Organic Gardening Techniques

The success or failure of the organic approach depends on how gardeners use and prepare organic matter. Organic matter improves soil tilth and prevents soil compaction and crusting. It increases the water holding ability of the soil and provides a more favorable soil environment for earthworms and beneficial microorganisms. It slows erosion, and in later stages of decay, organic matter releases nitrogen and other nutrients to growing crops. Carbon dioxide from decaying organic matter brings minerals of the soil into solution, making them available to growing plants. Many soils of the world have been ruined, mainly because they have been depleted of organic matter from prolonged cultivation without proper soil management.

Sources of organic matter

Animal manures. Where available, animal manures are excellent sources of organic matter and nutrients for the soil. It is best to apply manures after they have been composted and partially broken down. Fresh manure may be applied directly to the soil, but this should be done in fall and plowed down so that there is adequate time for sufficient breakdown and ammonia release before crops are planted.

Those who do not have access to fresh or composted animal manures may find packaged dried manures for sale in nurseries and gardenstores. Because fresh, composted manure contains high amounts of water, an equal weight contains fewer nutrients than dried manure. Also, the fertility of manures from different sources varies widely. Table 1 gives some average figures.

Table 1. Major constituents of animal manures (percent).

.	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Organic matter	Water content
.	(N)	(P2O5)	(K2O)	(Ca)	(Mg)	.	.
Undried	.	.	.	.	.	.	.
Cattle	0.5	0.3	0.5	0.3	0.1	16.7	81.3
Sheep	0.9	0.5	0.8	0.2	0.3	30.7	64.8

Poultry 0.9 0.5 0.8 0.4 02 30.7 64.8
Horse 0.5 0.3 0.6 0.3 0.12 7.0 98.8
Swine 0.6 0.5 0.4 0.2 0.03 15.5 77.6
Dried . . . .
Cattle 2.0 1.5 2.2 2.9 0.7 69.9 7.9
Sheep 1.9 1.4 2.9 3.3 0.8 53.9 11.4
Poultry 4.5 2.7 1.4 2.9 0.6 58.6 9.2

To interpret the table, note that each 100 pounds of fresh cattle manure contains about one-half pound of available nitrogen, while 100 pounds of dried cattle manure contains about 2 pounds. Compare these amounts to a common commercial fertilizer such as 10-10-10, which contains 10 pounds of nitrogen per 100 pounds. By observing the nutrient content of the major constituents of a fertilizer, a guide to the appropriate rate of application can be developed (see Table 2).

Table 2. Manure application rates.

To apply from 1/4 to 1/2 pound actual nitrogen, add one of the following:

50 to 100 lbs. undried cattle manure

20 to 50 lbs. undried poultry manure

12 to 25 lbs. dried cattle manure

5 to 10 lbs. dried poultry manure

2.5 to 5 lbs. 10-10-10 fertilizer

Fresh manure should not be used directly among plants or mixed into soil immediately before seeds or plants are placed in the garden. Fresh manure produces ammonia as it decomposes. Ammonia in direct contact with plant roots can cause damage and must be avoided. Another disadvantage of uncomposted manure is the introduction of weed seeds into the garden.

Compost. Where manures are not readily available, you can make compost from lawn clippings, leaves and other plant materials. Compost is not only convenient, it is also inexpensive. Nutrient content of compost is relatively low, but its main benefit is the organic matter it adds to improve soil tilth. For detailed information on compost making, see MU publication G06956, Making and Using Compost.

Green manure and fall cover crops. Where the garden area to be improved is large, or where other forms of organic matter are not readily available, green manuring is often the most economical means for soil improvement. Green manuring means growing a cover crop in your garden and plowing it under, thus adding organic matter to the soil. The greatest response from green manuring comes from not using the garden for one season, while growing a grass or other green manure crop and plowing it under in early fall.

Another method is to seed a green manure crop in the fall and turn it under with a plow or large tiller in early spring. With this method, you can continue to use your garden normally, while gradually building up the soil.

In general, you should seed a cover crop in September, not later than October 1. The cover crop protects the garden from erosion during the winter. Plow under the cover crop when it is 6 to 8 inches tall. If it grows taller, mow it down before plowing.

Annual ryegrass is one of the most satisfactory plants for green manuring or covering. Seed it at 1 to 2 pounds per 1,000 square feet of garden space. Seed rye or wheat at 3 to 4 pounds per 1,000 square feet. Thorough incorporation into the soil is important in early spring to prevent regrowth and weediness from these grasses. Wait at least two weeks before planting.

Sawdust. In some areas where sawdust is readily available, it provides an excellent source of organic matter for the soil. You can use sawdust as compost, as mulch or for direct incorporation into the soil. A normal addition of sawdust would be about 3 to 4 bushels per 100 square feet of garden area. You should use only aged sawdust. Sawdust has no appreciable effect on soil acidity.

The major problem with adding sawdust is the greater likelihood of developing nitrogen deficiency. As sawdust breaks down in the soil, it uses nitrogen, making it unavailable to plants. Therefore, along with sawdust you need to add materials that supply nitrogen to keep plants from starving. Apply the additional nitrogen needed at the time the sawdust is added and repeat as a side dressing during the growing season. For each bushel of dry sawdust, apply about 3 pounds dried blood or 1 pound of potassium nitrate or 1/2 pound of ammonium nitrate. You can also use other materials at rates determined by the percentage of nitrogen contained. The garden may need later applications also if plant growth is poor due to lack of nitrogen.

Sewage sludge. In some areas, sewage sludge may be available as a source of organic matter. Two types may be available: digested sludge and dried, activated sludge.

Digested sludge is relatively low quality as a fertilizer in comparison to the other type. Apply and plow in digested sludge in the early fall. Do not apply digested sludge directly where you plan to grow a crop the same season, unless it has been composted. It generally contains from 1 to 3 percent nitrogen. Sewage sludge can be a highly variable product. Some sources may contain heavy metal ions and are best not used in the vegetable garden.

Dried, activated sludge is made from sewage that has been separated from coarse solids, inoculated with microorganisms and aerated. It is filtered, dried in kilns, ground and screened. It is useful as a fertilizer on lawns and is heat treated, making it sanitary for garden use. This type of sludge may contain from

5 to 6 percent nitrogen. Apply dried, activated sludge at about 5 to 7 pounds per 100 square feet; apply digested sludge at about 7 to 10 pounds per 100 square feet.

Never apply untreated or raw sewage to garden soil for any purpose.

Organic vs. inorganic or man-made fertilizers

One of the greatest arguments among gardeners comes in the area of fertilization. Some prefer totally natural materials; others are content with man-made materials; many use a combination of both. In some cases, the selection is based on economics. Often, the availability of organic materials is limited when large quantities are needed.

For plant growth, both forms of fertilizer can be equally effective. Organisms in the soil break down organic materials to form inorganic, water-soluble materials identical to those formed by people. Plants are unable to determine a difference in the original source of the compounds they absorb. Extra growth often is a response to better root environments and action of soil organisms working on the organic matter.

While some materials, such as manure, add organic matter as well as fertility, other organic fertilizers are not suppliers of organic matter. One of the major benefits of organic fertilizers is that they break down slowly and are less likely to release nutrients rapidly enough to burn plant roots if used in large amounts.

Many inorganic fertilizers are more soluble and can burn plants if used improperly. Since many organic materials break down slowly, they supply nutrients to plants for a much longer period of time without frequent applications. Because they are not quickly soluble, they are not leached from the soil during heavy rains and, therefore, are more continuously effective. Some organic fertilizers also contain micronutrients.

The availability of nutrients from organic fertilizers depends on their breakdown by soil organisms, which in turn depends on weather and soil conditions. Release of nutrients is much slower when the soil is cool or heavily saturated with water. Also, breakdown slows during drought unless soil is irrigated or heavily mulched to keep in soil moisture and keep temperature more constant. Where you need a quick fertilizer response, inorganic fertilizers tend to provide it. Many of the organics have a fertilization lag. Their nutrients are not available to plants until the organic matter has decomposed.

Sources of organic fertilizers

Following are some organic fertilizers that supply nutrients but add little or no organic matter.

Sources of nitrogen (N). Dried blood contains about 12 to 14 percent nitrogen, and therefore can be considered a nitrogen fertilizer, although it also contains about 2 percent phosphorus and 0.5 percent potassium. It may appear either red or black, depending on the process used to remove water during drying. Dried blood releases nitrogen relatively fast. General application is about 2 to 4 pounds dried blood per 100 square feet of garden area. It leaves an acid reaction in the soil. Dried blood is sometimes used as a rabbit repellent.

Hoof and horn meal contains 12 to 14 percent nitrogen as processed, dried hoofs and horns. Although once commonly used as a fertilizer, it is now nearly unavailable in most areas.

Tankage is derived from the dried and ground by-products of animal slaughter. While often available as a livestock feed, this same material can be used as a fertilizer. It averages about 6 to 11 percent nitrogen and may contain about 10 percent phosphorus. Garbage tankage, made from the dried, ground products of household waste, may also be used, although it is not readily available.

Fish meal is the dried, ground, processed material derived from non-edible fish or fish scraps. As a fertilizer it may contain from 8 to 10 percent nitrogen, 4 to 9 percent phosphorus and 2 to 3 percent potassium. As it breaks down, this material gradually becomes available to plants as a fertilizer. Fish fertilizers also benefit plants by the addition of many minor and micronutrients. Fish emulsion is a liquid form often used for house plants.

Sources of phosphorus (P205). Bone products, one of the earliest sources of phosphorus for fertilizing plants, are available in three forms:

bone meal (ground bone softened by steam under pressure)
acidulated bone (ground bone treated with sulfuric acid)
ground bone (bones cooked but not steamed).
Bone meal is the form most often used as a plant food. The meal from unsteamed bones may contain 20 to 22 percent phosphorus, while that from steamed bones will contain from 23 to 30 percent P2O5. Rate of use for soils low in phosphorus is about 2 pounds per 100 square feet. Bone meal is commonly used as a source of phosphorus in livestock feeds and is generally available from livestock feed suppliers.

Rock phosphate is made by grinding a natural rock containing one or more calcium phosphate minerals. It is used either directly after grinding or after concentration as a phosphorus fertilizer. Rock phosphate normally contains between 25 and 30 percent phosphorus. Rock phosphate is more effective in acid soils and relatively ineffective on alkaline soils due to its low solubility. It is most useful as an addition in composting manure and organic materials. Soils low in phosphorus may require ground rock phosphate at about 2 to 4 pounds per 100 square feet of garden soil. When applying with manure or compost, use about 2-1/2 pounds per 25 pounds of manure or compost.

Sources of potassium (potash, K2O). Wood ashes may contain from 4 to 10 percent potassium. In general, they average about 5 percent potassium with as much as 23 percent calcium. Because of this, they produce an alkaline reaction on the soil. Since they go quickly into solution, you should use them with care. Continued use may raise the pH of the soil, making it too alkaline unless adjustments are made. Use wood ashes at a rate of about 2-1/2 pounds per 100 square feet of garden area. Do not soak ashes in water before application or the potassium will be lost. Do not apply wood ashes if the soil pH is over 6.5. Apply ashes at least 3 weeks before planting seeds. Coal ashes are not beneficial to plant growth.

Greensand is sometimes recommended as a source of potassium but is not readily available in many areas. It is a hydrated salt of iron and potassium silicate and contains about 6 percent potassium, which is very slowly available to plants.

Seaweed can be the name for any plant that grows in the ocean, but the material used for fertilizer is usually made from brown or red algae. Giant kelp is a seaweed that was harvested for both fertilizer and explosives during World War I. Kelp contains 20 to 25 percent potassium chloride, but the seaweed that is normally available for use as a fertilizer contains from 4 to 13 percent potassium. Although seaweed was once commonly used as a fertilizer, availability is now relatively limited.

Other organic fertilizer sources. A wide variety of other materials may be used as fertilizer. Some have a more balanced range of nutrients in them, although often none of the nutrients are in large amounts.

Cottonseed meal is the residue after the oil is extracted from cooked cotton seeds. It averages 6 percent nitrogen, 2 percent phosphorus and 1 percent potassium, along with secondary and micronutrients. Nutrients from cottonseed meal become available to plants gradually. Cottonseed meal produces an acid reaction in the soil.

Soybean meal, as well as cottonseed meal, is mainly used as an animal feed. However, non-feed quality meal is sometimes used as a fertilizer. Its nutrients average about 6 percent nitrogen, 1 percent phosphorus and 2 percent potassium. Its reaction in the soil is only slightly acid.

In some localities, other plant materials are available that may serve as plant nutrients as well as add organic matter. Some of these include tobacco stems, castor pomace, cocoa shell meal, sunflower meal and mushroom compost.

Sources of inorganic fertilizers

Those choosing fertilizers from organic sources generally do not use those that are inorganically made by man. However, since references and recommendations are often made in terms of inorganic fertilizers, following are a few of the most common along with their major nutrient content, so you can make comparisons.

Sources of nitrogen (N). Ammonium nitrate is a common inorganic fertilizer that contains about 33.5 percent nitrogen. It absorbs moisture from the air when humidity is high, and therefore, must be stored in tight containers or bags.

Ammonium sulfate, another common constituent of mixed fertilizers, contains about 20 percent nitrogen.

Calcium nitrate, which forms when limestone reacts with nitric acid and is neutralized with ammonia, contains about 15 percent nitrogen. It has been used as a nitrogen source when additional calcium may be needed in the soil.

Sodium nitrate, also called Chile saltpeter, is mined from natural deposits in Chile but may also be produced synthetically. It contains about 16 percent nitrogen and 26 percent sodium.

Urea is an organic compound synthesized by combining carbon dioxide with ammonia under high temperature and pressure. It contains no less than 45 percent nitrogen (usually about 46 percent), which is rapidly available to plants. Urea is sometimes used for foliar fertilizer applications. Its rapid availability and high nitrogen concentration make careful use important.

A related product, Urea-formaldehyde fertilizer (also called Ureaform) has 35 percent or more nitrogen. A large portion of this nitrogen becomes available to plants gradually. It is much safer to use than urea, and fewer applications are necessary. It is a common nitrogen source used in lawn fertilizers.

Sources of phosphorus (P_2O_5). Superphosphate forms when rock phosphate is treated with either sulfuric acid or phosphoric acid. The process of production will determine the amount of phosphorus contained in the finished product and may range from 20 to 50 percent. A common superphosphate analysis is 0-20-0, while treble superphosphate is 0-45-0.

Sources of potassium (K_2O). Potassium chloride is also known as muriate of potash. It is made by the action of hydrochloric (muriatic) acid on potassium-containing materials. It contains about 60 percent potassium (potash).

Potassium nitrate is commonly known as saltpeter or nitrate of potash. Natural deposits occur in some parts of the world and were once mined extensively. However, most saltpeter is now made synthetically. It contains a minimum of 12 percent nitrogen and 44 percent potassium. A common analysis is 13-0-44.

Potassium sulfate is also known as sulfate of potash. It can be made from a number of potassium-containing materials and contains about 48 percent potassium.

Adjusting soil acidity

The acidity of a soil is measured in units called pH. The proper soil pH is important for the breakdown of organic matter and the release of nutrients in the soil for plant growth. A soil pH of 7.0 is neutral, neither acid or alkaline. A pH above 7 is called a sweet or alkaline soil, while a pH below 7 is known as a sour or acid soil. Most garden plants grow best in soil with a pH range from 6.0 to 6.8. Breakdown of organic matter, nutrient release by microorganisms and availability of most nutrients is greatest in this pH range.

A soil test is the only way to accurately determine the pH of a soil, but plant growth may be an indication of pH problems. When you have apparently applied adequate fertilizer, but plant growth is poor, you might suspect improper pH.

Ground limestone is normally used to make acid soils less acid, while sulfur is used to make alkaline soils more acid (see Table 3).

Table 3. Sulfur or limestone applications to adjust soil pH to 6.5 in pounds per 100 square feet.

pH change	Material used	Sandy loam	Loam soil	Clay soil
from 7.5 to 6.5	sulfur*	1-1/2	2	2-1/2
from 7.0 to 6.5	sulfur*	1/4	1/2	3/4
from 6.0 to 6.5	limestone	3	4	6
from 5.5 to 6.5	limestone	5	8	11
from 5.0 to 6.5	limestone	7	11	15
from 4.5 to 6.5	limestone	10	13	20
from 4.0 to 6.5	limestone	12	16	23

*Iron sulfate or aluminum sulfate may be used in place of sulfur but will require about 2-1/2 times more material to make an equivalent pH change.

Some soils tend to be acid rather than alkaline, making the addition of ground limestone more common than the addition of sulfur. Since the average garden performs best in a pH range from 6.0 to 6.8, Table 3 suggests sulfur or limestone required to make a midway change close to 6.5. Remember that these amounts are approximations, and soil type and conditions may alter the results. Proceed with caution at all times. Ideally, do not apply more than 1 pound of sulfur or 5 pounds of limestone per 100 square feet in one application. If larger amounts are required, split applications between spring and fall to create a gradual increase or decrease. Work the materials thoroughly to a depth of 6 or 7 inches.

If you use wood ashes to reduce acidity, use about two-thirds the amount recommended for limestone.

Disease control methods
Plant diseases may seriously stunt or even kill plants. They may appear as leaf spots, wilts, stunts, rusts or a variety of other symptoms. Plant diseases may be caused by fungi, bacteria, viruses, nematodes, or may be a response to environmental conditions that produce disease-like symptoms. The key to good disease control is prevention.

Some, but not all, diseases may require frequent spraying with traditional chemicals to provide adequate control. Use cultural procedures to prevent disease infection with or without spraying to help reduce the seriousness of some diseases.

Genetic resistance. Whenever available, the use of resistant varieties is the best way to prevent disease problems. Response to disease attack may vary, as indicated by the terms immune, resistant and tolerant. Disease immunity indicates that a plant will not get a disease even though the disease is present. Disease resistance implies that although a plant may occasionally contact the disease, it is much less likely to get it, and if attacked, may not be seriously affected. Tolerance to a disease implies that the plant usually contacts the disease when present but is able to survive in spite of being infected.

Resistant varieties are becoming more readily available in many crops. Look for disease resistance in variety descriptions. Disease resistance of vegetable varieties is indicated in MU publication G06201, Vegetable Planting Calendar.

Crop rotation. Crop rotation is as old as agriculture. Continued cropping in one area allows for buildup of disease organisms. Rotating crops each year to help prevent buildup of organisms in one place can reduce some disease problems. Diseases such as clubroot and some vascular wilts may persist in the soil for five or more years without the presence of a susceptible plant. For these and similar problems, very long rotation times are necessary.

Sanitation. Sanitation is important to the control of plant disease. Destruction of weeds or other plants that may serve as over wintering host plants, along with elimination of crop plants that have been diseased, is important. Careful selection of new plants, seeds or cuttings is important to avoid introduction of diseases into the garden or landscape.

Protection. In some cases, careful selection of disease-free seed and propagating material helps disease control by avoiding introduction. Certified seed potatoes are a good example of a case where the use of disease-free seed pieces keeps the soil clean and protects against inoculating the field with soil diseases.

Following are practices that can help control plant diseases:

1. Use disease-resistant varieties whenever they are available, as well as varieties suited to the local growing conditions.

2. Select garden locations with good soil drainage, adequate sunlight, and good soil.

3. Improve the soil with organic matter and fertilizers to develop the best soil tilth for growing seeds and plants.

4. Rotate the garden locations. If the garden space is too limited for garden rotation, rotate crops within the space available.

5. Use disease-free transplants and seeds from reputable suppliers. Do not plant more than you can take care of properly.

6. Eliminate weeds around the garden area that may serve to harbor diseases throughout the year.

7. Control insect pests that serve as disease carriers.

8. Pull up and destroy any plants showing diseases, as those caused by viruses, which can not be controlled. Pull off diseased leaves as soon as you notice them to help slow the spread of leaf spots and other fungus diseases.

9. Spade under or remove and destroy crop residue as soon as harvest is completed if disease was a problem during the season.

10. Do not overcrowd plants. Overcrowding prevents good air movement and exposure to adequate sunlight. High humidity and too much shade caused by these conditions can increase the development of some diseases.

Controlling insects

At one time, gardens had few insect problems. The current movement of people over long distances has helped move pests to areas where they were once unknown or uncommon. Many more problems that need control face the modern gardener.

Many common insect pests can be controlled with modern chemicals. In avoiding their use, however, you must be willing to work a little harder and accept some insect damage in your garden. Following are a few techniques that can help control insect attack and spread. Some of these are the same as those used to control disease:

Since you will not be able to avoid all insect damage, plant more of a crop for adequate harvest.
Check crops often and hand pick any insects present before they become too numerous.
Encourage natural insect predators when possible.
Although not common, some plants have insect resistance. Select them when available.
Do not plant crops in large blocks. Mixing different types of plants helps slow

the spread of insects that are present.
The concept of trap crops may also help. These are less desirable crops planted near the garden. The hope is that insects will be attracted to and consume these crops more than the desirable ones.
Supplement mechanical controls with biological and natural pesticides. These include dormant oils, lime-sulfur, elemental sulfur, pyrethrins, rotenone and nicotine. Use these materials carefully, according to directions of the manufacturer.
Fertilize, cultivate and water to promote vigorous growth. Healthy plants seem less attractive to insects, and those that are attacked are better able to survive and still produce a crop.
Rotate the crop. Some insects may overwinter in the soil or other debris. Moving the crop may delay their attack in spring.
Use transplants when possible. These develop more quickly than seeds in the garden. The quicker you can grow and harvest the crop, the less chance of insect pests seriously damaging the plants.
Destroy any garden debris or nearby weeds that may serve as breeding or overwintering places for insects.
Fall cultivate the garden. This buries deeply or exposes some insects and insect eggs to birds or to desiccation during winter freezing and thawing.
Keep the garden free of weeds that may harbor pests.
Biological control of insect pests. The biological control of insect pests refers to the use of disease organisms, predacious or parasitic insects, insect-feeding birds, toads and other animals.

When these are used, a certain amount of damage must also be expected, as these predators are not always present at the time the insects are numerous, and their increase in numbers usually follows an increase in the pests. Releasing pests (such as ladybugs) and predators has been successful in some areas. One of the most successful biological controls has been the use of a bacteria, Bacillus thuriengensis, for control of cabbage loopers and cabbage worms in cole crops.

Remember that when any kind of insect predator is released in the garden, the pests must already be present to serve for food. If insects are not present, the predators will move elsewhere looking for food.

Soap as an insecticide. Some people suggest that soap is effective as an insecticide. This recommendation dates back to the 1700s. Modern soaps vary widely, and their effectiveness as an insecticide also varies and is sometimes questionable. It seems that the most effective soap for an insecticide is the old-fashioned homemade soap prepared from waste lard, tallow, lye and water. If there is any benefit from these materials, remember that it comes from some of the more caustic soaps, not detergents.
http://www.maasnursery.com/organictechniques.htm