



Building Healthy Soils

*Annette Wszelaki, Associate Professor and Commercial Vegetable Extension Specialist
Sarah Broughton, Former Graduate Research Assistant
Department of Plant Sciences*

Benefits of healthy soil:

- Enhances drainage and water-holding capacity
- Promotes soil organisms
- Increases soil organic matter
- Supports plant fertility
- Reduces erosion

Soil Texture and Structure

Soil texture is the relative percentage of sand, silt and clay found in soil; structure refers to the way these particles are grouped, or aggregated, together. Coarser particles, such as sand, aid in drainage, but fields consisting mainly of sand-sized particles may not hold sufficient amounts of water for the plants to use. Finer soil particles, such as clay, have a higher water-holding capacity but, if out of proportion, become waterlogged and heavy. To supply required amounts of oxygen and water to plants, a soil must have a balanced mixture of particle sizes, providing proper drainage while still holding an appropriate amount of water within the root zone of plants.

Soil structure is highly influenced by organic matter content and soil microorganisms. Plant roots and substances produced during the decomposition of organic residues bind soil particles into aggregates. Microorganisms also assist in aggregating soils by producing glue-like substances that bind particles. Microbial networks, such as fungal hyphae, hold these aggregates together. A well-aggregated soil has a balance of large- and small-sized pores, promoting better drainage, aeration and water storage. Soils with these characteristics are said to have good “tilth” and are not restrictive to root exploration and plant growth.

Organic Matter and Soil Organisms

Organic matter refers to the portion of soil comprised of living organisms, decaying plant residues and humus. Humus is the end product of decomposition; it is relatively stable and requires long periods of time to further degrade. The benefits of topsoil rich in organic matter include rapid decomposition of crop residues, improved drainage and water infiltration, increased water- and nutrient-holding capacity and binding of soil particles. These characteristics facilitate tillage, reduce erosion and encourage root growth. Soil organic matter content can be increased through additions of plant material (such as crop residues and green manures), animal manures and compost.



Strip tillage disturbs the soil in only a small area around the rooting zone of the plant.



Extensively tilled, uncovered soil is susceptible to erosion by wind and water.

Soil organic matter also provides food for organisms. Many different types of organisms living in soils provide valuable services. Microorganisms, such as bacteria and fungi, support plant fertility by assisting with the release of minerals bound up in soil organic matter. Larger organisms such as earthworms create burrows in the soil, enhancing water infiltration and soil aeration, redistributing organic materials and nutrients throughout the topsoil and providing pathways for root penetration.

Soil building strategies:

- Reduce tillage.
- Retain crop residues.
- Incorporate cover crops, green manures and catch crops.
- Develop a crop rotation schedule.
- Utilize animal manures and compost.

Soil Management

• Tillage

Tillage has traditionally been used to stimulate the breakdown of organic matter, improving seed germination by creating a fine seedbed and control weeds. However, extensive tillage can result in soil degradations such as erosion, destruction of soil aggregates, reduction in organic matter, compaction and creation of plow pans, crusting and decreased populations of beneficial organisms. Conservation tillage systems reduce tillage and keep more than 30 percent of soil covered with plant residues, the level at which erosion is significantly reduced. Restricted tillage systems – such as no-till, strip-till and ridge-till – limit tillage to the area around the planting row. Leaving residue covers and reducing tillage eventually improves soil quality, reduces erosion and boosts yields.

• Cover Crops

Cover crops are intended to prevent soil erosion by protecting the soil with living vegetation and stabilizing the soil with root systems. When grown for incorporation into the soil, to maintain organic matter and increase nitrogen availability, these crops are called green manures. Catch crops, similarly, are cover crops grown to prevent nutrient leaching over non-cropped periods. Cover crops, green manures and catch crops provide many benefits. Living vegetation and leftover plant residues contribute organic matter to the soil, thereby increasing water infiltration and supplying nutrients. Cover crops also help suppress weeds, break insect pest cycles, maintain high populations of mycorrhizae and provide food and habitat for beneficial insects.

• Crop Rotation

Rotating crops can prevent problems caused by insects, weeds and diseases. The types of crops grown, their yield, the amount of roots produced, the portion of the crop that is harvested and the amount of crop residues left on the soil surface affect soil organic matter. A rotation of crops produced throughout the year furnishes the soil with living roots for prolonged periods of time. It is not solely the quantity of residue, but also the variety of types, that is important; therefore, rotations should include at least three plant families over multiple seasons within a year.



The no-till transplanter sets plants without cultivating the soil.

• **Manure**

The incorporation of animal manures enhances soil structure by maintaining organic matter, aiding in soil aggregation and providing greater amounts of pore space for the movement of air and water. Manure also promotes diversity and activity among soil organisms, facilitating the release of nutrients from organic matter available for plant uptake. Depending on the animal species, feed, bedding and storage practices, animal manures can have different properties. Therefore, manure should be analyzed and applied in quantities that supply sufficient nitrogen and phosphorous for a specific crop. A high percentage of nutrients in animal feed is available in manure – estimated values of more than 70 percent N, 60 percent P and 80 percent K, including significant amounts of other nutrients. Factors such as soil type, the ability of the soil to hold nutrients, time of application and how quickly the manure is worked into the soil will affect the amount of nutrients available to plants.

The U.S. Department of Agriculture’s National Organic Program regulates the usage of animal manures. Raw manure should be composted prior to application unless it is applied to land used for crops not intended for human consumption, is applied 90 days prior to harvest of a crop with edible portions not in contact with soil or is applied 120 days prior to harvest of a crop with the edible portion in contact with soil. However, due to food safety concerns, the use of raw manure is strongly discouraged; the use of composted manure is preferred.

• **Compost**

Though compost does not provide as much readily available plant nutrients as raw manure, the nutrients found in compost are more stable. Thus, compost releases nutrients more slowly, reducing losses caused by leaching and run-off. As primary decomposition occurs during the composting process, the bulk of raw organic materials – which may be mostly moisture content – are reduced, providing more nutrient-rich humus.

For more information on building healthy soils, visit <http://organics.tennessee.edu> or request a copy of “Building Soils for Better Crops” (Fred Magdoff and Harold von Es), available from SARE.

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