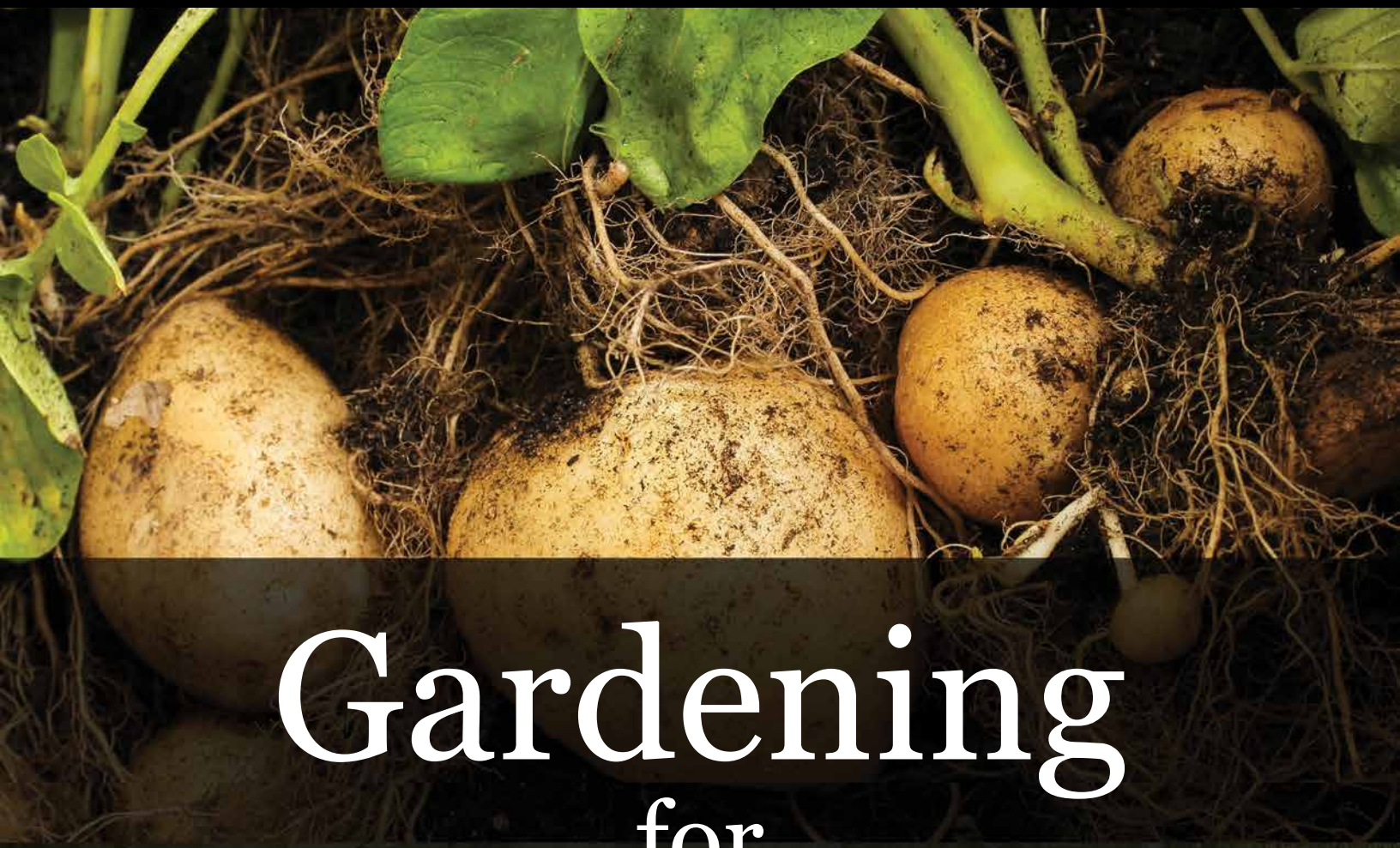
USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE



Gardening for Soil Health

No occupation is so delightful to me as the culture of the earth, and no culture comparable to that of the garden.

-Thomas Jefferson

Gardening for Soil Health

No-Till Gardening

Have you heard the buzz about soil health? It's not just for farmers and ranchers! Gardeners can also use five simple principles to improve soil health which decreases water and fertilizer use and, most importantly, makes your food more nutritious. These principles apply whether you manage thousands of acres or a backyard garden.

1. **Armor the soil**
2. **Minimize or eliminate soil disturbance**
3. **Grow a diversity of plants**
4. **Keep a living root in the soil as long as possible**
5. **Incorporate livestock wherever possible**

Did you know that healthy soil is full of life? Millions of species and billions of organisms make up a complex and diverse mix of microscopic and macroscopic life that represents the greatest concentration of biomass anywhere on the planet. Bacteria, microscopic insects, earthworms, beetles, ants, mites, and fungi are among them. There are more soil microorganisms (microbes) in a teaspoonful of soil than there are people on the earth. The five soil health principles will make your soil an ideal habitat for all these soil microbes.

Why are soil microbes important? The biology in the soil has a distinct relationship with plants. Plants take carbon from the air and convert it to a sugar which is stored in the roots. Plants release this sugar in the soil to attract micro-organisms. The micro-organisms take the sugar and in exchange give the plants nutrients and water that are needed to grow. If our soils aren't functioning as nature intended, we must supplement plants with synthetic nutrients that they need for growth. When soils aren't functioning, plants are also more susceptible to diseases and insect pests, which may require treatment with chemicals.

Implementing the five soil health principles allows for nature to function properly and improves your soil which will decrease water use, eliminate the need for fertilizers, pesticides, or fungicides, save you money, and most importantly grow more NUTRITIOUS food.

Soil Armor

Soil armor is simply residue that is covering the soil surface. Nature abhors bare soils and is always trying to cover it – with weeds. If we cover our garden with residue, it eventually becomes food for the microbiology in the soil. Cover on the soil also reduces water loss through evapotranspiration, reduces erosion, and decreases soil temperature. Like us, soil organisms can't survive if they are too dry or too hot.

Minimize/Eliminate Soil Disturbance

A spring or fall chore for many gardeners includes turning over the soil, with a shovel or tiller, in preparation for planting. Soil is habitat for soil biology, tilling the soil destroys their homes and food. Mycorrhizal fungi is a very important micro-organism that brings food and water to plants with a weblike feature that expands extensively in the soil. Tillage destroys this web and it has to grow back after disturbance. What you also may not know is that about half of healthy soil is water and air, which exist in the open spaces between soil particles bound into stable aggregates. When soil is tilled, the soil aggregates break down, and the pore spaces disappear which decreases how much water is able to infiltrate the soil and how much water can be stored in your soil. When soil aggregation is destroyed, it also makes the soil more susceptible to erosion by wind and water.

Plant Diversity

The journals of Lewis and Clark describe the northern plains landscape as supporting many different types of plants. Numerous species were observed working together as a plant community to provide forage for large herbivore populations. Our soils were built over geological time in this environment. All the different plant species correlate with the diversity of the micro-organisms in the soil. When there is diversity and the microbiology is in balance, plant diseases and pests decrease or are eliminated. Many different micro-organisms are responsible for providing many different nutrients to the plants. More diversity of soil micro-organisms means healthier plants.

Gardens are naturally very diverse, if the plants you are growing are rotated around the garden from year to year. A good rule of thumb is to never grow the same crop in the same place longer than two years in a row. Other ways to add diversity to your garden is to relay crop, intercrop, plant species beneficial to pollinators, and use cover crops. Relay cropping is planting a crop immediately after you harvest another crop. Intercropping is planting two or three species that complement each other in the same space. Planting flowers and species that benefit pollinators in your garden attracts pollinators and predator insects that prey upon garden pests. A cover crop is a diverse mix of many species that can be planted in areas that you don't intend to use for vegetable production. Cover crops can grow for the full growing season or for parts of the season when garden plants aren't growing.

Keep A Living Root in the Soil

Keeping living plants growing as long as possible provides food to the soil microbes during the entire growing season, from the cool spring through the summer heat and to the cool fall. Plants release sugar through their roots to feed the microbes in exchange for plant nutrients. If there is no living root in the soil, there is no food for the biology. In nature, both warm season and cool season plants grow. This means there is a living root in the soil for the whole growing season. Garden plants are also both warm and cool season. For example, peas thrive in our cool season and squash in the warm season. Cover crops can also be used, if needed, to extend the duration of growing plants in the garden.

"Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals."
- Aldo Leopold, A Sand County Almanac, 1949

How do you know you are making progress in improving the health of your garden soil? There are many indicators. You will probably notice that the plants are healthier and more productive. You may have fewer weed and insect pest problems.

An easy way to test soil health is to examine a shovelful of soil. What does healthy soil look like? It will be held together by roots, have good soil structure, and earth worms or evidence of them will be present.

Healthy soils look like cottage cheese. Darker soils usually indicate more organic matter, which provides essential nutrients for plants and soil biology as it is decomposed by microbes. Worm holes are also an indication of excellent soil health.

Watch the Soil Health Minute: Evaluating Soil Health at bit.ly/3Dqs7RO.

Incorporate Livestock

Incorporating livestock can be more difficult in a garden situation, but not entirely impossible. Smaller livestock such as chickens, goats, and sheep could be incorporated after the gardening season. The addition of livestock speeds up the improvements to the soil. Livestock break down garden residues and make them smaller and more accessible to the micro-organisms in the soil. So the cycling of nutrients speeds up with the addition of livestock. Soil health improvements are still very possible without livestock.

How Do I Get Started with My No-Dig Garden?

Site Preparation

If you are starting with sod, you have two basic options:

1.

Spray with herbicide in the fall prior to when you'd like to plant the garden.

In this example, sod was sprayed with glyphosate in the fall to expand an existing garden area (see top photo).

Expert Tip:

Planting directly into the dead sod may have worked, but the gardener planted a cover crop into the sod to break down the residue and jump start the soil microbiology to prepare for planting the next year (see bottom photo). Species planted in the cover crop included radishes, turnips, soybeans, sunflowers, millets, sorghum sudan, and corn.

2.

Smother the plants using plastic or a layered combination of newspaper/cardboard + compost/ manure + wood chips/straw/hay. Learn more about the layered method by searching sheet mulching, no dig, or lasagna gardening in your web browser.

The smothering methods block sunlight from the plants beneath and create an environment where the existing plant species cannot survive. The area should be well watered to encourage any weed seeds to germinate and be killed due to the excessive heat and lack of sunlight at the soil surface.

When using tarps, they should be opaque, the area should be watered before the tarps are put down, and the tarps should be left in place for a minimum of three weeks prior to planting the garden to ensure perennial species have been adequately smothered and their nutrient reserves depleted. In this situation you would want to plant warm season garden species such as squash to allow time for the tarps to kill the perennial vegetation.

Tarps are used in this case to smother existing plants and prepare a future garden site.

This garden expansion was created using the smothering method. The addition of water is very important in our dry climate.

If you are starting with bare soil – cover it.

If you are starting with bare soil, plant your garden and cover all areas of remaining bare soil. Then continue to apply cover as you see bare soil emerge. The second year of your no-till garden, you will be planting into cover from the year before. NRCS's state soil health specialist covers her garden with lawn clippings and leaves. Some use old hay or straw.

Expert Tip:

It is important to know where your cover comes from. If it has been sprayed with a broadleaf herbicide, it can be detrimental to your garden plants.

You can see last year's lawn clippings and corn residue the soil cover in the photo on the left. If there is bare soil, there will be weeds.

Expert Tip:

As the soil microbiology becomes more active and functions at higher levels, they will break down the residue more quickly than you expect. So, it may take more residue to keep the soil covered than you think.

Planting

When planting, minimize the disturbance in the soil as much as possible. There are lots of tools for planting that can be used. After planting the seed, make sure the soil is covered with residue to minimize the opportunity for weeds. After seedlings emerge, add cover at the base of the plants.

Jab Planter

This works well for large seeds such as peas, beans, and corn.

Pizza Cutter or Shovel

To create narrow openings in the soil for seeds.

Move residue aside, make a slit in the ground with the pizza cutter or shovel, put seeds in the slit, and press the slit closed with your fingers, add some residue over the slit. Add water down the row if the soil is dry.

Pizza cutter.

Seeds planted in the narrow trench, which will be pinched closed.

Shovel. A cinderblock has been used for down pressure.

Expert TIP:

Planting peas alongside last year's corn stalks allows the peas to climb, means you don't have to remove the stalks in the fall, and helps to facilitate rotations of different types of plants within the garden.

Residue on planted garden. Residue is limited over the seeded rows so that seedlings can emerge.

Lawn clippings placed on the garden between plants discourages weeds and helps soil hold moisture. As the residue breaks down, it will add organic matter to the soil and feed soil microbes.

Compost

Compost can be added about an inch deep to the top of garden beds before planting or seeding crops. The compost will help build organic matter and help increase nutrients available to plants.

Compost added to permanent beds is then leveled and ready to direct seed garden plants.

No-till Potatoes

Move residue aside, put potatoes on top of soil, add three inches of residue on top of potatoes. As potatoes start to grow add residue around the plant continually to protect the potatoes. Later on, you can harvest potatoes and the plant keeps growing.

On a large scale, seed potatoes could be placed on the ground and then mulched with straw or hay using a bale processor.

On a smaller scale, pull aside the soil cover, place seed potatoes, and recover with the residue.

Throughout the growing season, add more mulch to keep potatoes covered and protected.

Expert Tip:

You can pull back the mulch to check if the potatoes are ready for harvest. You can even harvest some potatoes from a plant and leave the others to keep growing.

Jang Seeder

This is a precision push seeder that can be more efficient when planting larger areas. It is also a handy tool that limits the amount of bending needed to plant your garden. The Jang seeder does not work well with seeds that need to be planted deeper in the soil. It is best to use the jab planter for large seeds such as corn, peas, beans, and squash. The Jang seeder works for the smaller seeded garden species.

Maintenance

a.

Continue to add residue between the rows and right up to the base of the garden plants throughout the growing season. Where there is bare soil, there will be weeds.

b.

Use less water. Due to the soil cover, you will retain more moisture. As your soil improves you will also store more water.

c.

Gradually cut fertilizer use. As you use less fertilizer, the soil biology will form natural associations with the plants and provide the necessary nutrients. If you continue to add fertilizer to the system, that association doesn't happen. It is best to cut fertilizer gradually over a three-year period.

d.

There will still be weeds. Especially where you planted and disturbed the soil. Remove or kill weeds before they go to seed. Remove weeds with hand pulling. Weeds can be laid on the top of the ground to provide cover to the soil. However, there are certain weeds that you may want to dispose of that can reseed themselves even after pulling.

e.

You may see more slugs in your garden the first four years. This can be attributed to over watering but may be just the change in the system. Check the soil prior to watering to determine if watering is necessary.

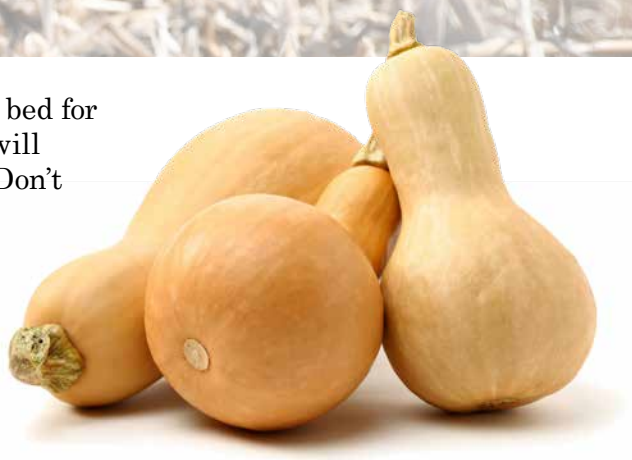
Expert Tip:

Adding plants that attract pollinators can help with slug issues because they attract the predator wasp that kills slugs. Pollinator plants can be added on borders, between rows, and in other open spaces. These plants will also help to support pollinator species that are so important to the success of gardens and crops.

Phacelia, the purple flower, is a species that is highly attractive to pollinators.

Ready for Winter

Before winter, put lots of residue on the garden to put it to bed for the winter. You will be surprised how much bare soil you will find in the spring if you don't cover the soil before winter. Don't worry about planting into the residue next spring, it will break down faster than you think. As your soil health improves, the residue will break down even faster. If possible, tromp the garden residue flat instead of letting it stand upright for the whole winter. Laying it flat exposes it to the micro-organisms and it will break down faster.



Backyard garden put to sleep for the winter with grass clippings, leaves, and garden aftermath.

Garden covered for winter with straw, which is catching snow that will infiltrate the soil.

For more information about soil health, your soils, or gardening to produce healthy food for your community, visit nrcs.usda.gov/montana or contact your local Natural Resources Conservation Service office. Find contact information at nrcs.usda.gov/contact.

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