

Home Composting and Worm Bins

Soil School

15 April 2023

By Dean Moberg

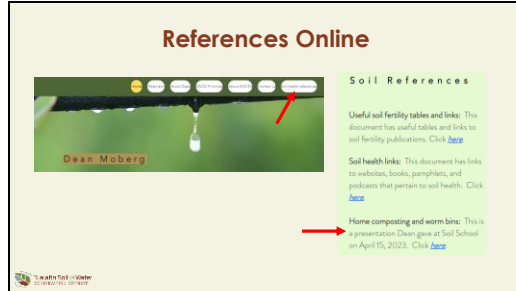
Slide 1



Slide 2



Slide 3

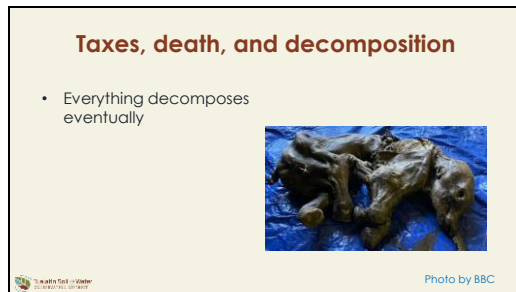


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BBC (2022). Frozen baby mammoth discovered in Yukon.

<https://www.bbc.com/news/world-us-canada-61936818>

Estimated 30,000 years old.

But point is that composting is just a managed way to control decomposition to get a desirable product without undesirable consequences like odor or rats.

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Organisms

- Bacteria
- Fungi
- Protozoa
- Invertebrates (worms, soldier flies, millipedes, etc.)



Photos from Global Soil Biodiversity Atlas and Dean Moberg

Orgiazzi A. et al. (2016). Global biodiversity atlas. European Union, Luxembourg.
<https://esdac.jrc.ec.europa.eu/content/global-soil-biodiversity-atlas#tabs-0-description=0>

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Water, oxygen, warmth

- Pores ~ 50% water, 50% air
- Temperature 32 – 150° F



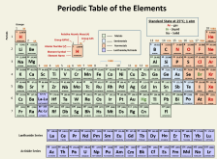
Photo by Dean Moberg

50% water content is like a wrung out sponge.
Worm bins should be more like 75% water.

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Carbon and nitrogen

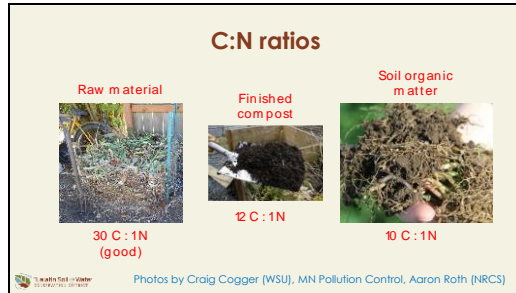
- Carbon = energy and cell building block
- Nitrogen = most limiting mineral for cells



Periodic Table of the Elements

There are 20 or more elements essential to life, but C, N, O, H account for about 96% of living matter.

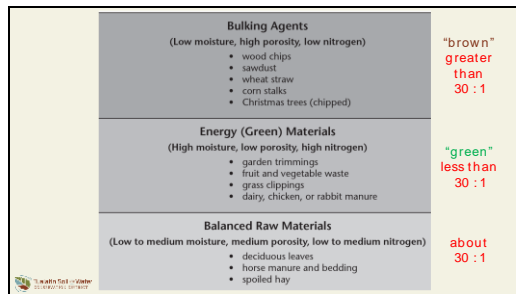
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C:N ratio is based on mass of C, mass of N
Microbes convert about 2/3 of carbon into CO₂ and incorporate the other third in their bodies.
Exact numbers vary.

Cogger et al. (2017). Backyard composting. WSU.
<https://pubs.extension.wsu.edu/backyard-composting>

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Approximate C:N ratios:
Wood chips 600:1, Sawdust 450:1,
Wheat straw 130:1,
Maple leaves 30:1, Kitchen scraps 15:1,
Grass clippings 17:1, Chicken manure (no bedding) 6:1

Richard, T. et al. (2014). Moisture and carbon/nitrogen ratio calculation spreadsheet. Cornell University.
<https://ecommons.cornell.edu/handle/1813/44670>

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Be cautious with manure from farms that use clopyralid or aminopyralid herbicides.
Lime slows down the composting and can cause more ammonia generation.
Some questions about whether glossy paper may contain heavy metals.

EPA (date unknown). Composting at home.
<https://www.epa.gov/recycle/composting-home>

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Oak leaves decompose slowly

- C:N ~60:1
- Tannins
- Acidic
- Tough
- **But composting is still fine**
- Consider chopping with mower
- (Cornell Univ, Iowa State Univ)



Photo by Dean Moberg



C:N Oak leaves 60:1, maple leaves 30:1

Photos of oak leaves left on ground, taken in January.

Consider chopping oak leaves with lawn mower to speed decomposition.

English walnut leaves have allelopathic juglone like black walnuts, but not as much.

Jauron, R. (2011). Yard and garden – fallen leaves. Iowa State Univ.

<https://www.extension.iastate.edu/news/yard-and-garden-fallen-leaves>

Richard, T. et al. (1989). Home composting slide show.

<https://compost.css.cornell.edu/slideshow/home.slide3.html>

Brewer, L. (2022). Walnut leaves: safe for composting?

<https://extension.oregonstate.edu/ask-expert/featured/walnut-leaves-safe-composting>


Wisconsin DNR (2017). Home composting – the complete composter.

<https://dnr.wi.gov/files/PDF/pubs/wa/wa182.pdf>

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2. Methods

- a) Fast and hot
- b) Slow and cool
- c) Worm bins
- d) Other



Millet,
Man With a Hoe

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Fast and hot

- 3-6 months
- 120 – 150° F
- Can kill weed seeds and plant pathogens
- Build pile all at one time
- Difficult for gardeners



Photo Cogger et al.

Cogger et al. (2017). Backyard composting – EB1784E. Washington State University.

<https://pubs.extension.wsu.edu/backyard-composting>

130F kills most weed seeds and pathogens

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Fast and hot recipe

- Chop ingredients
- Use 30C : 1N
- At least 3' x 3' x 3' pile
- Cover from rain
- Ensure ~50% moisture
- Monitor temperature (120 – 150°F)
- Turn pile weekly for 1-2 months (aeration)
- Let pile cure 2-3 months




Photo from Eartheasy.com

30:1 C:N is often roughly 1 bulk : 1 energy

Curing helps make the compost more neutral pH (around 6-8) and transitions the organisms from thermophilic to mesophilic.

Eartheasy. Compost thermometer – 20" stem.

<https://eartheasy.com/compost-thermometer-20-stem> Accessed April 2022.

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Horse farm manure compost system.

3 bins allow material to be turned from one into the next so you have new material, partially composted, and curing compost.

A smaller 3-bin system made of wood and wire can be used in backyards.

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2 bulk : 1 green refers to volumes
Adjust moisture by watering if too dry or (more likely) adding more bulk if too wet.

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Free wood chips from PGE or Free Wood Chips Portland are 10-20 cubic yards (too much for just a backyard composter).

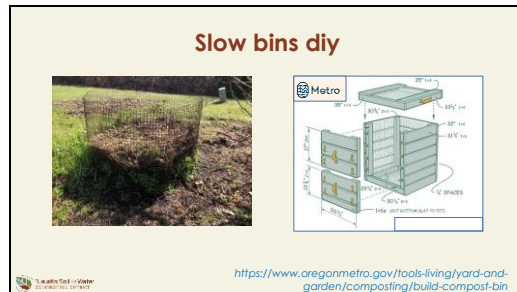
Bagging dry fall leaves also good.

Cully Farm Store.

<https://cullyfarmstore.com/>

Accessed April 2022.

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Metro (date unknown). Basic compost bin construction.

<https://www.oregonmetro.gov/tools-living/yard-and-garden/composting/build-compost-bin>

Accessed April 2022.

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Perling, A. (2021). The best compost bins, according to Wirecutter staff.

New York Times – Wirecutter.

<https://www.nytimes.com/wirecutter/reviews/best-compost-bins/>

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Using hot or slow compost

- **Troubled soil:** 3-4" applied on top of ground for 1-2 years
- **Maintenance:** 1" applied on top of ground each year
- **Timing:** after soil warms in spring and/or before fall rains




Photo from OSU

Best not to have compost touching the plant stems.

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Worm bins

- For kitchen scraps
- Time: 6 months until compost harvest
- 40 – 90°F
- No weed seed control
- Higher nitrogen than compost
- Easy for gardeners



Photo by Dean Moberg

Worms consume most scraps within 2 weeks.

Angima, S. et al. (2011). Composting with worms. OSU.

<https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9034.pdf>

Fun Facts • Red wigglers can eat half their body weight in food scraps a day. • Worms have five hearts. • Worms have both male and female reproductive organs, but still need another worm to reproduce. • One mature worm can give birth to about 100 worms a year. The space and amount of food in a worm bin will keep their population size in check. • A worm's life span is approximately one year.

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Worm bin recipe

- **MOIST** bedding (shredded paper, cardboard scraps, straw, coir, old leaves) to fill 2/3 of bin
- Red wigglers (*Eisenia fetida*)
- Grit (soil, pulverized egg shells)
- 1 pint food scraps / week **to begin**



Photo by Dean Moberg

Moist bedding like wrung out sponge.
Photo is ½ pound, or about 1 pint.

Pronounce:

i-SEN-eee-ah fe-TEED-ah or
i-sen-EEE-ah FE-teed-ah or....

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Worm bin maintenance

- **Keep out of sun**
- **Optimum:** 55 - 77°F
- **Good:** fruit, veg scraps, eggshells, coffee grounds, tea
- **Maybe OK:** a little moist bread, potato peels, avocado skin
- **Not good:** meat, oils, dairy, onions, pet waste, citrus




Photo by Sam Angima (OSU)

Backyard compost optimal moisture is around 50%, but optimal moisture for worm bin is more like 75% (if you squeeze the vermicompost, you can form a ball and your hand will be moist, but no water will drip out).

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Worm bin maintenance

- **Gently** bury 1-2 qts scraps/week max. after worm population established
- Maintain **moist** bedding on top
- **Don't overfeed** (scraps should be gone in 2 weeks)
- Add a little grit every 2 months
- **Empty leachate**




Photo by Dean Moberg

1. Worms Talk - Update
© 2012 Oregon State University

Rule of thumb: 1 quart scraps per square foot of bin.

Helpful to bury scraps in different locations.

Helpful to chop scraps into 2-inch chunks.

Turkey baster from thrift store is handy for removing leachate without lifting up the bin.

Bedding on top might be shredded paper or a piece of moist cardboard cut to fit the top dimensions. It's OK not to have bedding on the top. Also OK not to bury scraps. BUT bedding on top and burying scraps reduces fruit flies.

Freezing or microwaving scraps before adding kills fruit flies.

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Worm bin DIY

- OSU EM 9034
- Two bins (one inside the other).
- Get used bins at thrift store



Composting with Worms
EM 9034 - October 2011
Sara Angima, Michael Hanks, and Sally Hanks

Photo by Dean Moberg
<https://catalog.extension.oregonstate.edu/em9034>

1. Worms Talk - Update
© 2012 Oregon State University

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Worm bin specifications

- Top bin opaque, 8-16" deep.
- Bottom bin can be clear
- PVC pipe in bottom for drainage
- 14 gal bins process waste for family of 2-3, but are HEAVY when full




Photo by Dean Moberg

14 gal of finished vermicompost is around 70 pounds.
PVC pipes are held to the top bin with lath screws.

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Worm bin specifications

- 4-8 breather holes @ 1" on top of side
- ~20 drainage holes @ 1/4" on bottom
- Bottom bin has no holes



Photo by Dean Moberg

Caulk holds window screen to bin. Best to put on the outside of the bin because it tends to fall off if on the moist inside. Large holes could be in the bin cover rather than in the side. The screen is probably more to keep fruit flies etc. out than to keep worms in.

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Worm bin purchasing

- Craigslist
- Local garden stores
- Online garden stores



POPULAR MECHANICS

The 8 Best Worm Composters for a Healthier Lawn and Garden

1 BEST OVERALL: Worm Factory 310 Composting System

2 THE RUNNER-UP: HUNGRY BIN Worm Farm Compost Bin

3 MOST PORTABLE: Riverstone Industries Mize Farm Worm Bin

4 BEST FOR OUTDOOR USE: FCMP Outdoor The Essential Living Composter

McGuigan, K. (2022). The 8 best worm composters for a healthier lawn and garden. Popular Mechanics.
https://www.popularmechanics.com/home/q39838822/best-worm-composters/?utm_source=google&utm_medium=cpc&utm_campaign=arbgapopd bm comm org us q39838822&qclid=Cj0KCQjw r6hBhDdARIsA MIDhV-FKGOirxkBV8U1N9jpUH-MRjBkZmFtPIltfnYDPbXe0mtcahWJHqaApu0EALw wcB

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Worm procurement



- Symbiop, or
- Get worms from a friend, or
- Look in your compost pile

© 2012 SymbiOp Garden Shop
All rights reserved.

SymbiOp Garden Shop.

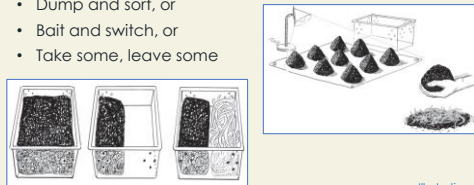
<https://gardenshop.symbiop.com/>

Accessed April 2022.

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Harvesting worm compost

- Dump and sort, or
- Bait and switch, or
- Take some, leave some



Illustrations by
New York City Dept. of Sanitation

New York City Dept. of Sanitation
(date unknown). Indoor composting
with a worm bin.

<https://www.nyc.gov/assets/dsny/downloads/pdf/promotional-materials/indoor-worm-bin-composting-brochure-06340-f.pdf>

Harvest when bin is full or when you
need the compost, but at least once
per year.

Dump and sort takes about 20
minutes. Don't let the worms bake.
Bait and switch takes about 1 month.

Take the **BOTTOM** half of the compost
– leave the **TOP** half, where most
worms are.

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Using worm compost and leachate

- Apply 1" thick on soil around base of garden plants
- Mix worm compost up to 25% with potting soil
- Dilute leachate (10 water : 1 leachate), apply to soil



Photo by Dean Moberg

Best not to have compost touching plant stems.

The study referenced below demonstrates that worm compost has high nitrate, modest ammonia, high phosphorus, and potassium levels. pH is roughly neutral. Application of worm compost to potting soil can increase concentrations of beneficial bacteria and nematodes.

Przemieniecki, S. (2020). An evaluation of selected chemical, biochemical, and biological parameters of soil enriched with vermicompost. *Environ Sci Pollut Res Int*, 28(7): 8117-8127.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7854409/>

Miller, W and Mann, J. (2021). How to use compost in gardens and landscapes. OSU.

<https://extension.oregonstate.edu/pub/em-9308>

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Other composting methods

- Pit
- Sheet



Dall-E2 (artificial intelligence app), Compost Pile as it Would Be Painted by Claude Monet

Dall-E2 (artificial intelligence app), <https://openai.com/product/dall-e-2> Accessed April 2022.

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Pit

- Dig pit or trench
- Cover scraps with at least 8 inches soil.
- Wait one year?



Photo by Dean Moberg

Wisconsin DNR (2017). Home composting – the complete composter.

<https://dnr.wi.gov/files/PDF/pubs/wa/wa182.pdf>

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Sheet or “lasagna” composting

- Mow grass or veg very low
- Loosen soil
- Remove tough weeds
- Cover ground with cardboard or newspaper
- Wet the paper
- Alternate green and brown in 1” layers



Photo by Anne Donahue (OSU)

Fall is good time to begin.
Can take 6 months or more.


OSU (date unknown). Sheet composting, aka lasagna composting.

<https://extension.oregonstate.edu/gardening/soil-compost/sheet-mulching-aka-lasagna-composting-builds-soil-saves-time>

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3. Problems, solutions, other topics

- Slow decomposition
- Odors
- Rodents, etc.
- Other brief topics



Millet,
Man With a Hoe

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Slow decomposition

- **Compost:**
 - materials too big/tough?
 - too dry?
 - turn pile?
- **Worms:**
 - too dry or cold?
 - needs bedding or grit?
 - stop feeding what they don't like



Photo by Dean Moberg

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Odors

- **Compost:**
 - add bulking material
 - turn pile
- **Worms:**
 - remove leachate
 - reduce feeding



Edvard Munch
The Scream

Odors are usually caused by compost that is too wet, becomes anaerobic (maybe just in the middle or bottom) and then produces sulfur compounds like hydrogen sulfide (rotten egg smell) or unpleasant organic compounds like cadaverine, putrescine, and skatole.

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Rodents and other varmints



- **Compost - rodents:**
 - sturdy lid and bottom
 - use pits or worms for kitchen scraps
- **Worm bin - fruit flies:**
 - add moist bedding on top

Photos by Dean Moberg

Wood and hardware cloth bottom with bin screwed onto the bottom as shown. Or buy/make a bin that has a screened bottom or plastic bottom with holes.

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Soldier flies: NOT compost varmints

- **Good** in compost
- Good chicken feed
- **Not good** in worm bin
- Adults are black and look like wasps



Photo by OSU

Pokorny, K. (2022). Don't worry, maggots help break down compost. OSU.

<https://today.oregonstate.edu/news/don%E2%80%99t-worry-maggots-help-break-down-compost-pile#>

Soldier fly larvae: *Hermetia illucens*

Soldier fly larvae may out compete worms in a bin - consider emptying bin and starting over.

Sowbugs, beetles, nematodes, a few mites are OK in worm bin.

Topic: compost teas

- **Leachate:** liquids draining from compost or worm bin
- **Extract:** compost mixed in water for **less than 1 hour**
- **Tea:** compost in water for **more than 1 hour**
- Tea made with additives should be tested for pathogens (NOP Guidance)




Photo from Harvard University
<https://energyandfacilities.harvard.edu/sites/energyandfacilities.harvard.edu/files/How%20to%20Build%20A%20Brewer.pdf>

Most compost tea devotees recommend brewing tea for 12-36 hours, using water that was left in the sun for several hours to remove residual chlorine.

Several peer-reviewed studies demonstrate benefits of vermicompost extract and leachate applied to soil. Benefits may be due to nutrients and/or plant-stimulating compounds in the liquid. Opinions vary about tea in general and foliar applications in particular (e.g. see <https://sustainable-farming.rutgers.edu/organic-farm-calls-evidence-based-agriculture-and-aerated-compost-tea/> vs <https://www.mofqa.org/resources/compost/compost-tea/>)

National Organic Program (NOP) (2006). NOSB recommendations for guidance: use of compost, vermicompost, processed manure and compost teas.
<https://www.ams.usda.gov/sites/default/files/media/NOP%20Final%20Rec%20Guidance%20use%20of%20Compost.pdf> :

“Compost” = hot compost.

Possible additives include molasses, kelp, fish hydrolysate, blood meal, humic acid, minerals, etc.

Tea is usually aerated.

Extracts, teas without additives, and teas that have been tested may be applied without restriction to the soil.

Rules about foliar application are less clear.

Cautious approach might be to use just extracts and apply them to the soil rather than edible portions of plants.

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References Online



Soil References

Useful soil fertility tables and links: This document has useful tables and links to soil fertility publications. Click [here](#)

Soil health links: This document has links to webinars, books, pamphlets, and podcasts that pertain to soil health. Click [here](#)

Home composting and worm bins: This is a presentation Dean gave at Soil School on April 15, 2023. Click [here](#)



Tualatin Soil & Water Conservation District

www.deanmoberg.com

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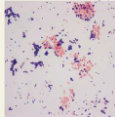

Visit: www.tualatinSWCD.org
Call: 503-334-2288

7175 NE Evergreen Pkwy #400
Hillsboro, OR 97124



Topic: fungi / bacteria

Plant community	Fungi : bacteria mass in soil
Old growth conifer forest	High
Undisturbed prairie	Low
Highly disturbed cropland	Very low

Photos from Orgiazzi et al.

THIS SLIDE WAS PROBABLY NOT INCLUDED IN THE SOIL SCHOOL PRESENTATION DUE TO TIME CONSTRAINTS.

Fungi prefer lower pH and less disturbance

Bacteria prefer easily decomposed organic matter

F:B - Forest may be >>100:1, prairie around 1:1, tilled vegetables <1:1

Much popular writings about analyzing the fungi : bacteria ratio (mass basis) in soils.

There are some efforts to produce compost with different fungi:bacteria ratios to match needs of crops. Some of this is based on idea that inoculating soil with fungi will cause higher F:B. But not a lot of peer-reviewed research on this subject. A review of research and analysis of claims made by growers, vendors, consultants, is beyond our scope in this Soil School presentation.

Photos by Orgiazzi, A. et al. (2015).
Global soil biodiversity atlas.
European Union Joint Centre.

<https://esdac.jrc.ec.europa.eu/content/global-soil-biodiversity-atlas>


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National Organic Program
Subpart A, Section 205.2 - definitions

- **Compost.** The product of a managed process through which microorganisms break down plant and animal materials into more available forms suitable for application to the soil. Compost must be produced through a process that combines plant and animal materials with an initial CN ratio of between 25:1 and 40:1.

Producers using an in-vessel or static aerated pile system must maintain the composting materials at a temperature between 131 °F and 170 °F for 3 days.

Producers using a windrow system must maintain the composting materials at a temperature between 131 °F and 170 °F for 15 days, during which time, the materials must be turned a minimum of five times.

 <https://www.ecfr.gov/current/title-7/subtitle-B/chapter-I/subchapter-M/part-205>

THIS SLIDE WAS PROBABLY NOT INCLUDED IN THE SOIL SCHOOL PRESENTATION DUE TO TIME CONSTRAINTS.

7 U.S.C. 6501-6524

Section 205.203 states that farmers can apply non-composted plant material.