Ecology Action's GROW BIOINTENSIVE® Compost Protocol

"How can [humankind] regulate its affairs so that its chief possession—the fertility of the soil—is preserved? On the answer to this question the future of civilization lies."
- Sir Albert Howard, botanist and organic farming pioneer, 1942

Purpose
GROW BIOINTENSIVE is a powerful method for increasing productivity and sustainable fertility, but used incorrectly, it will damage your soil. The purpose of each of Ecology Action's three GROW BIOINTENSIVE (GB) Protocols — the Soil Protocol, the Sustainability Protocol, and this Compost Protocol (all available online at www.growbiointensive.org/grow_main.html) — is to emphasize that GB teachers' primary goal must be to learn the GB method thoroughly, remain true to the method as taught by Ecology Action, and make sure that all eight foundational principles of the method remain *undiluted in their teaching and demonstration*, so that the people they teach do not "cut corners" and practice GB in an unsustainable way.

This Compost Protocol is for teachers and certification candidates to use in conjunction with the Soil Protocol and the Sustainability Protocol, while practicing the GROW BIOINTENSIVE method as taught by Ecology Action and the book *How to Grow More Vegetables*. In this protocol, you will find new material that brings Ecology Action's research on compost up to date and makes that information easier to put into practice.

A Story—Alfalfa and Leaching
Some years ago, The Jeavons Center Garden Manager and an intern came to John Jeavons with an idea: to grow alfalfa on all the beds as compost crops, so that the roots—which grow to great depths—would pull up all the nutrients which had leached out of the beds over the course of the growing season. John was pleased the two were coming up with such creative ideas. However, it was clear to John (because of his experience using the GB method in combination with the soil and the seasonal cycle at The Jeavons Center site) that using alfalfa to pick up leached-out nutrients in the spring would prevent the GB soil system from functioning at an optimal level to maintain fertility and reduce resource use.

By paying close attention to the conditions at the Jeavons Center site, John knew that, to make the soil optimal for sustainable soil fertility, specific 60% compost crops need to be planted on or near September 15th each year. Planting on this date allows the root systems of the crops to develop enough so that *by the time the rains start, the roots have already captured the nutrients that might have otherwise leached out*. If compost crops are planted later (like spring-planted alfalfa), or if slower-growing plants are used, lots of nutrients leach out before the root systems are large enough to capture them. John knew that the alfalfa suggested by the newer farmers wouldn't grow fast enough if you planted it by Sept. 15 to catch the nutrients, and if planted in the spring, would be too late to catch the nutrients. Also, even though spring-planted alfalfa could pick up leached-out nutrients from deep in the soil, the spring planting unnecessarily uses "Bed Crop Months" that could be freed up for food crops by using a properly timed autumn crop to capture the loose nutrients quickly.

The purpose of this story is not to say that everyone globally should plant compost crops on September 15, or that you should never plant alfalfa as a cover crop, but that every soil and climate requires well-thought-out and *experienced* variations to develop and maintain sustainable soil fertility in each person's farm or garden. As you learn the GB method, you must internalize it, which means taking note – as John did in the story above – of how the method functions in your own soil and climate, while staying open to the input Nature will have as you work with her, and staying true to the 8 principles that support GB as a whole system.

Compost is Important to Food Security
The United Nations has noted that in the next 10 years, two-thirds of the world population—5.5 billion individuals—will face significant risk of severe malnutrition or starvation, due to *insufficient* water to grow enough food to maintain health… or life. Integrating compost into farming practices is an excellent way to reduce water use, because *compost holds six times its weight in water* **and** *it also holds water-soluble nutrients*, keeping them from leaching out of the plant-root growing area. This is especially key as most of the world's soils are low in organic matter and plant-growing nutrients, and therefore lack the ability to hold water and nutrients efficiently.

And if using compost is good, then improving the "power" of the compost you use can make all the difference in the world. Therefore, it is important to understand that:

<u>All Compost Is *Not* Equal</u>
Through our mini-farm research, Ecology Action has discovered five factors that may enable GROW BIOINTENSIVE compost to give you 2-10+ times, the *quantity* and *quality* — the "compost power" — as compared with other, non-GB compost. Factors 1, 2, and 3 have already been proven, while anecdotal evidence has been provided for 3 and 5, which we are still researching.

1. **GB compost as prepared according to Ecology Action standards (as described in *How to Grow More Vegetables* and *The Sustainable Vegetable Garden*) has been shown to increase crop and biomass yields, which increases compost yields, creating a cycle of sustained fertility.**

   In a world with increasingly depleted and desertified soils, creating and using appropriate and sufficient amounts of compost will be key to building and maintaining soil fertility and productivity. Because the GROW BIOINTENSIVE Sustainable Mini-Farming system can yield 2x-6x the quantity of biomass as other systems, there will also be a similar increase in the amount of biomass available for making compost.

2. **Cold-composting according to Ecology Action standards may increase your yields further**.

   Many people advocate **hot compost piles**, because they are said to kill weed seeds, disease organisms, and insect larvae. However, we dispute this assertion: compost piles cure at around 139°F; at this temperature, probably only about 25% of the pathogens and weeds are destroyed. It takes a temperature of about 178°F to kill 100% of them—and this temperature oxidizes or "burns off" a lot of the organic matter that could become cured compost, *so to increase our efficiency, we have adopted a cooler pile approach*.

   Cool compost piles make greater use of coarse materials, more structural carbon or mature material (rather than metabolic carbon), and a little more soil and water than hot compost piles, and a reduction or elimination of the "turning" of the compost. All this means proportionally somewhat less nitrogen in the pile and a lower temperature. **Cold compost** has the potential to produce up to 40% and more of cured compost, due to the moldering process—as opposed to the combustion process (often accelerated even more by the turning of the pile), which "burns up" a significant amount of organic material. If a pile is turned, it returns to the first stage of decomposition, increasing its temperature again, and oxidizing more carbon— resulting in the production of *less* cured compost. More types of microbes can live in a cold compost pile; there are fewer types in a hot compost pile.

The first time experimented with cold compost, we got 38% more cured compost, compared with the “control” hot compost pile. One publication implies that up to 100% more may be possible using these techniques. You can create a cold compost pile by using:

- slightly more carbonaceous material and/or less nitrogenous material than you would for a hot compost pile,
- more coarse materials and fewer fine ones,
- slightly more soil when building the pile,
- slightly more water when building the pile, and
- a “no turn” approach.

In EA's research, it is interesting to note that all compost piles have been found to be “hot” when built at the beginning of the main/hot growing season: **30:1** piles are hot/139 degrees F for about **3 weeks**; **44:1** piles for about **2 weeks**; **60:1** piles for about **1 week**. Such piles are normally termed: Hot, Cool and Cold. Actually, all piles are hot for a time, and it is the piles that cool off more quickly that are referred to as “Cool” and “Cold”. Also interesting is that the **all the piles cure in about the same amount of time**. **Hot piles** take about **8 weeks**, the **Cool piles** about **9 weeks** and the **Cold piles** about **10 weeks**. But how do the Cool and Cold piles accomplish this? Nitrogen makes up the largest amount of the elements in the air, and the compost piles have nitrogen-fixing bacteria in them!

3. ***Maintaining* the curing compost piles *carefully***. A cured compost pile that has been properly maintained—such as stopping the pile at the right time, letting the compost dry out fully in a warm, dry, shaded area, and storing the cured compost correctly—can yield 20+% more *cured organic matter* rather than the more typical 8% to 10% produced by a compost pile maintained less diligently. This is important, because organic matter is what holds water and nutrients in the soil. One cubic foot of cured compost with a high percentage of organic matter may have double or more the “compost power” of compost with less organic matter!

4. **Building a pile with a carbon/nitrogen ratio of 44 to 1 may be the “golden ratio” for building sustainable soil fertility.** Instead of using the traditional 30-parts carbon to 1-part nitrogen or 60-parts carbon to 1-part nitrogen ratios when building your compost pile, try using a 44-parts carbon to 1-part nitrogen ratio. In our research gardens, *we have seen that over time, using the cured compost resulting from a 44:1 carbon to nitrogen ratio to grow crops consistently produces higher crop yields in terms of calories and biomass produced*. In one test comparing compost made of 30:1 versus 44:1 ratio, the 44:1-derived cured compost produced *double* the calories and dry biomass from grain and high-calorie root crops as compared to the 30:1-derived compost. We are continuing to research this difference in productivity and looking forward to better understanding why it occurs.

Note: Even though the 44:1 compost discussed above seems to provide optimal productivity, it is important to remember that different carbon:nitrogen ratios in compost piles can serve different purposes. For example, one of the best compost mixes to address the problem of feeding 5.5 billion people on soil that is too depleted to hold water or nutrients could be a GB cured compost that contains 50% soil combined with 50% of a compost blend of:

- **two-thirds** compost made with a 30:1 carbon/nitrogen ratio,
- **one-sixth** compost made with a 44:1 ratio, and
- **one-sixth** compost made with a 60:1 ratio.

What is important to know functionally of compost made with these different ratios? The **30:1 built pile** has more readily available nitrogen and nutrients; the **44:1** has nitrogen and nutrients that are partially readily available and partially more slowly releasing; and the **60:1** has nitrogen and nutrients that are less easily available, and release over time. This mix of the three types of organic matter provides a good immediate base for growing food and soil, plus an intermediate base for the longer term, and a base for the long term.

5. **Building a pile that uses more structural forms of carbon than metabolic forms of carbon may give your compost more power over time.**

   Structural carbon is the equivalent of pasta which, when eaten, has staying power and energy in the body. Metabolic carbon is like eating a chocolate bar, which breaks down quickly, with its energy fix soon crashing. Structural carbon, when transformed in cured piles, is resistant to decomposition—making it better for building soil. It has the staying power of 2 to 4 years. Metabolic carbon breaks its materials down rapidly and only lasts in the soil from 0.1 to 0.5 years. Cured compost from a pile made with a lot of structural carbon releases nitrogen and nutrients less rapidly and grows crops more slowly.

   Using more structural carbon like cellulose and lignin (mature straw and stalks) and less metabolic forms of carbon, such as sugars and starches (immature leaves and stalks) may result in more durable, longer-lasting cured compost. For example, compost created with a 60:1 carbon:nitrogen ratio is sustainable in a special way: some of it lasts (holds water and nutrients and provides carbon for plants to grow on) for up to 5,000 years! However, if you are trying to grow crops on very poor soil while building up that soil so it will regenerate and produce sustainably, you need to pay attention to the balance of structural and metabolic carbon in your compost pile, to achieve the optimal mix of seasonal productivity while building soil fertility over time. (See *Appendix: Soil Organic Matter Flow Chart* on page 7**)**

Notes

- Care must be taken to avoid overdependence on worm castings as a fertilizer; the nutrients in them are highly bioavailable and can therefore be more easily lost from the soil system.

- Helen Philbrick and Richard B. Gregg, *Companion Plants and How to Use Them* (Old Greenwich, CT: Devin-Adair Company, 1966), pp. 75–76.

- To learn more about how the forms of cured compost in the soil (called soil organic matter or SOM) act in the soil—including lasting for up to 5,000 years—see the Soil Organic Matter Flowchart in *The Nature and Properties of Soils,* 1996, pp. 390-91. For more information about compost, see the webinar Compost with John Jeavons at https://vimeo.com/ondemand/ecologyaction. Also, see Appendix (page 7) of this protocol.

General Information on Compost

- Compost provides only 4% of the nutrients needed to grow crops. The other 96% comes from air and water.

- The purpose of using **soil** in building a pile is to reduce smell and flies, to assist in holding water and to keep the pile cooler. The soil also contains microbes that help the compost pile in its break-down process.

- If for some reason you need compost cured quickly, there are three ways to speed up the decomposition rate in a compost pile—though they will probably leave you with much less cured compost per unit of material added to your pile originally, rather than the greatest quantity of life-enhancing compost you must seek.

- **One way** is to increase the amount of nitrogen. The ratio of carbon to nitrogen is critical for the breakdown rate. Materials with a high carbon:nitrogen ratio—such as dry leaves, grain straw, corn stalks, and small tree branches—take a long time to decompose alone since they lack sufficient nitrogen to feed the bacteria that decompose organic material. To boost the rate of decay in carbonaceous materials, add nitrogen-rich materials such as newly cut grass, fresh manure, vegetable wastes, green vegetation, or a fertilizer such as alfalfa meal; 12 to 20 lbs. of alfalfa meal per cubic yard of compost will fortify a compost pile with a high carbon content. Lightly sprinkle these fertilizers on each layer as you build your compost pile.
- A **second method** is to increase the amount of air (aeration) in the pile. Beneficial aerobic bacteria thrive in a well-aerated pile. Proper layering and periodic turning of the pile will accomplish this.

- **Third**, you may increase the surface area of the materials. The smaller the size of the materials, the greater the amount of their exposed surface area. Broken-up twigs will decompose more rapidly than twigs that are left whole. We discourage the use of power shredders because nature will do the job in a relatively short time, and everyone has enough access to materials that will compost rapidly without resorting to a shredder. The noise from these machines is quite disturbing and spoils the peace and quiet of a garden. They also consume increasingly scarce fuel.

- **Compost what you have, when you have it.** Don't wait to build your compost pile until you have accumulated the "perfect" materials with the optimal amount of structural and metabolic materials, because this will result in the loss of carbon and nutrients from the compostable materials as they wait to be used. While it is nice to have all the materials at hand to build an entire compost pile all at once, that's not always possible. If your compost materials are only available periodically, or in smaller amounts than an entire compost pile requires, then it is important to use whatever amount of materials you have *as* you have them.

- **Don't use manure in your compost pile if you can avoid it.** In the short run, for people just starting out and utterly lacking in other sources or organic matter, it is tolerable (but not desirable) for them to incorporate manure into their compost pile at a rate of $1/6^{th}$ of the total volume of the compost pile, which will result in a cured compost that is 16% manure. This can be done for 1 to 3 years to provide a "running start" towards increasing soil fertility enough that it can support the growing of non-manure compost biomass but is <u>significantly</u> not sustainable and must not be continued for longer than 3 years (*see the Use of Cow Manure Appendix in the EA Sustainability Protocol*).

<u>Additional Information on the GB Compost Method</u>

- **GB composting rotation**. Compost piles can be rotated to different beds over the years, adding extra nutrients from the compost juices that leach out when those beds are later used for crops. Also, according to Will Britton at Woods Hole Institute in Massachusetts, crop diversity is inherent in Biointensive farming, and the residues from the diverse crops all go into the compost. In this way the compost is, of itself, an "invisible" form of added rotation.

- **GB composting accelerates accumulation of soil organic matter**. In nature, Soil Organic Matter (SOM) can generally only be increased very slowly – by only $^1/_{20}$% annually. Using compost in conjunction with the other principles of GB gives farmers the potential to significantly improve the SOM accumulation rate.

- **At least 3 different textures of materials should be used** when building a compost pile.

- **3'x3'x3' is the minimum size for a compost pile**. John Jeavons prefers 4'x4'x4' or 5'x5'x5' for the additional insulation they give to hold the curing heat. If piles are longer than 6', holes for aeration must be added every 6' in the middle of the width of the pile. This can be accomplished by placing a 4'x4" wooden stake at the 6' point(s) in the middle of where the pile will be, building the pile around them, and then removing the stake(s) after the pile is completed.

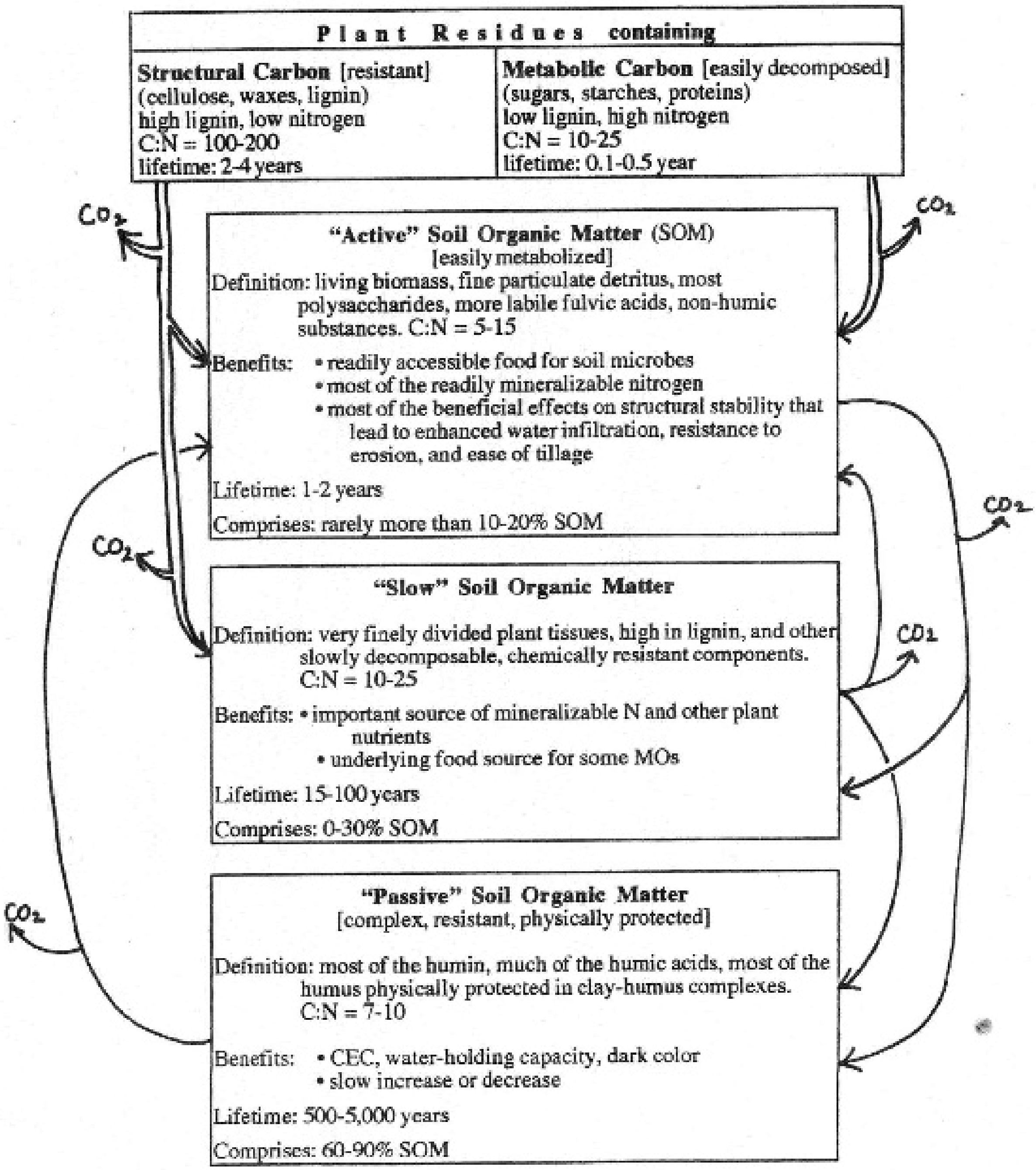
- **The fourth stage of composting, one to be generally avoided, is *mineralization*.** Even though cured compost at the mineralization stage contains carbon and minerals, these elements are not in as living and dynamic a form as non-mineralized forms, and are not as readily used by plants (or the humans who eat them).

- **Don't use urine as a fertilizer**. While it is true that urine diluted 10:1 with water can provide a significant amount of nitrogen for plant growth, it should **not** be used, as it can contain the organisms that cause hepatitis, venereal disease and HIV/AIDS. Also, the nitrogen in the diluted urine would be too readily available — and would break down valuable soil humus as it seeks carbon to bind with.

- **There are *3 different types of compost*: animal-manure-based, plant-based, and root-based**. Root compost is 8x more effective than manure compost qualitatively and 2x better than non-root plant-based compost. This is because roots are in a dynamic choreography with the microbes and soil, so that one cannot tell where each begins and ends. One of several especially good sources of root material comes from cereal rye — one plant puts out 3 miles of roots a day, 387 miles of roots in one season, and 6,603 miles of root hairs a season. Up to 833 plants transplanted on 5" offset centers can fit into a 100-sq.-ft. growing bed. That is a lot of compost power! We sometimes use four times the seed (on a broadcast basis) gently chopped gently into the soil with a bow rake to begin loosening up a clay soil. Alfalfa is another good root crop, puts down roots as deep as 125 feet, if rock is not encountered. And, as always, whatever crop you plant needs to be planted at the right time to work with the seasons and soils of your farm or garden site.

Appendix
Soil Organic Matter Flow Chart

SOURCE: *The Nature and Properties of Soils*, 11th ed., 1996, pp. 390-391.



Information formatted by Ecology Action, 5798 Ridgewood Road, Willits CA 95490-9730. September 25, 1998.