Reading #1

Why Must We Replace Nutrients Back Into The Soil?

Farmers and ranchers understand the connection between good land stewardship and making a living to produce food and fiber that people depend upon. They know if they take care of the land, it will produce healthy crops for generations to come.

Long ago, when people began to settle in one place to farm, they realized that particular lands were good for growing fruits and vegetables while other land was better suited as pasture land for their animals. There was enough land and water available for those who needed to grow their own food. People would settle in those prime farming areas, especially river fronts and valleys, due to the fertile soil. When an area became overcrowded, people would migrate to other desirable places. People noticed that the manure from their animals made the soil better, and learned that if they rotated their crops, their soil would not become "tired." We now know to use crop rotation to enhance soil fertility and use it to help prevent insect and diseases in crops. Early farmers learned these techniques through trial and error.

As the human population has grown, the amount of available agricultural land has shrunk with the growth of shopping centers and housing developments. New and expanded towns are now covering much of the land that was once used for agriculture production. Farmers and ranchers must produce their crops on the limited land they own or lease, and much of this land has been farmed for generations.

For these reasons farmers must be creative in order to keep their soil fertile so it will continue to produce enough food to meet the demand of a growing human population. Farmers and scientists know that plants need more than just sunlight, water, and carbon dioxide to grow. Plants require the right amount of nutrients. Most of the needed nutrients are in the soil and water, but when a crop is harvested the nutrients contained in the harvest are removed with the crop, and soil nutrients must be replaced if another crop is to grow there.

Let's look at a scenario from the past:

Tractors are not yet invented, and teams of horses or oxen are used to plow the wheat fields to prepare the soil for planting. Wheat is planted and harvested by hand then sent to a small local mill to be made into flour for the people of the community of Wheatland.

Cattle roam in the harvested wheat field and eat what remains. Cattle manure and wheat stubble that are left after harvest is plowed back into the land to return soil nutrients. This land is left alone for at least one year before another crop is planted. The farmer has plenty of land and rotates fields that are planted each year. Perhaps the next time the field is planted it will grow beans or corn.



Reading #1 (continued)

This story gives one example of how agriculture has changed over the years. In the past, farmers produced less product per acre, and were responsible for feeding fewer people. Human populations continue to grow, yet the amount of farm land decreases as towns and cities become larger. This means that today's farmers must use the latest science and technology to grow more food crops on less land for more people than ever before.

For today's agriculture to remain sustainable, nutrients and plant matter that are removed from the soil and sold locally or far away must be returned to the soil in one form or another.

Reading #2

Crop Rotation, Green Manure, and Nitrogen-Fixing Plants

There are many ways to replace soil nutrients that are lost from the soil when crops are harvested. As the population of California and the rest of the world increases, farmers must produce more food from less land, while maintaining or improving the quality of the land. Limited water availability is also an issue in California. Farmers, ranchers, and scientists continually work together to develop innovative farming practices that will meet the increasing demand for an abundant and affordable food supply, while also protecting the environment. The next sections on crop rotation, green manure, and nitrogen-fixing plants describe some different ways of enhancing soil quality.

Crop Rotation

Many plants, including corn, cotton, and tomatoes require a significant amount of nutrients to grow, and if grown on the same land year after year, they can deplete soil nutrients, especially nitrogen. Farmers have learned that other crops, such as legumes (alfalfa, peas, peanuts, and beans), actually replace some soil nutrients that other plants take up during the growth process. Farmers rotate the crops that require more nutrients with crops that have fewer nutrient requirements in order to replenish the soil with organic matter and nitrogen. Below are some examples:

One year farmers might plant corn in a field. Corn requires a significant amount of nutrients. After the corn is harvested, a crop of beans is planted. The beans are a type of legume that help replenish the soil with nitrogen that was removed with the harvest of the corn crop.

A farmer might plant beans in between her plum trees. These beans put nitrogen back into the soil. Several things can happen to the bean plants once they mature. The beans may be plowed back into the soil, adding organic material and nutrients to improve soil quality, or the beans may be harvested before tilling the remainder of the plant back into the soil. The beans provide another crop for the farmer and more food for people. Beans may also attract beneficial insects that reduce the populations of harmful insects.

Green Manure

Green manure is fresh or growing, green vegetation that is not harvested, but is plowed into the soil to increase the amount of organic matter in the soil. Green manure is full of nutrients and replenishes soil with minerals it may be lacking. The optimal time to plow green manures into the soil is just as the flowers are beginning to form because this is when the protein content is highest.

Green manures often include crops such as alfalfa, clover, lupines, vetch, or other legumes because of their unique ability to fix nitrogen gas from the atmosphere into other forms of nitrogen that are usable to plants that don't have the ability to fix nitrogen. Legumes have symbiotic bacteria called Rhizobium in their root nodules that allows for nitrogen fixation. Mustard plants have deep taproots and are able to obtain nutrients that other plants cannot reach. For this reason, mustard may be planted in between grape vines or other crops then plowed into the field to provide the soil surface with nutrients obtained from deep within the soil.

Reading #2 (continued)

Nitrogen-Fixing Plants

Legumes are very special plants. A legume is a plant that has a pod, such as peanuts, peas, alfalfa, clover, and beans. Legumes are special because they have a unique "symbiotic" relationship with a certain type of bacterium called Rhizobium. Symbiotic means that both organisms help each other survive. The Rhizobium bacteria help the plant survive by fixing atmospheric nitrogen into a form of nitrogen that the plant can use. The plant provides habitat for the bacteria in the plant's root nodules and supplies the bacteria with food. When farmers plant a field of legumes, they inoculate the soil with the Rhizobium bacteria to make sure there are enough beneficial bacteria in the soil to produce the needed nitrogen. Sometimes, the legume seeds are coated with the bacteria before they are planted. Often, after replanting the same type of legume, the soil does not have to have Rhizobium added to it because a sufficient population of bacteria has already been established. Next time you go to a nursery, ask to see the packets of Rhizobium they have for sale.

Summary

Crop rotation, green manure, and nitrogen-fixing plants are all important methods for maintaining and enhancing soil quality. However, these methods alone don't solve all soil nutrient problems. These farming techniques help increase the amount of nitrogen and organic matter in the soil, but plants also need potassium and phosphorus. Other challenges arise if green manure or nitrogen fixing crops require more water than other crops. Planting and harvesting dates of rotated crops may conflict with one another, and there is not always a demand for one of the rotational crops. Each of these challenges requires continuing research and analysis. Farmers must consider the new strategies and techniques that become available to grow enough crops while keeping the land healthy and making a living.

Reading #3

Manure and Composting

There are many ways to keep soils healthy. It is important to enrich soils, especially ones that are used year after year to grow crops so that the plants grown in them are strong and healthy. This reading explains the use of animal manures and composting to improve soil quality.

Manure

Centuries ago, farmers would cart animal waste from their barns and pastures out to their fields to get rid of it. They found that the animal waste, or manure, made the soil better for growing crops. This process of using manure to enhance soil quality is still used today. Perhaps you have been to a plant nursery and have seen bags of chicken manure, steer manure, or bat guano for sale in the fertilizer section.

Animal manure adds many things to soil. It provides organic matter, which improves soil quality by creating air spaces that plant roots and water can penetrate more easily. It also replaces nutrients, especially nitrogen that is removed from the soil when crops are harvested. Many different types of animal manure are available at nurseries and each type contains a different percentage of nitrogen, phosphorus, and potassium. The cost of manure per ton is generally less expensive than other types of fertilizer and it is readily available. However, there are some drawbacks to using manure as fertilizer. Uncomposted manures are high in salts that can burn plants if too much is applied. It can also be expensive and bulky to transport enough manure from animal farms to match the needs of the crop fields, which may be a great distance away. Additionally, the nutrients in manures may be released slowly and a large amount of manure may be needed to supply the nutrients that the soil needs. This makes it labor intensive to apply manures on a large scale.

Compost

Compost is a rich, natural fertilizer and soil conditioner. It adds both organic matter and nutrients to the soils, just as manures do. Compost is made by mixing materials such as lawn and tree clippings, straw, and kitchen waste with manure and topsoil. The compost pile must be allowed to sit and decompose. The decomposition process creates heat. As the temperature of the compost pile increases, seeds and a variety of plant diseases are killed. Topsoil that is added to the compost pile provides micro-organisms such as bacteria and fungi that are needed to decompose the waste into nutrient rich soil.

Earthworms can also be used to help decompose waste materials and add nutrient rich worm castings to the compost. This method is called vermicomposting.



Reading #3 (continued)

Composting is not only a great way to enrich the soil; it is also a good way to reduce the amount of waste put in landfills. Below are some tips for making your own compost bin at home.

- Start a pile of organic matter such as lawn clippings or leaves. Layer the pile with different types of leaves, and vegetable and fruit scraps so the compost will contain a variety of nutrients and will decompose faster. Acceptable materials for composting include: fruits and vegetables, eggshells, coffee grounds and filters, yard trimmings, sawdust, tea bags, and grass clippings.
- Do not add meat scraps, dairy products, fats, grease, or oil as these wastes will create bad odors and may attract flies and rodents. Don't add diseased plants as diseases might transfer to other plants when you apply compost. Don't add pet waste as it may contain pathogens that are harmful to people.
- Allow air to circulate through your compost pile by mixing the compost pile with a shovel or pitchfork once a week.
- Keep a well-like depression on top of the pile so rainwater can collect. Water your compost pile periodically if you don't get rain frequently.
- ▶ For more information on composting see this website from the EPA: *www2.epa.gov/recycle/composting-home*

Summary

The two nutrient supplements mentioned above, manure and compost, are called organic fertilizers. They are fertilizers that originate from living things. These methods are often very suitable for smaller scale farming, although they can have drawbacks. Manures often contain seeds from weeds that the animals have consumed and these weeds can then sprout in crop fields where the manure has been applied. It is difficult to apply enough compost needed to supply required nutrients on large farms and the exact amount of nutrients present in the manure and compost is not known, so farmers may not know if they are under or over-fertilizing their crops. Research continues to discover ways to make organic fertilizers more feasible for different types and sizes of farms.

Fertilizers

A fertilizer is a substance that provides one or more nutrients necessary for plant growth and development. There are two classes of fertilizers: organic fertilizer and inorganic, or commercial, fertilizer. Either type can be used by farmers and home gardeners to replace nutrients removed from the soil by previously harvested crops or to add nutrients that may be naturally lacking in the soil. Plants do not have a preference for either type and can only take up nutrients that are dissolved in water regardless of whether their source is organic or commercial fertilizer. Some differences and similarities between these two types of fertilizers are described below.

Organic Fertilizers

Organic fertilizers are anything that an organic farming certification system considers to be acceptable for organic farming. Usually, these fertilizers originate from living organisms and go through little processing before being used on crops. Some organic fertilizers include fish and seaweed emulsions that are made by liquefying seaweed and fish. Other examples include compost, worm castings, bone meal, ground oyster shells, and steer and chicken manure. Organic fertilizers usually contain many different nutrients in low concentrations. Their nutrients are often in forms that must be broken down by microorganisms before they can be used by plants, and the release of nutrients takes time, especially in cold weather when microorganisms in the soil are less active. In addition to adding nutrients to the soil, organic fertilizers also add organic matter that improves soil structure by increasing pore spaces, air circulation, and water-holding capacity.

There are some disadvantages to organic fertilizers. Some have a disagreeable smell and can be very labor and cost intensive to apply on large fields. Since their nutrient concentrations are low, large quantities may be needed to supply sufficient nutrients for crops. If manures are not composted before being used as a fertilizer, they can be a source of weed seeds and can damage plants if the manure has high salt content. Also, the exact nutrient content of organic fertilizers is usually not guaranteed which makes it more difficult for the farmer to know just how much should be applied to the crop.

Inorganic (Commercial) Fertilizers

Commercial fertilizers are fertilizers that have been produced in factories from nitrogen gas from the atmosphere and other natural materials like rocks, minerals, petroleum, and animal products. Commercial fertilizers are prepared to contain exact amounts of nutrients in forms that can be immediately used by plants. They generally contain nitrogen, phosphorus, potassium, and a few trace minerals at concentrated levels. Some examples of commercial fertilizers are potassium sulfate and ammonium phosphate.

Nitrogen is the most abundant element in the Earth's atmosphere, but plants cannot absorb atmospheric nitrogen gas from the air. It must be converted to a special form to be used by plants. Inorganic nitrogen fertilizer is made by combining hydrogen from natural gas and nitrogen from the air. The scientific discovery of capturing nitrogen from the air to make fertilizer is called the Haber-Bosch process. It has often been called the most important invention of the 20th century and is responsible for feeding billions of people worldwide.

Reading #4 (continued)

Inorganic phosphorus is made by mixing phosphate rock, mined from the Earth, with sulfuric acid and water.

Potassium fertilizer is commonly called potash (pronounced "pot ash"). This name comes from the fact that the ashes left over from a campfire contain potassium and were, throughout history, put into fields. Potassium is usually obtained by mining from deep within the Earth. Potash is mined in New Mexico, Utah, and parts of Canada. Potassium can also be obtained from brine (salt) deposits on the Earth's crust. Brine deposits are places where large bodies of salt water once existed and have since evaporated, leaving the salt behind. One example of a brine salt deposit is the salt flat near the Great Salt Lake in Utah.

Inorganic fertilizers are used by many farmers for a variety of reasons. They are easy to transport, store, and apply, and they are available in a variety of formulas to meet the specific nutrient requirements of crops. Some of these fertilizers are formulated to be high in nitrogen while others are high in phosphorus or potassium.

Whether using organic or commercial fertilizer, farmers and home gardeners must take care to use fertilizers appropriately. Farmers work closely with scientists and certified crop advisors to determine the best types of fertilizers for their crops, when to apply, how much to apply, and how to protect the environment. Home gardeners can take courses or obtain information about proper use of fertilizers from local garden clubs and University of California Cooperative Extension offices.