations in the corn belt revealed significant infiltration increases by returning crop residues as compared t their being removed.

One of the most significant factors affecting organic matter content is erosion. The table below, as reported by Shaxon (11), illustrates the highly discriminatory removal of organic matter and soil fertility.

Table I. Characteristics of soil constituents on and from an eroded area of unfertilized sandy clay loam.

Places Tested	pH	Carbon(%)	N(%)	P(ppm)	P(me)	Ca(me)	Mg(me)
Areas of loss							
Planting ridge	5.4	1.72	.13	9	.62	5.13	2.00
Exposed subsoil	5.0	1.11	.10	9	.39	3.63	1.51
Areas of deposits							
Coarse	5.3	0.35	.05	24	.33	3.03	1.35
Fine	5.7	4.02	.29	15	.68	10.00	3.29

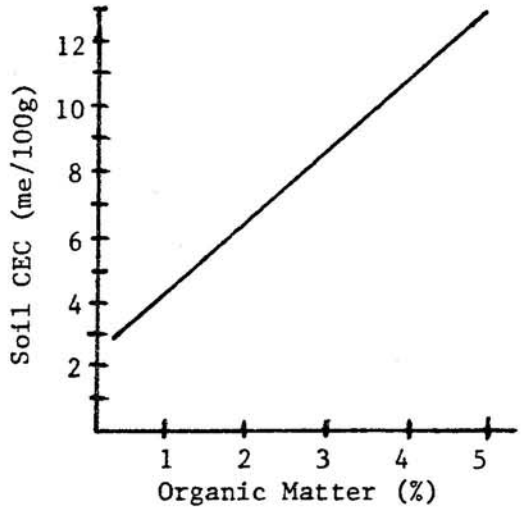
It is said that organic matter is the key to water erosion control. Bette soil aggregation assures better infiltration, reduced runoff, and also increases the soil's resistance to raindrop impacts.

Buntley (3) also recognized that infiltration problems arises as the surfa soil, along with its accumulated organic matter, is eroded away, resulting in a breakdown of structure and crusting of the surface. He suggests that perhaps we "need to put less emphasis on the soil being lost and more emphasis on the water being lost. Whereas soil loss reduces production potential and yield over time, the water loss reduces production potential and yield every year."

Buntley (3) reported that ten years of research at Clemson University has shown that no-till corn planted in vetch and rye mulch averaged 3.11 inche less water runoff per year, 2.4 tons per acre less erosion, and yields were equal to or greater than that of plowed, unmulched check. Also, the degree of soil aggregation and aggregate stability increased under mulch treatmen but were reduced considerably under the plowed check.

Research in North Carolina has shown a highly positive correlation between organic matter content and the CEC of the soil. This is true, even if the organic matter is present only in small amounts. An average of 55 percent of the CEC came from the organic matter portion of the soil.

Figure I. Relationship between soil organic matter content and cation-exchange capacity of soils from 18 locations in southeastern North Carolina. (7)



There is evidence that phosphorus and potassium derived from decayed plants are more readily available for the next crop than if derived from mineral soil particles (6).

Flaig (5) notes that potassium in soil is made more available by the decomposition of organic matter, citing a study which revealed more potassium available than was added by the organic material. Upon decomposition, organic matter produces organic acids and carbon dioxide, which help to release potassium from mineral sources and thus increases its availability.

Also, humus holds ammonium in an exchangeable and available form, thereby reducing loss of ammonium fertilizer by leaching (10). Soil minerals, lime magnesium, and phosphorus are made water-soluble and thus available to plants (12).

Organic matter provides a substantial amount of nitrogen for crop growth an serves as a store-house for this essential plant nutrient. In addition to the primary supply of nitrogen, soil micro-organisms associated with organi matter fixes nitrogen from the atmosphere. Also, inorganic nitrogen is mor effective in the presence of organic matter (2). A larger supply of nitrog is held in the soil by the addition of organic materials (4).

The tables below provide insight on the nutrient contents of various green manures and crop residues.

Table II. Average nutrient composition of green manure crops (6).

Plant tops and roots	lbs. of N, P, and K per 100 lbs. of dry matter		
	N	P	K
Red clover	4.81	1.49	3.02
Alfalfa	4.34	0.94	1.90
Crimson clover	3.70	1.07	2.35
Rye (hay)	1.07	0.50	1.70

Table III. N P K values in crop residues, average percent. 1/

Crop	N	P	K
Barley	0.75	0.11	1.25
Corn	1.11	0.18	1.33
Soybeans	2.25	0.22	1.05
Wheat	0.67	0.07	0.97
Fescue	2.0	0.35	2.0
Vetch	4.3	1.6	4.9
Tobacco	1.5	0.21	3.0

1/ From Foy Hendrix, former Conservation Agronomist, USDA, SCS, Raleigh, North Carolina.

Of the several factors that influence the extent of success in organic matter management, there seems to emerge three factors that are under the direct control of the manager. They are: (1) type and quality of the organic material used; (2) amount used; and (3) how it is utilized.

Perennials of good quality seem to best pass the test of the first two factors. Kononova (8) reports that perennial grasses and legumes of good

of roots are many times greater than wheat. Green manures and fresh crop residues have little effect on stabilizing soil aggregates, but as they decompose, microbial slimes are produced which do have marked stabilizing properties (1). Residues, with their higher lignin content will contribute more to long-term accumulation of organic matter than will green manures, but the latter will normally give less tie-up of nitrogen during decomposition. Mitchell (9) reports greater soil moisture under no-till in cover crops than in residue. Organic matter was also slightly higher, but this is very likely due more to the no-till system itself, rather than to a difference in stability of the two types of material. Or, it could have been due to a difference in quantities produced.

The age of the plant determines its quality. This is adequately shown in Table II. There is, then, considerable room for use of perennials, annuals as green manure crops, and of crop residues in an organic management program as an integral part of farm management.

If any principle comes through loud and clear, it is the relationship between soil disturbances and organic matter levels. There are three basic choices as to how to utilize organic material: (1) leave it on the surface as with no-till; (2) incorporate it somewhat as with a chisel or a light disking, and (3) bury it with disk and turnplow with the full traditional approach. The traditional method is much more damaging to organic matter levels.

Research has shown increases in soil organic matter through no-till systems. Buntley (3) reported on a ten year test by Clemson University in which the organic matter content increased from 1.5 percent to 2.6 percent under the mulch while it dropped from 1.5 percent to 1.2 percent under the plowed check. The nitrogen content increased under the mulch from .047 percent to .069 percent, while declining under the check from .047 percent to .036 percent. An eight year test by Mitchell (9) shows the highest organic content with no-till where hairy vetch was used as the cover crop. At the end of the test, his findings for organic matter content (%) were 1.5, 1.9, 2.1, and 1.8, respectively, the conventional, no-till in rye, no-till in vetch, and no-till in corn residue. A highly significant common denominator in influencing organic matter content is the plow. Without exception, those who have researched the influence of cultivation on organic matter levels conclude that conventional cultivation processes are quite devastating to organic matter. Research and testimonials alike point very positively to strong potentials in organic matter improvements through reduced or modified tillage practices. There is a suggestion that levels can be increased without massive doses of organic materials through the use of no-till and that levels at deeper soil depths can be achieved through the use of chisel plow or noninversion tillage. This prospect, it seems, deserves closer attention, refinement, and encouragement as a technique in organic matter management.

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