Recommended Strategy for Soil Preparation and Fertility: A Living Document for City Gardeners
Soil is our passion at NOFA/Mass. After many years of working on our own farms and the urban, rural and suburban gardens and farms throughout the state, we have gathered some insights and best practices to share with those who are starting up or who are wanting to improve their soils. As we continue to learn new and better strategies, we will add them to this document too - it is a LIVING document. If, upon reading it, you have resources or suggestions to add, please contact us so we can include your soil wisdom and experience too. Happy soil building!

Northeast Organic Farming Association, Massachusetts Chapter (NOFA/Mass)
www.nofamass.org
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Seek out a Knowledgeable Mentor

Growing food on newly established sites can be difficult. It can be discouraging to experience unexpected challenges such as unbalanced soil fertility, pest and disease pressure, soil contamination, or lack of water access. By seeking out a knowledgeable mentor or experienced grower in your area, one can avoid common pitfalls. A local farmer has intimate knowledge of the specific conditions of the area: soil type, weather patterns, cost of production, zoning laws, etc., and can share this experience and knowledge with someone just starting out. We suggest, for the health of your soil, crops and community, that you seek out a mentor with organic cultivation skills.

You may know one of these growers from your farmers’ market. If you don’t, NOFA/Mass has a large network of farmers, gardeners, and land managers throughout the state who have technical expertise in many areas. We can help you find the right person. By connecting longtime growers with new growers, we hope to encourage collaboration and support across the state for successful growing. By finding a mentor, especially one that is knowledgeable about your specific growing conditions (soil type, urban vs. rural, and local climate conditions), you can experience a higher level of overall success, grow more abundantly as well as produce higher quality and better tasting food. Taking the time to find the right mentor is well worth the extra time invested up front.

Working with an organization like NOFA/Mass to match your needs with their network of experts can help make the process of finding a mentor easier. For example, NOFA/Mass has a Beginning Farmer Program that matches experienced farmers with those who are starting out. The program hosts a webinar series, workshops at our Winter and Summer Conferences, and on-farm trainings throughout the year. In addition, NOFA/Mass has developed a technical assistance program that focuses on soil testing and analysis, soil recommendations and amendment application. More specific to city gardens and mini-farms, NOFA/Mass has a comprehensive training, mentoring and technical assistance service for urban gardening projects and individuals.
The first thing you should do on a new site is to test your soil. This is an important way to identify existing problems such as contaminants and mineral imbalances or deficiencies in your soils. There are many labs through which a grower can get soil tested. These tests usually cost between $15-40 (depending on any extra testing requested). They typically measure essential macronutrients such as calcium (Ca), Magnesium (Mg), Phosphorus (P), Potassium (K), and sometimes Nitrogen (N), as well as micronutrients that are essential but needed in much smaller quantities such as Sulfur (S), Boron (B), Sodium (Na), Zinc (Zn), Copper (Cu), and Manganese (Mn). Some laboratories will also provide additional micronutrients upon requests such as cobalt (Co), selenium (Se) or molybdenum (Mo).

To take a soil test, follow recommended practices listed by your testing laboratory. Generally, soil testing involves taking at least a dozen samples from a variety of depths (some at least 6 inches deep) and locations around your planting area. Once collected, mix the samples together thoroughly. Some soil testing facilities request you dry the mixed sample, while others do not. Send 1-2 cups of the sample with the laboratory’s printed testing form and payment (information available online). Results should be returned to you 1-3 weeks later, and can be delivered by mail or email.

**Regardless of what soil testing laboratory you use, be consistent.** Soil testing laboratories are calibrated differently and use different techniques to get results that are best suited to the majority of the growers they serve.

The soil-testing laboratory can provide tailored mineral amendment recommendations based on the test results, and may cost extra (usually $25-30). If you are new to soil testing, these recommendations can be helpful. However, if you would like help on how to implement these recommendations, it might make sense to seek the advice of a local soil consultant who can help you implement the recommendations over the growing season, who knows the local soil conditions, and can sometimes source specific amendments.
Recommended soil testing laboratories and local consultants:

**Logan Labs Soil Testing Services**  
[www.loganlabs.com](http://www.loganlabs.com)
- Tests for full spectrum of macro and micronutrients, including trace nutrients which are not usually available in other testing labs
- Basic tests $25, add $5 micronutrients, and $25 for tailored recommendations
- Mehlich III paste test, which is a common extraction method used by soil testing laboratories to help establish soil nutrient value

**University of Massachusetts, Amherst Soil Testing Facilities**  
[www.ag.umass.edu/services/soil-plant-nutrient-testing-laboratory/ordering-information-forms](http://www.ag.umass.edu/services/soil-plant-nutrient-testing-laboratory/ordering-information-forms)
- Great and inexpensive place to get general nutrients and heavy metal testing
- Starting at $15 per test, plus extra for soil organic matter and Nitrogen-testing
- Uses a Modified Morgan testing method for nutrients and some micronutrients, which are based on acid, New England soils, but not always suitable for sites with high organic matter, greenhouse soils, or potting mixes.

**NOFA/Mass Soil Technical Assistance Program**
- NOFA/Mass is beginning its own soil technical assistance program in 2017, starting with a low consulting rate for our members, to respond to the need of growers and gardeners in the state and to improve the turnaround time for soil technical assistance. For more information, call NOFA/Mass at 978-355-2853.

**Bionutrient Food Association**  
[www.bionutrient.org/growers/agronomy-consulting](http://www.bionutrient.org/growers/agronomy-consulting),  
David Forster

**Brix Bounty Farm**  
[www.brixbounty.com](http://www.brixbounty.com), Derek Christianson

**Food Forest Farm**  
[www.foodforestfarm.com](http://www.foodforestfarm.com), Jonathan Bates
Dealing with lead and other types of contaminated soils
It is important to test for lead and other heavy metals, especially if you are growing in an urban environment. Lead is the most common contaminant in soils. Lead was commonly found in gasoline, paint, and even sprayed on old orchards. The UMass Amherst Soil Testing Lab provides good, inexpensive lead testing included in their basic test as well as some recommendations for how to deal with lead in soils:

UMass Fact Sheet on Soil Lead Contamination: Includes recommendations and good gardening practices to avoid lead exposure. www.ag.umass.edu/soil-plant-tissue-testing-lab/fact-sheets/soil-lead-testing-interpretation-recommendations.

Lead is not an essential nutrient to plants. Ideally, plants will not take lead up into their system if they have all the correct nutrients available. However, as the level of lead increases the likelihood of the plant taking up lead in place of another nutrient is higher. If you have low to medium lead levels in your growing area, you can choose to continue growing in that space being mindful of practices to minimize lead uptake including the following:

- Growing only fruiting crops. In soils with medium to high lead levels, you will see much higher concentrations of lead in leaves and roots (ex: lettuce and radish) versus fruiting crops (ex: tomatoes and raspberries). If the level of lead in your soil is of concern but still within the medium threshold, consider growing only fruiting crops.

- Avoid ingesting soil residue or dust on your crops either by washing produce thoroughly, avoiding crops that touch the ground (ex: strawberries) or ensuring crops stay off the ground by using mulches or trellises (ex: tomatoes and cucumbers). You are at higher risk of ingesting or inhaling high levels of lead through dust or soil residue than by eating plants grown in that same soil. Keep your soil covered, healthy, and avoid conditions where soil is exposed and dust is created.

- Keep well-mineralized soil with plenty of organic matter. A soil that has the proper balance of minerals can provide the plant with what it needs and is far less likely to uptake lead, a nonessential plant nutrient. Lead is also less available in properly balanced soil where the pH that is not too low or acidic and in the range where most vegetable thrive, between 6 and 7. Organic matter, either added or built with a thriving biology in the soil, can provide an important buffer and ensure lead is less available to your plants.
Soil Oxygenation

It is important for plant roots to have room to grow deep, expand, and have enough air and water. Without proper aeration at all depths of root development, production will be limited. There are three main ways to improve aeration:

a) Physically breaking up compaction layers
b) Balancing ratios of major cations in the soil:
   Calcium, Magnesium, Potassium, and Sodium
c) Using soil biology to build and improve soil structure

Example from GTC Soil Restoration Program:
At the Hancock Street growing site, much effort has been spent to build a rich surface topsoil layer, yet in 2015 after digging down into the soil, a hard, compacted layer of gravel was discovered about 8-10 inches beneath the surface. Delicate plant roots cannot penetrate these compacted layers, much less access water and air essential for their growth.

Physically Breaking Up Compacted Soils
Occasionally soils will initially be too compacted to work with. Hard pans can develop from excessive tilling over time or sometimes can exist in urban settings for a variety of reasons based on the previous use of the land.

Using a broadfork to break up these layers allows for greater productivity in future. By allowing water, air, and plant roots to reach new depths, you also activate beneficial soil biology at lower levels, which can continue to improve the soil conditions at these levels, further increasing the productivity of the soil. Aerating the soil with a broadfork is a great task for a large group of youth or volunteers who get to see the direct impact of their work the following growing season. Remember, however, that although an initial broadforking is useful with a hard pan, the goal is to solely use soil biology and root systems to create air pockets for growing plants. Do not make broadforking or any other tilling a regular practice.
Some tips for maintaining and increasing the soil’s oxygenation:
- Avoid unnecessary compaction by driving or stepping on the soil surface.
- Maintain distinct pathways.
- Avoid working with the soil when it is overly wet or dry to avoid damaging the soil structure and biology.
- Keep as much of the soil surface covered and protected as possible by mulches, plant covers, or added crops, including pathways.
- Avoid tillage.

Balancing Major Cations in the Soil
One of the many benefits of taking a soil test is to identify the ratio of major cations in the soil, or the base saturation values of Ca, Mg, K, and Na. These ratios help determine the structure, pH, and nutrient availability in the soil. A soil consultant who is well-versed in this can help you navigate the complexities of mineral balancing, advising you to be careful not to add too much of certain nutrients, and giving recommendations for quantities as well as the mechanics of how to apply these nutrients.

However, it is important to realize that the ratio of these cations, especially the ration of Ca to Mg, largely determines how loose (Ca) or tight (Mg) a soil is, and thus how much air or water is able to move and permeate into the soil. The approximate ratio (though it will depend on your soil type and region also) is 60-70% Ca: 10-20% Mg: 2-5% K: 0.5-3% Na with 10-15% Hydrogen available at the remaining exchange sites. Finding a soil consultant who understands the importance of these ratios, also known as William Albrecht’s Base Cation Saturation Ratio, and how the ratios relate to soil structure is important.

For those who are interested in more thoroughly educating themselves on this topic many resources are available, including the following:

- The Ideal Soil by Michael Astera
- Hands-On Agronomy by Neal Kinsey
- The Art of Balancing Soil Nutrients by Bill McKibben
- The Farm as Ecosystem by Jerry Brunetti
- The Intelligent Gardener by Steve Solomon w/ Erica Reinheimer
- The Bionutrient Food Association - www.bionutrient.org
- NOFA/Mass Soil Technical Assistance Program www.nofamass.org
Using Soil Biology to Maintain Soil Structure

Tilling the soil is a common strategy for opening up the soil for planting, but ironically it can decrease soil aeration by damaging soil structure and destroying beneficial soil organisms which help maintain pore spaces and soil aggregates, which help soil act like a sponge. Practicing no-till growing methods can increase your soil biology over time, improve the soil’s water holding capacity, and increase crop production. NOFA/Mass encourages growers to move to no-till systems for maximum fertility management, health of crops and environmental stability (carbon sequestration).

The following are resources for learning about no-till:

- “Carbon Farming” Issue of The Natural Farmer, Fall 2016. www.thenaturalfarmer.org/issue/winter-2016-17-carbon-farming/
- Interviews with no-till growers by Julie Rawson at NOFA/Mass: www.nofamass.org/tags/carbon-sequestration
Remineralizing the Soil

Many soils in agricultural settings can be fairly degraded from long time use, tillage, or use of conventional pesticides and fertilizers. Urban gardens and farms may also have had topsoil removed, contaminated from a previous land use, eroded or severely compacted. Ironically, many weeds that we associate with these difficult compacted, acidic, or otherwise degraded environments are actually nature’s first line of defense in trying to restore the land. Weeds hyper-accumulate micronutrients in their leaves, and when they break down eventually release those nutrients back into the soil. Deep taproots help aerate and rebuild “arteries” for soil life: water, air, nutrients, and a living plant. This happens very slowly, yet all these natural processes have a certain wisdom to them. Over time, you too might be able to observe what weeds are growing and what conditions they signify in the soil. In working with the land, we can learn from nature and help speed up the process by regenerating and remineralizing the soils.

For more information on this topic, check out these resources:
- *Weeds and What They Tell Us* by Ehrenfried Pfeiffer
- “Listen to Your Weeds” Rodale’s Organic Life: www.rodalesorganiclife.com/garden/listen-your-weeds

A highly mineralized soil has good structure, holds onto nutrients, helps plants resist pest and disease pressure, and produces higher quality, nutrient-dense food. Many soils are depleted of certain essential plant nutrients or have excesses of certain nutrients that create imbalances in the soil. These imbalances can impact soil structure and can be the difference between a light, spongy soil and a tight, compacted soil. Many soils also lack sufficient levels of trace nutrients, a situation which is only recently beginning to be recognized as essential for plant growth in more conventional agricultural circles. These trace nutrients are essential, but are needed in much smaller quantities than macronutrients.
Take time to observe. As you begin to work to correct nutritional deficiencies or imbalances, take the time to observe how your plants respond and how even minor adjustments impact your land, plant growth, and production. This learning will happen over time. As you learn what your plants need, you will begin to recognize what healthy plants look like. Look for shiny, dark green leaves, vibrant colors, strong aromatics, thick, robust stems that do not break when you brush against them, and increased resistance to common pests and diseases.

For a specific example, consider the micronutrient boron (B). It is needed in very small quantities, yet also has the tendency to wash out of soils with low organic matter. A boron deficiency might be evident in hollow stems of broccoli and other brassicas, or it could be a more subtle sign such as when your beets are not sizing up properly or broccoli is not forming a big head. A deficiency in boron, in fact, can induce a deficiency of many other essential macronutrients, including those required for photosynthesis, and can limit plant growth and productivity. When adding anything to the soil, do so slowly. Too much of any nutrient – especially a trace element needed in very small quantities – can also cause problems.

Start small, and experiment with small area at a time. If you are uncertain or new to remineralization, you might consider designating a small area to start and do all you can for that one area. Observe and record the results. It is often easier to see the positive effect when conducting side-by-side trials than to inconsistently apply some techniques to the entire growing location. It can be an easier way to commit financially to investing in soil remineralization when you confirm your own success with this method.

Be consistent. Soil tests will serve you best when taken over time. To be truly valuable, there needs to be some consistency on where and when you take soil tests. For example, a test taken in the cooler fall months might show very different results than a test taking in the middle of a drought in the summer.

Keeping good records. Make sure you know which soil tests came from what locations. This is especially true if working with multiple sites with different needs. Be clear about how many soil tests you are taking. It can be helpful to draw a map of your site, and designate how many soil tests are being taken and correlate them with the map. On a larger scale, one might decide to take one soil test per acre. Urban farms and gardens might be divided differently, such as per location or lot, by soil type, based on a site’s previous use (such as a separate test in the soil beside an old building to test for contamination). When designating areas for soil testing, make sure you can track these same areas over time, and also that you could manage those areas differently if the tests came back with very different results. Soil tests, in this sense, are only as useful as your ability to keep good records.
Timing soil test recommendations. Getting a soil test sent in to a soil testing lab takes time. So does waiting for the results, sending in the results to a soil consultant, waiting for the response from the soil consultant, and then acquiring the recommended mineral supplements or fertilizers. Plan for it. Ideally take soil tests in the later summer or early fall. If possible, apply mineral amendments in the late fall or winter – though applying mineral amendments before planting in early spring is also an option. By adding the amendments early, they will have time to become more incorporated into the soil over the winter months, and you avoid risking any poor germination or growth rates that result from improperly applying amendments too thickly in one area.

Learn how to apply the mineral nutrients. Adding too much of a single nutrient too heavily in one place can be detrimental and create a localized toxicity. This is particularly true when applying trace elements to the soil. Boron, as mentioned earlier, is a really important micronutrient, but it is needed in very small quantities, and can actually kill your plants if applied too heavily. Therefore, it is important to thoroughly mix and spread amendments so that you do not inadvertently apply too much in any one area and create a temporary, localized toxicity. An effective way to do this in smaller locations for dry mineral amendments is premixing minerals together in buckets or wheelbarrows, then spreading the nutrients by hand. Another option is to use a lawn seed or fertilizer spreader. Be wary of mixing minerals of different consistencies. Consider mixing powders and more granular mixtures separately to avoid over or under applying. Mixing small amounts of minerals with compost or humates can improve your capacity to spread them evenly and also help buffer them for the soil microbes.

During the growing season, you might also decide to add nutrition or particular fertilizers if you are aware of a problem in the field. There are several ways to do this during the growing season:

- **Fertigation**, or adding liquid fertilizers or mineral amendments through the irrigation water. Inexpensive systems can be used to pull liquid fertilizers from a bucket or similar container into the irrigation line. The end result is a slow, diluted release of nutrients across the irrigated land area. Examples of liquid fertilizers one might use during the growing season are fish or kelp fertilizers, sea minerals, or specific minerals tailored to different stages of growth. See the list of suppliers below for liquid mineral options. Fertigation can be done on a small scale by diluting an appropriate amount of liquid fertilizer or mineral amendment into a watering can for application.
• **Foliar sprays.** Foliar sprays are liquid nutrients or fertilizers that are mixed and sprayed on the surface of leaves during the growing season. Plants can absorb nutrients directly through the surfaces of their leaves as well as through their roots. If irrigation is not available, it can be a way for small and large growers to apply nutrition during the growing season. When foliar spraying liquid micronutrients, most pre-prepared products are mixed with humates, fulvic acid, compost tea or other materials to help buffer their impact on the plant leaf surface such as temporarily, yet substantially altering pH, and to prevent them from leaching or washing away. Because foliar feeding plants when the sun is out will burn leaves, it must be done either early in morning or late afternoon/early evening.

• **Side dressing.** Another strategy for adding nutrients during the growing season is to “side dress”, or add the nutrients (often dry amendments or fertilizers) on the surface of the soil. This is a much slower-acting method as you are directly feeding the soil to eventually support the plants. Often this is done in combination with compost, applied around the base of the plants or alongside a row of plants. You may use specific mineral amendments such at sul-po-mag, kelp, vegetable meals such as linseed, blood or alfalfa meal, potassium sulfate, or other reasonably fast acting materials to help address the specific needs of your soils and crops during the growing season.

**Sourcing mineral nutrients**

Here are a few places to source nutrients:

• NOFA Bulk Order: [www.nofabulkorder.org/product-category/amendments](http://www.nofabulkorder.org/product-category/amendments) (orders due end of January each year)
• Bionutrient Food Association Mineral Depots: [www.bionutrient.org/growers/amendment-suppliers](http://www.bionutrient.org/growers/amendment-suppliers)
• Fedco: [www.fedcoseeds.com](http://www.fedcoseeds.com)
• Soil technical assistance: [www.nofamass.org](http://www.nofamass.org)
• Rock dusts, greensand, azomite, carbonatite, sea water, lime
  o Advancing Eco Agriculture: [www.advancingecoag.com](http://www.advancingecoag.com)
  o Lancaster Agricultural Products: [www.lancasterag.com](http://www.lancasterag.com)
  o Agri-Dynamics: [www.agri-dynamics.com](http://www.agri-dynamics.com)
Soil is alive. In fact, it is a full ecosystem and, in one tablespoon of healthy soil, there are more microorganisms than there are people on this planet! These microorganisms provide a wide range of benefits to your plants. Mycorrhizal fungi, for instance, is the major communications and delivery system for plant roots. In exchange for sugars exuded from the roots, the fungi will literally mine nutrients for the plants that are otherwise inaccessible to them. These fungi also produce sticky glomalin, a carbon-rich glue that helps stick soil particles together and maintain aggregated soil structure. It is inside the soil aggregates that bacteria are able to fix Nitrogen, solubilize Phosphorus, and manufacture other compounds for plant health. And a more aggregated soil will be better able to resist erosion and weather extremes. By maximizing the conditions needed for mycorrhizal fungi and the other microorganisms of the soil food web to thrive throughout the season, you are increasing plant health, productivity, and quality of harvest.

**Consistent watering is important.** Plants and soil life need water. Consistent water moisture minimizes plant stress, keeps beneficial microbes alive, maximizes plant structure production, root growth, and disease resistance.

Some options for watering:

- **Efficient drip irrigation systems**: Timed drip irrigation systems can be very efficient, simple, and cost effective. See Curtis Stone’s resources on how to make the most of your drip irrigation: [www.theurbanfarmer.co/in-focus-drip-irrigation/](http://www.theurbanfarmer.co/in-focus-drip-irrigation/)

- **Sprinklers or other overhead watering** can be added to a site as long as there is water access and enough pressure to adequately distribute the water. If watering larger sections of land, consider a timer or some way to turn off the water after a certain point. One challenge for this method is that continually getting the leaves of certain plants wet, such as tomatoes, can encourage diseases to develop over time. Avoid wetting plant leaves, if possible. Additionally this method wastes a large amount of water due to evaporation.
• **Watering by hand:** Watering by hand is effective and a good way to take the time to observe the growing space. However, it can be very time and labor intensive depending on the size of the growing area and how dry it is.

• **Water for transplants and seeds:** If you are not able to water consistently, try to either time seeding or transplanting for a time it will rain or time your own watering at the time of seeding and transplanting. If you have limited water, add water to the transplant holes just before planting or to the furrows just before planting the seeds, then plant into those wet areas to ensure the roots or seeds will be surrounded by moist soil.

• **Rainwater collection:** Consider collecting rainwater for your growing space or to supplement your growing needs. Large surfaces like building roofs, sheds, or greenhouses can be excellent options for collecting rainwater. Take care to filter this water or avoid using it on low-growing edible crops if you have any concern about the water quality. Also consider raising rain barrels high enough to get water pressure for irrigation hoses. (For urban rainwater collection, refer to *Tool Box for Sustainable City Living* by Scott Kellog and Stacy Pettigrew and other resources.)

**Make water access a high priority.** If you are selecting a site, make water access a high priority, especially when growing in urban areas. Water access can be surprisingly expensive to install, but some cities do offer help for local growers to subsidize costs. Some local governing bodies may work to come up with creative solutions to make water access possible. Check with pre-existing gardening and farming organizations such as Food Policy Councils, local gardening groups, or urban agriculture resource extensions in your area to see if these resources are available to you.

**Maximize living roots in the soil for as long of the year as possible.** Living roots provide a home and food source for beneficial soil microbes. The more diverse the plantings are above ground, the more diverse the soil microbiology will be below ground. Consider a diverse planting, which may include perennials and annuals, fruits and vegetables, trees crops, and herbs. Perennials continue to have live roots in the soil year round, and make great borders and edible hedgerows.

**Reduce or eliminate tillage to maximize soil life and structure.** Tillage destroys soil structure, exposes soil carbon to oxidation, and destroys soil life. Consider no-till techniques, or ways to reduce tillage depth or frequency. For more information on no-till techniques and other soil carbon (aka soil building) practices, visit:

- [www.nofamass.org/carbon](http://www.nofamass.org/carbon)
- [www.nofamass.org/tags/carbon-sequestration](http://www.nofamass.org/tags/carbon-sequestration)
- [www.nofamass.org/audio/no-till-organic-gardening](http://www.nofamass.org/audio/no-till-organic-gardening)
Avoid synthetic fertilizers and pesticides. Many synthetic fertilizers break down soil structure over time and create acidic conditions in the soil that don’t allow soil macro and micro organisms to thrive. Synthetic fertilizers can also drive away earthworms, break down mycorrhizal fungi hyphae, prematurely age soils, strip important nutrients like calcium from the soil, and make soil more prone to compaction and erosion. Similarly, conventional pesticides, fungicides, and herbicides that are not approved for organic use, actively and sometimes indiscriminately kill many beneficial organisms in addition to the “problem” organisms. This leaves soils defenseless, and ironically, more prone to pest and disease pressure in future without the natural beneficial defense system in place. Avoid these products.

Adding inoculants or microbes into your soil. Adding good compost, worm castings, fungal seed or root inoculants, effective microbes, or compost teas can all be ways to improve the diversity of microbes in the soil. Some of these products such as fungal seed or root inoculants are relatively inexpensive to buy and difficult to make oneself. While other products are easy to produce at high quality on your own: worm castings, good quality compost, or compost tea. The Korean Natural Farming method, for example, provides techniques anyone can use to create your own effective microbes to help diversify microbes and their many benefits on your land. ([www.nofamass.org/search/node/Korean%20Natural%20Farming](http://www.nofamass.org/search/node/Korean%20Natural%20Farming))

Keep the soil surface covered year round. Watering is one way to add moisture to the soil, but consider also the value of conserving moisture and preventing the soil from drying out. By keeping the soil moist and protected, you can maintain thriving soil biology. Cover crops can be used in all seasons, even the New England winter, keeping the soil covered and photosynthesizing for as much time as possible.

Mulches and Cover Crops. Mulches and cover crops are useful in keeping the soil covered and providing a home for soil biology, which, in turn, will build soil structure, help with drainage, retaining soil moisture and nutrients. In order for the biology in the soil to thrive, it needs “food” and needs to be protected from extremes in temperature, flooding, or lack of water. That is where cover crops and mulches come in. Whether you use a straw or cardboard mulch that keeps the soil surface shaded and cool, perfect for earthworms and great carbon-rich food for beneficial fungi, or you use clover as a cover crop which can work together with nitrogen-fixing bacteria to provide you with free fertilizer, keep the surface moist and covered, support fungi and bacteria through root exudates as well as providing blossoms for native pollinators.
Remember that soil biology equals soil resilience, and therefore maintaining a highly functioning system is the key to helping your crops thrive. Keeping the soil covered, keeping living roots in the ground for as much of the year as possible, and minimizing physical, chemical, and biological stresses to the soil, can help maintain this important biological resilience in the soil.

**Common mulches may include (but are not limited to):**

- Straw
- Hay
- Cardboard
- Woodchips *
- Shredded leaves**
- Cocoa or rice hulls
- Seaweed
- Other more unusual mulches: used mushroom substrate, coffee grounds, compost, pine needles, corn husks, or recycle other similar “by-products” which may be available near you such as shredded paperco.

* Consider adding a layer of compost underneath wood chips for sandy or poor soils for best results.

** Avoid Black Walnut and Eucalyptus leaves, which contain plant-inhibiting compounds. These compounds can inhibit the growth of certain garden vegetables such as those in the nightshade family (tomatoes, peppers, potatoes).

To maintain appropriate carbon:nitrogen ratios in the soil, do not till in these mulches but allow earthworms and biology to access them at their own sustainable rate.

**Some thoughts on cover crops.** Cover crops can be used for many purposes. It is important to think through what you want from your cover crops before deciding on which ones you will plant. Farmers generally plant cover crops for the following benefits: reducing erosion, increasing organic matter and fixing nitrogen, increasing yields for the crop following the cover crop, controlling weeds, reducing compaction and generally building soil structure.

Nitrogen-fixing cover crops include hairy vetch, clovers (red, white, crimson), or peas, and may be a particularly good choice for depleted or sandy soils. Other cover crops with deep taproots might be good for aeration or building soil structure such as forage radish or daikon. Cover crops for building extensive root structure, soil protection in the winter, or soil structure include oats, rye (root-nematode prevention), sorghum-Sudan grass and buckwheat. Consider also the benefits of **cocktail cover crops**, or sowing multiple cover crops at once, with the idea that more diversity above ground equals more diversity below ground.
To have success with cover crops, identify what conditions they need to grow best: cool vs. warm, spring or summer or fall to overwinter. Do not try to grow cool season crops like oats and peas, for instance, in the heat of summer where buckwheat or sorghum-Sudan grass might give you better success.

In an urban or otherwise limited space, it can be hard to imagine solely dedicating part of your limited growing space to cover crops. If that is the case, you may consider getting the benefits of cover crops while simultaneously growing your main crops. **Interseeding cover crops** between existing rows of crops such as sowing clover seed (nitrogen-fixing cover crop) just before you plant corn transplants (a nitrogen-heavy feeder) into a row is a possibility. In this example, the corn will continue to grow tall and will benefit from the clover keeping the soil cool and moist around its shallow roots as well as providing the extra nitrogen fixed into the soil. Once the corn plants die back in the fall, the clover continues to feed the microbes in the soil with its living roots for a while longer until the winter months. Some farmers might also **consider choosing cover crops you can harvest**. Fava beans, for example, can produce a crop of tasty beans while simultaneously improving the soil.

Both the National Resources Conservation Service (NRCS) and the Stockbridge School of Agriculture through the University of Massachusetts have some excellent resources on cover crops, and are continuing to develop resources for growers to creatively incorporate cover crops into their planting systems.

**Common cover crops** (not limited to):

- Clover (white, crimson, red)
- Oats
- Rye
- Barley
- Wheat
- Hairy vetch
- Mustards
- Field peas
- Fava beans
- Sunflower
- Buckwheat
- Forage radish
- Turnips
- Sorghum-Sudan grass
To learn more about how you can manage soil health and go a step further, consider the 14 Spokes of Soil Health, a resource developed by National Resources Conservation Service (NRCS) on soil health. These 14 spokes are management principles and techniques to improve soil health:

1. Diversify Crop Rotations
2. Plant Cover Crops
3. Diversify Cover Crops
4. Maximize Living Roots
5. Grow Living Plants
6. Manage Carbon
7. Use Interseeding
8. Plant Green
9. Enhance Soil Armor
10. Manage Nutrients
11. Manage Manure
12. Manage Pests
13. Avoid Compaction
14. Integrate Crops and Livestock

To read more, visit the full publication at www.extension.psu.edu/publications/ee0174
Continue to build your expertise by integrating **workshops, mentors, and community support and connections** into your year and growing season. These resources can help you continue to learn and develop new goals while also continuing to produce food of higher quality and quantity. By staying connected to a network of support, challenges become opportunities to learn. A drought-filled summer, for example, might be an opportunity to host a workshop on irrigation and soil moisture retention strategies. There are many ways to enhance and build your own understanding and continue to become a better grower; and there are many benefits to being a part of a community of growers and local support. Take the time to go to education events hosted on other farms, farming and gardening conferences, or consider collaborating with education organizations such as NOFA/Mass to host events on your land or in a community center near you on topics you want to learn more about.

Connecting with a “farm mentor” throughout the season is another way to actively ask and tackle questions you or your organization might have during the growing season: from maximizing the health of newly planted seeds and transplants to improving soil conditions in a season extender such as a hoophouse or high tunnel, to identifying and dealing with new pests or diseases. Mentors can provide ongoing support to a community of growers. Mentors might be technical experts in a certain field such as soil fertility, or they could be local farmers who are experiencing the same growing season and local challenges you might also be facing. If you are a youth-run or community organization, consider hosting a workshop from an outside expert on a topic that is new to your organization, then inviting youth or community members to teach their perspective on that topic in the future. Education events and partnerships provide a unique way to collectively engage in challenges, support each other in the process, and build a deep connection to the land, the harvest, and our communities.
Having support to deal with the inevitable challenges can make an enormous difference to you as a beginning farmer or gardener, but it can also be useful for advanced growers to continue to learn new techniques, better connect with their community base, and more effectively deal with problems when they arise. In many ways, it is about creating the same kind of network above ground in our communities as exists below ground in the soil beneath our feet.

**Some Educational Opportunities to Check Out**

- NOFA Education Events, Winter and Summer Conferences  
  [www.nofamass.org](http://www.nofamass.org)

- Urban Master Gardening courses through the Boston Natural Areas Network  
  [www.thetrustees.org](http://www.thetrustees.org)

- Massachusetts Horticultural Society Master Gardener certification  
  [www.masshort.org](http://www.masshort.org)

- “Train the Trainer” Course in Springfield  
  anna@nofamass.org

**Many other organizations that exist to help:**
Extension services, NRCS, Food Policy Councils, other growing groups/non-profits/farms in your city.