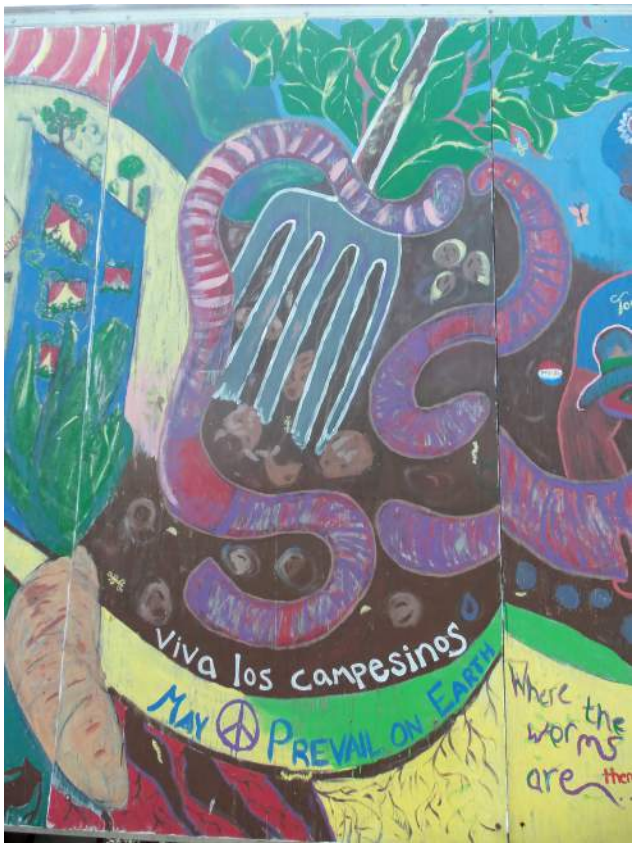
Compost Coordinator Handbook



Written for the UW Farm, Summer 2015. First Edition.

Hello to All,

Welcome to the UW Farm's Compost Coordinator Handbook. This text is written in the hopes of aiding future UW Farmers in perpetuating the compost program on campus. If you find yourself reading this now, please take a moment to recognize the power of your position. Compost is an essential component of any sustainable agriculture operation; without the addition of nutrients and organic matter lost from harvest, agricultural systems would soon be unable to support crop life. I encourage you, as you read on, to keep in mind the ecology and cyclical tendencies of the entire farm (and how compost fits into this larger system). Decomposition is a (mostly) silent process with uncanny influence over future growth. When thinking about how to best invest energy in future program, looking for ways to support the existing ecological structures is an excellent start.

Best of luck, compost on.

Chapter list

The Basics: Facts and Questions

Composting is assisted decomposition. What is Decomposition?
Decomposition in its most basic form is the breakdown of organic molecules into simpler compounds. This allows elements to be restructured into different molecules that can preform different functions for plants (e.g. nitrate [NO_3^-], humic material). The end product of composting is called humus. Humus is a hard concept to define; there is no classification by shape, structure or character. This is the technical term for the breakdown of organic matter over time (i.e. composting) is "humification".

Humification=organic plant and animal inputs→nutrients, sugars, starches, proteins, carbohydrates, lignins, resins, and organic acids.

Composting can be thought of as a recycling system for organic material, a cycle from raw organic material to humus and back again. The decomposer food chain supports the grazing food chain by breaking down dead tissues and making them productively available for primary producers and other soil exploiters.

There are different ways to compost.
There are three main agricultural composting methods that come to mind: hot, cold, and vermiculture. Hot composting and vermiculture will be covered in this text, but you should know that cold composting exists. In cold composting, a pile is build and allowed to breakdown in place (no turning). This takes 2-3 times longer than hot composting but is extremely low maintenance. Read on for hot compost and vermicompost specifics.

Who breaks down compost?
Compost creation is driven by an arsenal of microbes and soil fauna. Many arthropods reduce the size of coarse materials (e.g. leaves, vegetables, woodchips) and create more surface area for the chemical decomposers (e.g. bacteria, fungi) to get to work on. The composition of compost organisms changes most prominently with the temperature of the pile.

What are the benefits of compost?
-Builds soil structure (compost promotes aggregation of soil components, which is responsible for many of the benefits listed below)
-Drought protection
-Erosion resistance
-Aeration
-Water retention
-Slow release of nutrients
-Diversity of nutrients
-Toxin neutralization
-pH buffer (worms are responsible for this perk)
-Growth stimulator for plants

Building the Pile: Hot Composting

First things first, you need somewhere to put the compost. The UW Farm has infrastructure in place already so this guide will not go into bin types. However, if the ultimate goal of the composting program is to eventually make all of the compost for the UW Farm on site, it is wise to begin to think about what infrastructure is necessary for that larger scale. If you're interested in infrastructure ideas, large or small, I suggest you check out:

Martin, D. L. & Gershuny, G. (1992). *The Rodale Book of Composting: Easy Methods for Every Gardener*. Emmaus, PA: Rodale Press.

The Complete Gardener's Guide. (2011). New York, NY: DK Publishing.

Cornell Extension: Composting. http://compost.css.cornell.edu/

Ingredients

Creating compost is all about the ratio of carbon to nitrogen (C:N). All plant matter has both carbon and nitrogen, but in different proportions relative to each other. The sweet spot of finished compost is 25:1 - 30:1.
Organic matter with a C:N smaller than 30:1 is considered a nitrogen.
Organic matter with a C:N larger than 30:1 is considered a carbon.

Nitrogens		Carbons	
Manure	15:1	Hay	40:1
Coffee grounds	20:1	Leaves (dried)	40-80:1
Vegetables	20:1	Straw	80:1
Leaves (fresh)	30:1	Wood chips	700:1

Use these numbers to *approximate,* you don't need to do anything ridiculous like use measuring cups. Here are some guidelines for estimating C:N using volume:

Summer: You want a 1:1 (by VOLUME), e.g. 4" carbon, 4" nitrogen.

Winter: You want a 1:2, e.g. 4" carbon, 8" nitrogen.

Building the Pile

1. Start with a layer of carbon 6-12 inches deep.
2. Water the pile until the layer is saturated but not water logged.
3. Add a layer of nitrogen at an appropriate depth relative to carbon
4. Repeat 1-3 until the desired volume is achieved, ending with a carbon layer

A Note about Manure

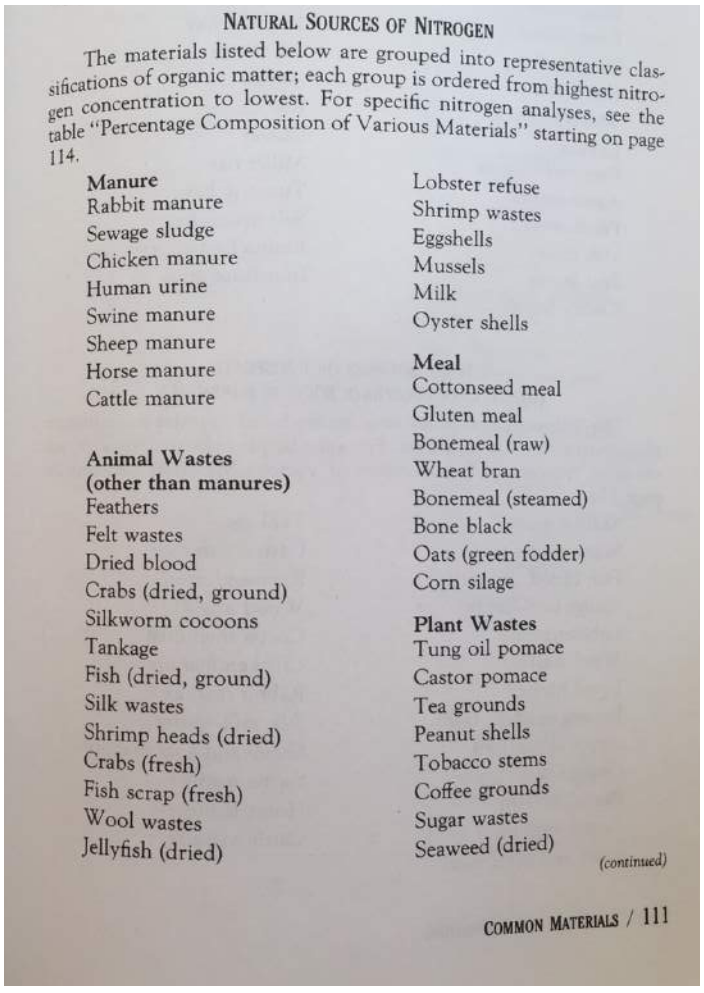
There are a couple of additional things to think about when composting with manure. Different types of animals produce manure with different qualities, so check out the specifics before you use any manure in compost. Horse manure, for example, is actually

considered a carbon because all of the undigested straw in it. Also, manure is a hot bed for biotic activity; there are many fecal pathogens that you want to kill before spreading compost on your fields. If you're using manure, you MUST keep a temperature log of the pile. The pile should reach 130-150° F at peak temperature to sufficiently kill pathogens and weed seeds; in order to reach these temperatures, compost manure in a bin at least 3x3x3 ft^3. It is also important to know what the animals were fed, some animal feed has chemicals that don't break down during the compost cycle.

Sourcing

Pesticides, fertilizers and other chemicals used on compost ingredients may find their way into finished compost. Be wary of grass clippings, generally they get the most in the way of chemical treatment. Forming relationships with the people donating ingredients is the best way to know that they are safe. Make sure and ask what they used on the plant matter while it was still living.

Ideas for Nitrogen and Phosphorus



NATURAL SOURCES OF NITROGEN

The materials listed below are grouped into representative classifications of organic matter; each group is ordered from highest nitrogen concentration to lowest. For specific nitrogen analyses, see the table "Percentage Composition of Various Materials" starting on page 114.

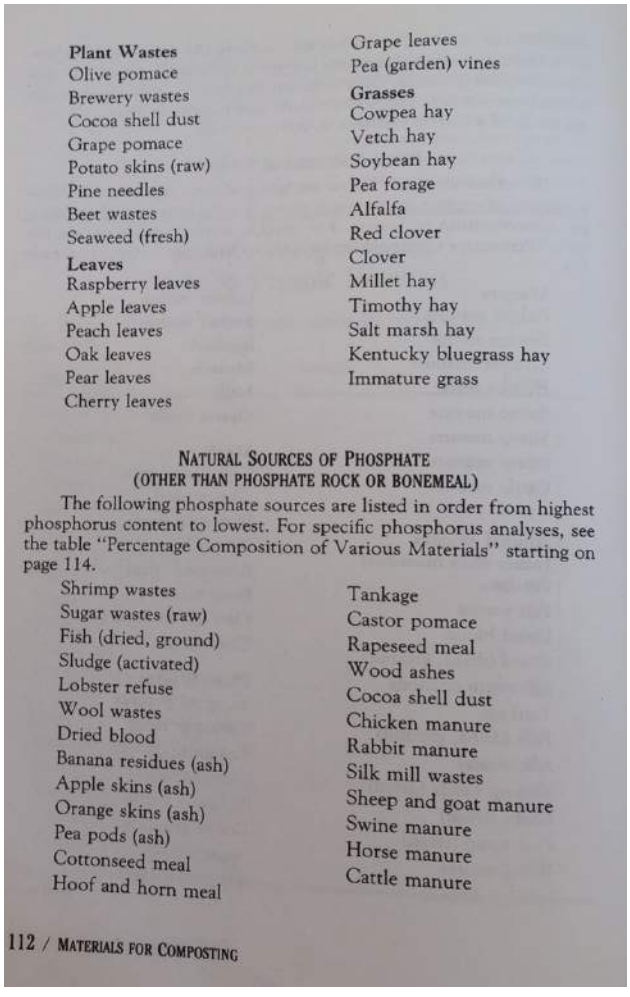
Manure
Rabbit manure
Sewage sludge
Chicken manure
Human urine
Swine manure
Sheep manure
Horse manure
Cattle manure

Animal Wastes (other than manures)
Feathers
Felt wastes
Dried blood
Crabs (dried, ground)
Silkworm cocoons
Tankage
Fish (dried, ground)
Silk wastes
Shrimp heads (dried)
Crabs (fresh)
Fish scrap (fresh)
Wool wastes
Jellyfish (dried)
Lobster refuse
Shrimp wastes
Eggshells
Mussels
Milk
Oyster shells

Meal
Cottonseed meal
Gluten meal
Bonemeal (raw)
Wheat bran
Bonemeal (steamed)
Bone black
Oats (green fodder)
Corn silage

Plant Wastes
Tung oil pomace
Castor pomace
Tea grounds
Peanut shells
Tobacco stems
Coffee grounds
Sugar wastes
Seaweed (dried)

(continued)



Plant Wastes
Olive pomace
Brewery wastes
Cocoa shell dust
Grape pomace
Potato skins (raw)
Pine needles
Beet wastes
Seaweed (fresh)

Leaves
Raspberry leaves
Apple leaves
Peach leaves
Oak leaves
Pear leaves
Cherry leaves
Grape leaves
Pea (garden) vines

Grasses
Cowpea hay
Vetch hay
Soybean hay
Pea forage
Alfalfa
Red clover
Clover
Millet hay
Timothy hay
Salt marsh hay
Kentucky bluegrass hay
Immature grass

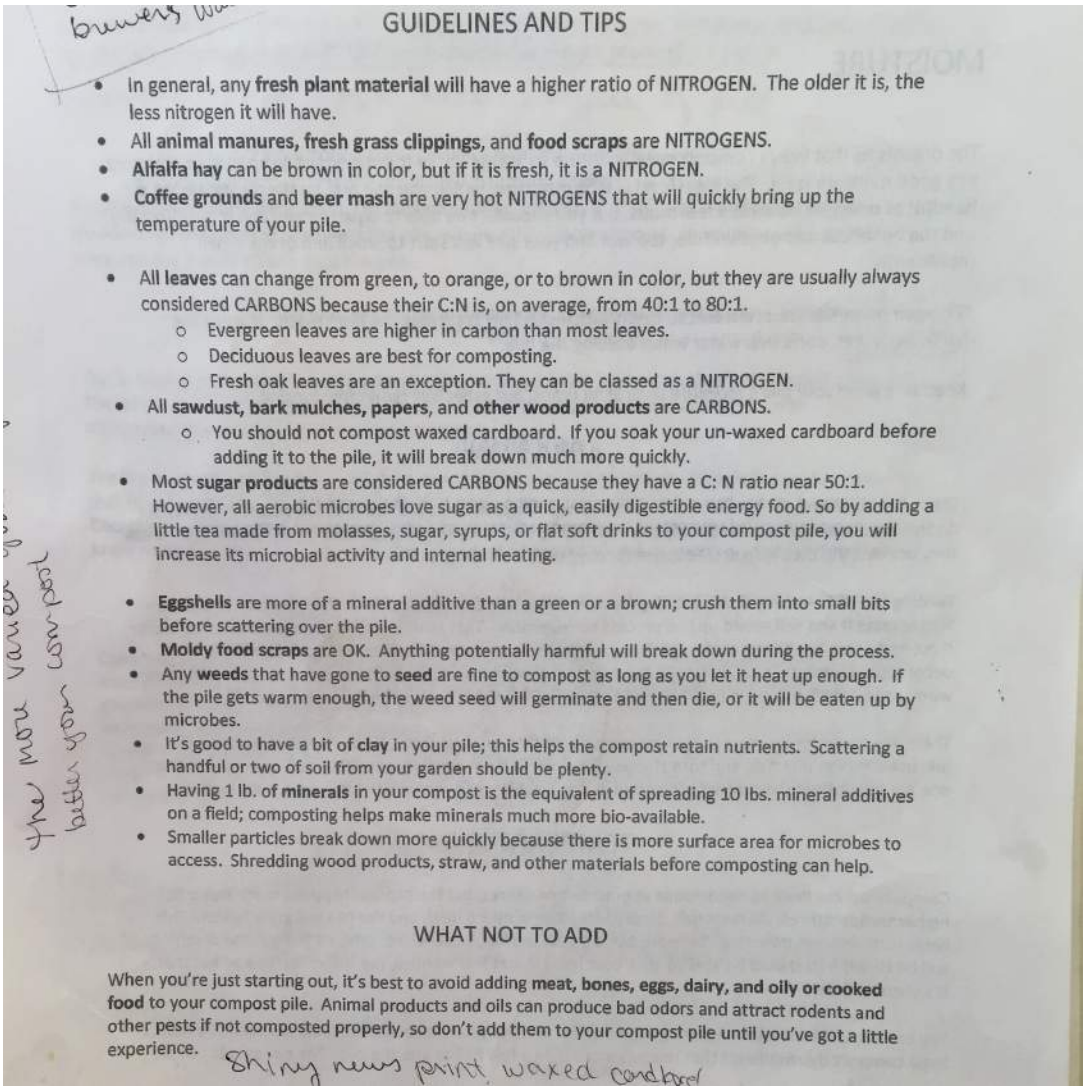
NATURAL SOURCES OF PHOSPHATE (OTHER THAN PHOSPHATE ROCK OR BONEMEAL)

The following phosphate sources are listed in order from highest phosphorus content to lowest. For specific phosphorus analyses, see the table "Percentage Composition of Various Materials" starting on page 114.

Shrimp wastes
Sugar wastes (raw)
Fish (dried, ground)
Sludge (activated)
Lobster refuse
Wool wastes
Dried blood
Banana residues (ash)
Apple skins (ash)
Orange skins (ash)
Pea pods (ash)
Cottonseed meal
Hoof and horn meal
Tankage
Castor pomace
Rapeseed meal
Wood ashes
Cocoa shell dust
Chicken manure
Rabbit manure
Silk mill wastes
Sheep and goat manure
Swine manure
Horse manure
Cattle manure

Rodale Institute, *The Rodale Book of Composting*

Here are some guidelines as outlined by Growing Power, I could not have said it better myself.



GUIDELINES AND TIPS

- In general, any **fresh plant material** will have a higher ratio of NITROGEN. The older it is, the less nitrogen it will have.
- All **animal manures, fresh grass clippings**, and **food scraps** are NITROGENS.
- **Alfalfa hay** can be brown in color, but if it is fresh, it is a NITROGEN.
- **Coffee grounds** and **beer mash** are very hot NITROGENS that will quickly bring up the temperature of your pile.

- All **leaves** can change from green, to orange, or to brown in color, but they are usually always considered CARBONS because their C:N is, on average, from 40:1 to 80:1.
  - Evergreen leaves are higher in carbon than most leaves.
  - Deciduous leaves are best for composting.
  - Fresh oak leaves are an exception. They can be classed as a NITROGEN.
- All **sawdust, bark mulches, papers**, and **other wood products** are CARBONS.
  - You should not compost waxed cardboard. If you soak your un-waxed cardboard before adding it to the pile, it will break down much more quickly.
- Most **sugar products** are considered CARBONS because they have a C: N ratio near 50:1. However, all aerobic microbes love sugar as a quick, easily digestible energy food. So by adding a little tea made from molasses, sugar, syrups, or flat soft drinks to your compost pile, you will increase its microbial activity and internal heating.

- **Eggshells** are more of a mineral additive than a green or a brown; crush them into small bits before scattering over the pile.
- **Moldy food scraps** are OK. Anything potentially harmful will break down during the process.
- Any **weeds** that have gone to **seed** are fine to compost as long as you let it heat up enough. If the pile gets warm enough, the weed seed will germinate and then die, or it will be eaten up by microbes.
- It's good to have a bit of **clay** in your pile; this helps the compost retain nutrients. Scattering a handful or two of soil from your garden should be plenty.
- Having 1 lb. of **minerals** in your compost is the equivalent of spreading 10 lbs. mineral additives on a field; composting helps make minerals much more bio-available.
- Smaller particles break down more quickly because there is more surface area for microbes to access. Shredding wood products, straw, and other materials before composting can help.

WHAT NOT TO ADD

When you're just starting out, it's best to avoid adding **meat, bones, eggs, dairy, and oily or cooked food** to your compost pile. Animal products and oils can produce bad odors and attract rodents and other pests if not composted properly, so don't add them to your compost pile until you've got a little experience.

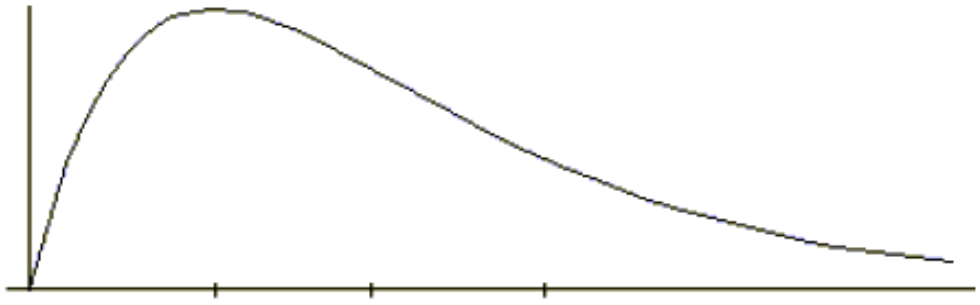
Maintenance and Use

Turning

Turning the compost homogenizes the different ingredients throughout the pile, provides oxygen, and allows heat and vapors to escape. A pile will need to be turned every ~2 weeks for 3-6 months. Different piles will differ in length depending on the C:N ratio, aeration, air temperature and water content. In the bins at CUH, it is ideal to shovel a pile into the bin immediately adjacent to it. Over the lifetime of the pile it is shoveled back and forth between only two bins. This method minimizes physical labor needed for shoveling. Below are some things you want to think about after you've made a pile. I suggest that you use a temperature log to determine when to turn the pile (2 weeks is a good guideline). At the same time as turning you may need to water the pile. The ideal water content is 60%. Pick up a handful of compost, it should feel moist but should not expel water when you squeeze it. If the compost is too dry, water it several times as you turn the compost (adding water throughout the pile as you transfer the contents from one bin to another).

Temperature

Decomposition happens at most temperatures, but it generally happens quicker at higher temperatures. This is why hot composting can take half the time of cold composting. After a pile is assembled, the internal temperature will increase until ~130-150° F (this should take 3-7 days). After awhile the temperature will start to decrease, this is the indicator to turn the pile. After turning the temperature will repeat the same pattern (increase, stabilize, decrease). There are a number of compost thermometers already on the farm. I suggest measuring temperatures twice a week, 1.5 feet below the pile surface.



^This is a visual representation of a compost temperature curve without turning. Turning should happen as the temperature starts to decrease.

Microbial Perspective

It is important not to lose sight of the fact that it is the microbes that are doing the heavy lifting during decomposition. Most of compost maintenance consists of idealizes conditions for microbial life. When problem solving it is often helpful to ask yourself, "How can I optimize the conditions for microbial life?" or "What conditions are inhibiting microbial life?". Temperature conditions of 130-150° F support a group of microbes called mesophiles, this group proves especially

beneficial in compost production. Microbes are also the reason for aeration and water additions.

Aeration
The fauna in the compost pile need oxygen to survive because decomposition is an aerobic process. Turning helps incorporate air throughout the pile, allowing temperatures to increase as microbial metabolism also increases. There are white PVC pipes with holes in them at CUH, these are to increase aeration in a pile. Place them in the bin with one end outside of the bin and shovel the compost on top. Experiment with them, they may be helpful to a pile that is slow to breakdown.

Final Product and Use
Some indicators of finished compost:
-moist and crumbly
-you can't recognize any of the original ingredients
-earthy smell
-low temperature

Compost is a living entity; it is best used when it is fresh and its biota most populous. Compost can be applied at the time of planting, used as side dressing, or used as potting soil.

Troubleshooting

Problem	**Possible Causes**	**Solution**
Pile is too hot	Too much N	Add water Mix in more carbon material
Pile isn't breaking down	Too dry Too cold Not enough N	Add water Add coffee grounds or other N source Turn the pile
Pile is smelly	Anaerobic conditions	Turn the pile, adding in woodchips or utilizing another aerating mechanism

Adapted from Growing Power

Vermicompost

The Basics

Worms are crazy; they can eat their weight daily. This means they help break down organic matter very quickly and in the process produce their most valuable crop, worm castings. Worm castings are essentially worm poop. The detritus they ingest is inoculated with bacteria as it passes through the worm's intestine, producing a partially digested nutrient rich casting. These castings increase microbial populations in the soil, protect plants form pathogens and provide a source of bioavailable nutrients.

**If you want to start a worm bin, I HIGHLY RECOMMEND that you check out Worms Eat My Garbage by Mary Appelhof. This book has all the answers concerning starting up, maintaining and harvesting a vermicompost system.

The system currently at the CUH is very system and small scale. Worms are fed food scraps from the DRC and Merrill Hall kitchens. Once weekly, scraps are collected (make sure and line the kitchen bins with bags) and fed to the worms. This can be done biweekly as well.

Feeding Instructions

1. Make a hole in the middle of the worm bin
2. Check and see if you can see the worms, if the food is being digested, and what the moisture level is.
3. Place food scraps in the hole
4. Bury completely with finished compost from the bin
5. Insulate with dry newspaper

The Dos and Don'ts of Worm Food

-Fruits/veggies
-Bread
-Pasta
-Tea bags
-Coffee/filters
-Eggshells
-Rotten/moldy food scraps

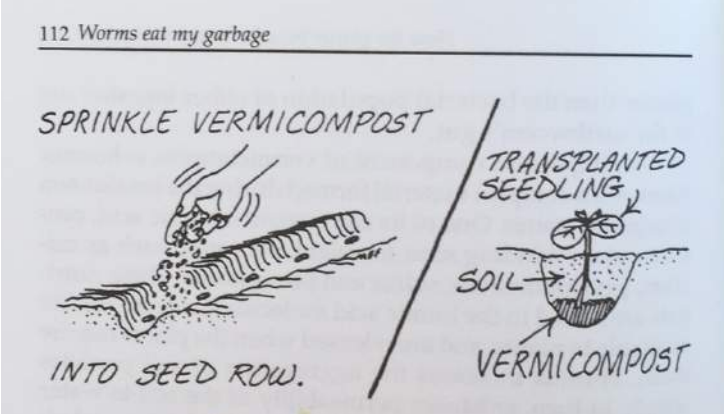
Please, **no meat, citrus or spicy foods**.

Worm Care and Harvest

The CUH system is a stackable worm bin; you start with worms on the bottom most layer with compost, food, and wet newspaper. Insulate the top layer with shredded dry newspaper and cover with the lid. Feed the worms ever 1-2 weeks by burying food until the container is at capacity. Allow worms enough time to fully digest the food then add another bin on top. In this top most bin, bury fresh food in compost. The worms will move upward towards the fresh produce and you are free to harvest the bottom bin.

Periodically you may need to water the worm bin, check the moisture level each time you feed the worms. It should pass the squeeze test described in the previous section. The compost should feel moist but should not release water when squeezed. Worms prefer dark warm environments, it is wise to bring them indoors for the winter, when night time temperatures drop below 40° F (They're ideal temperature is 77° F).

Application Tips



M. Appelhof, *Worms Eat My Garbage*

It is also possible to make "worm tea" similar to compost tea. This requires foliar application but is worth experimentation (I smell possible future project!).

Weekly Duties

-Check compost temperatures (twice weekly at least)

-Turn and water piles that need it

-Collect food scraps and feed worms

-Assemble new piles if necessary

-Check out the infrastructure, fix or note problems to be addressed

-Take time to communicate with other UW farmers and any outside contacts you are sourcing ingredients from (e.g. manure, leaves)

Seasonal Duties

Spring
This is a good time to ramp up compost production, start to build piles and bring the worms back outside. If you are planning to compost with manure, reach out to a manure source and try to set up a regular pick up schedule. You can compost crop waste from the UW farm as the season begins.

Summer
Summer is compost maintenance season. Decomposition will occur quickly so continue to build, turn, water, and harvest the piles.

Fall
I suggest that you collect and store many deciduous leaves for use during the spring an summer. Continue to tend to the piles as the season winds down.

Winter
Winter is a good time to reflect on what worked and didn't during the last season as well as much any infrastructure adjustments that are needed. Make a plan of attack for the season ahead; start thinking of contacts for ingredients or future projects.

Resources
Here are some texts that I would recommend you check out (please add to the list!).

Appelhof, M. (1997). *Worms Eat My Garbage* (2nd ed.). Kalamazoo, MI: Flower Press.

Cornell Extension: Composting. http://compost.css.cornell.edu/

Martin, D. L. & Gershuny, G. (Eds.). (1992). *The Rodale Book of Composting: Easy Methods for Every Gardener*. Emmaus, PA: Rodale Press.

The Complete Gardener's Guide. (2011). New York, NY: DK Publishing.

The Future
When thinking about what projects to undertake or what the next step in composting progression will be, I encourage you to keep the end goal in mind. How can the UW Farm make all of the compost it uses? What infrastructure, tools, materials and personnel will that take? Each new project should help the farm move closer to this goal, best of luck and many good thoughts to all that undertake this mission.

Compost Temperatures

Pile Name/#	Date created	Temp (F) /Date (* indicates turn date)