

Q & A: Improving the Soil



Skimming a cover crop

Q. I intend to double dig new beds as soon as the ground warms up and dries out. Do I do anything special with the rye cover crop that needs to be incorporated or do I just double dig as recommended in Jeavons' book. I was confused because on p 16 "Organic Gardening Primer" you talk about leaving the root mass in and not disturbing the soil structure, but if I double dig that's not possible.

1. If you are going to use permanent beds, mark off your beds (e.g., 5 x 20' or 4 x 25' if you or workers are shorter). You'll want to be able to reach easily to the center of the bed from the edge. Leave room for your paths (we find 2' to be a minimum – you want to be able to navigate with tools, a wheelbarrow, etc.). Longer beds can work, but you'll have farther to walk to get to other side without stepping on them. Walking on the beds compacts the soil and should be avoided.
2. Cut the cover crop tops to the ground. We use shears, but you can mow if the rye is not too tall. Compost the green tops. Then skim the top. Work from the path or the bed. For this latter, you will require a sturdy digging board – 3' x 4' x 3/4" exterior plywood works best. Round corners, cut a slot big enough for a gloved hand, in from the long side down a bit (6-12") to serve as a carrying handle. Finish with two coats of exterior polyurethane. Store between uses under cover to prevent warping. Ours have lasted 15 years.
3. To skim, stand on your digging board, facing the end of your bed, and make a cut with the edge of your spading shovel (flat, sharp edge) across the 4-5' width. Make this cut slightly wider than the width of your shovel blade. Cut this row of turf into 5-7 even rectangles. You will stack these. Working first from the edge of the bed, or from the digging board, insert shovel into a sweet spot just below surface and push to sever top turf from roots. For us, the thickness is around 2". You will leave behind the roots in the soil, and it is these roots that decompose.
4. Continue skimming across that row, piling the 5-7 turf rectangles carefully in a wheelbarrow. Move the digging board down a bit and cut a second line as before, divide into rectangles, and

skim, again piling rectangles in your wheelbarrow. When the wheelbarrow is full, we roll it to our turf pile, where we pile it up in layers. When it decomposes, it makes a rich and loamy topsoil we use to make potting mix, sprinkle on our compost pile, or use to fill in low spots on our finished garden bed.

5. Fall-planted rye overwinters and does most of its growing as spring advances. We use rye before June plantings of warm crops: tomatoes, squash, corn, melons, beans, tomatillos, etc. We skim those beds around May 7 for a June 1 transplanting date, leaving 3 weeks for the roots to decompose. For earlier crops, we use oats (or oats plus vetch to fix nitrogen). By the way, it is good to mix rye with vetch in the fall for this same reason, except before beans. From our Rotation Chart, column 1, you would not plant a legume before a legume.

6. You are correct in saying it's not possible to double dig without disturbing the roots of the cover crop. This is a conflict when you are first double digging, and want to use the bed that season. If you start double-digging early, my guess is that the rye would not have gotten very far. If this is the case, you can skim quickly from the edges using the sharp edge of your spading shovel. The young grass/immature turf will cut easily. Rake off and compost. You will leave most of the soil behind. Compost the green matter. Start your double dig. This procedure is only possible because you have not let your rye grow to maturity. A better cover crop to have used would have been oats (with vetch). Oats winter kills. You would have had to have planted this by end of September for decent growth before heavy frost killed it.

7. With spring cover crops, you should be able to get two to three cuttings before you cut for the final time prior to skimming. We cut at around 12-15" down to 6" or so. If you let it get too tall, the grass may lodge (fall over), making it difficult to cut. I use good quality grass shears to cut; Tania uses her Felco pruners. We chop all cuttings, and anything else we add to our compost pile, into smaller pieces in the range 3-9". This ends up making the compost easier to turn, and break down.

Making and using compost

Q. I have not started my compost pile, so plan to purchase organic compost for the first year. I'm wondering if you'd recommend adding amendments to purchased compost? I didn't even realize the amendments get added to the compost until I read your primer. I thought they were added directly to the beds.

You can add compost and amendments to the beds directly. As you are double-digging for the first time, follow Jeavons. Work in compost as you double dig, but add amendments last, after you have finished double digging. Add amendments to the top, and work in lightly using a twisting motion of your spading fork or light turning of the top only. Rain will help the amendments percolate down through the bed. Adding amendments to compost allows time for the amendments to break down and get incorporated. It is easier to measure out the amendments on a bed square-footage basis. Because sulfur breaks down slowly, and does not move easily through the soil, add this amendment to the soil as you double dig.

Q. Some folks at the UU Fellowship are building a raised bed butterfly garden and intend to use 100% compost as the soil. That seems insufficient to me but they insist that it has worked elsewhere. What is your opinion? Andy

Compost is intended as a soil amendment, used to build the soil, replace organic matter used up by the plants, and support soil microbial life. Once a bed is prepared (using soil) all one has to add is 1/2 to 1" of compost annually, depending on whether the compost was made only with organic matter (1/2") or some soil (1"). This compost should be worked into the soil to prevent oxidizing.

Being high in organic matter, compost will oxidize quickly. Thus, a bed consisting only of compost will "disappear" over a short period of time. One could easily lose half of it or more during the growing season, especially if unmulched. Mulch, say wood chips, will also break down and eventually oxidize, forming CO₂. This is why it is added by landscapers annually.

If the plants used to build the butterfly garden are perennials, you would want their roots secured in soil, not compost. Soil does not go away. Compost does.

From your brief description, I get the impression the project champions want to finish this project as quickly as possible. Put up the frame and fill it with compost. Stick in plants and voila, you're done.

One of the aims of gardening is to improve the soil where you are. Compost helps one do this. Building raised beds is a short-cut, requiring that you import all your fertility from elsewhere.

Examining the claim that "it works," my guess is that two things happen. First, rain helps leach nutrients from the compost into the underlying parent soil, and second, the roots of the perennials work their way into this parent soil. If the parent soil is clay, this could take some time, during which the plants would suffer. If the soil is good, then this process will proceed more quickly.

Storing compost

Q. I was hoping you might have some suggestions regarding what type of containers I could use for storing my finished compost (p 18). For small amounts, you can get some inexpensive plastic garbage containers with covers (say, 30 gallon containers). Make sure it is finished (properly cured and somewhat dry); otherwise, you may get anaerobic activity or molds growing. If you have a three-bin system, you would store the compost in the third bin. We produce several cubic yards, more than can be stored with the first two options. We arrange this in a large rectangular pile. We line the ground beneath to prevent root intrusion from surrounding maple trees (plastic tarp over 6 mil plastic) and cover the whole pile with another tarp, suspended by a tent-pole in the middle and short stubs at other points so that air circulates and rain is kept off. For this last, check out our web site page "Backyard Minifarm Part A" at <http://neo-terra.org/PASA2.aspx> about half-way through, beginning "Part 3 How We Do It," for pictures of preparing compost, turning, and final pile.

Cover Crops



Q. Can you suggest any good guides on crop rotation and cover cropping?

I recommend heartily the following in the NOFA Handbook Series. The title is: Crop Rotation and Cover Cropping on the Organic Farm, by Seth Kroeck. 95 pages. Concise, full of tables, farmers' tips, insights. You will get a lot out of this. I am attaching one of the charts. Check out the other guides on this page. The website for this guide is at:

http://www.chelseagreen.com/bookstore/item/crop_rotation_and_cover_cropping:paperback

You will also find many good NOFA publications at <http://nofavt.org/books-merchandise> particularly under the "Farming/Gardening" category. You may want to consider joining NOFA or at least going to one of their conferences: <http://www.nofany.org/events/winter-conference>

On buckwheat, you mentioned getting two cuttings out of this. I believe what is meant by this is two crops, not cuttings. It grows fast. You plant twice, and cut twice during the season, then incorporate it in the soil. It is a smother crop for weeds. Cutting/mowing kills it. It is used because it stands summer heat, and bees love it. Other summer cover crops are Japanese millet and sorghum/sudangrass, which produces much organic matter.

Q. I thought I had it with just the companion plants but not sure how to plant summer cover crops in the spring and still have the beds available for planting mid-May. We aim for a 40% cover crop ratio. We show you the calculation around p. 39 (Organic Garden Primer). Simply put, you have to allocate bed sections for summer cover crops.

Q. I assume I'd follow Coleman's method of planting the cover crops in the beds 4-5 weeks after the main crop (unless you have another suggestion) and am not sure what spacing I should follow with the cover crops. When we finish a crop, say peas, we clean the bed and immediately plant the cover crop. We use Japanese millet after peas, and have a flat of J. millet ready to transplant. You can see the flat planting dates on the cover crop chart. Jeavons has spacing for most cover crops. On our chart you will find 8" for J.millet. For grasses and vetch, we clean the beds, aerate as normal, or loosen soil with a twisting or light turning motion of our spading fork, break clods (or remove clods if large and put in your compost pile), rake out soil. Then we broadcast seed and chop in with a garden rake. You will find our rates of seed application in our "Metrics" chart. The key thing about getting cover crops established is

light spritzing to keep seed wet, especially during the heat of spring or late summer. You may want to spritz in mid to late morning, and then again in late afternoon. Do not spritz in early evening or before dark, as you will invite slugs. Of course, you can plant flats of oats and transplant on 5" centers, but this is a lot of work, and oats are inexpensive. Same for rye, barley, vetch. By the way, use inoculant on vetch and other legumes. Get the right inoculant (see www.fedcoseeds.com).

Q. A couple of questions concerning which cover crops to use this year: If you recall, you gave me some barley and vetch to try last summer, which I planted late, probably sometime in June. I devoted one quarter of each of my two garden plots to this cover crop combination. This year, I plan to plant an adjoining quarter of each plot with a similar cover, possibly oats/vetch. I may also plant a winter cover crop of rye/vetch in another bed, favas this spring ahead of my tomatoes in my summer crop bed, and perhaps some buckwheat in yet another bed in the fall. Buckwheat requires the sun and heat of summer. Oats plus vetch will do well in the fall if planted by late summer say, by mid-Sept. I will buy the appropriate inoculants for these crops. My question is, do you recommend planting **crown** vetch this spring and, if not, what can I use as a substitute for vetch?

I assume "crown" vetch is a slip of the tongue. Never plant crown vetch; this is highway grass, puts down deep roots, and is difficult to kill or remove.

I never noticed the "crownvetch" in the Bountiful Gardens chart. I don't know why they would recommend that, unless it is something completely different from the crownvetch developed at Penn State. Crownvetch is an invasive from the Mediterranean that ended up on a farm in Berks County back in the 1930s. A PSU agronomist discovered it, and developed it for use on highway cuts. It is hard to remove.

Use another vetch – hairy vetch, or Madison hairy vetch. I have never had trouble using vetch in the spring. Another possibility is crimson clover. I never had much luck with crimson clover, perhaps for the reason the BG table suggests -- it is not recommended for heavy, cool soils. It is a pretty plant. Keep in mind it requires a different inoculant.

Q. Your previous description of applying the inoculant indicates a separate application of inoculant for the Pea and another for the Vetch even though each is spread in the same garden area.

You will broadcast the peas and vetch separately, as they come in separate bags. Just easier to do, as the seeds are of different sizes. I measure out the amount of seed I will be using into a small container. I add rainwater (not city water, which contains chlorine and will act to inactivate the bacteria in the inoculant). If city water is all you have, put a small amount of tap water in a shallow pan and let sit outside in the sun, or on your counter for 24 hours so the chlorine will evaporate. Or heat the water to boiling for a few minutes and let cool.

Then, pour some of this water into the pea, then vetch container. Stir to moisten seeds. Drain completely. Sprinkle some inoculant onto the seed. Stir around until seeds are coated. You are now ready to broadcast.

Q. Is there a spreader for the seed or some other method? Some practice is required here. We take a small amount of the seed in our hand and scatter broadly over the area we want to plant. For the vetch, we had earlier used a soup spoon to sprinkle, but found this tended to cause the seed to fall in too narrow an area. Our beds are 5' wide, so broadcasting by hand is easy to do. If you are planting an entire area, you may want to do this a narrow section at a time so that you can chop in the seed with your garden rake. By the way, if your garden soil is hard packed, chopping in may prove difficult, so you may want to loosen the soil in this part of your garden (using a spading fork, rototiller, etc.). If there are big clumps of soil, break up and rake out so that you have something relatively smooth. The chopping action of your garden rake acts as a farmers drill.

If you're uneasy about broadcasting too much, divide your allotted amount in half, and spread it over your area. Then spread the second half over the same area. This gives you two chances to practice.

Q. How do you sprinkle the inoculant? Sprinkle from the bag, or take a small teaspoon, dip into the bag, and sprinkle from the spoon. You will have more than enough inoculant, so be generous. You cannot use this next year, but reserve some for use for the late summer-fall planting of vetch with rye.

There is the question as to how much seed to use per unit area. Fedco may give you application amounts. I am attaching our Metrics table, which gives the Fedco and Bountiful Gardens amounts, and the amount we use for different bed areas. See third table, Cover Crop Weights.

I know this may all sound overwhelming, but try a small section first. You will get the hang of it. Remember to water the cover crops -- water lightly. The seed is near the surface. You do not want to waterlog the soil this early in the season. Keep wet. During sunny days, you may want to spritz twice -- morning and late afternoon. Avoid evening watering as it may attract slugs.

Using fava beans



Q. I planted fava beans this year to precede my tomatoes. I have you saying to let the beans grow until June 1 and on that day, cut the bell beans to the ground, cut the bean stalks into 3" pieces or so with shears or pruners, and turn the pieces under when you work in compost and any minerals indicated by your soil report. Then transplant tomatoes. Is that correct? Meaning unlike rye

and vetch no need to skim the sod, cut and let it decompose 3 weeks in advance of planting?

Correct. No need to wait. Transplant tomatoes directly after chopping and turning in favas. Make sure the fava roots are below the soil surface. These contain nitrogen nodules, and you do not want these exposed to the air, as the nitrogen will oxidize. Just push the roots below the surface (may need to use a trowel).

Also I noticed that Tania wrote on-line that in your experiments w/fava and verticillium wilt, you planted tomatoes in the same bed the following year (preceding it that year w/the fava beans). Was that just for the purposes of the experiment that you decided not to rotate the tomatoes to a different bed that year? I assume you still rotate because of other potential problems w/tomatoes aside from the wilt, right? Correct.

Sulfur

Q. I have a dumb question but here goes --I'm not sure about whether certain products, like sulfur for example, have both an organic version and a synthetic or more toxic version. Sulfur is sulfur. It comes micronized (a fine powder) and in small split pea-like pellets called pastilles. I've used both. While the powder will break down faster, it blows around in application, and sticks to the soil particles, particularly clay clods, and doesn't mix as well in the soil. Sulfur is caustic when breathed in, and it is hard not to when applying the powder. I now use the pellets. It eventually dissolves, and is easier to apply and distribute.

Q. It's garden time again and I'm not off to a great start as I just got my soil results back from PSU. Unfortunately, despite the sulfur I added last spring and fall, coupled with no longer putting my wood ash in the garden, the pH is still the same as it was about four years ago, 7.9. Serving as a background pH is a close by "virgin" plot that I planted potatoes in last summer; I just had it analyzed too and it resulted in 7.1. Do you think I should become a little more aggressive with sulfur or try something else in my main garden?

Wood ash increases pH, so it is good you stopped adding this. Your addition may explain your pH of 7.9. Pelleted sulfur will break down slowly, and the results will not be apparent for a while. Keep at it.

Consider the following table, plus note below the table.

www.homeharvest.com/soilconditionerspH.htm says:

**Pounds per 100 Square Feet of Loamy Soil
Desired pH**

Present pH	6.5	6.0	5.5	5.0	4.5
8.0	3	4	5	6	7
7.5	2	3	4	5	6

7.0	1	2	3	4	5
6.5	NA	1	2	3	4
6.0	NA	NA	1	2	3

The rate for going from 7.5 to 6.5 is 60% higher than PSU recommendation of 1.25 # Sulfur/100 sq ft.

Using the more conservative PSU recommendation, you should be adding 1.25 #/100 sq.ft. I would split this in two batches, 10 oz in the spring, 10 oz in the fall. Sulfur pellets, also called “pastilles,” are better than the fine sulfur powder as this latter blows around and sticks to the clayey soil that we have in our valley. Alternatively, mix carefully with the compost you will be spreading on your bed, or mix in wheelbarrow with garden soil you get from your bed, and then spread evenly back on bed, turning under.

For your 800 sq.ft. garden you will require 8 x 1.25 lbs or 10 lbs of sulfur pellets. Add 5 lbs this spring, and 5 lbs in the fall.

Langbeinite

Q. I was trying to purchase amendments locally and Agway doesn't seem to really know. For example, when I asked them if they could get greensand they told me to use K-mag to supply the potassium. K-mag seems to be a combination of langbeinite, potassium, magnesium sulfate, and sulfate of potash magnesia. I don't know if that means it's just elements found in the ground or whether there's something there I wouldn't want to use in my garden.

Here's a good post on your question regarding Langbeinite:

<http://forums2.gardenweb.com/forums/load/organic/msg0322113124241.html> Langbeinite is a marine deposit, and is included on the National Organic Program list. However, it sounds like what Agway sells combines it with chemical fertilizers. Agway sells to industrial farmers. Stick with the greensand. For sources, search under "greensand fertilizer" and try to find local stores. One brand is Espoma. Check around for local feed mills or farm supply centers. A PA firm that sells it is Fertrell, but I don't know how far they distribute it. It comes from New Jersey, so you should be able to find something locally.

By the way, I don't remember if you are trying for organic certification. If so, you should check with Northeast Organic Farming Assoc (www.nofa.org).

Boron

Q. We talked about making a solution of all that I need for the 1100 SF of beds I have. I've only prepared some of them for planting so far. I know you said once the mixture cools I can reheat it but if it's in the bottom of a one gallon jug and has crystalized that may be difficult. Any reason not to just make the tiny batches I need each time? Yes, you can make small batches at a time. Also the Boron is in a nice sprinkleable form now – I got it from the guy who sells Fertrell products. Is that the right kind? It looks like I should be able to just sprinkle it on w/o

cooking it first in hot water. Either I have the wrong kind or you were trying to tell me that boron has to be cooked first to be usable???

1. Your soil test results (Bed A/B) require adding 1/2 oz per 100 sq. ft. There is no way you can sprinkle this small amount evenly. Repeat: DO NOT SPRINKLE DIRECTLY. Farmers mix the boron with other sprays, fertilizers, amendments, and this dilution makes more even spreading possible. You are doing the same thing by dissolving in water. The boron we got from Timberleaf is a 1# bag of "Fertibor," Look on the bag you got from Fertrell. Does it say "Fertibor?" Does it give the percentage of boron? If the percentage is different, we will have to adjust the amount you apply to compensate.

2. You do not cook it, but heat the water and stir while pouring the required amount of boron into the pot. This is to aid dissolving. Otherwise, it tends to clump. Once dissolved, you can do as with copper sulfate: put in a gallon container, top with water, and divide the prepared amount among the beds corresponding to the amount of boron you dissolved. Then, take that required amount, put in a watering can, fill with water, and sprinkle evenly on your bed. This gets much better distribution.

Using soil test results

Q. My soil test recommends adding phosphorus. Fedco carries phosphate, both Bone Char (0-16-0) and Tennessee Brown (0-3-0). If you recall, I need a phosphate source that does not include Ca because my pH is already too high. I'm wondering if maybe the Bone Char would be a viable source. Unfortunately, both have calcium. Bone char has 7-9% from one source, Tennessee Brown 20% according to another source. I guess I would stick with the bone char. You may find that as you add sulfur to bring down soil alkalinity, your phosphorus reading goes up. This is because available phosphorus in strongly acid or alkaline soils may be low.

Starting without your own compost

Q. Do you have any advice regarding how we can nurture our soil, despite our lack of compost? If you can get well-aged horse or cow manure, that can be your compost for preparing your soil, and that can be often had for the effort of hauling. Lacking that, does Fairmont have a sewage treatment plant that produces compost from sewage? Our local sewage treatment authority makes a high quality compost cleared for vegetable use. Years ago, when we had manufacturing plants dumping chemicals down the drains, we could not use it, but these plants have closed (moved abroad). There is still the problem of pharmaceuticals that humans ingest and end up in our sewage, but for first time use, this is a good, inexpensive option. Lacking that, you may have to purchase truckloads of compost from a landscaping supply company. Avoid using chicken manure as your main compost. It tends to be too high in nitrogen, too hot (will burn seedlings), and too low in organic matter. Best mixed with other compost. Once our soil test results are in we will put lime down (do not assume you will put down lime. If your pH is high, do not add lime, which will make your pH even higher!), and some type of fertilizer. (If you use compost, you will not require additional and expensive organic fertilizer. Your goal must be to build up the organic matter content of your soil.)

That is all I can think of for now, hopefully I did not ask too many questions. Your help was, and will be, much appreciated. And, to answer your question, I am not sure how I found your website. I logged a lot of hours googling sustainability and biointensive gardening and organic gardening and W.Va. and the surrounding area; I'm sure I found you through one of these searches, or maybe through some link on an intermediary site. Yours has been one of the most helpful, though. I've crawled through most of your pages and documents several times. And, I am particularly impressed with the transparency of your project. It seems to me that most people view sustainability as almost a sort of neo-mysticism that is as strange as it is unattainable. I think that coherent explications of current sustainable practices, like biointensive gardening, like your website, are a really important part of educating people about the attainability of sustainable living. Beyond the information you provide on your site, I've also found its design and basic function inspiring. Thank you for your kind thoughts. It is gratifying for us to be of use to fellow enthusiasts!

Treating heavy clay soils

Q. I hit a spot of pretty solid clay – about 15 ft. of a 45 ft. row for the blackberries. I was wondering what you'd recommend to put in there before I plant the blackberries – something to help aerate that area. It depends on the "quality" of the clay. We remove pottery-quality clay and pile it up to weather, scraping the top as it breaks down and turning it back into our compost pile. Left in place, pottery quality clay will not break down in any reasonable time frame (as witnessed by its very existence under your soil). Can you break up the clay into smaller clumps with a fork, shovel, or pick? If so, humic acids from your annual addition of compost on top for blackberries will gradually help the clay break down. A regular program of annual compost will do wonders. A pH neutral compound to use is gypsum (calcium sulfide) which helps to break down clay. You can get this in 40# bags from an ag supply center. Pelletized sulfur will also help, and your soil pH is high, so the sulfur will compensate. We have used both. Regardless of what you use, it will take time.

Chlorine filters

Q. What filter do you use to get chlorine out of your garden water? A principle consideration is how much a given design reduces water pressure at the hose end. One we have found that reduces the pressure less than others is the CuZn garden water filter. Info at www.cuzn.com. It is good for 20,000 gallons and then you replace the filter cartridge. We installed a water meter on our garden supply line.

You must install the filter after the shutoff valve, and turn the valve off when not in use. Otherwise, as we have found out twice, the plastic housing can rupture from water hammer. The company has been very good about replacing the housing under their guarantee. Price online is \$69.95 http://www.cuzn.com/main_rv-garden.html Other filters reduce water pressure considerably (e.g., Garden gro). If you have a 1/2" water line serving your garden, do not use less than a 1/2" hose. That reduces water pressure even further.

The PVC housing will degrade in sunlight. We painted ours with two coats of exterior latex, a standard remedy. Use a primer on the first coat, or use fine sandpaper to roughen up the surface so the paint sticks better.

Converting soil test recommendations to organic equivalents

Q. I got a soil report on our garden soil but I am at a loss as to what to do next. The report suggests adding Urea and 0-46-0. Are these organic choices? Can you suggest where I might get organic supplies to improve my soil? I'll attach the report in case you can add some insight. Many thanks!

With your answers, I can now make the following observations:

1. The PSU soil test recommendations are for synthetic forms of nitrogen -- 0.5 lbs of urea (46-0-0) -- and phosphorus -- 0.5 lbs of (0-46-0) per 100 square feet. Since your garden area has three 8' x 4' beds, for a total of 96 sq.ft., the PSU recommendation of 0.5 lbs would suffice for all your garden beds.
2. If you are using mushroom compost, that will be more than sufficient to provide nitrogen, as mushroom compost is a good source of organic matter and nitrogen. For example, the PSU mushroom compost rating is 1.12-0.67-1.24. The numbers are percentages. The first number is nitrogen, the second phosphorus, the third potassium (hence, NPK, the symbols from the periodic table).

Thus, PSU's recommendation of 0.5 lbs of 46% nitrogen is equivalent to $0.5 \times 0.46 = 0.23$ lbs of pure nitrogen. The question is "How much mushroom compost is equivalent to 0.23 lbs of nitrogen?" Or Y lbs mushroom compost $\times 0.0112 = 0.23$ lbs pure nitrogen. Solving for Y we get $Y = 0.23/0.0112 = 20.5$ lbs per 100 sq.ft. I imagine you will be easily using at least 20 lbs of mushroom compost for all your beds. You do not describe the source of your mushroom compost. If you know its nitrogen content, you can duplicate the above math and get the answer. In short, you will have no problem supplying nitrogen using mushroom compost.

3. On phosphorus, since the percentage of synthetic phosphorus is the same as the percentage of synthetic nitrogen, the question is the same: "How much mushroom compost is equivalent to 0.23 lbs of phosphorus?" Or Y lbs of mushroom compost $\times 0.0067 = 0.23$ lbs of pure phosphorus. Solving for Y we get $Y = 0.23/0.0067 = 34.3$ lbs of mushroom compost for all your beds. Thus, if you use at least 35 lbs of mushroom compost for all your beds, you can supply both nitrogen and phosphorus as required. Doubtless you will be using more. That isn't much compost to be using.

4. The lesson here is that it doesn't take all that much high quality compost to supply your nutritional requirements for organic gardening, without using any synthetic fertilizer.

Pine needles for acidifying

Q. Can one use pine or hemlock bark mulch for acidifying? I searched under "do pine needles

acidify soil" and came up with two relevant responses to your question on one web site:

--NO! Research done by many people including Dr. Abigail Manyard at the UCONN Agricultural Research Station in New Haven, Conn has shown that there is no significant change in soil pH after years of adding oak leaves or pine needles to soil.

--Myth! pH has more to do with the mineral makeup of the soil, and the amount of rainfall, and only a little affected by the vegetation. So much of gardening lore on this point is just wistful thinking.

Double-digging following Jeavons vs making raised beds with compost

Q. Gene, I am working on a paper titled "Engaging Poverty – Urban Agriculture as a Site of Agency. I have a question for you to see if you can give me a couple of leads. Thanks, Lucky

It is clear that when we talk about urban farming we are not talking just urban locations. Urban farming is possible because there is now decent data on the productivity of bio-intensive agriculture. Jeavons talks about double digging, loosening the soil and then putting the soil back in trenches. But this is not what I saw in Milwaukee and Chicago where some of the soil had not even been tested for toxicity. Instead, they talked about putting a barrier down to prevent toxins being absorbed by plants, building raised beds, filling that with compost (wood chips and food waste) and growing food in that medium. I did not see any soil being brought from outside for the raised beds.

So two questions: Are raised beds a substitute for double digging? And is compost a substitute for soil? I have always thought of compost as something to improve the existing soil. Your thoughts?

Your two closing questions ride on a base of premises requiring examination. All agriculture, whether or not urban, goes against nature by simplifying ecology and concentrating effort and inputs in a small space and on a limited range of "crops." Whether my field of wheat is 100 sq. ft. or 100 acres, the farmer focuses on one crop in his "field" and tries to get the most per square foot out of it. American industrial agriculture is said to be highly productive at the same time it is highly inefficient – that is, it uses an awful lot of inputs, energetically speaking, to get the high yields for which it is known. Whereas prehistoric man got 10 calories out of the soil for every 1 calorie he put in, the American farmer gets the opposite – 1 out for every 10 calories put in. (On this latter ratio, I once saw a ratio of 1 out for every 7 in, but the 1:10 ratio is commonly used.)

This modern inversion is only possible because we use "energy slaves:" fossil fuels now, but wood earlier to produce steam, for example. Not to pick on fossil fuels, the same would be true for nuclear fuels if we could package its production in a small "engine" and put it on four wheels.

Unfortunately for the planet, for its complex ecosystems, and for the various species that occupy these ecosystems, this spreading of a high-energy input form of production creates destructive forces which have the serious consequences we are now facing.

Taking a larger historical picture, we also find that anthropocentric destruction of the earth has a long history preceding fossil fuels. From the Hoplites of Ancient Greece and their cousins in the Tigris-Euphrates valley, to the early corn-based Mayans, but also including the rice paddies of SE Asia and the Polynesian islanders, humans have wreaked destruction on ecosystems via their agriculture, strip-mining the surface and all the species in its way. Our own dust bowl of the 1930s, contamination of underground water supplies with nitrates, and rivers with synthetic fertilizers and pharmaceutical endocrine disruptors serve as recent American examples.

Now that more of us have become aware of this, interest has turned to creating a less destructive agriculture, which goes by many names: sustainable, ecological, biointensive, biodynamic, biological (in Europe), perennial polyculture (Wes Jackson's Land Institute), regenerative (Bob Rodale), and, of course, organic. Again, these can be done in spaces large and small. At this past weekend's PASA conference, I came across a new book titled "Square Inch Gardening," a takeoff of the popular "Square Foot Gardening" book. In this and another new book, I noticed that the making of compost was relegated to the last chapter! We're still not getting it.

But how are we to distinguish one of these from the other? What counts for "less destructive?" For Jeavons, the much vaunted "organic" brand, as practiced on big farms in California for example, is every bit as industrial (and destructive) of the soil and therefore every bit as non-sustainable as its chemically-based industrial cousin. Jeavons has organized biointensive in the tradition of French intensive urban gardening, Chinese intensive techniques that go back four millennia, and indigenous practices around the world. All of these require, for the survival of their practitioners, that they get more calories out of their agricultures than they expend, physically growing the food. Otherwise, they'd be dead. Therefore, use of fossil-fueled machines is excluded, together with all the machine-based accoutrements of industrial agriculture, however practiced.

Jeavons is not popular in the U.S. Judging from his newsletters and training programs, biointensive is widely practiced in African countries, Russia, Asia, Latin America. It is followed because it can support the subsistence requirements of small peasant householders. It can also provide a small income, but this is not its purpose. Once you begin producing for the market, your mode of production changes and you undermine the sustainable part of practices by introducing fossil fuels at one or more stages of production, e.g., rototillers, small tractors, purchased inputs, mechanical harvesting, coolers, trucking to market, etc.

With this brief introduction I now turn to your note and its two questions. I make the following points:

1. The urban farming you mention in Chicago and Milwaukee, relying as it does on greenhouses, vehicles to collect organic matter and deliver produce, is not sustainable in the

Jeavons sense. It relies on fossil fuel. This is industrial farming on a small scale. Its purpose is not to provide subsistence, but food for market and employment. It is food for exchange value, not use value. I am not speaking against this form of farming as so little of the food we eat is produced in a sustainable fashion.

2. An important objective in Jeavons and other sustainable practices is to improve the soil. This is the bedrock. Since urban soil can be contaminated, the urban farmers in your examples rely on organic matter that is available – the food wastes and wood chips you mention that are turned into compost. The farmers then grow food in this compost. Compost oxidizes quickly, so they will require a lot of imported inputs to keep the urban farm going. In soil-based agriculture, you require only 6% organic matter, which is easy to realize using compost and cover crops. Putting this another way, the compost in a compost-only operation could improve a lot more soil area – namely 1/0.06 or 17 x as much area to the same depth. With soil-based urban farming there is at least the possibility of realizing a higher degree of sustainability than in purely compost-based urban farming. In Detroit, as that link I sent you earlier illustrated, urban farmers work to improve the soil. I imagine the soil in vacant urban lots is less toxic than soil in industrial or commercial areas.

3. Therefore, raised beds filled with compost are the polar opposite of double-dug beds. The first uses only compost, the second improves the soil. With the same compost, you can improve much more growing area in soil than in raised beds. Double-digging is a technique to improve soil; filling raised beds with compost is not. You are correct when you say that compost is used to improve the soil.

You hoped I could give you a couple of leads. Coincidentally, I just came across two items.

The first is a reflective piece on urban agriculture, which abstract can be read here:

<https://journals.cambridge.org/action/displayAbstract;jsessionid=9DCC6907A646C84DF82D8FEAC3FAC433.journals?aid=9530250&fileId=S1742170513000525>

With the second, I came across Curtis Stone's story of how he became a SPIN urban farmer in British Columbia. SPIN stands for Small Plot INTensive. If you go the Video page, you can watch several in succession. At the third and fourth one you get a sense of how he actually does things. You will note how he illustrates how turning the growing of food into a business takes you off the path of sustainability by importing inputs and using machinery and other fossil fueled inputs. Nonetheless, such practitioners use the term "sustainable" and "biointensive". SPIN is all about making a living out of growing food in urban areas. Farmer Curtis Stone trumpets this proudly, and propagates the faith by giving workshops in the winter. Just shows how elastic the terms sustainability and biointensive are, which is why Jeavons, for example, had to jettison these terms and coin his own: Grow Biointensive, to distinguish his approach from the others. Here is the link: www.greencityacres.com/

Mycorrhizae

Q. I've been hearing a lot about mycorrhizae, and their importance to soil health. Do you have any opinion on this topic? Best, Jackie

Reviewing the Dec.2014 issue of HortScience online (abstracts only for non-members) I came across the following article:

Effect of Arbuscular Mycorrhiza and Temperature Control on Plant Growth, Yield, and Mineral Content of Tomato Plants Grown Hydroponically

The investigators found that adding mycorrhiza did not make any difference in plant growth. What mattered was temperature control. Tomatoes grown hydroponically in a temperature controlled greenhouse outperformed those grown in a non-temperature controlled greenhouse.

We have been using mycorrhizae since 2013 which we have purchased from <http://www.bountifulgardens.org/> but can't say we've noticed a dramatic difference. On the other hand, we have not undertaken careful experiments either.

Q. Gene, according to basic soil chemistry, soil is about 50% inorganic (sand, clay, loam), 40% water and air and less than 10% is organic. I am wondering how Will Allen is growing plants on raised beds with compost (food waste + wood chips). I forgot to ask him about soil. Of course hydroponics does not use soil at all. Any thoughts on my query? Lucky

If you can accept that it is possible to grow plants hydroponically, that is, without any soil at all, and with soil at the other end of the continuum, then some intermediary position on this continuum (e.g., using wood chips and food waste) shouldn't pose a mental hurdle.

I have had squash, tomato and bean plants grow out of our kitchen food scrap pile during the summer months; there is little soil in this pile of scraps.

Plants get only 5% of their energy to grow from soil nutrients; the remainder comes from water, sun, and CO₂ (don't quote me on the 5% figure -- this is what I recall from years ago). The soil acts as a medium to secure the roots of the plant and a way to recycle nutrients through biological decay. In this sense, wood chips and food waste can be used to secure the roots of the plant. Over time, the wood chips and food waste will break down, forming organic compounds which the plant's roots will absorb as nutrients. Does Will compost wood chips with food scraps before placing the composted material in his beds or does he grow his vegetables directly in raw food scraps mixed with wood chips?

This small percentage of energy from soil describes why it takes time to deplete a soil farmed aggressively without nutrient replacement. The organic content, already low at the 5% range, depletes even faster without replacement. At 3% the soil is already poor. Our own garden soil has ranged from 6-10%. Six percent is considered good.

Here is a short tutorial on soil organic matter, which speaks to how even raw organic matter, of the sort Will is using, becomes part of healthy soils. Left unexplored is the question of sustainability -- that is, comparing various ways of producing food along a common set of criteria, to judge how each stacks up as being easy on the earth.

<http://www.uvm.edu/~organica/OrganicOrchardInformation/Horticulture/OMfuelforsoil.html>

Bio-char

Q. I read about you in the newsletter, then I stumbled upon you on the net. I live in Hay River of the NWT in Canada. We have 3 acres and I just wanted to tell you I also have been studying the three systems -- permaculture, bio-intensive and Mr. Coleman's work! Because of the long winters here we are building a special winter greenhouse along with having an outdoor garden and 1000 sq ft poly house. We have a small 1000 sq ft trailer home we have renovated, we are installing a wood gasification boiler for heating. We have community hydro power. I just have a few questions. I noticed you have lawn on your garden paths; do you find that better than mulch? I was worried the grass might be hard to control yet I felt the grass would give biomass? Second, have you considered ducks or geese, since they are more vegetable eaters for egg and meat production? Lastly have you heard about biochar yet? I believe it will become a very helpful addition in our goals. <http://www.biochar-international.org/> and <http://holon.se/folke/carbon/simplechar/simplechar.shtml> . Thank you for taking the time to create your web page. Jackie M.

Yes, we use grassy paths. We find them easy to maintain over mulch or hay, which can harbor slugs, and have to be replaced. Grass is easy on our feet, attractive and cool to the eyes on hot summer days.

Ducks and geese would be great if we had a pond or a nice body of water for them to enjoy as well; plus we would have to consider how to grow feed for them to eat for the winter months. We are on the foothill of a small mountain and water drains downhill, so no water ponds here! Also, with our limited space, we cannot grow food for livestock. We have certainly considered it because we would love to raise chickens for their eggs. It is just not possible to do sustainably on our 0.8 acres (which has many large mature trees on it and limited sunny spaces).

We have heard of terra preta/biochar, and, at present, have not had time to investigate it in depth. One question that comes to mind is, what happens to the volatile gases that are driven off in the process of making biochar? Also, what happens if/when this is conducted on a large scale? What volatile gases will we be polluting our air with next? We will watch others conduct the tests for now. Other lines of investigation may be more promising: the use of mycorrhizae (fungi which develop a symbiotic relationship with plant roots), Effective Microorganisms (<http://sam.vmicrobial.info/>, and <http://joshkearns.blogspot.com/2006/12/effective-microorganisms.html>), and other kinds of bacterial formulations (<http://www.tainio.com/>).