Strength in Microbes: A Guide to Improving Soil Health

Samantha Taggart
Dedicated to all who are inspired by the things going on beneath our feet.

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A special thanks to my friend Thea for all of her help with the layout of this book.
Foreword

As farmers, we have a lot on our plates. Our focus is constantly shifting from seed purchases, to rotational planning, harvesting, obsessively checking what the weather is going to be like, and taking care of the most pressing tasks around the farm. Occasionally we’re able to take some time to repair damaged fences and equipment, reorganize the tool shed, update our records, or do any of the other many things that sometimes fall to the wayside on a farm.

But wait a second – stop focusing on all of that! Instead, I want you to walk outside into a field, stick your hand down, and bring up a fistful of dirt. For now, you can forget the rest, because for better or for worse, what you’re now looking at is your most important asset.

This is a guidebook written to benefit farmers, gardeners, and anyone else who is interested in the beauty that is the soil.
Part One:
Understanding
Soil Health

Healthy soils make for an abundant garden.
Why Care About Soil Health?

“The single greatest leverage point for a sustainable and healthy future for the seven billion people on the planet is arguably immediately underfoot: the living soil, where we grow our food.”
– Mike Amaranthus & Bruce Allyn, “Healthy Soil Microbes, Healthy People”

Soil is the medium for life’s support system. It is the foundation upon which we rely to sustain us. Out of the soil comes our food, which provides the nutrients that nourish us as individuals and as a civilization. The more we seek to improve long-term soil fertility, the more we are supporting a healthy, well-fed population in the future. Healthy, fertile soils lay the groundwork for a strong and resilient food system.

As farmers, we care deeply about the lands that we cultivate and want to keep them fertile for many years to come. However, for the past sixty or so years, our large-scale, “conventional” soil management techniques have largely ignored one the most fundamental requirements of the soil health – that is – life in the soil. Yes, life. Thriving, complex life. After all, you can’t sustain the planet on dead soil.

To see where our large-scale management of soils went awry, we must take a closer look at the history of agriculture in the last century. Beginning with the “Green Revolution” in the mid-1900s, conventional soil management techniques have focused on three things: N, P, and K (i.e. Nitrogen, Phosphorus, and Potassium). Fed by a fear of how to feed the world in light of massive population growth, the “Green Revolution” was a series of agricultural research and development initiatives that led to the specialization of crops, the intensive use of chemical fertilizers, fungicides, herbicides, and pesticides, and heavy tillage. Due to the heavy emphasis on

“technology transfer” programs at the time, the effects of the Green Revolution went far beyond the borders of the United States and impacted conventional agricultural techniques worldwide. There is no doubt that the Green Revolution produced a vast amount of food, however it was at the expense of the long-term vitality of the soil. As a result of these practices, many of the microbes that support the health of the soil have been eliminated from most commercial agricultural lands. The loss of life from the soil has been disastrous, resulting in decreases in soil fertility coupled with increases in soil erosion and nutrient runoff as well as many other repercussions. We now see more and more degraded lands because they lack the soil life that for hundreds of millions of years had helped to conserve and cycle nutrients and water for plants.

Yet, hope springs forth from the ground. We can heal our lands by putting life back into the soil. There are many ways to cultivate life in the soil, several of which will be discussed in this guidebook. This guidebook advocates a restorative approach to soil management through the reintroduction of essential microorganisms back into the soil.

Must be some good soil because that’s one happy spinach seedling!
What is “Healthy” Soil?

Healthy soil is living soil.

It is soil that is chalked full of different species of bacteria, fungi, earthworms, and other soil microorganisms that promote the growth of high-yielding and high-quality crops season after season. Soils that support a high diversity of microorganisms are better able to stave off different diseases and pest species that might otherwise harm crops. Think of the microbes in soil as you would the colonies of bacteria and other microbes that make up your own gut flora, which help to fight bad bacteria and viruses that enter your body. Cultivating a healthy population of microorganisms in the soil is like eating yogurt to restore intestinal microbiota.

Soil organisms are constantly interacting with one another as part of a larger soil food web. Sometimes these interactions are mutually beneficial, or symbiotic, as is the case with bacteria that live inside earthworms digestive systems to help decompose organic material. However there is also intense competition that occurs amongst the organisms living in the soil. Since there are a few species of soil organisms that can actually harm plants, this competition amongst species generally improves soil health because the “good” bacteria, fungi, nematodes, and insects are able to out-compete the “bad” ones. Following the advice of soil scientists Fred Magdoff and Harold Van Es, “one of the goals of agricultural production systems should be to create conditions that enhance the growth of beneficial organisms, which are the vast majority, while decreasing populations of those few that are potentially harmful.” Practices that farmers can employ to increase their populations of beneficial soil microorganisms will be discussed in detail later on.

Besides out-competing disease organisms that affect crops, soil microorganisms contribute greatly to soil health by breaking down organic materials to make nutrients available to plants. This is one of the most important functions of microorganisms in the soil. Soil microorganisms feed on crop residues as well as organic materials such as compost added from off the field. These organisms form an important link in the process of nutrient recycling. Without them, the cycle is broken and soils are left worse-off after each season. If this happens over a long period of time, soils become degraded and nutrients are lost through runoff and erosion. Reintroducing microorganisms into the soil along with the organic materials they feed on is one of the most important steps in the “development of sustainable agriculture and food security based on restored soil health.”

In addition to competing with disease organisms and making nutrients available in the soil, soil microbes also help to fix nitrogen in the soil, remove harmful toxins from the soil, increase water infiltration and retention, and much more! It is so pivotal to soil health to have a flourishing population of soil microbes doing their thing in the dirt.
Meet Your Microbes!

Each type of microorganism in the soil food web has a different role to play. It is valuable to understand the many ways that microbes can improve soil health.

**Bacteria**

Bacteria are by far the most prevalent type of organism in the soil. They were the earliest form of life on earth, and as such, have evolved to be a vital component in the life cycle of the soil. Bacteria are one of the first organisms to begin decomposing residues in the soil, making previously locked-up nutrients available to plants. A group of bacteria known as the actinomycetes is able to breakdown a molecule called lignin, which is found in plant tissue, especially stems, and is difficult for most organisms to break down.

Some types of bacteria also function to convert nitrogen in the atmosphere to a biologically-available form that plants can use to make amino acids and proteins. Since nitrogen is one of the most important compounds for the growth of plants, without a healthy population of nitrogen-fixing bacteria in the soil, the yield and quality of a farmer’s crop is likely to suffer.

Bacteria also play a role in nutrient retention in the soil. Bacteria help to retain nutrients that might otherwise be lost from the soil through leaching or nutrient runoff. Since the nutrients are retained in the cellular structure of the bacteria and the bacteria are attached to soil particles, “the nutrients remain in the soil instead of being washed away, as is the case with chemical fertilizers.” The nutrients remain immobilized inside of the bacteria until they are eaten by another soil organism such as a protozoa. Since most bacteria reside in the root layer or the “rhizosphere” in the soil, the nutrients are released directly where the plant can absorb them.

In addition to the roles previously mentioned, bacteria are often responsible for breaking down pollutants and toxins in the soil. You may have heard of bacteria being used to clean up oil spills along the coastline of oceans. Similarly, in a process known as bioremediation, bacteria have been used to remove contaminants from the soil by using them as an energy source in their normal metabolic processes.

There are two main categories of bacteria: aerobic and anaerobic. Aerobic bacteria thrive in well-oxygenated environments and tend to be the more beneficial types of bacteria to gardeners, helping with decomposition, bioremediation and the suppression of disease organisms. Anaerobic bacteria live in oxygen-depleted environments and tend to be pathogenic or disease-causing themselves. Since bacteria inhabit compost piles and soils, it is important to keep your compost pile well-aerated with a pitchfork or tractor (depending on the scale of your pile) and your soil full of aerating microorganisms to support the growth of aerobic rather than anaerobic bacteria.

More to come on that later.

**Fungi**

Much like bacteria, fungi play an active role in supporting the health of soils in a garden or farm. Fungi begin their life as spores and then grow into thread-like structures called hyphae. To give you
and plants. The second symbiotic relationship that fungi form is with plant roots. In this relationship, “micorrhizal fungi seek out water and nutrients and bring them back to the plant” in exchange for exudates (i.e. sugars released from plant roots to feed symbiotic fungi). Studies have shown that at least 90% of all plants form mycorrhizae, and that percentage is probably 95% or even higher.

Beneficial fungi can also improve soil health by competing for nutrients and forming “protective webs and nets, often in conjunction with bacteria, around roots” to prevent pathogenic and parasitic fungi from invading the plant. Both fungi and bacteria function as decomposers, nutrient cyclers, soil structure builders, and beneficial symbionts in the soil food web.

**Algae**

Algae are single-celled, thread-like photosynthetic organisms that inhabit moist soils. At one time algae helped to start the succession of life by serving as pioneer organisms, “growing on moist rock surfaces and, when they died, combining with weathered rock, and air, and water to form early soils.” Algae also creates soil by forming carbonic acids that cause rocks to weather. Once resultant bits of minerals combine with dead algae, this process eventually creates soil. Algae can also excrete polysaccharides, mucilage, and slimes, which help to build soil structure by binding and aggregating soil particles. Algae can also help to repair compacted soils by forming air passageways through the soil.
Slime Molds

Slime molds are strange-looking, amoeba-like organisms that live on damp, rotting organic material. Slime molds ingest bacteria, fungi spores, and small protozoa, “locking up the nutrients they contain and preventing them from leaching out.” In this way, slime molds help cycle nutrients and, as you can imagine by their name, help to bind soil particles together with the slime they excrete.

Protozoa

Protozoa are single-celled organisms that, in most cases, obtain their nutrients by ingesting bacteria and fungi and, on rare occasions, other protozoa. All protozoa require a moist habitat. By consuming other microorganisms, particularly bacteria and fungi, protozoa help to keep microbial populations in balance, make nutrients that were locked up inside of bacteria and fungi available to plants, and assist in the process of decay.

Nematodes

Nematodes are nonsegmented, blind roundworms that act as major consumers in the soil food web. Along with protozoa, nematodes help to mineralize nutrients that are contained in bacteria and fungi. Each species of nematode has developed a specific mouthpart to enable them to prey on specific organisms in the community of soil organisms. Nematodes eat bacteria, protozoa, algae, and other small members of the soil food web such as slugs. In this regard, they can be used to control populations of pest species in a garden. Mineralization is one of the most important functions that nematodes perform in the soil food web.

Arthropods

Arthropods make up the largest animal kingdom on the planet and include most animals that we generally lump together as “insects” or “bugs.” This includes spiders, mites, centipedes, beetles, and flies, as well as many others. All arthropods have in common an exoskeleton made from chitin, which is the same material that makes up the walls of fungus cells. In addition to being food for other members of the soil food web, “soil arthropods are important to the community as shredders, predators, and soil aerators.” The presence or absence of arthropods can tell a farmer a lot about the health of his or her soils.

Arthropods help to increase fungal and bacterial activity by chewing up organic matter and creating smaller pieces for those other microbes to decompose. As they move about, arthropods also help to transport microbial life attached to their bodies to other parts of the soil. Additionally, in a similar manner to protozoa and nematodes, arthropods eat fungi and bacteria, helping to release nutrients back into the soil.

Earthworms

Earthworms are one of the most important organisms to have in a garden or farm. There are about seven-thousand or so species of earthworms common to good garden soils. As crazy as it sounds, “an acre of good garden soil contains 2 to 3 million earthworms (anywhere from 10 to 50 per square foot),” and believe it or not,
“this crew is capable of moving an astonishing 18 tons of soil a year in search of food.”

The role of earthworms on a farm is key. These creatures are crucial players in the shredding of organic matter, the aeration of soil, the aggregation of soil particles, and the movement of organic matter and microorganisms throughout the soil. Earthworms primarily feed on bacteria and thus soils with large populations of earthworms tend to be bacterially dominated. To a lesser degree they also feed on fungi, nematodes, and protozoa, as well as organic material present throughout the soil. Earthworms depend on the bacteria that reside within their intestines to digest the food that they consume.

Perhaps the most important contribution of earthworms to the health of the soil is their poop, or more elegantly stated, their “vermicastings.” Soil that has passed through the intestine of a worm is 50% higher in organic matter than soil that has not moved through worms. That is an astounding increase in organic matter! The processing of soil through the digestive systems of worms greatly increases the cation exchange capacity (CEC) of soils. The cation exchange capacity of the soil is an extremely important term to farmers and gardeners because it describes the capacity of soil to hold onto nutrients. Soil with a low CEC will lose nutrients rather rapidly in the form of runoff and leaching and will thus become degraded more quickly or require the use of amendments more often than soil with a high CEC. Soils with a higher CEC are able to hold onto more nutrients and are better for growing plants.

The burrowing and tunneling of earthworms deep into the ground creates air pockets or “pores” throughout the soil that help with water infiltration, air passage, and root development.

A thriving population of earthworms in a garden or farm is a clear sign of a healthy food web community since these organisms wouldn't be there without the support of organic matter, bacteria, fungi, protozoa, and nematodes. In essence, we love worms and all that they do.

**Gastropods**

Gastropods, Greek for “stomach-foot,” include some 40,000 species in the order Mollusca. As their name would imply, the body of a gastropod is basically “one big foot that does a lot of eating.” Gastropods include two organisms that many of us are probably very familiar with – snails and slugs. Garden slugs and snails are nocturnal, most likely because nighttime is the time when soils are the moistest and these organisms have high moisture requirements. Many people think of snails and slugs as merely a nuisance in the garden. However, when their populations are controlled by other members of the soil food web, slugs can actually play a beneficial role in the soil. Besides eating living organic material (like your lettuce and kale crops), snails and slugs also graze on fungi, algae, lichens, and rotting organic matter. Snails and slugs can help to “speed decomposition and decay by shredding their food before they consume it.” Moreover, much like earthworms, the underground channels that snails and slugs create when looking for food sources in the soil generate pathways for air, water, and roots. The slime that snails and slugs produce also helps to bind soil particles, increasing both nutrient and water retention.
Part Two:

Building and Maintaining Life in Your Soil

Now that we’ve discussed the many benefits that the presence of a diverse community of organisms can have to the health your soil, it’s time to talk about how YOU can revitalize your soil…

See anyone you recognize? Here’s a hint...he’s brown and squirmy and is known for his castings...
4
Where to Start: Getting a Closer Look at Your Soil

The first step to creating any kind of positive change is to try to understand the complete picture. In terms of changing your soil management practices so that they promote life in the soil – the first step should be to get a closer look at what's going on in your soil.

The normal route for assessing the health of your soil is to take a soil test either through your local cooperative extension office or a private company. There is no doubt that these tests can provide you with useful knowledge about various components of your soil such as pH, organic matter content, micronutrient and macronutrient availability, and cation exchange capacity. However, for the purpose of determining how full of life your soil is, it may be more helpful to take a hands-on, DIY approach to assessing the health of your soil.

First, take a minute to consider whether or not you’ve been observing trends on your farm that might indicate that your soil is lacking in life…

Are your yields declining?

Is your soil obviously compacted? Is it hard to work with, and/or plant into?

Does the soil crust over easily? Have you been observing signs of runoff and erosion?

After a big rainfall, have you noticed the pooling of water throughout your beds and fields?

Have you noticed an increase in problems with diseases, pests, or nutrient stress?

If the answer is yes to any of these questions or if you have general concerns about the health of your soils, read on!

There are several tools out there to help you assess the health of your soils. Many of them are in the form of “soil health scorecards,” that help you to identify key limitations or problems in your soil and make changes accordingly.

Here are the links to two very helpful soil health scorecards:

The Cornell Soil Health Assessment Training Manual:
http://soilhealth.cals.cornell.edu/extension/manual/1basics.pdf

Wisconsin Soil Health Scorecard:

Additionally, the following pages (18-19) contain a table adapted from the book “Building Soils for Better Crops” that may help you to assess the health of your soils.
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Best Assessed</th>
<th>Poor Quality</th>
<th>Medium Quality</th>
<th>Good Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworms</td>
<td>Spring/Fall</td>
<td>0–1 worms in shovelful of top foot of soil. No casts or holes.</td>
<td>2–10 in shovelful. Few casts, holes, or worms.</td>
<td>10+ in top foot of soil. Lots of casts and holes in tilled clods. Birds behind tillage.</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>Moist soil</td>
<td>Topsoil color similar to subsoil color.</td>
<td>Surface color closer to subsoil color.</td>
<td>Topsoil clearly defined, darker than subsoil.</td>
</tr>
<tr>
<td>Color</td>
<td>Anytime</td>
<td>No visible residues.</td>
<td>Some residues.</td>
<td>Residues on most of soil surface.</td>
</tr>
<tr>
<td>Organic Matter Residues</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root Health</td>
<td>Late spring (rapid growth stage).</td>
<td>Few, thick roots. No subsoil penetration.</td>
<td>Off color (staining) inside root.</td>
<td>Roots fully branched and extended, reaching into subsoil. Root exterior and interior is white.</td>
</tr>
<tr>
<td>Subsurface Compaction</td>
<td>Pre-tillage or post-harvest. Good soil</td>
<td>Wire breaks or bends when inserting flag.</td>
<td>Have to push hard, need fist to push depth of flag in.</td>
<td>Flag goes in easily with fingers to twice the plow layer.</td>
</tr>
<tr>
<td>Moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Tilth Mellowness</td>
<td>Good soil moisture.</td>
<td>Looks dead. Like brick or concrete cloddy. Either blows apart or hard to pull drill through.</td>
<td>Somewhat cloddy, balls up, rough pulling seedbed.</td>
<td>Soil crumbles well, can slice through, like cutting butter. Spongy when you walk on it.</td>
</tr>
<tr>
<td>Friability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erosion</td>
<td>After heavy rainfall.</td>
<td>Large gullies over 2 inches deep joined to others, thin or now topsoil, rapid runoff the color of soil</td>
<td>Few rills or gullies, gullies up to 2 inches deep. Some swift runoff, colored water.</td>
<td>No gullies or rills, clear or no runoff.</td>
</tr>
<tr>
<td>Water Holding Capacity</td>
<td>After rainfall. During growing season.</td>
<td>Plant stress two days after a good rain.</td>
<td>Water runs out after a week or so.</td>
<td>Holds water for long period of time without signs of drought stress.</td>
</tr>
<tr>
<td>Drainage Infiltration</td>
<td>After rainfall.</td>
<td>Water lays for a long time, evaporates more than drains, always very wet ground.</td>
<td>Water lays for a short period, eventually drains.</td>
<td>No ponding, no runoff, water moves through soil steadily. Soil no too wet, not too dry.</td>
</tr>
<tr>
<td>Crop Condition (How well it grows)</td>
<td>Growing season. Good soil moisture.</td>
<td>Problem growing throughout season, poor growth, yellow or purple color.</td>
<td>Fair growth, spots in field different, medium green color.</td>
<td>Normal healthy dark green color, excelent growth all season, across field.</td>
</tr>
<tr>
<td>pH</td>
<td>Anytime, but at same time of year each time.</td>
<td>Hard to correct for desired crop.</td>
<td>Easily correctable</td>
<td>Proper pH for crop.</td>
</tr>
<tr>
<td>Nutrient Holding Capacity</td>
<td>Over a five-year period always at same time of year.</td>
<td>Soil tests dropping into “low” category.</td>
<td>Little change or slow down trend.</td>
<td>Soil tests trending up in relation to fertilizer applied and crop harvested but not into “very high” category.</td>
</tr>
</tbody>
</table>
How to Put Life Back Into Your Soil

Putting life back into your soil is not like adding a one-size-fits-all dose of chemical fertilizer, pesticide, or amendment to the soil. It takes time and dedication to cultivate a healthy soil ecosystem and the benefits are much more robust and long lasting than they would be from a single amendment. Fear not though, my friends, there are many ways to put life back into your soil and they happen to be pretty interesting and fun to take on!

Compost

In its most basic sense, composting is the process of recycling nutrients. Good compost contains a whole world of different organisms. This is key when trying to build up the diversity of life in your soil. Properly made compost contains all of the microorganisms that make up a healthy soil food web as well as the organic matter upon which they depend to survive. Once added to your land, the organisms present in compost will take off in the soil, spreading life wherever they go.

There are three critical factors to consider when making compost – those are - carbon-to-nitrogen ratio, air, and moisture.

The key to making good compost is getting the Carbon to Nitrogen (C:N) ratio correct. This is because the real ones doing all of the work in your compost pile are the soil microbes and they have very specific dietary requirements. If there is too much carbon present in the pile, soil microbes will quickly use up the nitrogen and the decay process will slow down. Conversely, with too much nitrogen, carbon will be “vented to the atmosphere or mixed with water and washed out of the pile.” Scientists recommend a ratio between 25:1 to 30:1 of C:N to successfully feed your soil microbes and thus make wicked good compost. Compost can be manipulated so that the end product is highly fungal or highly bacterial, depending on the preferences of the plants that you’ll be using the compost to grow. To increase bacterial populations in your compost, simply increase the fresh, green materials (e.g. fresh-picked weeds) in your compost pile. These materials are good nitrogen sources and preferred by bacteria. In order to increase fungal populations in your compost you can add more brown materials (e.g. autumn leaves, twigs, branches), which are high in carbon. These materials are made up mostly of difficult-to-digest lignin, cellulose, and tannin, which fungi have the enzymes needed to digest.

Composting is a great way to put life back into the soil.
Compost should also be well-aerated. On a larger scale, this can be done by using a tractor to turn your compost at least once a week. On the scale of home gardening, compost can be aerated using a pitchfork to turn the pile and cover fresh materials that have been added to the pile. The size of your compost pile also has to do with the air that will be able to reach the inside of the pile. A larger compost pile will have to be turned more often in order to keep the pile from becoming anaerobic. In order to generate enough heat to support bacterial populations within the pile, a compost pile should be at least one cubic meter (3.5 feet square) in size.\(^2\)

Also important for creating a good compost pile is moisture content. In order to maintain an aerobic environment for your soil microbes, the compost pile should remain at a moisture content level of 40-60% by weight. Any wetter than that and you’ll wind up with quite a foul-smelling pile of compost. A handful of compost should feel slightly moist and clump but not release any liquid when squeezed nor stick to your hands.

### Mulch

Mulch is any type of material that can be placed on top of the soil to help retain moisture, suppress weed growth, and insulate plants. Organic mulches are “mulches that come from things that were once alive and can be recycled back into nutrients by soil food web organisms.”\(^2\) These include materials such as leaves, grass clippings, bark, wood chips, straw, and plant debris. In addition to the benefits of mulching that have already been mentioned, mulching also provides nutrients and habitat for several types of soil organisms that can improve the health of soils.

As was the case with compost, different mulching materials support different types of soil microorganisms. It should come as no surprise that a mulch of aged, brown materials contributes more fungi to the soil ecosystem, whereas a mulch of fresh, green organic materials supports more soil bacteria.

One must be careful in the world of mulching, however, because if done improperly, mulching can actually result in nutrients being tied up rather than released to the soil. If the carbon to nitrogen ratio of the mulch that you are using is 30:1 or greater, the microbes inhabiting the mulch layer will first use up the nitrogen in the mulch and then, once that is gone, start robbing nitrogen from the soils touching the mulch. This process is called “immobilization” and can be avoided by making sure the woodchips (or any other materials) that you are using to mulch are at least 3/8 inch or larger. This lowers the bacterial colonization that you would see in smaller wood chips and bacteria are the ones that would be doing the most immobilizing of nitrogen.

### Compost Tea

Compost tea holds a key advantage over the other two methods previously mentioned when it comes to putting microbial life back into the soil. While adding microbes to the soil via composting and mulching takes a while to impact the rhizosphere (or root zone) of the soil, compost tea can be applied right where it is needed. Compost tea can be applied to the soil or directly to the leaves of plants. Moreover, there is no such thing as using too much compost tea. It will not burn plant roots or leaves.

To give you an idea of how concentrated the population of microbes is in a well-made compost tea, if compost contains 1 billion bacterium, a teaspoon of the tea made from it will have upwards of 4 billion bacterium. That’s a lot of microbes!

One of the most beneficial types of compost tea being brewed today is called actively aerated compost tea (AACT). This compost tea is made by “adding compost (and some extra nutrients to feed its microbes) to dechlorinated water and aerating the mix for one or two days.”\(^2\) This ensures that the mixture contains a safe concentrate of beneficial, aerobic microbes.

Actively aerated compost tea is made using a brewer, which can either
be purchased commercially or, in a more DIY fashion, made at home. All you need to make your own compost tea brewer is a five-gallon plastic bucket, an aquarium air pump and air stone, and about four feet of plastic tubing.

A general guideline for how much compost tea to apply to your soil is five gallons of compost tea per acre. If in addition to applying it to the soil, you are applying it directly to the leaves of plants then that number changes to ten gallons per acre. In addition to thinking about quantity, we should consider the timing of compost tea application. If your soil has “had applications of chemical fertilizers for years, you should put down compost tea every other week for three months to establish a healthy soil food web population.” After that, you can start applying the tea once a month for a season and then move to three times a year. Note – ultraviolet rays kill microbes and thus you will want to apply compost tea either in the early morning or late afternoon in order to ensure that you do not loose your microbial stock.

Compost tea can be used to treat specific disease organisms – remember how you can alter your compost to support more fungi or more bacteria depending on what you put into it? As an example, fungally dominated compost teas have been used to prevent and suppress the growth of powdery mildew, downy mildew, and rusts.

Once you have built up the microbial populations in your soil, it will be important to implement practices on your farm that support them. Why go through all that work of cultivating life in your soil just to see it die off from the application of chemical fertilizers or the use of heavy tillage each season? Below is a list taken from “Building Soils for Better Crops” that shows what kinds of practices enhance soil diversity and what kinds of practices degrade it.

**Practices that promote a balanced soil ecology (i.e. healthier soil and greater biodiversity):**

- Low disturbance
- Practices that reduce soil compaction (stay in paths, out of beds)
- Direct seeding
- Permanent planting
- Cover cropping
- Crop rotation
- Residue cover
- Building organic matter
- Enhanced moisture conservation (through mulching)
- Timely irrigation management
- Sufficient soil fertility/slow nutrient release (i.e. compost rather than chemicals)
- Use of manure/composts
- Maintenance of a neutral pH
Practices that lead to species imbalance (i.e. unhealthy soil and prevalence of pest/disease species):
- High disturbance
- Tillage
- Burning
- Steam sterilization
- Monoculture
- Overgrazing
- Using fumigants, herbicides, fungicides, and/or insecticides

By now we have discussed why cultivating an abundance and diversity of life is so crucial to the health of the soil. Life begets life. The organisms present underneath the ground are the true enablers of plant growth. Soils that are depleted of life are put at a great disadvantage when it comes to nutrient cycling and retention, water infiltration, disease suppression, and many other processes that contribute to soil health.

As folks who care deeply about the lands we cultivate, we must begin to pay more attention to the complex life that exists beneath us. We must foster that life by building up diversity in the soil through methods such as compost, mulch, and compost tea. We must maintain that life by employing practices that enhance rather than degrade the soil ecosystem. Ultimately, it is the soil that sustains us and it is our greatest responsibility to care for its health.
Resources


About the Author

Sam Taggart graduated from the University of Virginia with a Bachelors of Arts in Environmental Thought and Practice, an interdisciplinary major that encourages students to look at environmental issues from a sundry of perspectives. Her major allowed her to explore the ethical as well as environmental dimensions of our current food crisis and develop a more robust understanding of what’s going on in modern industrial agriculture.

While at U.Va., she managed a one-acre student garden on Morven Farm. The garden is entirely student-run and uses crop rotation, polyculture, drip irrigation, and organic compost in an attempt to produce a sustainable food system that builds soils rather than depletes them.

Through her fellowship at the Allegheny Mountain School, she hopes to become an agricultural steward of the earth and learn how to carry out the values of community, healing, interconnectedness, and love in the ways all creatures interact with each other and with the Earth.