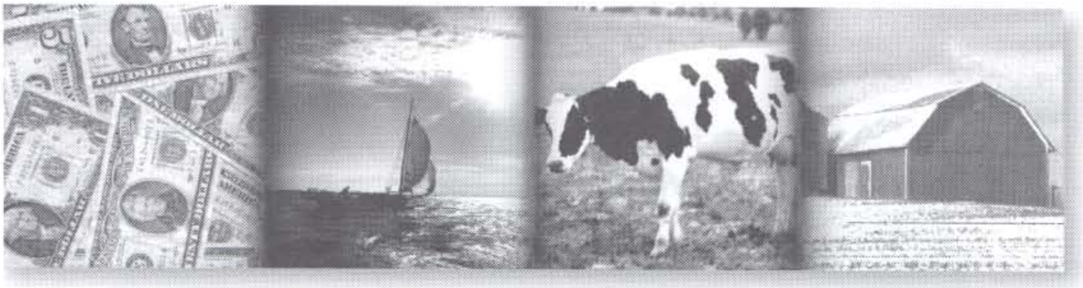

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Focus On Organic Matter

Organic matter comprises only 2 percent to 5 percent of most soils. Yet it overwhelmingly affects soil properties. What is organic matter and where does it come from? Why is organic matter important for healthy soil? This issue of Nutrient Manager *will examine the marvelous stuff that we call organic matter.*

WHAT IS ORGANIC MATTER?

Soil organic matter refers to all those materials in a soil with molecules made from a carbon framework. As the late Hans Jenny, a pioneer soil ecologist said, "Any organic carbon assembly, large or small, dead or alive, is classified as soil organic matter."

Three different groups of material—**biomass**, **residues** and **by-products** of living creatures, and **humus**—constitute soil organic matter. Please refer to Table 1. The three types of material are intricately interrelated but each has a distinct and unique function.

Biomass, the living component of a soil, includes all living soil organisms. Included is a phenomenal array of creatures from the microscopic viruses and bacteria to earthworms and millipedes that we can see with an unaided eye. As in other ecosystems, members of this group are part of an intricate food web that includes grazers, predators and their prey, and creatures whose diet consists of the waste products of others. The microscopic organisms are very active in residue decomposition and nutrient cycling. Larger (and generally more mobile) organisms break down residues into smaller pieces, move residues around in the soil and create channels or "biopores" by means of their burrowing activities.

That the soil microorganism *Streptomyces* could kill bacteria is a fact discovered by Selman Waksman, a soil biologist from Rutgers University in New Jersey. His discovery led to the production of the commonly used antibiotic known as Streptomycin and its widespread use in treating human infections. The discovery won him the Nobel Prize in 1952.

Residues and **by-products**, composed of old plant roots, crop residue, manure and dead soil organisms, are food for most of the soil organisms. Residues supply the nutrients and energy for soil organisms.

While soil organisms are digesting residues to sustain their lives, they leave behind nutrients they do not need in a process called **mineralization**. These nutrients are then available to meet the nutritional needs of crop plants.

If nutrients in residues are inadequate for their needs, microorganisms will consume, or **immobilize**, soil nutrients that crop plants would otherwise use. To keep nutrients cycling and maintain optimal soil structure and tilth, producers need to replenish residues on a regular basis.

In the process of breaking down residues into humus, soil organisms often exude or give off by-products that are sticky or gummy. These materials hold soil particles together in clumps or aggregates and form the basis for good soil structure and tilth.

Residues that are difficult for soil organisms to decompose contribute to the formation of humus.

> "As organic matter is decomposed, nutrients are made available to plants, humus is produced, soil aggregates are formed, channels are created for water infiltration and better aeration, and organic matter originally on the surface is brought deeper in the soil. Soil organisms influence every aspect of decomposition and nutrient availability." Fred Magdoff, soil scientist at the University of Vermont, from his book *Building Soils for Better Crops*.

Humus, the end product of the **humification** process, is the result of the activity of soil organisms upon residues. Composed of a complex mixture of very small and very reactive particles, humus forms the majority of organic matter. Humus enhances the water holding and nutrient-supplying capacity of the soil, which significantly benefits crops.

Humus is stable and resists further decomposition. Thus, it is not a source of nutrients and energy for soil organisms.

For a look at organic matter cycling in the soil, see Figure 2.

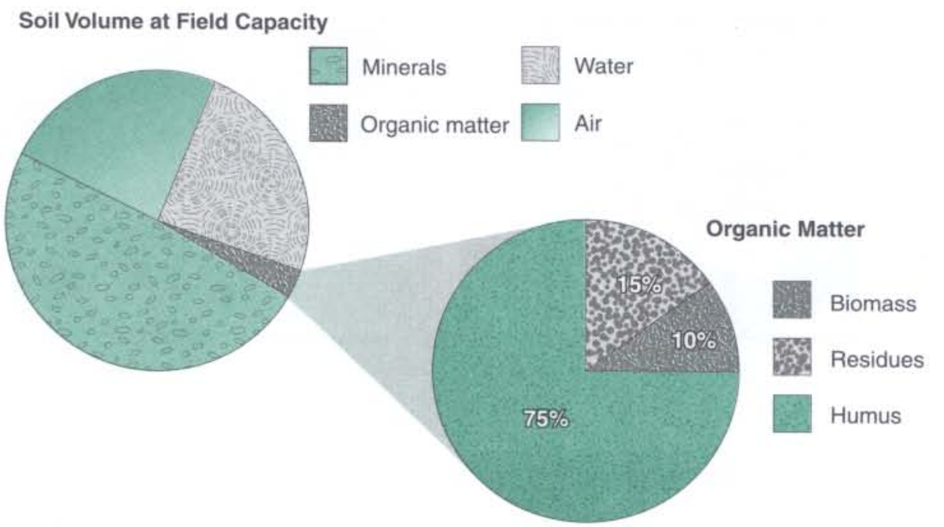

Figure 1. Organic Matter in the Soil.

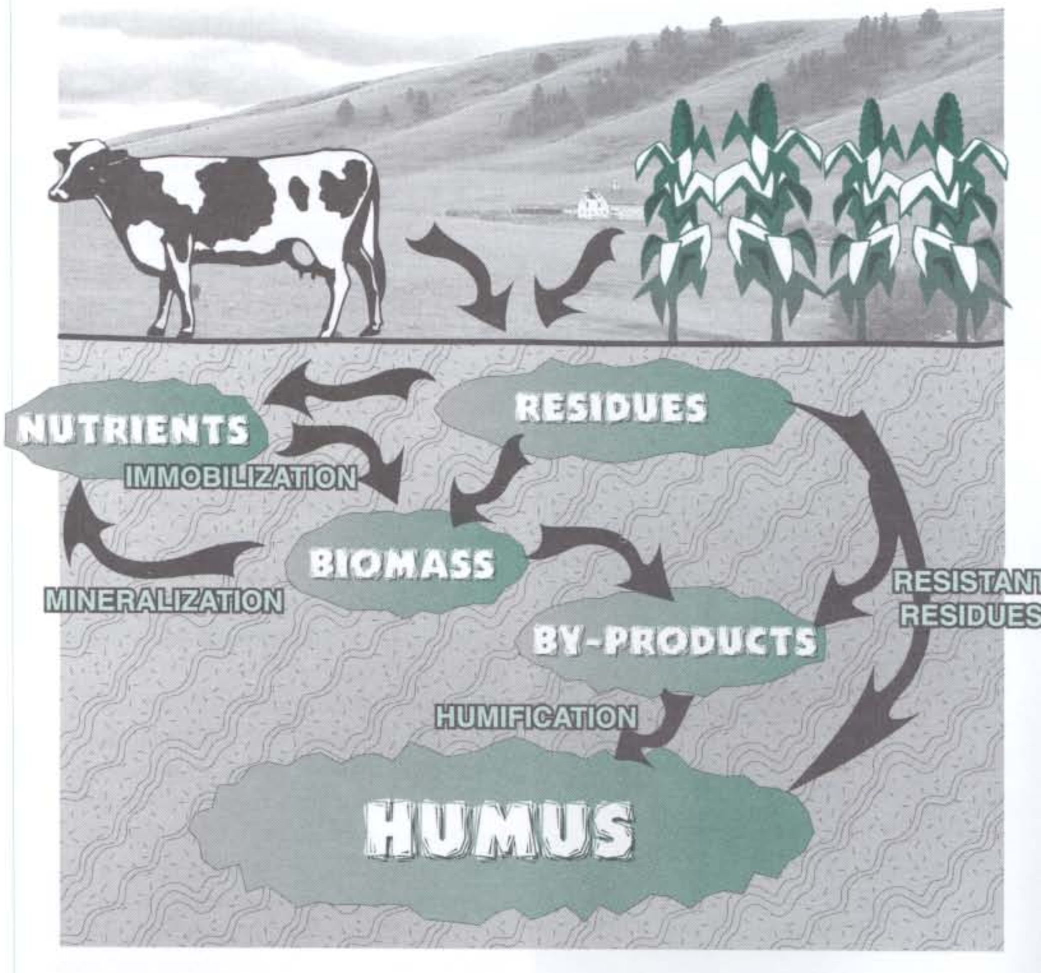

Figure 2. Soil Organic Matter Cycle.

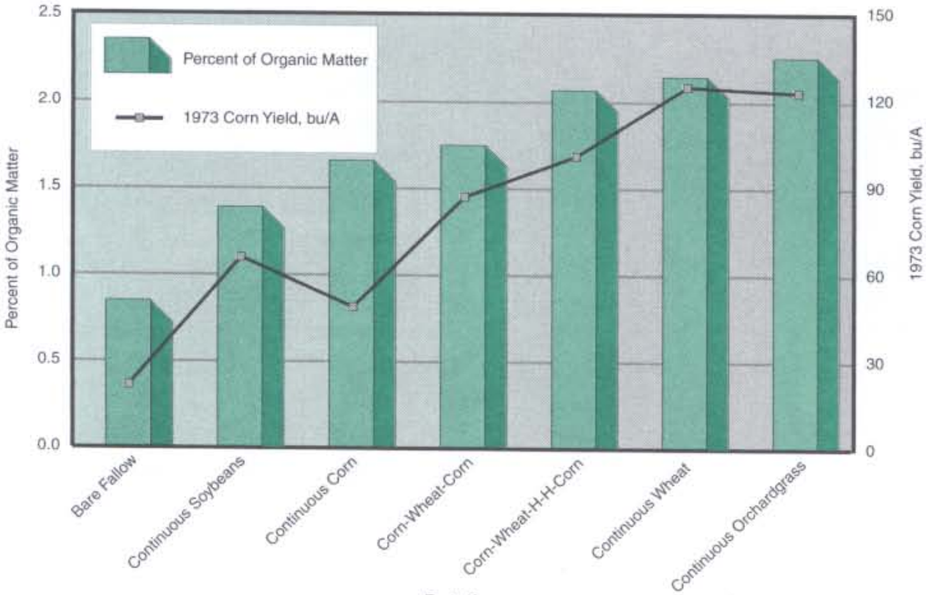

Figure 3. Organic Matter and Corn Yield.

WHAT AFFECTS ORGANIC MATTER CONTENT?

Soils differ in their organic matter content even within a climatic region. Generally, the organic matter content is greater in the surface layer of a soil than in the subsurface. Poorly drained soils usually have more organic matter than well-drained soils. Fine-textured soils tend to have more organic matter than coarse-textured soils. Cultivated soils tend to have less organic matter than their counterparts still in a native state.

The amount of organic matter in a soil is a function of both the additions and losses of organic matter that have occurred over the years. The type of crops grown, the yield of those crops, the portion of the crops harvested and the management of the crop residues all have impacted the amount of organic matter previously in a soil. The choice of tillage regimes and erosion may have increased or decreased organic matter losses. Organic matter decomposition slows down under reduced tillage, no-till systems and in rotations where cultivation is infrequent.

Ed Strickling, soil physicist at University of Maryland from 1950 to 1984, studied the long-term effect of 13 different cropping systems or rotations on soil organic matter and aggregate stability. His study, which was conducted on the Beltsville silt loam soil and maintained from 1952 until 1972, looked at a continuum of cultivation intensities from fallow (which was tilled every year) to grass (which was not cultivated after it was established). All rotations were fertilized identically at 100, 120, and 120 pounds per acre of nitrogen, phosphate and potash, respectively.

Organic matter content after 20 years in a cropping system varied from a low of .85 percent in fallow to a high of 2.26 percent for orchardgrass.

Even more impressive is the residual effect of each rotation. In 1973, at the end of the rotation experiment, corn was planted on all rotations. Even with an application of 200 pounds of nitrogen, corn grain yield on areas with low organic matter and low aggregate stability were greatly reduced compared to areas with higher organic matter and aggregate stability. Dr. Strickling attributed the improved yields to the greater infiltration and storage of rainwater in areas where the crop/tillage regime produced soil with higher organic matter and higher aggregate stability. The organic matter contents and corn grain yield in 1973 for seven of the rotations are shown in Figure 3.

Dr. Strickling's investigation was started before the era of conservation tillage. However, the lessons we learn from his work are just as valid today as they were in 1973. Some combinations of crop rotations and tillage methods can critically deplete organic matter to the point where soil physical properties are adversely affected. Nutrient applications cannot compensate for poor soil tilth. To respond to recommended nutrient management, a soil must first be in good physical condition.

SOIL ORGANIC MATTER

TYPE	BIOMASS	RESIDUES AND BY-PRODUCTS	HUMUS
COMPOSITION	Fungi Bacteria Viruses Insects Earthworms	Crop residue Dead roots Manure Dead animals Metabolic by-products	The end product of decomposition
FEATURES	• Active in decomposition of residue. • "Mineralize" nutrients in residue, making them plant available. • May immobilize nutrients if supply is inadequate. • Creates "biopores". • Sticky by-products aid in soil aggregation.	• Nutrient rich. • Decomposition supplies energy for biomass organisms. • Needs to be replenished regularly. • Rate of decomposition depends on tillage, moisture level.	• Particles hold water, nutrients, pesticides. • Stable–resists further decomposition.

Table 1. Soil organic matter composition and functions.

HOW IS ORGANIC MATTER MEASURED?

Soil testing laboratories routinely determine total organic matter. The total is usually expressed as a percent of the dry soil. Most laboratories use one of two methods, wet oxidation or dry oxidation. Both methods "burn off" or oxidize the organic matter. The wet oxidation method uses chemicals like acids while the dry method uses a very high temperature. Both methods have inherent weaknesses; the wet method tends to underestimate the amount of organic matter and the dry method tends to overestimate organic matter. When you are monitoring the organic matter content in your fields, stick with one lab and one method so results are comparable from year to year.

At the University of Maryland Soil Testing Laboratory, an evaluation of organic matter is included in routine tests done on every field crop soil sample. Using the dry method, a sample is heated at 675°F. For more information on the University of Maryland Soil Testing Laboratory, contact your county Extension office.

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If you do not receive this newsletter by mail and would like to, contact your county Extension office or the address above. The Maryland Cooperative Extension Agricultural Nutrient Management Program is funded by the Maryland Department of Agriculture.

Front photos of woodland topsoils courtesy of Ray Weil, soil scientist at the University of Maryland.

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