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Introduction

If you are a beginner, wondering if you can develop a "green thumb," you will love organic gardening. Why? Because when you do all the right things, you get satisfying results. Soon after you do the planning and some simple work, you see visible results. Your seeds sprout, your plants grow. Within weeks or months you pick food you grew yourself.

Beyond your health, the joys of gardening include the knowledge you accumulate with every season. This is lifelong learning at its best, because you apply the knowledge to the ground under your feet. And the benefit of that knowledge comes into your kitchen as a healthier, more natural diet.

The biodiversity in your backyard is a natural laboratory with more specimens than a college life sciences department. At home for little cost, you learn about the microbes in the soil, the insects that crawl and fly, the plants you grow and the nutrition they hold.

The garden gives you a reason to continue learning and to keep exercising. It also gives you something to anticipate with excitement. For many gardeners, "Harvest time is party time."

Gardening is based on science not magic. Many years of careful research, close observation and innovation have given us a deep understanding of life down to the molecular level. If you give a plant what it needs in the right amounts (sunshine, water, nutrients and warmth) it will grow. Unless you interfere with it, you cannot stop life.

If you are a veteran gardener, this book can add to your knowledge of why and how the right things you do are right. And why the wrong things are wrong. For example, what makes digging your wet kitchen scraps into the soil a great thing for

your garden? What makes a synthetic, liquid fertilizer such a threat to your garden and your health? What makes your local grocery store not a good place to find the most nourishing food?

Whether you are new to the garden or have done it for many years, growing a healthy garden (rather than just a beautiful one) is a most rewarding experience. When people start growing their gardens, their quality of life improves. A healthy garden offers a place for you and your family to share something natural and uplifting, a place you can regularly depend on for both challenge and achievement. When you teach your children to garden, you give them lifelong skills, an appreciation for what and how we feed ourselves and a meaningful way to connect with you and the world.

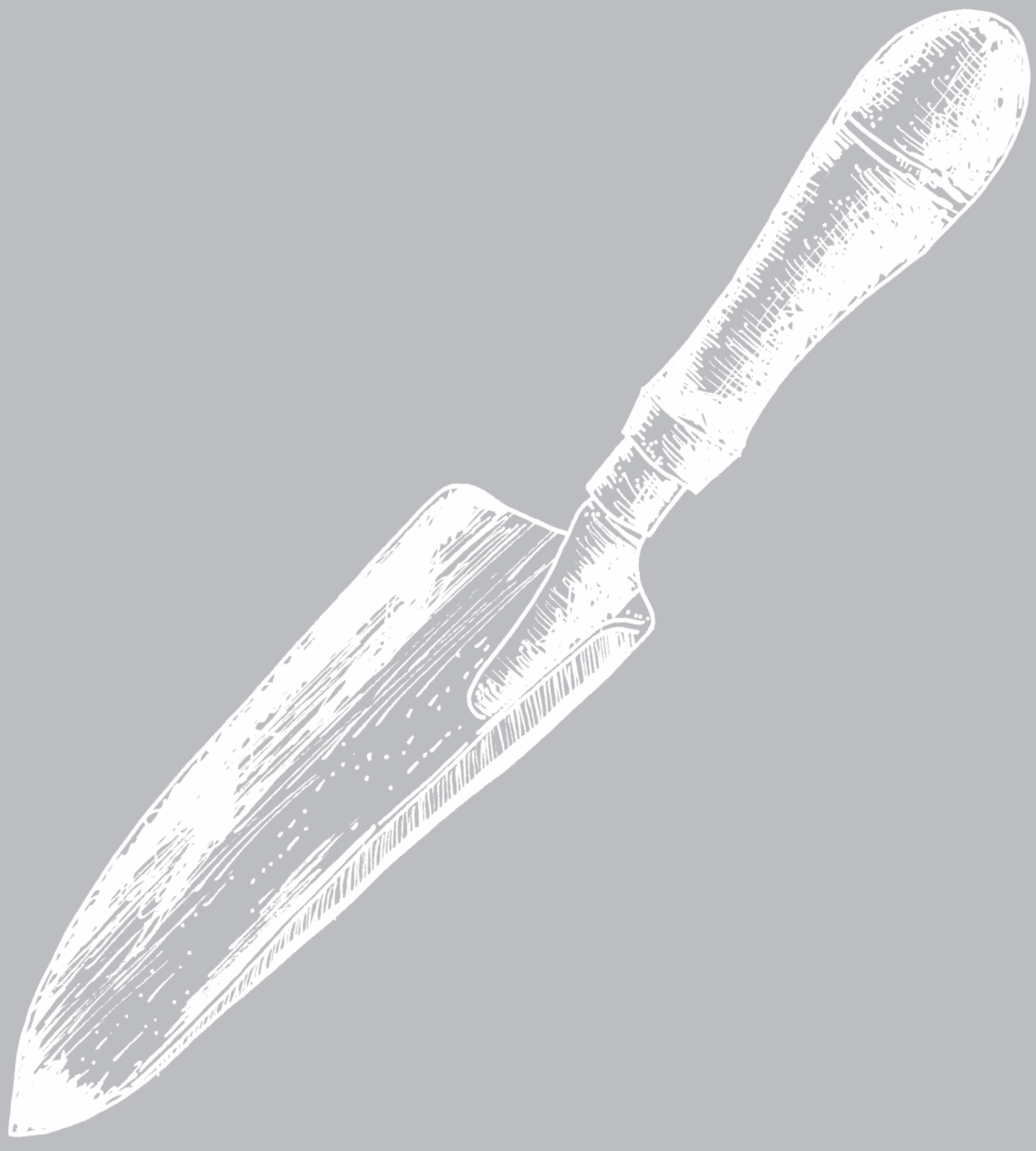
Gardening gives you more than the activity and the harvest. You become a steward of the earth, one of millions of organic gardeners who want to make the world a better, healthier place to live. What a wonderful feeling when you see how you helped foster a natural process as old as life itself.

Gardening as work can transcend the purely physical to become a spiritual experience. Working with the soil and nurturing plants for food goes back thousands of years. I feel wonderfully connected to the past by remembering my ancestors did the same thing ten thousand years ago. In a sense, my garden links me to all of humanity past and future.

Look at your backyard as a place of worship, a healing ground or a place of nurturing. In churches, synagogues and meditation halls we nurture our souls and connect with a higher power. What else but a higher power makes biology happen?

The garden is like a natural chapel that can heal and connect you to all of life. Many spiritual men loved working in their gardens. Many of the best gardeners I have known or read about were deeply spiritual in their own way.

Grow your own food for the health of your world.



CHAPTER ONE

Life Begins in the Soil (Don't Call it Dirt)

Growing healthy food begins with natural soil where healthy plants get their vitality. Analyze your soil and amend it with organic materials to suit the plants you want to harvest. Read on for the details on how to do it.

Amending your soil returns it to its natural state

You may ask, "How can you call the soil 'natural' when you amend it with something?" Amending your soil returns it to its natural state before the industrial world took the life out.

Plants get their essential nutrients from what lives in the soil. We, in turn, thrive by extracting our essential nutrients from healthy plants that grow in living soil. Whether you plan a quaint home garden or a large urban farm, focus on nurturing the soil. After you analyze your garden and its environment, you will know what you have to work with and what to do next.

Focus on nurturing the soil

TODAY'S SOIL QUALITY AND HOW WE GOT IT

To understand the soil we have today, we need to look into the past. The earliest forms of agriculture began around 10,000 B.C. Nomadic groups of hunter-gatherers settled in the area of the Near East the Greeks called Mesopotamia ("between the rivers.") The Tigris and Euphrates Rivers still flow through what is now modern Iraq.

The nomads found wild barley and wheat growing abundantly. As they learned to plant, cultivate and harvest food, they built villages with a surplus of crops growing nearby.

Chemicals have killed the nutrient value in farm soil

As populations grew, they altered the balance of Nature. They weeded out undesirable plants. They separated domestic animals and crops. They built irrigation systems to divert waterways. They also cleared forests for more space and sunlight. As these industrious, well-fed people multiplied and spread, they demanded an ever-increasing supply of food. The portion of the earth under cultivation grew with the population.

Until well into the 20th Century, most food came from small farms run by individual families using traditional, organic methods. With increasing demand for more and cheaper food to feed a hungry nation (and sell the surplus abroad at a profit), U.S. agriculture grew into a large industrial system. The goal and standard of performance became high yields and high returns on investment.

In the process of consolidation for efficiency, the large farm corporations bought up more than four million U.S. farms that could not compete. After World War II, the U.S. farm population shrank dramatically. In 1960, one farmer fed 25 people. Fifty years later, one farmer fed 129 people. (Source: National Cattlemen's Beef Association.)

To further increase yields at low cost, corporate farming demanded new technologies. Plant scientists at universities and private companies developed chemical fertilizers, herbicides and pesticides.

The increasing use of chemicals has killed the nutrient life in farm soil that supported food crops. Our dead soil is now just an anchor to hold plants. As a result, commercial crops now contain ever-weaker concentrations of essential vitamins, minerals and micronutrients. What was a natural process of agriculture has become unnatural, commercial and a threat to our health.

What happened to degrade our soil? It became one more factor to manipulate in a system that puts profits before people. What to do? Grow your own food free of chemicals.

GET TO KNOW YOUR SOIL

If you look at our abundant plant life, you may wonder:

What makes plants grow large and healthy?
What makes plants wilt or not produce?
How do you get a "green thumb"?

Plants depend on favorable environmental conditions to survive and grow. A healthy plant begins with good genetics suited to its environment. Each plant species then needs its own balance of sunlight, temperature, water and nutrients from healthy soil. Wind, rain and other living organisms also affect a plant's life course.

Any factor out of balance in the equation of life (too much, too little or at the wrong time) can weaken or kill a plant. Nature copes well with soil conditions, ensuring that only suitable plants survive to propagate. But the backyard gardener wants to grow a wider range of plants than local conditions allow. You do this by improving the soil.

What is in soil? About 90 percent of it is non-living solid minerals. Half of that is air space, called pores. The other 10 percent is organic matter. Some living matter grows and expands, such as organisms and roots. Most of the visible biomass is plant roots. While only one-tenth of the soil mass is living matter, it controls plant health. More life in the soil means healthier plants.

More life in the soil means healthier plants

As a home gardener, you cannot control the outdoor environment nor plant genetics. Organic growers, in particular, cannot control the genetics of their seeds.

Since so many factors affect plant development, you cannot completely control your results. Instead, control what you can: the health and balance of your soil. Modify it as best you can to cultivate it successfully.

IMPORTANT SOIL QUALITIES

To wisely choose the right plants for your environment, you need to know the qualities of your soil. These specific factors also determine the best ways to modify your soil.

The most fertile soils have great consistency and structure for root extension, water retention, and an abundance of organisms living in symbiosis with plants. Two key soil qualities matter most for the home gardener: Composition and pH (the acid-alkaline range.)

Composition

Your garden has one of three basic soil types. Clay has the finest mineral particles and the least amount of air in its structure. Clay soil has such small particles that very little oxygen penetrates it.

To create a more porous texture in clay soil, add organic matter and possibly some grit. Adding gypsum also helps. If the soil is waterlogged and does not drain well, consider installing a drainage system.

In particle size, silt lies somewhere between sand and clay. Silt feels silky. You can often find it in river valleys. If it has lots of organic matter in it, silt makes good garden soil.

Sand has the coarsest mineral particles. Lightweight, sandy soil drains too fast and retains little moisture. Sand needs lots of added organic matter to bind the particles and improve moisture retention. During a drought, plants in sandy soil suffer and often die.

Texture

To the naked eye, soils look much the same. The nature of the soil comes from the underlying rock. In a river valley, water grinds down rock particles to form silt or clay. In areas with only a thin covering, the soil may be rocky or sandy.

To learn what your soil consists of, take a lump in your hand

and crumble it between your fingers. If the soil is sandy, you will hear grains rubbing together and feel them between your fingers. Silt has a soapy feel. Clay is heavy and sticky, with a surface glaze that makes it almost shine.

You will find many different textures in natural soil. Sometimes adding compost or organic fertilizer is not enough to get a beautiful tilth (another name for the ideal state of being cultivated and ready to receive seeds or transplants.) You may need to add grit to get the right texture. Often you must experiment to find the best way to make your soil fertile.

Pores are spaces between soil particles where water and air flow. In the best soil, about half the volume consists of pores. Water and air fill these gaps and attach to the soil particles.

Pore space is crucial to good tilth. Without it, fertilizer will not get into the soil to feed the plants. Also, pores let moisture travel upwards by capillary action.

Loam is what all gardeners aim for, a rich mixture of soil that feels light and friable to the touch and has a pleasant, brown, earthy color. This soil structure has a good combination of organic matter with essential mineral particles, whether they are sand, silt or clay.

Loamy soil encourages earthworm activity and is well aerated. Because it is neither too dense nor too crumbly, loam holds moisture to the right degree with plenty of oxygen for microbes and mycorrhizae, a beneficial fungus. You get loam by generously applying composted material. This creates valuable pore space for roots to travel and accumulate nutrients for their growth.

Microbes that digest organic matter can influence how well a soil holds together. Their activity helps stabilize the soil by binding particles together. Microbes also release a by-product called glomalin that acts like glue for mineral particles and organic matter. Microbial activity helps build the right soil structure by creating semi-stable aggregates.

Often a gardener must experiment to find the best way to make his soil fertile

pH value affects nutrient uptake

pH (Acid-Alkaline Range)
pH is an essential consideration not visible in the soil. Proper pH promotes plant growth by helping roots absorb essential nutrients.

pH stands for parts of Hydrogen, a measure of acidity and alkalinity. Acidity means more hydrogen ions. Alkalinity means more hydroxyl ions. The pH scale goes from 0, completely acid, to 14, completely alkaline. Pure water has a pH of 7.0 and is called neutral.

Most edible garden plants grow best in a slightly acidic soil with a pH of 6.5. Some plants prefer alkaline soils. (See the section on 100 easy-to-grow plants for specific pH needs.)
The pH value affects nutrient uptake. If the soil pH is not correct, you can give your plants more nutrients, but the roots may not absorb them.

Buy a pH meter at your local nursery. Test the soil in your planting bed at a few random spots and calculate the average pH. The numbers should range between 6.0 and 7.2, with the ideal 6.5 to 6.7. (For more accurate, reliable results, consult an agricultural experiment station or a private lab.)

If your soil is too alkaline, increase the acid level by mixing in peat moss or soil sulfur. Clay soils need more of both.

With acid soil, offset the low pH by mixing in crushed limestone or wood ash. The amount to apply depends on the soil texture and how much you need to change the pH.

For the organic gardener, pH is not usually a problem. Organic materials tend to naturally adjust soils to a slightly acid range. Also, microbes in organic matter help create the right pH environment.

THE LIFE IN YOUR SOIL

Soil is alive with all types and size of essential organisms: bacteria, fungi, algae, earthworms, actinomycetes, mites and

springtails, among many others.

Bacteria are essential to plant nutrition. They form an enormous portion of living matter in the soil, weighing more than a ton per acre. Each gram of fertile soil has about one million different species of bacteria just on the surface. Bacteria also exist far below, but they are most active at the root depth of plants, known as the rhizosphere.

Bacteria are decomposers and recyclers. Some decompose naturally occurring organic matter such as dead cells released by roots or other organic plant and animal remains. Through their metabolism, they release carbon dioxide and other nutrients for plants and animals.

Other types of bacteria transform inorganic matter into forms plants can use. These organisms need carbon dioxide to function. Bacteria also provide essential nitrogen through a process called nitrogen fixation. The Rhizobia bacteria, for example, are symbiotic with the legume family, which includes more than 18,000 species. They convert atmospheric nitrogen from its gaseous form to a water-soluble form plants absorb through their roots.

Fungi decompose fallen leaves and digest dead plants and animals. Fungi come in many different species with many different functions. Some work to degrade organic matter in sequence, from tough fibers down to soft, simple matter that yields usable nutrients. Others form mutual relationships with plants by protecting roots from attack by nematodes or other bugs.

Perhaps the most beneficial fungus for plants is mycorrhizae, which forms a symbiotic relationship with roots. The fungi extend their arms (hyphae or filaments) out into the soil to increase the reach of the roots both wider and deeper. Extensive mycorrhizae webs allow an entire plant population to share nutrients.

Actinomycetes also decompose and recycle dead organisms.

Like bacteria, they break down organic matter and convert atmospheric nitrogen into soluble particles plants absorb. They also serve as a source of antibiotic drugs. Actinomycetes help prevent the overgrowth of bacteria and show that even at microscopic levels, nature keeps an ecosystem in balance.

Even at microscopic levels, nature keeps an ecosystem in balance

Algae add organic matter to the soil. Blue-green algae fix nitrogen from the air, retaining this critical nutrient for plant growth. Algae improve soil structure by helping soil particles stick loosely together, which enhances water retention and decreases erosion. They are also food for other bugs living in the soil.

Earthworms travel through the soil by burrowing, eating minerals and organic matter as they go. As they move, they perforate and loosen the soil. During digestion, they transform many unusable minerals for plants to use later. The remains of earthworms, or worm castings, are high in nitrogen, phosphorus, potassium, calcium, trace minerals and beneficial bacteria. In their life processes, earthworms create more nutrient-rich, fertile soil with a pH close to neutral. Many earthworms in your yard shows you have good soil.

Along with earthworms, nematodes and pot worms decompose organic matter into humus. In the process, they secrete a sticky substance that helps the soil form nice, cake-like aggregates. Most abundant on or near grassland, prairies and pastures, they feed on plant debris as well as some bacteria that share the topsoil.

Many earthworms in your yard show you have good soil

Because nematodes feast on insects in the soil, some gardeners use them as a natural form of pest control. In turn, some larger bugs and even mycorrhizal fungi feast on nematodes. Mites and springtails, the most abundant soil dwellers, decompose many types of organic substances. They belong to the arthropods, which have characteristic exoskeletons and jointed legs. Of the arthropods, mites and springtails are the most vital source in creating humus. In the process, they break down everything from nematodes and pot worms to fungus and leaf litter.

These are only a few of the billions of organisms in or around your garden. The amount of nitrogen fixed for plants by bacteria, actinomycetes and green algae is double the amount in commercial fertilizers. Nitrogen is already present in the soil naturally. You just need to feed and nurture it.

Mother Nature never wastes anything

HUMUS: BLACK GOLD FOR THE GARDENER

When plants die, they appear to rot away as waste. But Mother Nature never wastes anything. Many varieties of microbes and fungi eat dead plants. As they do, they release nutrients back into the soil for future plant generations.

Everything that goes back into the soil helps to build it by providing the essential nutrients where plants need them, at the root zone. You could say plants grow their own soil.

Microbes are crucial to life because they hold the nutrient energy plants captured from the sun as they grew and thrived. Microbes and fungi pass on their accumulated nutrients to the soil as they actively decompose plant remains. These remains in turn decompose as part of the cycle. Life ends in death. Death feeds life. This cycle creates stable humus and helps form rich, healthy soil.

Life-Death lifecycle creates stable humus

Humus is usually dark brown, spongy and gooey. Some types of humus contain highly soluble molecules that readily break down further, known as active humus, the best for feeding soil microbes. Stable humus, crucial to the physical qualities of fertile soil, resists breaking down, because its large, insoluble molecules bind tightly to clay molecules.

Organic matter gets consumed many times. As microbes and fungus continue to break down the remains of various organisms into simpler compounds more available to plants, they also add stable organic matter to the soil.

Humus also acts as an important reserve between the fresh organic matter from which it comes and the simpler forms of carbon dioxide, water and minerals that return to the soil,

sometimes several years later.

Humus formation varies with air temperature. Above 80°F, organic matter decays faster than it is generated. Below 40° F, activity in the soil slows down, building humus reserves for plants to draw on later. Eventually, this digested organic matter transforms into tiny particles of dark humus.

Add both raw and composted organic matter to your garden. This keeps the biology going strong and adds the physical properties to create beautiful, healthy soil.

Water transports nutrients from soil particles to plant roots

MAKING YOUR SOIL FERTILE

Soil is like people. Fertilizers are the vitamins, wind and rain are the exercise, and sun and shade are the rest.

Organic fertilizers feed the microorganisms in the soil rather than the plants directly, which is how synthetic fertilizers work. You might ask, "What's the difference if my plants grow?"

By feeding the soil (or fertilizing it) you let it build nutrient reserves that roots tap into as needed. Organic fertilizer builds good soil structure, creates pores for roots to extend their reach, helps suppress disease, and supports biological diversity. It also helps maintain a neutral pH to support humus formation, adding minerals and micronutrients to the living soil.

WATER AS TRANSPORT

In childhood, we learn that plants need water. Yet, water is not just for plants to "drink," as we do when thirsty. Instead, water transports nutrients from soil particles to where the roots absorb them. A soil's ability to do this is called the "cation exchange capacity." As this capacity increases in the soil, plants absorb more nutrients.

COMPOST AND MANURE

Well-made compost works like good organic fertilizer, but it

is not as rich in nutrients. Compost is simply (and nutritiously) the decaying remains of dead organisms broken down by the feeding action of microorganisms.

Compost usually comes from yard wastes, grass and plant trimmings, leaves, soil with microbes, and various wet kitchen scraps other than meat. (Why not meat? It attracts four-legged pests that will feast on your ripe fruits and vegetables.) Apply this composted substance to your soil and get great tilth, microorganisms and nutrients.

Do not use compost made from biosolids or sewage sludge

Healthy, diverse compost also gives a slow, steady and wider range of nutrients for plant health and disease resistance than a short burst of synthetic nutrients. High quality compost can nourish your plants for a year or more. Because compost is constantly breaking down, you must reapply it to sustain the benefits. Four times a year is a perfect recipe.

Caution: Do not use compost made from biosolids or sewage sludge. They can contaminate your soil with toxic levels of heavy metals, unused or outdated drugs flushed down a toilet, and, most dangerously, human pathogens.

Compost is especially valuable if the ground was degraded in the past and never remediated. All our houses were once construction sites. The weight of the building materials and the house compacts the dirt. (Don't call THAT soil.)

Also, the construction workers may have left behind solids that are not biodegradable, such as iron nails, broken glass, concrete mixing debris, aluminum cans, cigarette butts and plastic trash. The toxic liquids can include both paint from brushes and rollers and the solvents used for cleaning. Whether you see it or not, construction debris and waste can contaminate your ground.

If you don't want it in your body, don't put it in your soil

Whatever is in the soil, both nutrients and poison, can be absorbed into the edible parts of your plants. If you don't want it in your body, don't let it be in your soil.

If your garden plot has never been worked, your first task is to find and remove all you can that does not belong in your soil. It can be hard work with a shovel and a sturdy metal rake (great for your fitness) or you can use a mechanical rototiller. (With all power tools larger than a hedge trimmer, if you have not used it before, hire a professional who can do the job safely.)

Apply premium compost to your clean ground

Once your ground is as clean as you can make it, apply premium compost you make or buy. To get safe, effective compost, look for a trusted nursery or professional grower who can tell you how to maximize your soil's fertility.

You can avoid the ground contamination problem by growing your crops in raised beds you fill with the soil you want. See Chapter 3, How to Go Organic, for more on how to make and use raised beds.

Manure, or animal waste, is another effective but risky way to add nutrients to your soil. Manure gives a huge boost to soil fertility for large-scale agriculture, but it must first be composted for a long time.

Manure is not the best choice for a home garden, especially when better alternatives are readily available. Raw manure may release ammonia, which is detrimental to plant health. Never use the waste of a carnivore (meat eater) such as a cat or a dog. It can carry pathogens.

Once composted, manure is a nutrient-rich material to mix with your soil

Once composted, manure is a nutrient-rich material to mix with your soil. You can safely apply manure from rabbits, sheep, horses and cows. Just remember to compost it thoroughly before you mix it into the soil.

Chicken manure is a special case. Not all chicken manures are the same. Most retail chicken manure comes from factory farms, where the birds are fed grain from genetically engineered plants or GMOs. (The organic community opposes the use of GMOs in food products because of the unknown long-term, and perhaps unintended, consequences of using

them.) Factory farms also use hormones to make poultry ready for market faster. They also use antibiotics to prevent infections fostered in the crowded, unhealthy conditions in the cages. If the chicken manure contains pathogens or toxins, those go into your soil and expose you to disease.

Read the labels on organic fertilizers. Make sure you know the chicken manure and its source. If you raise your own chickens organically, their manure is safe.

Remember to compost manure thoroughly before you use it.

Organic fertilizers let you work with Nature

ORGANIC FERTILIZERS AND SOIL AMENDMENTS

These are the best in all ways. They consist of natural ingredients that feed beneficial microbes and help create ideal soil structure. Popular ingredients of organics include:

- Fishmeal
- Alfalfa Meal
- Kelp Meal
- Seaweed Extracts
- Liquid Fish and Seaweed
- Earthworm Castings
- Feather Meal
- Bone Meals
- Blood Meal

The meals and extracts contain organic matter and nutrients, while the bacteria and the symbiotic mycorrhizal fungi convert nutrient sources into forms plants can absorb as needed. Also, mycorrhizal fungi extend the reach of plant roots to acquire more nutrients and water.

Organic fertilizers are also safer than the alternatives, because they have a much lower chance of leaching through the soil to contaminate the water table. With organic fertilizers, nutrients are physically bound into larger pieces of matter lodged in the soil and available so that microbes can free them up for plant use. Organic fertilizers persist and work for many months, because they are part of the living soil.

Organic fertilizers let you work with Nature rather than against it. You use them to recycle organic matter back into

Direct plant feeding sounds attractive, but it adds nothing beneficial to the soil

the soil rather than discarding it and relying on chemicals. Your local nursery stocks a number of different organic fertilizers and amendments. Some are formulated to feed particular plant categories such as vegetables, while others take an all-purpose approach for a variety of plants.

Fertilizers are generally tested and proven for a specific purpose. Choose a selection specific to your plants.

Whatever you choose, organic fertilizers and amendments are geared for the slow, controlled release of plant food. They are perfect for preparing the soil for upcoming seasons. Organic nutrients are never wasted and never wash away.

CHEMICAL FERTILIZERS: WHY NOT?

Chemical fertilizers are easy to apply and work fast. They feed plants directly, because they mimic natural soil nutrients in a form plants can absorb immediately. What's the problem? Direct plant feeding adds nothing beneficial to the soil. Also, commercially synthesized chemical fertilizers do not have the beneficial soil microbes that feed the plants certain bio-chemicals such as vitamins and antibiotics. Over time, chemical fertilizers deplete the soil of these nutrients.

With chemicals, the soil becomes a dead anchor to hold plants in place. While this approach may have good short-term results with high yields, in the long run it leads to disaster for the earth.

Chemicals make the soil a dead anchor to hold plants

When organic matter is not replaced in the soil, beneficial organisms die out, the soil structure breaks down, and the soil becomes hard, airless and unproductive. Chemically "force-feeding" plants causes soft, sappy growth, making them vulnerable to pests and disease.

With all the protective organisms gone from the soil, the chemical farmer must apply herbicides and pesticides to replace the lost protection of Mother Nature.

In addition to killing off organisms, chemical fertilizers are water-soluble and temporary, often lost through leaching away or conversion to an unusable form, such as nitrogen gas. Unnatural chemicals in the soil get washed away during rain or irrigation and can pollute ground water, streams, lakes and oceans.

Other negative effects of chemical fertilizers:

- Make certain micronutrients and heavy metals, (iron, magnesium and aluminum), more soluble in the soil and more toxic to plant tissues
- Reduce the productivity of bacteria (nitrogen fixers) making nutrients less available
- Decrease a soil's ability to hold onto positively charged nutrients, making it easier for water to wash them away
- Lock up other micronutrients and make them unavailable to plants while concentrating harmful molecules in the soil
- Reduce soil fertility by attacking humus and organic matter reserves
- Increase salt concentration in the soil, changing the pH and adversely affecting plants
- Reduce the soil aggregation properties of microbes and sacrifice good tilth
- Effect is short-term. Requires frequent re-application.

FEED THE SOIL NOT THE PLANTS

Chemical fertilizer feeds only the plant, not the soil nor the microbes. Feeding chemicals to the plants instead of organics to the soil discards all the benefits from microbes. Organic matter feeds the beneficial microbes that make nutrients available for plants. When you feed the soil, you preserve the natural biological processes.

When you feed the soil, you preserve the natural biological processes