MOSES ORGANIC FACT SHEET

Managing Soil Fertility and Organic Matter

§ 205.203 Soil fertility and crop nutrient management practice standard (National Organic Standards)
(a) The producer must select and implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion.

Providing enough fertility to meet crop needs is one of the greatest challenges facing organic producers. Synthetic fertilizers provide nutrients in an inorganic, highly soluble form, which is immediately available for uptake by the crop. However, this makes synthetic fertilizers prone to leaching—nitrogen and phosphorous are especially mobile and can cause surface- and ground-water contamination. They also must be applied frequently to produce results. Organic nutrient sources are bound in more complex organic molecules that must be broken down by soil microbes before plants can utilize them. Soils that have been under conventional management often lack enough organic matter to supply nutrients and lack an active biological community to process those nutrients and make them available to the crop. It may take years of careful management and soil building to return these soils to productivity. Carefully planned organic fertility programs can minimize nutrient deficiencies in the transition years, and help build productive, disease- and pest-resistant soils for growing healthy crops.

Soil Organic Matter
Soil organic matter is the fundamental source of fertility in organic systems. It is important for producers to understand the basics of organic matter cycling in the soil. Soil organic matter is that portion of the soil that consists of biological residues from plants, animals, and microorganisms. Organic residues supply not only readily available nutrient sources, but also the building blocks of humus—the product that is left after decomposition ends. Humus increases and maintains soil fertility. It possesses a negative charge, which attracts positively-charged nutrients and holds them. Humus can be thought of as a bank that holds nutrients and slowly releases them in response to plant or microorganism needs.

A well-planned rotation of crops and cover crops ensures diverse sources of organic matter, and is an important strategy for increasing overall organic matter content of soil. Low carbon-to-nitrogen (C:N) ratio materials, such as legume residues, decompose quickly because they contain relatively large amounts of nitrogen, but they contribute very little to the building of humus. High C:N ratio residues such as cornstalks, on the other hand, break down more slowly in the soil. These residues increase humus content but contribute fewer readily available nutrients.

Crop residues from both nitrogen and carbon sources sustain a diverse and efficient microbial community. Bacteria are associated with high nitrogen materials, while fungi increase in relation to high carbon materials. If the C:N ratio of the soil is too high, nitrogen will be in short supply and will be used up by microorganisms before it is available to the crop. With good soil management, and the proper application of organic materials, the cycling of nutrients will reach equilibrium and be readily available for crop needs.

High organic matter content also has a positive effect on soil physical properties known as soil tilth. Soils with high organic matter content contain a greater abundance of water-stable aggregates and have a greater exchange capacity for nutrients. Soils with good tilth have better structure, water-holding and nutrient absorption capacities. Larger aggregates also slow organic matter degradation; producing a slowly mineralizing pool of nutrients. Long-term research at Iowa State University has shown that organic soils with high organic matter content will out-produce conventional fields during drought years due to the increased water-holding capacity. Organic matter also prevents soil from “clumping” and compacting. Air (oxygen) is just as important as water to the microbial community. Soils with good tilth have a balance of air channels and water-holding aggregates. This is only possible with high levels of organic matter.

Soil Fertility
When soil nutrients are out of balance, a crop can become attractive to insect pests. A plant grown in mineral-balanced soil first will produce simple metabolic compounds, such as amino acids and sugars, which are made into secondary metabolic compounds that promote vegetative/reproductive growth and enhanced insect- and disease-resistance. When over-fertilized with nitrogen, a plant will accumulate simple compounds, but be unable to metabolize these compounds further. These excess simple compounds attract herbivorous insects. Only when nitrogen and other nutrients are in balance will the plant produce the right balance of primary and secondary metabolic compounds.

Healthy soils with a diverse microbial community can suppress common soil-borne crop diseases because the microorganisms outcompete plant pathogens for resources. A soil system that is

nutrient-deficient or treated with "-cides" often lacks an active and diverse microbial community, allowing pathogens to thrive and cause serious problems.

Soil fertility also affects weed populations. Bacteria and fungi present in high-organic matter soils degrade and consume weed seeds. Weeds have the ability to adapt and survive in a vast array of soil conditions, but, like all plants, they thrive in certain soil conditions. Weeds can indicate soil imbalances. For example, giant ragweed is associated with low or unavailable soil potassium, and velvetleaf is associated with low or unavailable calcium and phosphorus. The book *Weeds, and Why They Grow* by Jay L. McCaman is an excellent resource on this topic.

Good management is key to creating healthy soils for growing healthy crops. Always start with soil testing. A comprehensive soil test that covers macro and micro nutrients, pH and organic matter can save you money by providing a clear picture of what your soil needs—you won't throw away money and time putting on amendments your soil doesn't need, creating even more imbalance in the soil. So, even though soil tests may seem expensive, especially if you have many fields, they pay for themselves by taking the guesswork out of managing soil nutrients.

Build healthy, well-balanced soils:

- **Crop Rotation (Diversity)**
- **Compost and Manure (Organic Matter & Fertility)**
- **Mineral and Nutrient Amendments (Soil Balancing)**
- **Green Manures and Cover Crops (Diversity, Fertility & Organic Matter)**
- **Liquid Organic fertilizers (Fertility & Soil Balancing)**

Crop Rotation

A well-designed crop rotation suppresses weeds and disrupts pest cycles. Fertility and soil tilth improve when cover crops are included and when combined with manures and/or compost. Crop diversity ensures sufficient organic C and N for humus formation and produces a pool of potentially available nutrients that can become mobilized according to crop demand. For best results, rotate crops that do not belong to the same family. The book *Crop Rotation on Organic Farms*, by Mohler & Johnson is an excellent planning guide.

Building Fertility

Compost and manure amendments, while not necessary for some soils and crops, generally are the cornerstone fertility inputs. Compost can come from plant materials only or a combination of plant materials and animal manures. The compost you use must meet National Organic Standards or should be handled as raw manure, which requires waiting 90-120 days from application to harvest, depending on whether or not the edible portion of the crop contacts the soil/manure. You can use conventional animal manures as long as they do not contain added chemicals or prohibited bedding materials like recycled lumber chips. The *Rodale Book of Composting* is a highly regarded resource on the subject.

Mineral & Nutrient Amendments

Mineral and micro-nutrient amendments can correct soil imbalances. It is a rare soil that is perfectly balanced. Calcium, magnesium, nitrogen, phosphorus, sulfur, and potassium are considered macro-nutrients. Iron, boron, zinc, manganese, copper and others are considered micro-nutrients. Most macro-nutrients can be purchased as naturally mined materials and applied directly to the soil. Micronutrients may be available in a naturally mined form, but also are allowed as an approved synthetic. However, that you can't apply micronutrients without a soil test that shows the need for it.

Green Manures and cover crops should be part of every organic farmer's soil fertility toolkit. Cover crops not only protect the soil from erosion and improve soil tilth, but also supply organic matter and fertility when worked into the soil. Legume cover crops like clovers, trefoil and alfalfa also fix nitrogen. It is possible to provide enough organic matter and fertility on good soils through cover cropping alone. *Managing Cover Crops Profitably* from USDA-SARE will get you started.

Liquid organic fertilizers such as fish emulsion, kelp emulsion, sea solids and compost teas have become very popular because they give a quick, readily usable source of fertility for growing plants. Usually sprayed or applied through irrigation systems, these liquid fertilizers give controlled results. They also stimulate soil microbiology and may even hinder some disease organisms. However, they do not build organic matter, and should be used in conjunction with methods that do.

Managing for good soil fertility is extremely important because the soil environment and the surrounding natural resources are inseparable. Establishing a functional and stable system in one environment can have far-reaching impacts in the other.

Resources & Links

ATTRA: attra.ncat.org/soils.html

The Biological Farmer, by Gary Zimmer, ACRES USA

Building Soils for Better Crops, by Fred Magdoff and Harold van Es, Sustainable Agriculture Network

Hands On Agronomy, by Neal Kinsey, ACRES USA

New Farm: www.rodaleinstitute.org/new_farm

Soil Biology Primer, Soil and Water Conservation Society

MIDWEST ORGANIC & Sustainable Education Service
MOSES

The Midwest Organic and Sustainable Education Service (MOSES) provides education and resources to farmers to encourage organic and sustainable farming practices. To learn more, please see:

www.mosesorganic.org

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