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Facts About Organic Farming and Gardening

by
Lyle A. Derscheid, agronomist, Cooperative Extension Service, and
Lawrence O. Fine, professor, Plant Science Department, Agricultural
Experiment Station, South Dakota State University

The frequently used terms “organic farming” or “organic gardening” have different meanings to different people. Some organic gardeners, for example, use sterile soil and furnish plant food in the irrigation water, but they refrain from using chemical herbicides, insecticides, fungicides or other pesticides. They call this “organic gardening,” even though they are applying the same “inorganic” plant foods—nitrogen, phosphorus, potassium—and any of a dozen other inorganic elements essential for plant growth that are provided by nature. At the same time, they refrain from using pesticides which are “organic” compounds.

Other growers raise either field crops or garden crops without the use of synthetic fertilizers or pesticides. Perhaps a more appropriate term for this type of production is “natural farming” or “natural gardening.” While it is possible to produce food by “natural” methods, more acres are usually needed with this system to raise an amount equal to that produced from a conventional system.

Organic Compounds

The term “organic” was coined about 400 years ago as a means of classifying chemical compounds originating from plants or animals. Today, we generally class all compounds as “organic” if they contain the element carbon.

A quick scan of a list of 300 commonly used pesticides reveals that all but 12 of them are “organic” compounds. The list includes 102 organic and 5 inorganic herbicides; 102 organic and 3 inorganic insecticides; 51 organic and 3 inorganic fungicides; 20 organic and no inorganic acaricides; 10 organic and 1 inorganic rodenticides; and 3 miscellaneous organic pesticides. All of the pesticides in the boxed footnote listing near the end of this publication are organic compounds.

Food Production

Plants are nature’s chemical factories. They convert the simple raw materials of light, water, air, and minerals into complex organic compounds which support and nourish all forms of life—man, animals, insects, bacteria. Many plants also fulfill our need for beauty.

Vegetables and fruits raised in the garden are frequently used as food without processing. Wheat, oats and corn are field crops that are processed to produce human food. Corn, sorghum, barley, alfalfa and grass are field crops that are fed to livestock for the production of meat and milk that are used for food.

To flourish, plants use carbon, hydrogen and oxygen from air and water. In addition, they need large quantities of soil-borne raw materials: nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. They need smaller quantities of other raw materials such as iron, manganese, zinc, copper, boron, molybdenum and chlorine.

Fertile soils contain 13 of these elements. However, seldom are these elements in sufficient quantities to support continued high crop yields. Crops such as grain, vegetables, fruit, and flowers grow by taking nutrients from the soil. These nutrients are removed as the crops are harvested.

Most of these elements come primarily from the mineral part of the soil. About half of the phosphorus comes from minerals and half from organic matter. Nitrogen comes entirely from organic matter.

Organic Matter in the Soil

Organic matter is produced by living organisms: plants and animals. It comes primarily from plant residues and manure, and contains about 50% carbon, relatively large amounts of oxygen and hydrogen, 1% nitrogen, and lesser amounts of phosphorus, sulfur and other nutrients.

Organic matter is decomposed by soil microorganisms and converted into simple “inorganic” compounds such as carbon dioxide, water, nitrates, phosphoric acid, ammonia, sulfur and others. Carbon dioxide is released into the air. The ammonia and nitrates provide the only source of nitrogen to plants. Approximately 60 to 80 pounds of nitrogen is released annually on each acre of soils of good organic matter content. This is not enough to produce high yielding crops. It takes about 1.5 pounds of nitrogen to produce one bushel of corn, 1.2 pounds for a bushel of barley, 1.8 pounds for a bushel of wheat, 5.5 pounds for a bushel of soybeans, 1.6 pounds for 100 pounds of bromegrass hay, and 2.75 pounds to produce 100 pounds of alfalfa hay. About a half pound of phosphoric acid is needed to produce one bushel of grain.

Continued growth of crops reduces the fertility of the soil. Approximately half of the original supply of organic matter in South Dakota soils has been depleted by cropping. It continues to decline each year the land is farmed. The addition of plant residues or manure is the most common way to replace organic mat-
ter. The organic matter increases the amount of plant food in the soil only slightly. One ton of corn stover, for example, will be decomposed into a large amount of carbon dioxide and water and about 100 pounds of humus containing about 5 pounds of nitrogen and lesser amounts of phosphorus, sulfur and other nutrients. The stover from a 30- to 35-bushel corn crop will provide this much organic matter; however, it contains only enough nitrogen to produce $\frac{3}{2}$ bushels of corn in the next crop.

A ton of manure contains, on the average, about 10 pounds of nitrogen, 5 pounds of phosphoric acid and 10 pounds of potash, which is only enough plant food to produce about $\frac{3}{2}$ bushels of corn, 9 bushels of barley or $\frac{3}{2}$ bushels of wheat.

Organic matter from a crop containing a higher percentage of nitrogenous compounds adds more nitrogen to the soil. A ton of residue from an alfalfa crop contains about 50 pounds of nitrogen and $\frac{3}{2}$ pounds of phosphorus. If a 2- or 3-ton crop of alfalfa is plowed under, it will add enough nitrogen but not enough phosphorus for one good corn crop. Although it is desirable every few years to plow down a crop of alfalfa to derive the other benefits obtained from organic matter, it is seldom practical to plow down alfalfa often enough to provide all the nitrogen needed for corn. This would mean plowing down a crop of alfalfa every second or third year. If it is plowed down, there is no income from the land that year so 70%, to 100% additional land would be needed to produce the same amount of corn. Even though the nitrogen supply might be maintained this way, the use of commercial fertilizer would still be needed to maintain the phosphorus supply on most South Dakota soils.

**Farm Management**

Clean seed, proper seedbed preparation, good crop rotations and sound soil management practices are the most reliable procedures for controlling weeds, certain insects and some plant diseases. These practices will eliminate many annual weeds and prevent infestation by most perennial weeds. Herbicides are valuable supplements to these practices. They are especially helpful when used in conjunction with competitive crops and special cultivation to eliminate weeds that are already established.

Several plant diseases and species of insects can be controlled largely by crop rotation and the use of resistant varieties. Insecticides and fungicides are valuable supplements to these practices. They are especially useful for controlling insects or diseases on crops that are not tolerant to the pest that has infected it. Continuous production of the same crop encourages invasion by certain weeds, insects and plant diseases. Crop producers then rely on the use of a pesticide. They may do so more often than is desirable. Continuous use of a pesticide may allow a species of a pest to develop resistance to it and may also cause harm to desirable species.

Crop rotation and good soil management are ways to maintain soil productivity. Nutrients removed from the soil in forming straw and stover may be returned by plowing down the crop residue. However, the nutrients removed by grain or forage must be replaced some other way. Plowing down a green manure crop—alfalfa is one example—increases the amount of organic matter. The organic matter improves soil structure, which increases moisture absorption, reduces runoff, decreases power requirements for deep tillage operations and adds some nitrogen, phosphorus, sulfur and other elements. However, the amount of nutrients liberated in the soil plus the nutrients from a green manure crop every 3 or 4 years generally will not meet the needs of a high producing crop. Therefore, plant nutrients frequently must be partially supplied with commercial fertilizer.

**Effect on Yield**

Although use of plant residue or manure is the most common way of adding organic matter to the soil, several so-called “organic” forms of fertilizer are available on the market. They have been compared with synthetic forms of fertilizer on numerous crops.

Commercial organic fertilizers (soil conditioners) have been used in numerous fertilizer experiments in South Dakota. Results in Union County are typical. Corn yields of 67 and 68 bushels per acre were obtained on land treated with 500 pounds an acre of commercial organic fertilizer costing $35 annually. Land treated with a commercial inorganic fertilizer and an insecticide costing $14.50 an acre the first year and $12.50 the second produced 77 and 83 bushels of corn an acre during the 2-year period. Net profit was $30 and $42 per acre more on the areas treated with the commercial inorganic fertilizer than on areas treated with the organic soil conditioner.

At North Platte, Nebraska, corn yielded 62 bushels per acre on plots treated with an organic fertilizer and 117 bushels when treated with commercial inorganic fertilizer. Sorghum yields were a comparative 42 and 82 bushels for the same two treatments.

The Nebraska Farmer magazine has described what happened when the Geneva Young Farmers Association in Fillmore County (Nebraska) compared older and modern methods of corn production. In 1971, the Association grew a Nature's Acre of corn. Beside it, a Today's Acre was planted. Nature's Acre received no fertilizer, no herbicide, no irrigation, no insecticide. Today's Acre was treated with recommended amounts of each. Harvest results: 37.74 bushels per acre from Nature's Acre, 121.9 bushels from Today's Acre. In addition to fertilizer and pesticides, irrigation was a factor in this test.

Ohio experiments produced yields with fertilizers that were five times greater than those without. Based on these figures, it would take five times as much unfertilized land to produce the same total yield as with
fertilizers. Additional suitable land to maintain such necessary production is not available. Use of marginal land is not a satisfactory solution because it is much more subject to erosion, even with the best management practices. Cultivation of such land might increase, rather than decrease, total nutrient losses.

Agronomists believe that it is better to fertilize most productive land for maximum yield efficiency and leave the remainder in protective grass or tree cover.

A study by Texas A & M University indicates that crop yields would decline 36% to 47% if all fertilizers and pesticides were banned in that state—resulting in a food cost increase of nearly 300%. Other estimates range downward, with one showing 40% less food costing consumers 75% more money.

In West Virginia, an investigator reported that a garden fertilized with 1000 pounds dehydrated cow manure, costing $50 there, produced 237 pounds of vegetables. A similar plot fertilized with 100 pounds of 10-10-10 fertilizer, costing $3.15, produced 1954 pounds of vegetables. The second plot was also treated with methyl bromide to control weeds, soil insects and soil diseases. Vegetables grown included blackeye peas, tomatoes, peppers, okra, lima beans, cabbage, eggplant, squash, cucumbers, cantalope, watermelon and corn.

In this West Virginia experiment, insects and soil-borne disease organisms completely wiped out some of the vegetable crops while causing low yields in others. Five rows of tomatoes, for example, yielded 446 pounds in the chemically protected plot and 14½ pounds in the “organic plot.” Five rows of cucumbers yielded 205 pounds in the chemically-protected plot and 28¾ pounds in the “organic” one.

Results for other vegetables were equally dramatic in this experiment. One row of white squash, grown under chemical protection, yielded 157 pounds compared to 3 pounds under organic methods. No eggplant was produced from the organic plot, due to a flea beetle attack when the plants were quite small, while 154¾ pounds came from the chemically-protected plot.

**Effect on Quality**

A science adviser for U.S. Department of Agriculture claims that the “recent outburst of enthusiasm” for organically grown food—that is, without man-made chemicals—has produced misleading information and misconceptions about eating habits.

“Although the greater cost of organically grown food may buy certain desirable characteristics not always found in the usual food market—it may be fresher and more flavorful—greater nutritive value is not one of them,” comments the adviser, adding that organically grown food is estimated to cost one-third to one-half more than the same items found regularly in supermarkets. “It is one thing to grow a few tomato plants on a balcony using organic fertilizer, but is an other thing to grow enough food for the nation by such methods.”

**Pollution**

Some environmentalists are claiming that fertilizers and pesticides are important contributors to pollution of our waterways and lakes. They insist that agricultural fertilizers not used by plants find their way into waterways and cause a buildup of mineral nutrients, a situation known as “eutrophication.” Nitrogen and phosphorus, the principal fertilizer elements, are of particular concern.

**Nitrogen.** Generally, almost all of the nitrogen available to plants is present in soil as nitrate. In fact, more than 90 percent of the nitrogen used by green plants is in the nitrate form. So, whether it comes from chemical (commercial) fertilizer or a compost heap, nitrogen which accumulates in the soil must be converted to ammonium or nitrate before plants can use it.

Nitrogen is not held by the soil. This is good from the standpoint of plant nutrition, since the nitrate is readily available for plant uptake. Nitrogen not taken up by plants is soluble in water and move freely, within limits, wherever water goes. Thus, they may leach, or “percolate,” downward through soil. If carried below the root zone, they are lost as far as plants are concerned and many eventually move into underground water supplies. This is the main process by which nitrates are lost from soils and become a potential source of pollution in fresh water supplies.

The amount of nitrate movement depends on the type of soil. More nitrate is lost by percolation through sandy soils than through clay type soils. Fortunately, fine-textured soils represent 80% to 90% of the agricultural land in South Dakota. Nitrates, when lost, are usually returned to the atmosphere through denitrification.

**Phosphorus.** Phosphorus, unlike nitrogen, clings to clay particles in the soil. This means there is little if any loss from the soil as a result of leaching. On the other hand, phosphorus is vulnerable to loss in another way—erosion.

Phosphorus moves with eroded soil. Usually it is washed with excess water into rivers and lakes.

Since phosphate pollution occurs almost exclusively in connection with erosion, farm conservation practices which prevent erosion are the best means of controlling pollution by this element. Conservation methods include cover crops, contouring and strip cropping, terracing, diversion ditches, use of crop residues, and reduced tillage.

**Pesticides.** Before a pesticide is approved for use by the Environmental Protection Agency (EPA) of the U.S. Government, several million dollars are spent to determine where it can be used and its toxicity to man and animal. Studies determine the amount of chemical residue that can safely be present in food and on
commodities. The levels of residue tolerance approved by the EPA are no more than 1/100th the amount shown to be harmful to test animals.

Older pesticides such as lead arsenate, the mercurials, and copper compounds are permanent and never degrade. This is not true of the organic pesticides. Some, such as the organo-phosphates and carbamates, have half-lives (the time it takes for half of the chemical to degrade) measured in hours or days, although many of them are exceedingly toxic, while they are around. Others, such as DDT, other organo-chlorines and triazines, have half lives measured in days, weeks and months. The rate of decay is subject to environmental factors such as moisture, light, temperature, soil acidity, and presence of organic matter and micro-organisms. The organo-chlorines are, as a group, highly insoluble in water so their movement in water is minute and slow. They do, however, have a strong affinity for fats and oils and tend to be easily absorbed by organic matter. When lakes or streams become contaminated with these chemicals, it is usually through erosion of treated soil which carries the absorbed pesticide into the water.

In sandy, dry soils in mild climates, DDT and derivatives do persist in some cases, with a half life of up to 10 years.

The phenoxy acid, benzoic acid and amide herbicides are as a rule, relatively insoluble in water, while the carbamates, triazines, and ureas are highly insoluble. Significant amounts of each group are adsorbed by soil particles. Although residue from several herbicides has been found in runoff water from high intensity rain storms shortly after herbicide application, most of the stream contamination from these herbicides is through erosion of treated soil. In either case, contamination can be controlled by good soil and water conservation practices and being careful not to apply the highly insoluble chemicals on slopes near bodies of water.

Eight years of monitoring at the mouth of the Mississippi River, which drains a vast agricultural area where millions of pounds of pesticides are applied annually, has failed to reveal an accumulation of DDT or derivatives.

Published records of unnatural fish kills in the U.S. over a 7-year period reveal that 1% to 3% of the total kill can actually be assessed against pesticides. Municipal and industrial wastes, on the other hand, account for over 70% of the kill each year.

1 **Organo-phosphates:** parathion, malathion, di-syston, gu-thion, diazinon, phorate (Thimet), dibrom (Naled), roxan (Korlan), coumaphos (Co-Ral), ruelene, famphur (Warbex), ciodrin, dichlorvos or DDVP (Vapona).  
2 **Carbamates:** carbaryl (Sevin), (Bux), barban (Carbyne), triallate (Far-go), diallate (Avadex), butylate (Sutan), vernolate (Vernam), EPTO (Eptam), DATC (Daclon).  
3 **Organo-chlorines:** toxaphene, aldrin, heptachlor, chlordane, methoxychlor, lindane, DDT.  
4 **Triazines:** atrazine (AATrex), propazine (Milogard), simazine (Prinex), prometone (Pramitol).  
5 **Phenoxy acids:** 2,4-D, 2,4,5-T, MCPA, 2,4-DB (Butyrac and Butoxone), silvex (Kuron and Weedone 2,4,5-TP).  
6 **Benzoic acids:** amiben (Chloramben), 2,3,6-TBA (Benzac 1281 or Tysben 200).  
7 **Amides:** alachlor (Lasso), propachlor (Ramrod).  
8 **Ureas:** linuron (Lorox), diuron (Karmex), norea (Herbex), monuron (Telvar).

This listing includes some of the commonly known pesticides and is not intended to be all inclusive. Commercial names in some instances are enclosed in parenthesis.

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