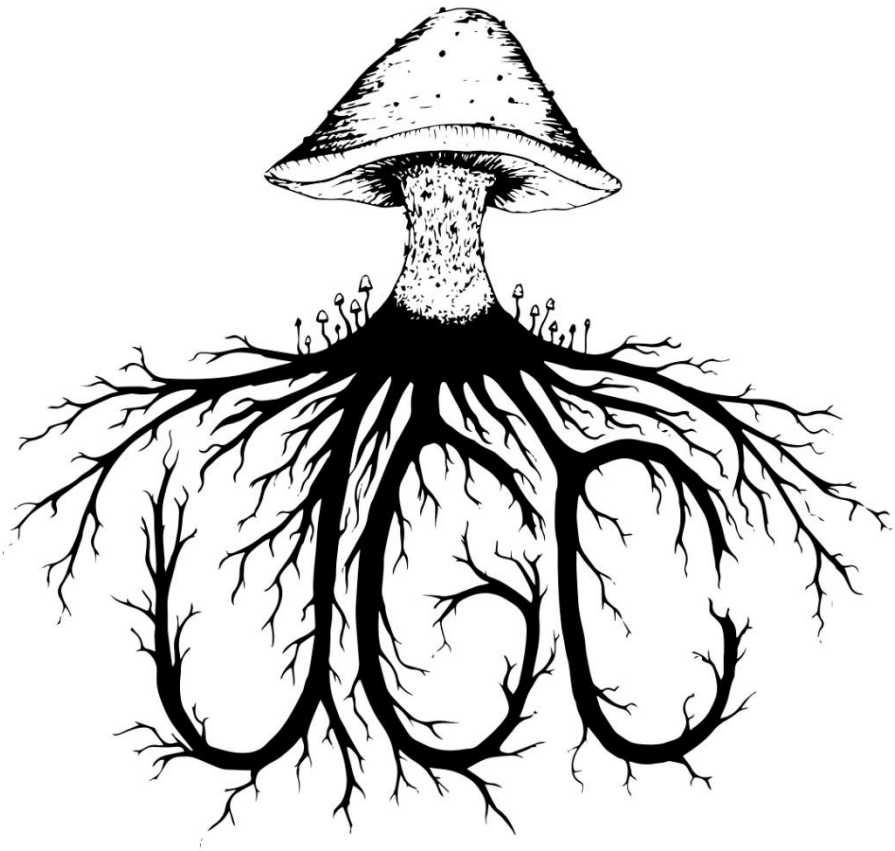
Creating and Maintaining Garden Beds



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The Underground Center

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All UGC artwork by Katie Fisher

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Garden bed overview:

At this moment folks are eager to make gardens. This is good. The current pandemic has shown a small glimpse of the types of threats to food security that the future will bring. At The Underground Center, we are developing and implementing techniques of creating fertile garden beds. Some of the methods we've been practicing for a decade, others are ongoing experiments. Like the rest of our "resilient infrastructure," the idea behind these garden beds are that they can be created by people without expertise, with materials sourced from our community, and require little to no fossil fuels (trucks to deliver materials help if you want things going quickly). Maintaining these garden beds once they are established is easy if we incorporate the habits of soil building in our everyday lives.

What we are offering with this text

This text is not an all-encompassing guide to making a garden or developing food self-sufficiency. There are some good resources out there for that. The folks at Soul Fire Farm recently published a book called *Farming While Black*. It is a thorough break down of every aspect of farming and an accessible DIY manual. It covers a spectrum of growing styles and scales but has a slant toward mid-scale commercial growing. There is also a great book by John Jeavons called *How to Grow More Vegetables Than You Ever Thought Possible On Less Land With Less Water Than You Can Imagine* that breaks down the bio-intensive method of farming. This is a solid resource to start gardening to feed yourself and your family in various climates. The info in Jeavons' book is framed around growing a lot of food in a small space.

What we, as The Underground Center, can contribute is sharing what has worked for us as we develop appropriate subsistence farming practices in our area. We have been transforming land into gardens at the foot of the Catskill mountains and in the Mid-Hudson Valley for a decade. During this time we've tried out lots of different techniques for creating fertile soil and growing enough food to survive off the land. We learn more every year about how best to feed our community.

Creating garden beds in the Catskill region can be challenging. Most of the soil we've encountered is clay with more rocks than dirt! There are some pockets of fertile land and lots of lawns that could easily be transformed to gardens. Generally speaking, if you apply the methods in this text, you can grow food anywhere as long as you have decent sun exposure and are not in a total swamp.

In the following pages we will articulate why we think soil building is important and the basic principles and techniques that guide our methods of creating garden beds. Lastly, we will share case studies of gardens that have proven successful, have become more fertile over time and continue to grow food to this day. Over the last decade of growing food, we've tried various garden beds, settling on 3 different styles that we'll lay out.

Why creating gardens is important

Topsoil is one of the most important resources on the planet for human survival. Industrial agriculture and reckless land use are destroying soil globally at an alarming rate. Without healthy soil, plants can't grow, water runs off quickly into the oceans, floods have a huge impact on our infrastructure and erosion washes away precious nutrients for growing food. In short, if soil dies, we die (if you think this is an overstatement read up on Easter island, the Ancestral Puebloans, fall of the Han dynasty, the dust

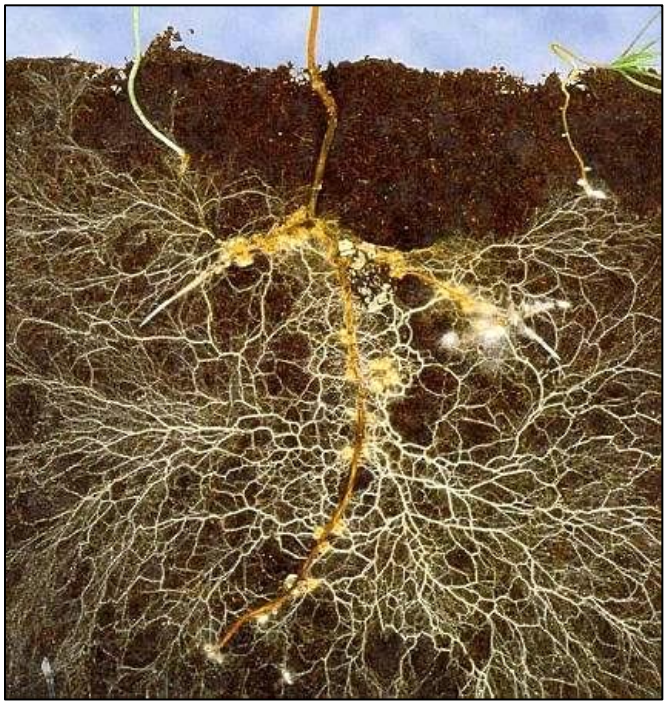
bowl in the US, or the current civil wars in Syria and Yemen). One of the most important things we can do as a society is protect the soil.

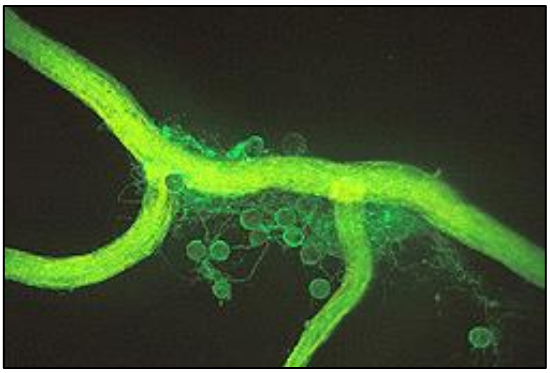
It would be great if our ancestors had been lovingly cultivating and nourishing soil for generations like the great "Bouwerie" of maize the Lenape were cultivating north of the village of Saugerties in the centuries prior to 1700. Or how the entire Rondout in Kingston was a beautifully tended, massive garden managed by the Esopus Indians before Dutch traders destroyed it to make a port to ship lumber and animal pelts to Europe. That way we could simply pick up where our elders left off and protect the soil that provides food to us. Unfortunately, this is far from reality. Instead we have parking lots and lawns. So we need to start creating soil from scratch in our communities. Maybe we can leave our children with something they can continue to nourish after we pass.

Healthy soil and climate change

As we've pointed out in our first e-book (*Composting: Foundations of a Nourishing Food System*), building soil is probably the most effective way to address climate change. This is true as a mitigation strategy (preventing damage) and as an adaptation strategy (dealing with damage). Healthy soil, with lots of plant life growing in it and organisms living below the surface, is a great way to pull carbon out of the air.

Most of us are familiar with how a tree absorbs Co2 and converts it to the wood that makes up its' body. Yet another organism that thrives in soil rich in organic matter is fungi. The "roots" of fungi (mycelium) do an incredible job of decomposing organic material and trapping it in the soil. Mycelium has a substance called *Glomalin* along its surface. This gooey substance is what makes good soil stick together when you squeeze it in your hand. It traps lots of carbon and can last for up to 40 years in the soil. The more mycelium spread throughout the soil (which we promote with our techniques of soil building) the more carbon is in the ground and not in the air. This is the ideal mitigation for our industries that spew carbon recklessly into the atmosphere





Left: Mycelium throughout the soil, connecting plant roots to nutrients and water deep in the soil

Top: photo of Glomalin on the hyphae (hairs) on the Mycelium

All this thriving soil biota and carbon beneath our feet is also a great adaptation for the negative affects of climate change coming down the pike. Major storms are going to be more frequent and they bring torrents of water in large bursts. Healthy, spongy soil can absorb many times more water than soil devoid of biota (let alone a road or parking lot). This can make all the difference in a flood and will minimize damage to our lives and infrastructure.

The most obvious adaptation strategy that healthy soil brings is its potential to provide food for us and our community. As fossil fuel becomes less readily available and income streams are interrupted by economic, climate, and disease crises, capitalist farmers and distributers won't have incentive to ship food to our communities. It will be more profitable for them to throw out their food than distribute it.

Farmers in Florida dumping zucchini and squash on the ground because restaurants are closed due to the pandemic. Meanwhile, food banks are struggling to meet demand (4/1/2020)

Joe Raedle/Getty Images

As exploitation capitalism contracts and eventually collapses, so will the food it provides to our local grocery stores and restaurants. Poor folks, and Black and Brown neighborhoods have always dealt with food deserts. Government subsidies and secure middle-class jobs have always been hard to find for the rural poor, but this is becoming true for more and more people. Soon inequality (a distribution issue) will become poverty (a production issue). Class, Race and Settler privilege won't buy us out of contributing to growing food. Why wait for collapse when we have the window of opportunity to make an egalitarian and ecologically sound system? Why exploit when we can Nourish right now?

Healthy soil helps individuals

If appeal to our collective social and ecological wellbeing isn't working (it rarely does), let's try a different approach: *Individual benefit*! At the UGC working the land, turning food and yard waste into fertile soil, creating personal relationships with plants, eating vegetables coaxed from the earth with our bear hands, and working together with people across generations and demographics has had incredible benefits on our physical and mental health. **Being outside in the sun and using your entire body to provide food for your family and community makes you strong and feel good about yourself.**

A lack of purpose is the root cause of many of our problems in society. Self esteem is hard to come by when we are told to "do something we love" instead of "do something that helps your community." We aren't taught how to be good in concrete terms, we aren't given opportunities to use our minds and our labor in ways that benefit ourselves, others and the systems that sustain us simultaneously. This wears on our sense of self-worth and overall mental health, which in turn destroys our bodies and then cripples our communities. We can think of no better activity to help build a sense of individual purpose and promote connection to community than building soil, growing food and feeding each other. This is not toil, it is a life of meaning.

Building gardens for community food security:

We believe food security should be a priority for everyone and should be taken seriously. "Business as usual" has transformed to "a long decline" with a possible collapse in our lifetime. Regardless of the future, the world would be a better place if we shaped our communities around growing and sharing food. It would benefit kids and old folks most of all. There would always be meaningful work for our anxiety ridden population. We have the resources and ability to create food infrastructure in our communities. There is ample land in our neighborhoods, we don't have war in our backyards, there aren't thousands of refugees that need homes in our neighborhoods yet. We should take advantage of this window and prepare for when these things are a reality.

From our experience, it takes three years to make fertile garden beds. After that they only require routine maintenance to have indefinite fertility. We believe that these techniques, if applied on a community wide scale, could feed everyone in our town. This community food approach can be the foundation of a nourishing, need based economy. If scaled up, where each community relies on mutual aid and transforms patch works of land into food infrastructure, we could achieve food sovereignty. This would be a resilient way of surviving the inevitable decay of the capitalist industrial food system and the uncharted climate chaos that looms in our future.

How to Make Garden Beds!

OK, now that we are done ranting and raving about the end times, lets talk about how to make garden beds! In this section we will point out considerations for sighting gardens, common attributes of our local soil, techniques to amend and maintain soil beds, and considerations for design.

Where to make a garden:

Sun: It is possible to make soil in most places, but you absolutely need sun for a garden to grow. If your garden is in the shade all day, pick a different spot. Partial shade (6 hours or less of sunshine) is going to produce stunted crops. In this situation, you would be better off using the site for shade plants or to make compost and find a friend with a sunny spot to share for garden beds.

Water: You also need to make sure you have water access. If there is no hose or stream nearby, you can build a structure and a rain catch. Otherwise it's going to be very hard to grow. We have had success with only the rain as our water source, but I wouldn't depend on this if you can avoid it. Without consistent water access, you could try to convert the space into a wildflower, clover, or perennial herb patch instead.

Access: Another important thing to consider is access to the site. Does the site have all the materials you need to build soil? If not, can you get a truck or trailer in the space or close by? Can you get a wheelbarrow to the garden from a road?

Contamination: Is the area you want to make a garden contaminated with lead or other chemicals? If you do a soil test and find out the soil is contaminated there are options. There are remediation strategies for dealing with contaminated soil. For example, diesel fuel evaporates into the air when you disturb the soil and lead can be removed by planting sunflowers and then bringing the sunflowers to the dump. A better option though, is to find a different location or build up soil in a raised bed or lasagna bed and get the roots away from dangerous chemicals.

Pests What kind of animals are around that might want to eat your garden produce? Deer and groundhogs are the most aggressive garden pirates that we've encountered, but squirrels, rabbits, moles and even mice can cause problems as well. Are you going to need a fence? Aside from one garden in the middle of town, we've always had to build a fence to protect the garden.[1]

Locations where we frequently make gardens:

Lawns to garden: Lawns are extremely destructive to ecosystems and require a wasteful use of resources to "maintain". The bizarre concept of a lawn arose in medieval Europe as a status symbol showing that you were privileged enough to not have to use land for a home or growing food. It was a demonstration of wealth through waste! With the advent of the modern suburb, this trend has become endemic. We've introduced the most widespread monocrop, grass, which we dedicate massive amounts

[1] Some crops like garlic and onions are safe from pests.

of time, water and fossil fuel resources to maintain.[2] What is the purpose of this? Is it useful in any way shape or form? Is it beautiful? The lawn is one of the most irrational trends of land use in our society.

if you have your own lawn, you can convert it to something that is useful. The space has already been cleared and the ecosystem destroyed – here is your chance to revive it! There are lots of lawns out there and if we transform them into food growing spaces we can feed everyone in our community. If you can't do the work yourself, maybe someone in your neighborhood can help you, and you can share the produce with them. Better yet, you can bring the crops it to a food share, or crop swap (there is one that the Long Spoon Collective organizes in Saugerties throughout summer and fall)

Lawns are a great place to start if you're making a garden. They often have sun. They are close to the utilities of the house. They are easy to access. And the farmer lives nearby. Take the labor you waste maintaining the lawn (or worse, money you pay someone to maintain) and turn your lawn into a mini-farm.

Reclaim forgotten gardens/farms: Something we've encountered frequently in this area are gardens that fizzled out. People often get excited about the concept of growing food without figuring out how to make it a priority in their lives. If you spot one of these abandoned projects, you might be able to jumpstart it. Sometimes these spaces already have fences and other infrastructure. The soil can probably be coaxed back to life with a little weeding and compost. If you're really lucky, there might even be wheelbarrows, shovels and rakes that come along with the garden space!

Forest to garden: A third possibility is to carve a garden out of the forest. It might sound counterproductive from an ecological perspective to cut down forest to make gardens, but if done right, in conjunction with responsible forestry techniques, it can actually enliven the forest. Careful land management can improve an ecosystem for plant and animal life. Many forests have grown back from being cleared in the last 40 years or so and are overgrown with massive pine trees. With thoughtful clearing, done without the destructive treads of big machines, a beautiful garden can be formed out of the forest and the tree life diversified.

The woods have all the ingredients you need to make beautiful soil as well as an abundance of lumber and other materials for raised beds, trellises, wood chip paths, stone walls, fences, etc. Also, if combined with housing, workshops, lumber production, material storage and greenhouses, a small clearing in a forest can meet many needs without doing much harm (if any). Eventually we would love to document our process of changing the land we steward, Shagbark Garden, from a completely wooded 22 acres to a flourishing educational garden site.

Although making a garden from a forest can be a great project, we don't suggest this unless you are really committed to many years of work. We've seen people get excited about the idea of growing food, pay someone to cut down a bunch of forest and drain wetlands to prepare a growing site, then lose interest. The result - all that habitat for frogs, waterfowl and other forest animals disrupted for nothing. This is not cool!

[2] Some tech-enthusiasts might retort that they don't waste fossil fuels because they have an electric mower. But where does that electricity come from? If you don't have solar panels, there a good chance coal, oil or natural gas are supplying electricity to your outlet!

General issues in local soil

There is a difference in soil conditions from the foothills of the Catskill mountains to the area closer to the Hudson River, but we have found some common themes with the soil we've encountered in this area.

Acidic soil:

We find a lot of soil is acidic. A common tree species near most gardens is the white pine. After all the forest was cleared in this area for the leather tanning industry and then the bluestone quarry industry, the quick growing white pines dominated the forest. The roots of the pine tree and its' needles create acidic soil.

To deal with this you can try to make the PH more basic by applying maple leaves as a mulch or in your compost. The most affective method for making soil less acidic quickly is applying hard wood ash. This also adds potash to the soil. Ideally this is done the fall before you plant.

The other solution to acidic soil is planting acid loving crops! Potatoes, peanuts, sweet potatoes, corn, beans, cucumbers, blueberries, blackberries, onions, and garlic are just some examples of acid loving plants. Damn near all the best crops!

Clay:

Most of the soil we've encountered is clay. Clay holds water and is very clumpy, making it hard for roots to spread. Gardening books will tell you to incorporate sand or peat moss to address overly clay soils, but where are you supposed to find sand or peat moss around here[3]? To address this issue, we like to incorporate a lot of compost into the soil, especially if it is made with leaves or sawdust.

Another option is just to build above the soil by making raised beds or lasagna beds, which we explain below.

Wet Spots:

Some areas have soil that is dry during parts of the season, but becomes a soggy mess during rainy times. We've encountered many garden spots like this. To address this issue, you can fill in the wet spots with sticks and brush and cover it with sawdust, cardboard and woodchips. Alternatively, you can make a giant mound starting with rotted logs, adding woodchips, leaves, and other organic material and ending with soil. Some people call this a *hügelkultur*.

[3] Many of gardening books promote peat moss for improving garden soils, making compost or starting seedlings. Although it does wonders for the soil, it is NOT a renewable resource. Peat moss is harvested from bogs in very unsustainable ways, so its best to find alternatives like leaf or sawdust compost.

Building up above wet spots with brush, rotted wood, carboard and woodchips

Rocks:

A Saugerties old timer once said “the first crop from your garden is rocks.” The closer you get to the mountains, the more rocks you’ll find in the soil. Rocks are a mixed blessing. They are a pain to deal with in the garden, but if you remove them from the soil they can be really useful for raised beds, borders, filters, drainage, and even building stone houses!

To deal with rocks you can either filter them through a screen, or build above the soil with raised beds or sheet mulching.

One of many piles of rocks 2 feet tall and 12 feet long that we filtered out of a garden by hand!

Soil testing, is it important?

Most gardening books highlight the importance of testing your soil for PH, nitrogen, phosphorus and potassium. A professional soil test will give you an equation of different fertilizers to add to the soil to get it where you want it. Like how the medical industry views the body as a machine instead of a relationship of interrelated systems, soil testing labs view the soil as a medium to insert various amendments to change its chemical composition. They don't tell you how healthy the soil biota is, how much organic matter is in it, or even how much nitrogen is present!

It's a good idea to get a baseline reading of where your soil in terms of PH and N, P, K (nitrogen, phosphorus and potassium), but the main reason we get soil tests is to see if there is lead or other heavy metals in the soil. Cornell Cooperative Extension can do these tests, but it is extra money to see what heavy metals are present (it's worth the cost, lead causes irreversible brain damage).

Since we don't use chemical fertilizers and rely on compost to build organic matter and encourage thriving soil biota, we tend to follow the same course of action regardless of soil test results: **Build soil!**

"Building soil"

Except for the one time we were lucky enough to grow food on an actual farm, the first step of starting a garden is building up the soil. Even when soil is decent (not extremely rocky, or pure clay) it's unlikely to have enough organic matter in it and has probably been over tilled or is compacted. For this reason, we always focus on building soil. When we say "building soil" we are generally talking about introducing organic matter into the soil structure, developing healthy soil biota, and getting active root systems growing in the beds.

The various ways we make gardens all depend on transforming organic matter, or "biomass" (anything that was once living) into soil. This is a collaboration with soil organisms; we feed them biomass and they give us soil! Depending on the type of biomass and your individual situation, you can build soil in these five ways. We will be referencing these terms throughout this text.

Compost/manure: (*soil made from bacteria!*) The fastest way to start growing food is by utilizing compost or manure. Even though they come from different sources, they can be used in a similar way to improve the soil. With compost or aged manure, you can make a garden with ease by just tilling it into existing soil in the ground. If it's well decomposed compost or manure you can plant directly in it.

Animals provide a service to the soil by converting biomass into a useable form by eating it and breaking it down in their stomachs and intestines. Manure can be acquired free or at a low cost. We find horse manure is easiest to find, but folks with cows, goats or even llamas might be happy for you to get their poop. Chicken and other poultry manure can be applied to the garden by letting them walk around and poop in your growing area the season before you grow your crops[4].

[4] If you are interested in animal husbandry there are awesome ways to integrate livestock into your garden systems. Moveable coops called "Chicken tractors" or other types of moveable fences can ensure the birds fertilize areas you want without them eating your garden crops. Combined with a cover cropping system, this can provide a closed loop fertilizing system that can also provide feed for the birds.

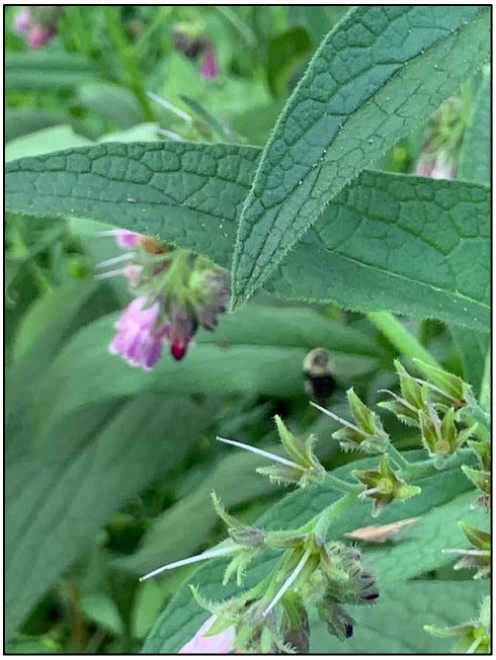
Compost can be bought from commercial composters. UCRRA is a reliable source and it costs $30 a ton. As with many large-scale composts, it isn't surprising to find plastic or even small shards of glass in the compost[5]. The best way to make compost is on the garden site itself to minimize transportation. Setting up compost infrastructure is easy (everyone should be doing it!)[6]. Combining food scraps, weeds, leaves, cardboard and any other organic matter in a bin is the ideal first step to starting and maintaining a garden.

"**Living mulch"** (*making soil on top of your garden bed*): One technique we've grown to love is applying what we call "living mulch" on top of a garden bed. This is a way to maintain soil fertility throughout the year and create new soil at the same time. Living mulch is a combination of decomposing biomass (grass clippings, mushroom straw, shredded leaves, weeds etc.) placed on top of an existing garden bed. It is a biologically active layer that slowly breaks down over the season to fertilize the plants and build humus for next season. It also helps keep moisture in the beds and protect the soil organisms from damaging sun rays (plants like sun, biota don't).

If you think ahead, you can plant crops specifically for biomass. This can be a cover crop on the bed (see below) or they can be weeds throughout the garden space that produce lots of material to lay down on your beds. At each site there is usually a weed that grows prolifically throughout the season. These are a blessing for soil building! They can be ripped out and used as a "living mulch" if they are small or placed in the compost bin or in a sheet mulching project (see below) if they are woody or have lots of seeds. Pokeweed, mugwart, nettles, horsetail and burnweed are just some examples of weeds we use as biomass in the garden.

<u>Left</u>: Burnweed, an edible plant also enjoyed by bees, grows voraciously at Shagbark and frequently ends up in our soil building projects.

<u>Right</u>: We plant comfrey, a medicinal plant, that has deep roots and is one of the best biomass plants for its fast growth, resilience, pollinating benefits, soil nutrient content and beauty!



[5] Broken down plastic is more problematic than it may seem. Scientists are finding "micro-plastic," broken down plastic particles, everywhere from the deepest trenches in the ocean, in the stomachs of animals and now inside of worms in our soil.

[6] Check out our UGC e-book on creating compost (*<u>Composting</u>: Foundation of a Nourishing Food System*) for more information.

During the growing season we harvest our biomass plants, take all the weeds from the garden, let them dry out, and then throw them on the beds. We take all the dead plants and leaves and apply them to the soil. This ensures any nutrients taken up by the plant is returned to the soil by decomposition. In ecology, this is known as "the law of returns." What you take out, put back in. Never throw this stuff away, you will be depleting the soil!

Weeds are biomass! A large pile of weeds and dead plants pulled from the garden in mid-March ready to be used in a soil building project! Much more will come out of the soil throughout the season.

We also love incorporating straw or *very* broken-down woodchips[7] inoculated with mushroom spores in our "living mulch." Spent bags of mushroom straw that are no longer useful to commercial growers make a great "living mulch" all on their own. They hold moisture and protect the soil. They also leach nutrients to the plants every time it rains, and the mycelium break down the medium into beautiful brown humus in one season. If you're lucky, some edible mushrooms will grow right out of your garden bed

[7] We do NOT suggest using woodchips that are not almost broken down into dirt as a living mulch. The chips can pull nitrogen from the soil and the large chunks block seedlings from growing. The exception is for growing potatoes, which like a wood-chippy medium, or for mulching acid loving berries.

If you are worried about the aesthetics of "living mulch", you can always rely on hay or chopped straw to cover it up. You can either top your "living mulch" with newspaper[8] (to block weeds and invite worms) or apply the straw or hay directly on top of the "living mulch". When it is time to plant in the spring or summer, you create a little "nest" through the mulch and paper until you reach the broken-down soil below and plant your seedlings or seed in there.

Onions and kale growing through "living mulch", newspaper and hay

Sheet mulching (making soil under your garden bed): This is a "no-till" technique to build up soil on top of the ground without the need to dig. It consists of stacking layers of organic matter on the ground to slowly break down into soil over time. It is similar to the "living mulch" approach but it isn't done on top of an existing bed. You can include more "coarse" materials that take longer to break down in the bottom of sheet mulching projects. Coarse materials like woodchips, rotted logs and corn stalks are great on the bottom of decomposing mound, but we wouldn't suggest including them in "living mulch" (which is on top of the bed).

This technique is great where digging isn't an option because of rocks or contamination (or a bad back!). This can be done over a large area or concentrated in a small spot to make a single garden bed (lasagna bed). This is a way to transform a lawn into a mini-farm or build over undesirable ground. We'll break this process down in more detail below.

[8] Make sure to use black and white newspaper as the ink is soy based. Glossy paper or colored ink contain sketchy chemicals and oil-based products.

Cover crops (roots to improve soil)**:** Cover crops are planted to improve the soil, not to be eaten. This is a great way to build soil and maintain fertility in the beds. The relationship between soil and plants goes both ways. As plants draw nutrients, water and minerals from the soil, they also work as a downward "pump," converting sunlight into carbon which is released through their roots. This creates a flurry of activity for the bacteria, beneficial fungi and other lifeforms in the soil that then help break down organic matter into nutrients the plant can use. Also, when the plant dies, it decomposes adding organic matter and breaking up compacted soil, improving and building soil simultaneously. An excellent example of symbiosis!

Cover crops also add nitrogen to the soil (nitrogen fixing plants)[9]. After they die, they can be cut at the root (not pulled!) and the decomposing roots of the plant will add nitrogen to the soil. The cut plant can be used as a mulch in a garden bed or added to a compost bin or sheet mulching project. Mature cover crops can also be used to feed animals (or in some cases us) after their done contributing to the soil.

Hulless oats and field peas. Two spring cover crops we love.

Woodchips, another way of building soil

An abundant resource in our area are woodchips. Between commercial tree services, town workers maintaining roads and our own personal clearing with rented chippers, it's relatively easy to get access to woodchips. This will probably be true as long as fossil fuels keep flowing! As we pointed out in our compost manual, we don't like using woodchips in our compost because it takes a long time for bacteria in the bin to break it down. Instead, we let fungi mycelium worms and other creatures in the soil break down and decompose the chips over time.

[9] Nitrogen fixing plants like beans, clover, peas, oats and peanuts have a symbiotic relationship with bacteria called Rhizobia that feed off carbon in the plant's roots. In return the bacteria transform nitrogen from the air into a form that the plant can "eat." The bacteria forms nitrogen rich nodules on the plant roots that not only help the plant grow, but also releases carbon and nitrogen in the soil after the plants die and the roots are left in the ground to decompose.

One destination for woodchips is in garden paths. Laying down carboard and then covering them with woodchips is a great way to neaten the garden and slowly make soil.

A woodchip path after 3 years. The carboard broke down, and the chips turned into a beautiful black fluffy medium full of worms and mycelium.

Woodchips can also be the base of a lasagna bed or used to build up wet depressions in the ground. (See building up wet spots in the garden with wood chips on page 9).

How to create garden beds:

Now that we've gone over where to make a garden and how to build soil, we'll share some of our preferred methods of constructing garden beds (probably the whole reason you're reading this!). We have 3 preferred methods depending on your soil conditions and personal preferences.

The goal of all these methods of making garden beds is to:

1) Incorporate organic matter for water retention and micro and macronutrients.
2) Create loose "fluffy" soil for roots to grow easily.
3) Create an environment that encourages biota like bacteria, fungi and worms to convert organic matter into nutrients for the plants.

Tilling existing soil

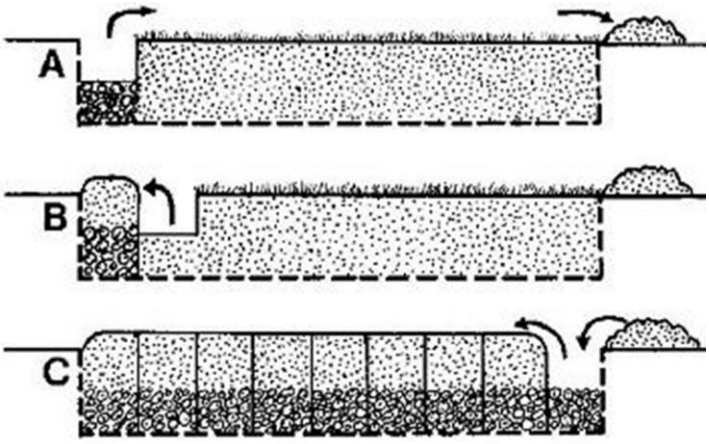
This method is probably what most people are familiar with. Till up soil that is already in the ground and amend it with compost or manures. Given our emphasis on letting soil biota thrive, it seems counter intuitive to chop up the soil. How is this different than industrial farms that just till up the land every year destroying the lifeforms in the soil and turning it to dust? The key to our method is not using machines, which compact the soil with their weight; incorporating lots of organic matter from compost, as opposed to chemical fertilizers; and focusing on a bed vs. tilling up a whole field, which leaves biota in paths undisturbed.

Lots of soil in our area is compacted, with heavy clay and mats of grass. The roots of our plants won't enjoy that. Unless you plan on making a raised bed or big lasagna bed, it's important to incorporate organic matter in the soil by digging into the ground.

Double digging:

A double dug bed, or "trenching", is a technique to create very fertile, loose soil in a bed by incorporating compost 24 inches deep and loosening up the subsoil. This technique makes nutrients easily available for the roots of the vegetables. In addition to adding organic matter, double digging also helps retain water deep in the prepared bed. Double digging encourages the growth of biota *after* the initial breaking up of the soil. The process of double digging is as follows:

1) Break up the soil with a pickaxe or shovel in the shape of your garden bed. Remove roots and clods of grass and weeds. (use them for soil building elsewhere!)
2) Cover the entire surface of the bed with 1-2 inches of aged compost or manure
3) Dig a trench as wide and deep as your shovel (12''), across the entire width of the bed. Move the removed soil to the end of the bed (**A**)
4) Loosen the subsoil under the trench an additional 12" (24 "total) with your shovel or a spading fork (optional: add a little compost on the lose subsoil)



5) Dig another trench adjacent to the first and flip that soil on top of the loosened subsoil in the first trench. The idea is to get compost and soil intermixed 24" deep. (**B**)
6) Continue these steps (removing top 12" of soil, flipping it upside down to the previous trench and loosening subsoil 12" deeper) until you reach the end of the bed. At this point, take the soil you removed from the first trench and put it in top of the last trench. (**C**)
7) Rake the soil smooth and shape the bed the way you want it. The soil should be much "fluffier" from the aeration.

If you don't like how the soil looks after this process (still clayish and clumpy) you can add a little more compost and work it in 2-3" with a rake.

Long double dug beds. Notice how fluffy the soil is. Carboard is laid down between paths, ready for woodchips.

According to the "bio-intensive" farming method developed by John Jeavons. these deeply prepared, beds can be planted "intensively" (close together, not in rows) to get high yields from a small area. (We confirm that this works!)

Although Jeavons suggests doing this every year, we only do this once and instead use "living mulch," cover crops, and compost lightly raked in to maintain fertility. After a few years, we may loosen up the soil, but this usually isn't necessary. We prefer letting the soil biota thrive especially since the roots of annual crops are usually only a few inches deep anyway.

Shallow Tilling:

A simpler technique of tilling the soil is to chop up an area with a pickaxe, lay down compost, manure and/or nice soil and then till it in by flipping over the soil with a shovel. When you're done, rake it smooth. This process gets the soil tilled about 12" deep. Our goal is to mix the clay and the compost together. Crops can be planted directly after this process.

The compost can also be laid down in the fall, a winter cover crop (like bell beans) can be planted and the bed can be left to overwinter. This is a good idea if your compost isn't completely broken down. The root activity from the cover crop, the biota in the soil and the overwintering will break it down more so it's ready to be tilled in in the springtime.

This technique is easier than double digging, especially if you aren't dealing with a uniform shape. Also, you can achieve more loose soil if you build up soil on top of the bed after words (which we always encourage).

Notes on tilling: We like tilling and improving existing soil because it is a quick way to start growing your own food. After our initial tilling, we don't continue this practice. We do not advocate using a rototiller to prepare a garden. The machine rips up the organic matter and its weight compacts the soil. It's much better to prepare tilled garden beds by hand.

After the tilling process plant the bed or apply mulch as soon as possible. Exposure to sun and air will dry it out and kill soil biota. It's best to get roots growing before rain compacts the soil to get the most advantage out of this technique. If it's too early to plant food, plant a cover crop.

If you have rocks in the soil, you can remove them as you till by hand. If it is extremely rocky, you can either filter (see *Underground Garden* case study pg. 24) or decide to build up with a no-till garden technique or raised bed.

No-till gardening

"No till" gardening is a response to intense industrial agriculture, with its emphasis on churning up the land every growing season, which destroys topsoil and soil biota, releases carbon into the air and compacts the soil. No-till gardening techniques focus on building up soil on top of the ground instead of digging in. This is an effective and gratifying method of making garden beds and has resulted in some of the most fertile soil we've ever had the pleasure of planting in.

No till gardening imitates how the forest creates soil. In the woods, different layers of organic matter (leaves, pine cones, rotting logs and tree roots, poop, mushrooms, dead animals etc.) pile up and create fertile soil over time. In the garden, we use whatever organic matter available to layer on the ground.

Sheet-mulching

Sheet-mulching is layers of organic matter placed over a large area. It's best to use "fine" material instead of "coarse" material unless you plan on building up very high. After the material is broken down (sometimes as quick as 5 months!) you can dig out paths and shape garden beds with the newly created soil. (see *Re:seed Garden* case study below for our prime example pg. 29)

Potatoes growing out of a first-year lasagna bed

Lasagna bed

This is the same concept as sheet-mulching but concentrated in a bed. We've had lots of success with this technique. As you build up layers start with coarse materials at the bottom (like rotted logs, branches, corn stalks, woodchips) and move to mid-sized materials in the middle (grass, leaves, weeds,) and finish with fine materials on top that will decompose most quickly (compost, mushroom straw, top soil).

(See *East Wing Garden* case study for more details pg. 35)

Import topsoil

Although this doesn't really qualify as building soil, one option is to buy it and truck it in. Topsoil is usually expensive (6 yards goes for $320 delivered locally from Rt. 32 Supply in Saugerties and that's on the cheap end). A lot of fancy organic soils can be twice as much and we're always disappointed with the quality of the soil. It dries up quickly and doesn't seem to have organic matter in it (despite how its advertised). If you only use topsoil to make your garden it won't go far and will be expensive.

A good option is to get topsoil to add to the top of your lasagna bed or raised bed so you can plant in it right away. You can also use it to till into clay soils. Either way, if you buy topsoil and bring it in, follow the soil building techniques we laid out above to keep it fertile and introduce organic matter.

Notes on no-till gardening

What about accommodating perennial bushes and deep-rooted plants? Some no-till enthusiasts and soil scientists advocate using deep-rooted plants (like perennial wheat) to break up clay and transform soil structure over time as roots decompose, fertilizing and aerating the soil without disrupting soil biota. This is a good idea, but it will definitely take time.

Sometimes we like to combine no till methods with tilling. We make a lasagna bed and plant shallow rooted annual vegetables for a few years. After the soil breaks down, it will shrink significantly. At this point, you can till it into the soil below to incorporate the newly created fertile soil.

This is especially important if you plan on planting trees and shrubs. Our friends made a beautiful sheet mulched Mandala garden. After a few years the garden that was a foot deep of organic matter, decomposed to a few inches of beautiful soil, with clay beneath it. The roots couldn't grow through the hard clay. They ended up having to temporarily dig out all the fruit trees they planted, tilling up the soil with a 24" inch tilling tool and then replanted the fruit trees!

Raised beds

The third technique we've grown to love over the years is making a raised bed. Raised beds are very convenient to garden in because you don't have to bend over (great for older folks). Also, you can hide lots of rotting material in the bottom of the bed as to not waste too much soil filling it up. The simplest way to fill a raised bed is 75% woodchips to 25% soil/compost. Alternatively, a raised bed can have a diversity of biomass, like a lasagna bed with walls. (see *Shagbark raised bed* case study for more info)

Raised beds are nice but require more technical skill and building materials. They also require lots of organic material to fill. Unlike these other techniques, the raised bed is somewhat permanent. You can't easily move the bed the next year as you change your garden design.

The raise beds we make are also containers to hold layers of organic matter while it breaks down. Because of this, the soil level shrinks over time and you have to keep adding material. This isn't necessarily a bad thing. If you keep filling the bed, it will create incredible soil over the years. Most of our beds are made of wood. The oldest bed we have made of wood is 6 years old and still going (one board fell off but was able to be reattached). It's best to think of the wood as part of the decomposition process. When it finally falls apart you will have great soil and can use the wood in the bottom of a lasagna bed!

Building raised beds can be fast if you are skilled (a few hours), but requires a truck to transport materials (unless you have lots of organic matter on hand)

Raised beds can also be made of stone or metal which last much longer. (see *Underground Garden raised bed* case study for more info on stone beds pg. 28)

Raised beds can be rustic or more refined.

Notes on raised beds

The vertical space of raised beds adds nice diversity to the garden. It a good opportunity to include personal creativity in your growing space. Most people aren't impressed by the look of the most productive garden beds, but as soon as you make a raised bed they fall in love. Raised beds are the "gateway drug" of gardening!

Keeping soil fertile over time

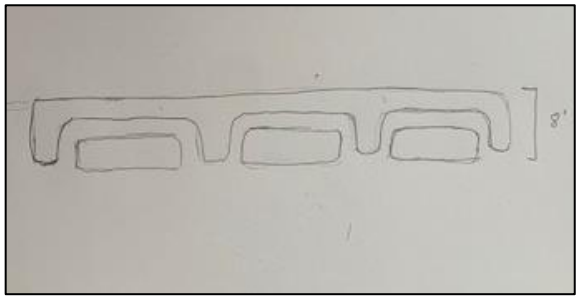
If you apply the processes of soil building to the garden (pg. 11), you will be able to improve soil, build new garden beds and maintain soil fertility indefinitely. In our view the best way to maintain garden beds is to integrate soil building into your existing routine. When fall comes, we take all the fallen leaves and dead weeds and put them in the compost, mulch beds with them, or create lasagna beds. During the spring and summer, when weeding or mowing is an ongoing task, we pile these nitrogen rich materials into garden beds or compost bins. When the town is chipping trees by the powerlines, we incorporate these into paths to break down into soil. In the winter when we burn our woodstove, we apply the hard wood ashes to the soil. As soon as we harvest the garden, we plant cover crops.

If this becomes a weekly or daily task, it isn't a lot of work at once, but adds up to a big impact throughout the year. If we spend as much time building soil as taking out the garbage, doing laundry, mowing the lawn, or checking Facebook we would have lots of fertile garden beds for our future!

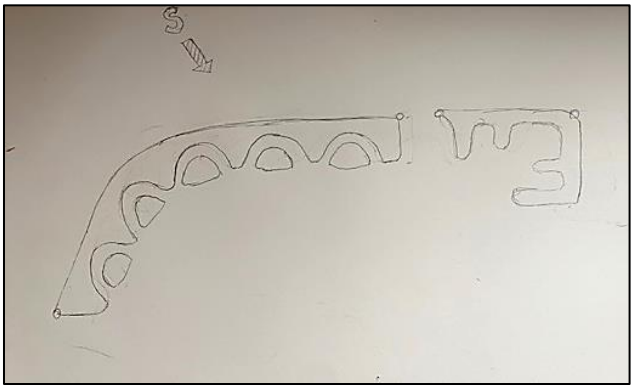
Design ideas:

A whole book could be written about garden design and layout, but for the purposes of this text, we'll include a few layout ideas for creating garden beds.

Edge bed: One of our favorite garden designs is the curvy edge bed. The edge of a garden is usually neglected, especially if you use square raised beds. Edge beds take advantage of underutilized space. If they are curvy you end up with much more surface area for growing and can create access for reaching the entire area.



Two edge bed designs at shagbark and Kingston High school. Lots of square footage of growing space in a usually neglected area.



Mounds There is a reason that indigenous farmers in our area grew crops in mounds. It is the natural shape that beds take when you build up soil over time and it has many benefits. Firstly, it warms up earlier in the season helping seeds to sprout. Second, the domed shape of a mound has more planting area as it is round, and you can plant along the sides. Third, a mound is helpful in a drought and during wet times. During a drought, rich organic material in the bottom of the mound can hold moisture for the roots of the plants. When it's rainy, the roots won't be sitting in water because its off the ground. It's the way to go![10]

Contours: Another piece of wisdom to adopt from the original inhabitants of this land is building beds along contours. If you have a slope to the land, create level beds along the contours. This can be a subtle mounding or full on terracing of the hill. The benefit is that it traps water and nutrient rich topsoil as water rushes down the slope. This will protect the soil over time and is also a great way to keep your beds watered without relying on electric water pumps!

Natural shapes: Everywhere you look in gardens, you find those 4 foot wide, 8 inch tall, square "raised" beds. What is the benefit of those beds? They aren't raised enough to give your back a break, they are a little too wide to comfortably reach the center, and their big, blocky nature makes for a clumsy use of space in the garden.

In our garden designs we always try to imitate patterns in nature (curves, circles, veins, leaves) for aesthetic and smart use of space. Also having various levels in the garden not only pleases the eye, but also benefits air flow across beds, creates different "micro-climates," and generally diversifies the movement through the garden.

Although it is important to think outside the box, it IS possible to get carried away. We have seen examples of gardens that lose function by focusing too much on aesthetics. This can make it harder to create fences or utilize row cover or navigate with wheelbarrows. Use organic shapes, but don't make it so complex that you can't work in your own garden!

Human scale: Design your garden for you, not machines. A common look of backyard gardens is a big square with lots of long rows, and real skinny paths. Although this seems to make sense to maximize space, it might end up making things *less* efficient because of the difficulty in navigating the garden. These gardens are usually designed for (and by) a rototiller, not the human hand. Also, looooooong garden rows can be really demoralizing. Planting a long garden bed can seem to go on forever. Making smaller "pods" of soil can keep morale high and help organize different crop combinations.

Also, don't skimp on paths! Having space to maneuver a wheelbarrow or invite friends with wheelchairs into the garden is a big plus. If you adopt the wood chips and cardboard method of making paths, you aren't wasting space by having big paths, you are making soil, breeding worms and spreading mycelium throughout the garden.

[10] Indian potato farmers in the Andes and peasant Irish potato farmers both utilize(d) a mound system for growing potatoes. This method creates a "heat sink" that encourages air flow. This drastically reduced the danger of blight which thrives on moisture. 19th century tenant farmers in Ireland were forced to give up this practice known as "lazy beds" for flat open field cultivation to accommodate newly invented machine plowing. Historians point out the correlation between machine plowing and the spread of the water mold that caused potato blight, infamous for the Irish potato famine.

Case studies

Given the range of techniques we've laid out in this text, we'll give you some examples of real life gardens that we've made over the years. These garden beds are still producing and have maintained or increased their fertility over time. Depending on your garden conditions, and materials you have available, you can copy the processes in these case studies that most closely apply to your situation.

Underground garden (technique: tilling with rocky soil**)**

This was the first attempt we took at creating a garden! The conditions were far from perfect, which we embraced. The idea was if it can be done here, it can be done anywhere. This was a model meant to demonstrate how individual initiative, non-experts, and hard work can create a productive space to grow food.

Conditions:

Sun: partly shaded immature forest. Small trees that can be taken down mostly with a handsaw and machete to give some more sun.

Soil: leaf litter rotting over time, creating a fertile layer of humus, a few inches below this was extremely rocky soil. There were more rocks than soil in the ground!

Water: There was a hose spigot on site, which we used for the first year, but then in the winter the spigot froze and broke. We were able to get 5-gallon buckets from a stream right next to the garden. The stream could also be pumped and then siphoned into a 275-gallon water tank where we could water with gravity pressure. We even used a garbage can that we'd fill with rainwater and hand water the plants with an old juice bottle!

Access: This garden was in a wooded area, a few hundred feet from vehicle access. Everything had to be brought in by wheelbarrow.

Soil building process:

Year 1 (spring) The soil was very rocky, so we decided to start by filtering out the rocks. This was an extremely labor-intensive project. We chopped up the soil with a pickaxe to loosen it up and then shoveled it into a filter to remove the rocks. We started with a milk crate and then upgraded to a steel wire mesh mounted at 45 degrees.

Alex filtering rocks on a metal grate over a wheelbarrow

We had help from Skidmore Students during a field trip. Note the pile of rocks in the background!

After we separated out the rocks (which became a massive pile) we raked out the dirt in the shape of beds. The soil was nice after we filtered it because there was about an inch of humus from decades of rotted leaves. After we had the beds in the shapes we wanted, we incorporated aged manure ("moo dirt" that we purchased) and planted immediately.

Note: filtering is much easier when the soil is dry. Don't filter when it has recently rained, or soil will stick to the filter!

This was before we knew the benefits of living mulch, so we used black fabric over the dirt to keep in moisture and prevent weeds from growing. We wouldn't recommend this product now because it does not last long or contribute to the soil building process.

Our harvest the first year was modest but successful given our lack of adequate sunlight (this is just one day, not the whole harvest!).

Year 2: After our first successful growing season, we repeated the same filtration process to expand the garden. We continued to fertilize with compost and manure.

Year 3 and beyond: The third year we expanded more and created a more permanent fence. We continued using compost to fertilize the garden each spring, but also began planting cover crops to add nitrogen and organic matter to the soil. We also realized that the lack of sun was going to be a limiting factor to the success of the garden. Because we didn't want to cut large trees down, and we had more productive gardens elsewhere, we planted shade tolerant fruit trees and berries. The garden still produces food after a decade but is slowly transitioning into a perennial food forest instead of an annual vegetable garden.

Other applications: We replicated this process in another forest site that we turned into a garden. We maintained that garden for 3 years. After the initial filtering of rocks and incorporating of horse manure, we transitioned to building up soil with the "living mulch" technique. This second garden was extremely successful after 3 years of no-till soil building and continues to be productive to this day (6 years going).

Final notes: If you have the energy (and back) to deal with rocks, this method works. The end products are fine soil and nice rocks for various projects. If you want to skip that step, and have access to soil building materials, you can create soil from scratch which we will get into shortly.

Two examples of filters:

a milk crate with a garbage can to catch the soil (Damian is understandably angry operating this hellish device) and a metal grate mounted to a frame at a 45 degree angle.

Underground Garden (Technique: stone raised bed)

After our filtering frenzy for the garden beds at the Underground Garden we had a mountain of stone. We used a portion of this mountain to make a big raised bed.

Year 1: We constructed the raised bed out of river stone and blue stone about 30 inches high. We filled it (from bottom to top) with rotted logs, leaves, weeds, and 12 inches of filtered soil. We planted berries and dwarf fruit trees in it and left spaces for growing annual crops.

Maintenance: We've maintained this raised bed with cover crops and "living mulch" consisting of weeds that we pull from the bed, leaves and the dead cover crops.

Other applications: Whenever we have the luxury of stone available, we try to make small stone raised beds. Stone never rots, so your bed will last forever if you make minor repairs over the years. At Shagbark Garden, we have an abundance of logs and some stone available, so we started making 12 inch high stone/log raised beds to terrace hills or make pretty accents in the garden. These are also great places to hide rotted logs which work great to hold moisture and feed mycelium in the bottom of the bed

Re:seed Garden (technique: no-till Sheet mulching)

The Re:seed garden is a collaborative project with the Boys & Girls Club in Saugerties. It began with a local artist Jennifer Zackin, the Long Spoon Collective and the Boys & Girls Club working together to transform the lawn into a living art piece that creates soil from scratch. After the initial art project, The Underground Center took the responsibility of managing the space. We transitioned it to a learning garden with the goal of teaching kids how to transform lawns into mini-farms.

On the site, we explore what a local diet could look like if we grow everything we eat. We also demonstrate soil building techniques and how to maintain garden beds. Lastly, we are trying to challenge the status quo of land use in Saugerties and encourage neighbors to transform their lawns into food infrastructure.

Conditions

Sun: Lots of sun exposure with a few large trees providing some welcomed shade throughout the day.

Soil: a classic lawn. Covered with grass. The soil was not rocky at all.

Water: A neighbor had a hose spigot that we could use.

Access: Right on the intersection of two streets. Can get a truck right up to the garden

Other notes: This garden is an empty corner lot in the middle of a residential area. Everyone has traditionally manicured lawns and flower plots. Very few people have gardens, and if they do, they are hidden in back yards or behind fences. The process of creating the garden had to be pretty enough not to have the tradition loving neighbors chase us out with pitch forks and torches!

Soil building process:

Year 1: **Spring**: This project was initiated as part of an art grant. The project needed to create community, build soil and also be considered art by the grant makers. Jennifer Zackin designed a soil building sculpture to accomplish this, essentially, a giant sheet mulching project.

Collaborating with the Boys & Girls club, members of the Long Spoon Collective, and community volunteers, we collected materials and laid them down in a triangular shape.

Lasagna bed layers:

1) Cardboard

2) Chopped up sod (dried in the sun and flipped upside down)

3) Partially broken-down woodchips

4) Lots of Leaves

5) chopped up mushroom straw (spent bags of commercially grown oyster mushrooms in straw with mycelium throughout it)

6) Many truckloads of aged horse manure

7) Black and white newspaper (to suppress weeds)

8) Thick layer of hay

After the sheet mulching was complete, we planted cover crops through the mulch to add nitrogen and organic matter. Also, the crops were selected for their color pallet to add to the soil sculpture (yellow sun hemp, purple bush beans). Additionally, a pattern of seeds, called an “earth tattoo” was laid down to add to the effect. The result was as beautiful as it was productive!

Year 2: The following Spring, the UGC set out to transform the art piece into a functional growing space. We reshaped the fertile soil into mounded garden beds. In between these beds, we laid down cardboard and wood chips to make paths.

We began a rotation of staple crops (potatoes, popcorn, beans, squash) and other vegetables that we plant continually each year.

Year 3 and beyond: Because we don't have a compost bin on site, we maintain soil fertility with biomass collected in the garden, and some imported materials.

Throughout the year, we maintain a "living mulch" on the beds. We build up with leaves from the maple and cherry tree on site and apply any dead plant parts from the crops we've grown in the fall. We also, bring in mushroom straw and hay during the fall to "put the beds to sleep."

Throughout the spring and summer, we pull any weeds and put them in a pile to dry in the sun, then mulch the beds with them.

In the springtime, we re-apply cardboard and woodchips in the paths. This is more for aesthetics, but it has built up incredible soil in the paths that we could plant directly in if we wanted. We also plant cover crops in the spring (usually field peas).

This process has resulted in beautiful soil built from scratch and lush vegetables for 4 years straight.

Final notes: This process was very effective at creating fertile soil and it was relatively cheap to create. Most of the materials were free aside from $30 loads of aged horse manure. The sheet mulching required multiple truckloads of material. Because we have our own truck it made it much more affordable. We also use the truck to bring in woodchips for the paths each year, but this step isn't really necessary.

It is important to note that the materials we used in the sheet mulching project were "fine" as opposed to "coarse" to begin with, so it all broke down relatively quickly into loose soil. Other projects that rely on unbroken down wood chips or rotted logs and sticks take longer to reach a state where you can plant deep rooted plants in it.

After the initial bed was made, we maintain it with cover crops and "living mulch" from materials harvested on site (especially because the trees produce a lot of leaves). Also, if we had an active compost bin on site, we could maintain it indefinitely without having to haul in materials. If you can get access to a truck and are a good scavenger, or can afford a few hundred dollars up front, you can definitely replicate this process.

The garden beds at the Re:seed Garden are the most productive garden beds we manage. The yields are more productive than industrial agriculture yields per square foot without using any machines, or chemical fertilizers. This site shows that if we converted lawns to gardens in our neighborhoods, we could feed everyone for free!

East wing garden at Kingston High School: (Technique: no-till Lasagna bed)

Another site where we are creating gardens is at the Kingston High School. Our first project was to demonstrate how food can be grown in “marginal” spaces where people wouldn’t normally site a garden. We also wanted to model to the administration, the staff in charge of grounds maintenance, and the students how a garden could be made cheap or free using materials in our community.

For this garden we applied a more focused no-till technique than a large-scale sheet mulching project. Our goal was to “landscape” the area with perennial berries and flowers, but instead of the school shipping in a thousand dollars’ worth of soil and lumber and making a manicured space, we wanted to demonstrate how to get to the same end point while building soil, sequestering carbon from the atmosphere, giving kids hands on experience, and producing food along the way. All the materials were free except for a $30 load of compost.

Conditions:

Sun: The site is on the east side of the campus. This means it gets early morning to midafternoon sun. In the late afternoon it is in the shade. In total it gets more than 6 hours of sunlight, which is enough for most crops

Soil: The garden was a narrow strip of land against a newly constructed building. A soil test showed no lead or other heavy metals, but an unusually basic (opposite of acidic) soil. The PH was as basic as it could be according to our test strips. It also had a very thin layer of soil before we hit a gravelly layer.

Water: A water spigot is close to the garden

Access: The site is adjacent to an access road and is framed by a sidewalk. Ideal for truck and wheelbarrow.

Other notes: The campus is very institutionalized. Our organic structure sticks out like a sore thumb! We initially were told to contain our project in pressure treated wood, but we pushed back and were allowed to carry out our three-year trajectory. Our goal is to set an aesthetic precedent on campus and transform the look of the place. We plan on replicating this process on every space possible to create a student designed “edible campus.”

Garden in the front of campus

Soil building process:

Year 1 (**Late fall):** Because of the lack of soil, we had to build up. We chose to create a large lasagna bed. We sourced the materials almost for free and laid down the layers in the following order:

Lasagna bed Ingredient list:

1) Lots of cardboard with tape removed (collected by teachers, sourced from the school)

2) Six yards of wood chips (free from a commercial tree service)

3) Sixteen large bags of leaves (collected from the side of the road)

4) Two stuffed garbage bags of fresh cut grass (from a staff member)

5) A yard and a half of compost ($30 from Ulster County Resource Recovery Agency UCRRA)

6) A half a truck full of bags of mushroom straw (free from a commercial grower)

7) Newspaper (free from a local store)

8) six bales of hay (free from the garlic festival)

Once the materials were collected on the site, we were able to make the 60 foot long by 8 food wide lasagna bed over three 40 minute classes on Halloween. The students and teachers and UGC staff all worked hand in hand to lay down these layers. We worked like a well-oiled machine; it was a beautiful site.

We moved the materials with wheelbarrows and five-gallon buckets. We used shovels, rakes and bare hands to apply materials and shape the bed.

The finished product was a beautiful hay covered mound, slowly decomposing outside the school!

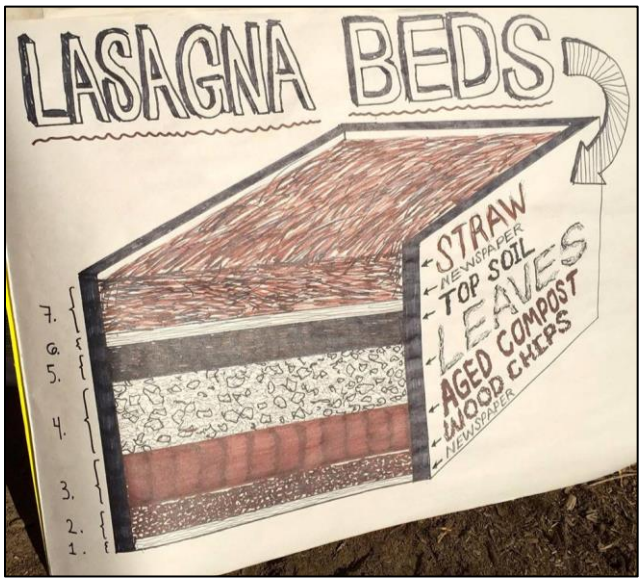
Year 2 (Spring): As soon as winter passed, we carved out paths in our lasagna bed. The material removed from the paths was shoveled on top of the planting area. We then added a small layer of soil on top of the bed so we could plant shallow rooted plants.

We planted Kale seedlings that we started indoors, peas, and potatoes. All the crops grew well, especially the Kale, which grew better in this medium than anywhere else. (we observed a similar situation when we made a garden like this behind the Saugerties Boys & Girls club)

Summer: When we returned for a summer session (in August) the crops were generally doing well. Unfortunately, we must have imported potato beetle eggs with the leaves we picked up off the street (potato beetles have to walk to the plant and overwinter in leaf litter). Since there was a break during the beginning of the summer, we were unable to kill the potato beetles by hand. Despite the pests eating the crops, we harvested a nice batch of early potatoes in the summer.

Fall: We harvested the rest of the potatoes which was a decent crop despite pests. We added compost and a little soil (optional), sprinkled on a thin layer of ash and planted garlic.

Year 3: **(Spring)** Because of a mild winter, the Kale survived and started putting out healthy leaves in February. For the third year (this year!), we plan on finalizing the shape of the bed, adding compost from an adjacent compost bin and planting perennial berries and flowers. Additionally, there will be space for growing annual crops. The maintenance of this garden will be annual cover cropping, adding "living mulch" and compost as part of the class curriculum and pruning the perennial fruit crops.



Other applications: We have applied this technique multiple times in various locations over the years. We often start with more coarse materials at the bottom, like rotted logs or branches. We've been doing this for 4 years at Grant D Morse Elementary and the soil is excellent.

We followed this same technique at another site. The lasagna bed was made up of decomposing wood chips, bark, large weeds harvested from the site, leaves, and some compost on top. We were able to harvest massive amounts of potatoes out of the garden on the first year, when the lasagna bed was not broken down at all. A lack of pests and consistent watering helped!

Another year, we tried to replicate this same process and had very inconsistent results. We suspect a combination of extreme heat and drought. Also, we didn't apply as many nitrogen rich weeds into the mix, which might have played a role in our poor harvest.

On another occasion, we created a large snake-like bed made of ripped up sod pilled upside down and covered it with compost purchased from Ulster County Resource Recovery Agency (UCRRA). We made this bed late in the season (end of June). This produced the largest harvest of butternut squash of our growing career (it filled up the bed of a ¾ ton truck).

Half of a late October harvest of potatoes from 6 coarse lasagna beds constructed in spring.

Final Notes: The Lasagna bed is one of our favorite methods of making garden beds. It utilizes "waste" and demonstrates how different materials decompose into beautiful soil. On the downside, you do need a good amount of materials to get started (although leaves are abundant in fall, weeds are abundant in spring and summer). If you start composting the year before, this can give you a big head start in collecting materials. Alternatively, you can get a load of compost or manure cheap ($30 a yard) if you have a truck, or have it delivered for a fee.

The other downside of the lasagna bed method is that you can't plant whatever you want immediately because the soil is only deep enough to support shallow roots. If you follow the planting schedule laid out in the "East Wing Garden" example, this shouldn't be a problem and you can produce food throughout the whole process of the lasagna bed breaking down:

Year 1 (fall) Make lasagna bed, top with fine compost or soil (if you have it)

Year 2 (Spring) plant potatoes (will grow in almost any condition of lasagna bed!) and shallow rooted leafy crops (Fall) Harvest potatoes, add compost if you have it, plant garlic

Year 3 (summer) harvest garlic, plant soup beans for food crop and nitrogen (fall) harvest beans

Year 4 (spring) plant perennial berry and flowers (if the bed isn't totally broken down, you can put soil just around where the roots will be planted. By the time the roots grow out of the soil, the lasagna bed will probably be broken down) **or** continue planting annual crops in it.

Shagbark Garden:

We began converting the forested 22 acres, that we later named Shagbark Garden, in January 2018. Gradually clearing acreage of forest to let in sun and expose soil has provided us with ample materials to create garden beds, and opportunities to showcase our soil building methods. Some sections of this space were soggy, other sections had rocks. The plethora of brush, logs and milled lumber that we accumulated from clearing the garden spaces allowed us to make interesting raised beds. To avoid repeating ourselves, we will just include three types of beds we created at Shagbark. If you want to see all the different growing systems on site, schedule a time to see them in person.

Conditions:

Sun: Before we cleared it was completely forested and shady. After we cleared, we have large areas of full sun and areas with partial shade along the south west end of the garden. Ideal for all different kinds of crops

Soil: leaf litter rotting over time, creating a fertile layer of humus. Some areas had rocky areas, but never enough to filter. Lots of the garden had seasonal wet spots not suitable for planting in. Some spots were good enough to till the soil up. Almost all the garden area is dominated by clay soils. Since it was a forest surrounded by pine trees, the soil is generally acidic.

Water: There are no utilities on this site. In order to water the garden, we had to bring in water. In the beginning we relied on heavy mulch to hold water in the soil through dry spells. Eventually we built structures and added rain catches. We currently have 1,500 gallons of water tanks connected to rain catches. From there we can water with hoses through gravity pressure.

Access: This garden was in a wooded area. We cut in a road and there are paths to the garden to accommodate trucks and wheelbarrows.

Shagbark bed 1 (technique: double dug bed)

In a few locations, we had soil dry enough and free of rocks enough to till the soil.

Year 1 (Fall): Put down unfinished compost in the shape of the bed, planted bell beans. Let the bed over-winter.

Year 2: In the spring, we double dug the bed. We removed the rocks (use them to make cool rock walls around beds!) This incorporates compost into the clay medium. After we tilled, we added mushroom straw, broken down leaves, and hay as a "living mulch"

After the last frost in May, we planted sunflowers and cucumbers

Cassandra finishing up a shallow tilled bed that we immediately planted oats in (a cover crop, animal feed and edible grain)

Fall: after harvesting the last crops, we added a little compost, mulched the bed with hay, and planted cover crops (bell beans) through the mulch

Year 3 Spring: drop cover crops (leaving root structure in soil! Don't pull). Plant next crop!

Year 4 and beyond: continue adding living mulch and cover crops and rotate crops so you don't plant the same type of plant twice in a row.

Other applications: We utilize double dug beds or shallow tilling whenever the soil permits. We've had success with this technique every time we've used it.

We made a double dug bed for growing corn last year. These beds grew great corn despite serious drought.

Final notes: This is hard work, but it's worth it! See page 17 for more info on double digging

Shagbark bed 2 (no-till swampy)

At shagbark, there are multiple areas that are swampy. This can be advantageous if you are clever. By building up a bed with rotted logs and brush on the bottom, it can absorb the moisture and keep it available to the plants when there is a drought. This technique can also be used for making a bridge.

Year 1 Lay down rotted logs and brush. Make sure you lay them parallel. It can be tedious. Avoid making a big pile of brush, otherwise it leaves pockets that take lots of material to fill in.

Next we cover this completely with woodchips and walk on it to compact it (as Manny demonstrates below).

On top of the wood chips we created five individual beds with material from a broken-down lasagna bed from another location.

We planted onions, Kale and Cabbage in them and got a decent harvest on the first year.

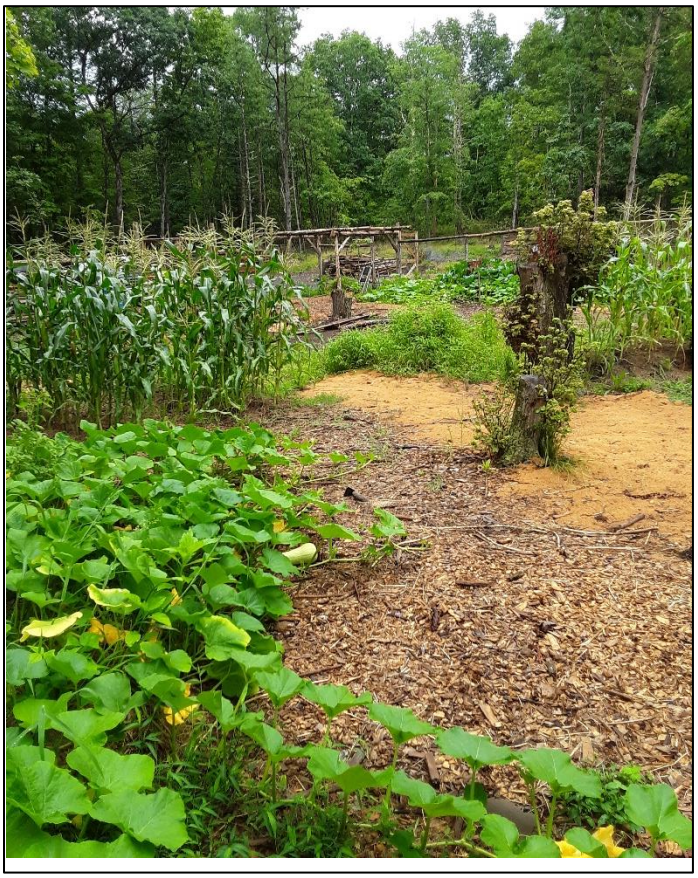
In the late fall, after we harvested all the onions, we applied a thick living mulch with weeds, compost, and mushroom straw. We then planted garlic in four of these beds

Year 2:

The second growing season, we harvested the garlic in summer and got a massive crop. We immediately planted beans, which are edible and a nitrogen fixing plant (see pg. 15 for more info).

In the fall we harvested the beans and again added a "living mulch."

Year 3: This year we plan on planting sweet potatoes. The beds are fertile and our technique of building up over wet spots was a success.



Side by side photo of the same location before and after we filled in wet spots and made beds

Other applications: In this case, soil from an old lasagna bed was used to build these beds. This is another option for the no till soil building technique. We used a similar approach for another location in the garden that was in a wet depression. In the example on the left we "mined" a lasagna bed from another location and made large mounds with rotted sticks on the bottom. We then filled in between the mounds with brush and wood chips to make a pretty tiered garden that is 16" above the water table at its highest point.

Shagbark Garden bed 3 (technique raised bed**)**

Another way we dealt with a wet location and a surplus of brush from clearing forest was to build two large raised beds. These were designed so that someone in a wheelchair would be able to plant in the bed. Also, on side of the bed is higher than another because of sloped land. This worked out so small children can plant on the low side. Also, there is a 4 foot space between the beds for plenty of maneuverability for a wheel barrow or wheel chair. If you're looking for comfort, this is a good option.

Year 1:

In the Spring we collaborated with apprentices from the Boys & Girls club to build two giant raised beds. All together, they have close to 200 square feet of growing space. We used slab wood from milled pine logs, 3 foot tall cedar logs for the posts, and milled cedar trim to give it a nice finish.

We filled the beds in this order:

1) rotted logs, brush and bark
2) Woodchips
3) food scraps from a restaurant
4) more woodchips
5) Leaves
6) 6 inches of Compost
7) 6 inches of screened topsoil
8) A "living mulch" layer of mushroom straw and chopped hay.

We planted it with tomatoes, carrots, beets, leafy greens, peanuts, string beans, peppers, cucumbers and herbs.

There was a multi-week drought and our rain catch system wasn't fully functioning. Despite this, everything grew well except the peanuts (which apparently needed more water) and the string beans (which got eaten up by deer before we repaired the fence)

Sierra and Christian posing in front of their work. The two raised beds take up a large footprint in the garden

In the summer, the lush plant life, and vertical growing space adds a magical touch to the garden

Fall: After we harvested everything, we topped it with a thick layer of “living mulch”.

Year 2 spring: We may have made too think of a layer of “living mulch” on one of the raised beds. The medium didn’t decompose enough to plant directly in, and it was about 8 inches until there was decent soil to plant in. To address this, we mixed the “living mulch” with topsoil which now looks suitable to plant in.

The other bed only had 2 inches of “living mulch” before we hit last growing season’s soil. For this bed, we planted cover crops (field peas) and it will be ready to plant in May.

Other applications: We've made lots of raised beds using this same technique. They are always pleasing to the eye and easy on the back. Last summer we made a large raised bed with our summer apprentices for the garden at the Kingston High school. It turned out to be one of the most beautiful beds yet.

We built it at Shagbark and transported it to the campus the next day. Once assembled, we filled it with woodchips, sod and weeds, compost and topsoil. Shortly after we planted it with cover crops (field peas) to give it nitrogen for the spring planting season

Summer Grace and Sasha Kay attaching the trim

Final notes:

As woodchips, compost, leaves, etc. break down, the soil level drops. You have to add more material year after year with decent growing medium on the top. Also, after 4-6 years, the wood will start to rot. You can repair it, or just remove the wood and repurpose the yards of beautiful soil inside!

Raised beds are a treat in the garden, but the more finished they are, the more technical skill and nice materials you need. Because we cleared forest and milled wood, we have access to nice materials, so this cuts cost. Paying someone to do this would be very expensive ($1-$2,000) so it might not be cost effectice unless you do it yourself. Alternatively you can use more rugged materials like logs, stones, and random wood, which can also have a nice aesthetic!

For more info on building garden beds, starting gardens or any other questions contact us at:

Info@theundergroundcenter.org

Resources and References

Most of the information in this text is from a decade of firsthand experience making gardens and mini-farms with various methods and scales. Trial and error have taught us a lot of what works and what doesn't. As for the science and historical information in this text, we referenced the following books.

Books:

The Early History of Saugerties 1660-1825 by Benjamin Myer Brink

*A book written in 1902 about life in Saugerties New York. The Author writes the book as if he is giving us a tour of Saugerties from the late 17th to early 19th centuries. Interesting examples of day to day life including farming, indigenous people, indentured servitude and slavery.

Kingston: City on the Hudson By Alf Evers

*History of Kingston, NY. Shows some glimpses of what pre-colonial and early colonial agriculture looked like in the Hudson Valley.

How to Grow More Vegetables than you ever thought possible on less land with less water than you can imagine by John Jeavons.

*This book is an awesome resource for growing food in in the Bio-intensive method which relies heavily on composting and cover crops to maintain soil fertility. Includes planting charts, how to lay out beds and walks you through every step of subsistence farming.

Five acres and independence by M. G Kains

*An in-depth manual of small-scale farming written during the great depression. Although some information is outdated, most isn't. Kains was an authority of faming at his time with many years of experience working the land. He also includes studies and cool drawings from the USDA.

1493: Uncovering the New World Columbus Created by Charles C. Mann

*A fascinating history of early colonial north and south America. Especially useful for our purposes are in depth histories of staple crops and other plants like potatoes, sweet potatoes, and rubber. Mann does a great job of showing how historical trends live on into the present.

Farming While Black: Soul Fire Farm's Practical Guide to Liberation on the Land by Leah Penniman

*A complete resource for getting up and running growing food. Includes practical as well as historical information about farming. The book is written through Soul Fire Farm's social justice oriented lens and promotes racial justice through land based practices. Great resource!

.*Eating the Landscape: American Indian Stories of Food, Identity, and Resilience* by Enrique Salmon

*Written by an indigenous ethnobotanist that explores stories of American Indian farmers in the southwest United States and northern Mexico. Discusses traditional indigenous ways of cultivating crops and preparing meals. Aside from being a good read from an anthropological perspective there are some

great examples of relevant environmental stewardship and ways of making garden beds in harsh terrain and utilizing staple crops that we plant in our own garden.

Cows Save the Planet: And Other Improbable Ways of Restoring Soil to Heal the Earth by Judith D. Schwartz.

*This is a well-researched book about the science of soil biota, carbon sequestration, and the role animal husbandry can play in creating soil and addressing climate change. The author Includes up to date scientific research about soil building.

The World In 2050 : Four Forces Shaping Civilization's Northern Future by Laurence C. Smith

*A conservative prediction of where the world will be in 30 years based on forces of globalization, climate change, demographic shifts, and natural resource demand. Although the projections don't consider (very possible) cataclysmic scenarios, it is still a grim prediction!