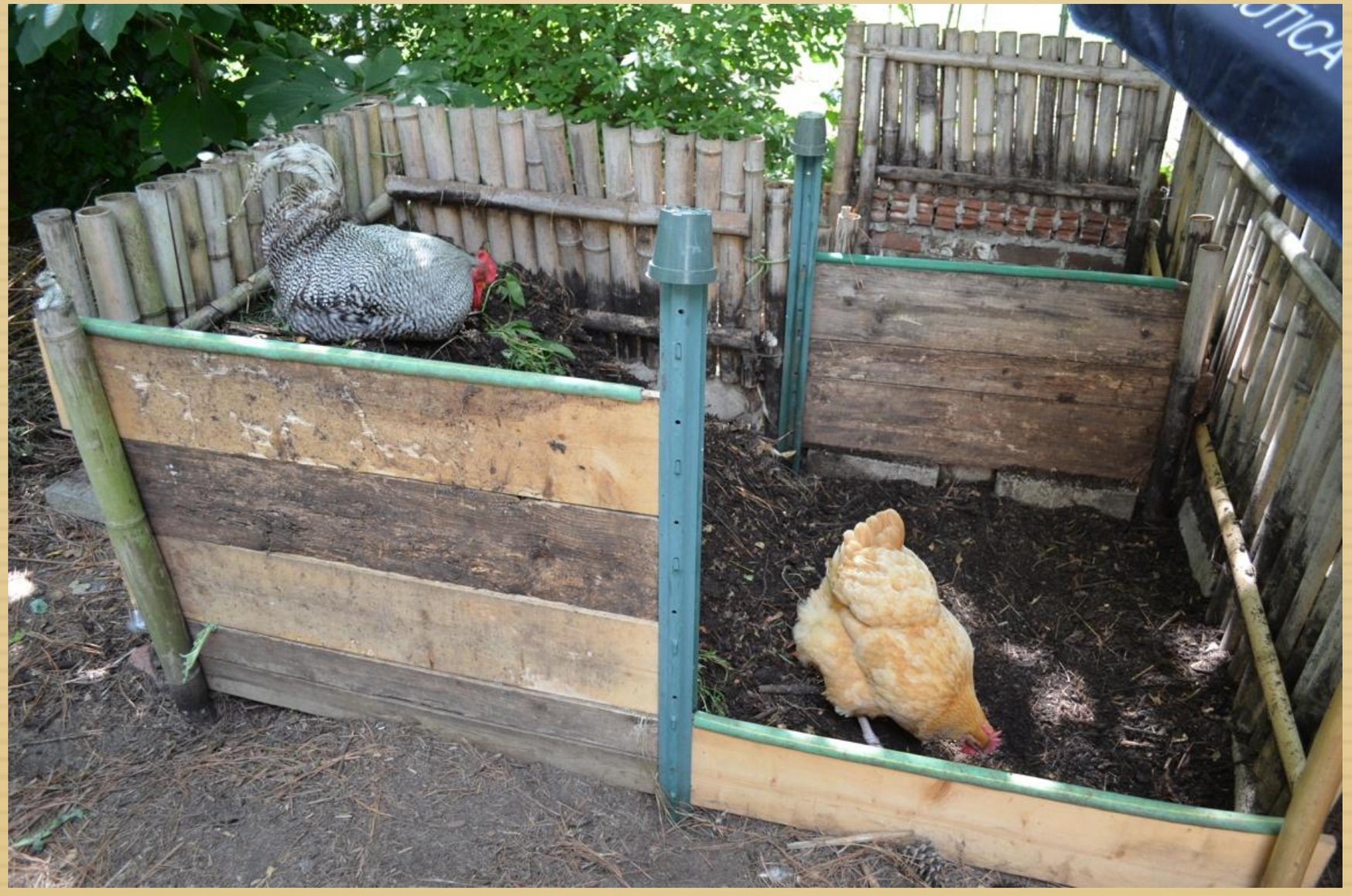
Composting



Carol Bartram
York/Poquoson Master Gardener, class of 2008
bartram2@verizon.net

What is composting?

- The biological reduction of organic matter into humus.
- Humus: The relatively stable end-product of composting; the dark brown organic component of soil

Composting throughout Human History

- Oldest existing reference: Clay tablets, Akkadian Empire, 1000 years pre-Moses
- Romans, Greeks, Talmud

Composting in Organic Farming

- Sir Albert Howard, father of the organic method: early 1900's, India. Indore method; materials layered sandwich fashion and mixed.
- Austrian Rudolf Steiner, 1924: Biodynamic
- J. I. Rodale, 1942: Father of organic farming in U.S. (*Organic Gardening* magazine)

Why aren’t we all composting?

- Composting is too complicated
- Composting is hard work
- I don’t have time
- Compost stinks
- I don’t have a compost thermometer
- I don’t have a biology, chemistry, or engineering degree
- My HOA prohibits it

Compost happens...

**"Ted, could you speed it up a bit?
Some of this is turning into compost."**

Overview

- Benefits of compost and composting
- Compost and plant health
- Life inside the heap
- Materials
- Methods
- Thinking outside of the pile

Benefits of Composting

- Reduces waste going into landfills
- Saves money (individual and local levels)
- Builds good soil structure: Aggregate formation, drought protection, reduced erosion, improved aeration
- Provides nutrients to plants and holds nutrients in soil (slow-release)
- Neutralizes toxins
- Buffers against high or low soil pH
- Creates living soils

Composting reduces waste going into landfills

- About 1/3 of all waste dumped in landfills consists of garden clippings and kitchen waste.
- Biodegradable matter does not necessarily biodegrade in landfills
- EPA: Amount of waste diverted from landfills via composting rose from 2% (1990) to over 8 % today.

Vermont Compost Company

- Employs 1200+ laying hens to help turn food waste into compost
- Keeps 13 tons of food scraps per week out of landfill

http://vermontcompost.com

Composting saves $

- Individual: Producing compost at home can cost less than buying fertilizer.
- Local: On a larger scale, recycling organic “waste” saves localities money in transport and tipping fees.

Compost vs. Chemicals: Plant Health

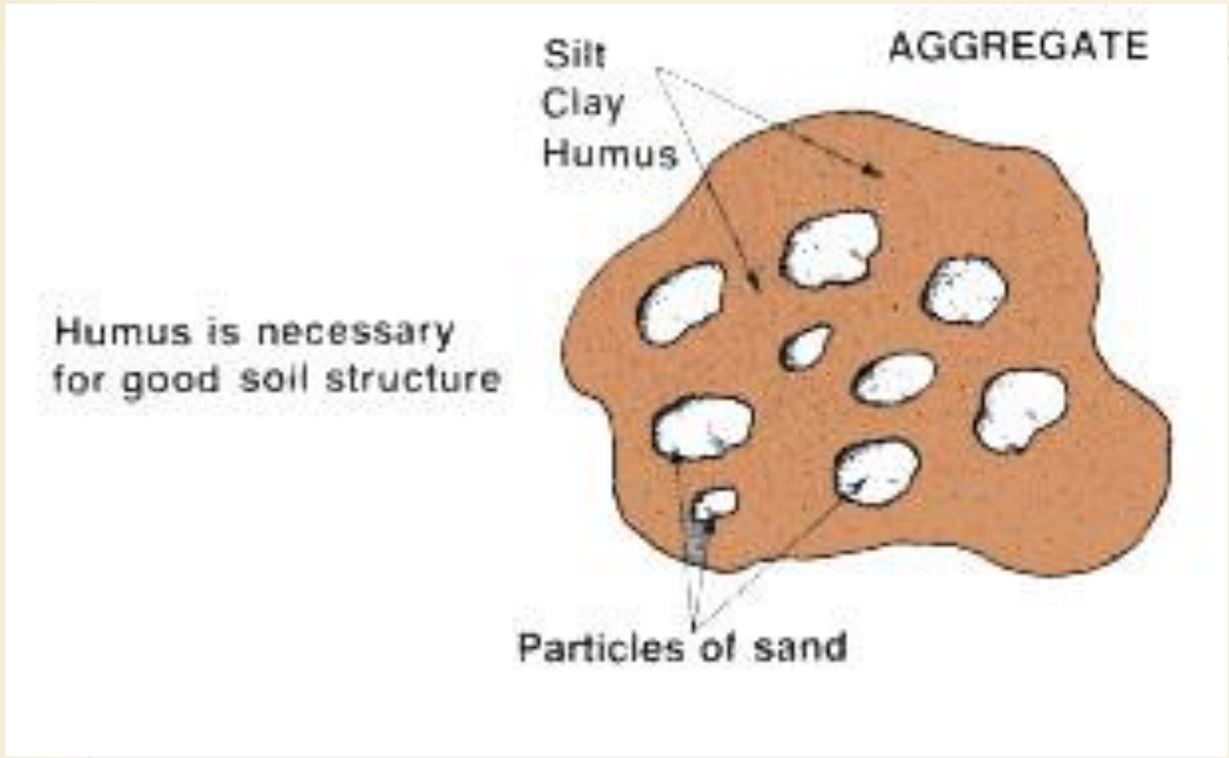
- Commercial fertilizer provides major nutrients in quick-release form (fast growth, but few long-term benefits)
- Compost contains chemical nutrients: NPK, and minor elements in relatively small amounts, but released slowly so plants can use them before they leach away
- Plants take nourishment through complex processes: Plants need living soils, not just chemicals

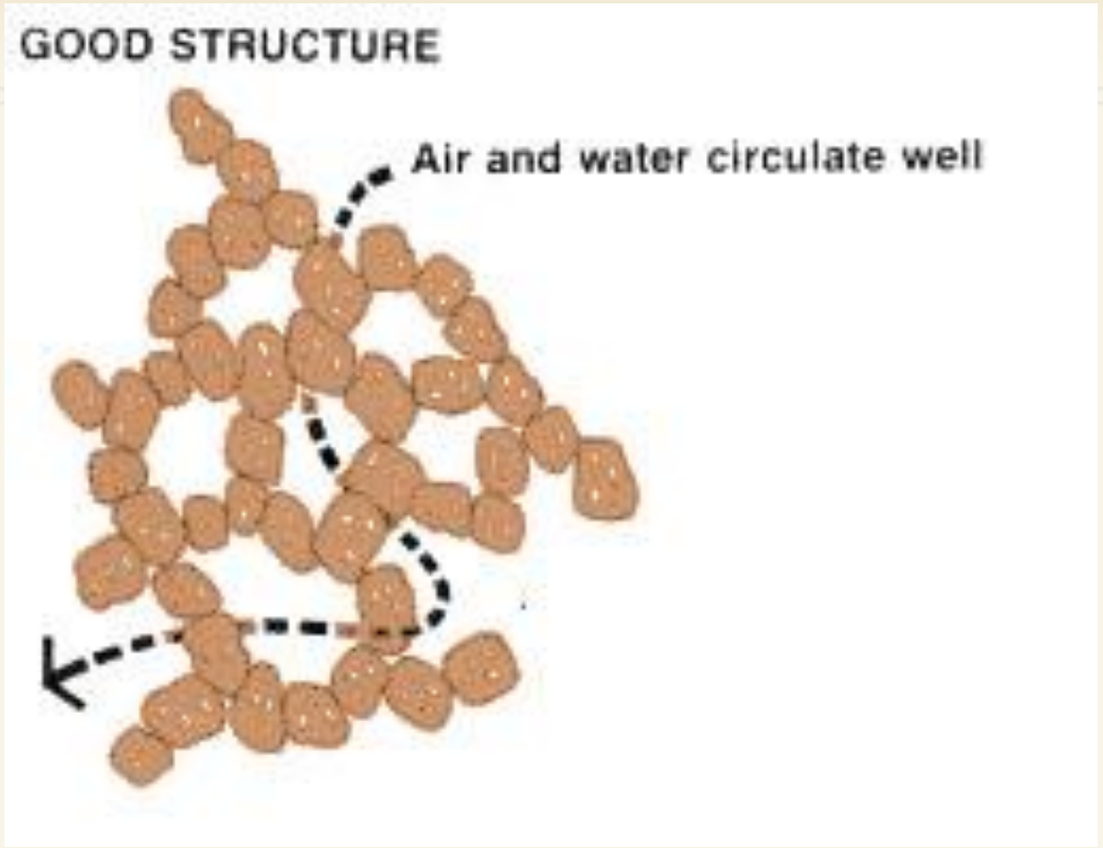
Compost vs. Chemicals: Environmental Health

- Chemical system relies on fossil fuels: corn uses equivalent of 51 gallons of gasoline/acre to produce.
- 35% of chemical nitrogen, 15-20% of P&K lost because plants can't use it.
- Pollution by nitrates from inorganic fertilizer = pollution from sewage *(Barry Commoner, Queens College)*
- When mixed with soil, allows air and water to reach soil organisms and plants, and allows soil to soak up water, so less runoff

Compost and Soil Structure

- In good garden soil, particles of clay, sand, and silt group together to form aggregates; granular, or crumb, is best.
- Compost can correct soil that’s either heavy clay or too sandy.
- Chemically treated soils with no addition of organic matter will lose structure.





Granular and crumb structures are individual particles of sand, silt and clay grouped together in small, nearly spherical grains. Water circulates very easily through such soils.

ftp://ftp.fao.org/fi/cdrom/fao_training/FAO_Training/General/x6706e/x6706e07.htm

Soil with good structure:

- Has pore spaces to allow air water in.
- Thin film of moisture coats each granule of aggregate, where plant roots can use it.
- Fungi/molds feeding on plant roots in living soils bind soil particles together.
- Earthworm castings also help.
- Humic acid compounds formed by breakdown of organic matter make crumbs stronger.
- Bacteria breaks down aggregates, so need to replenish organic matter periodically.

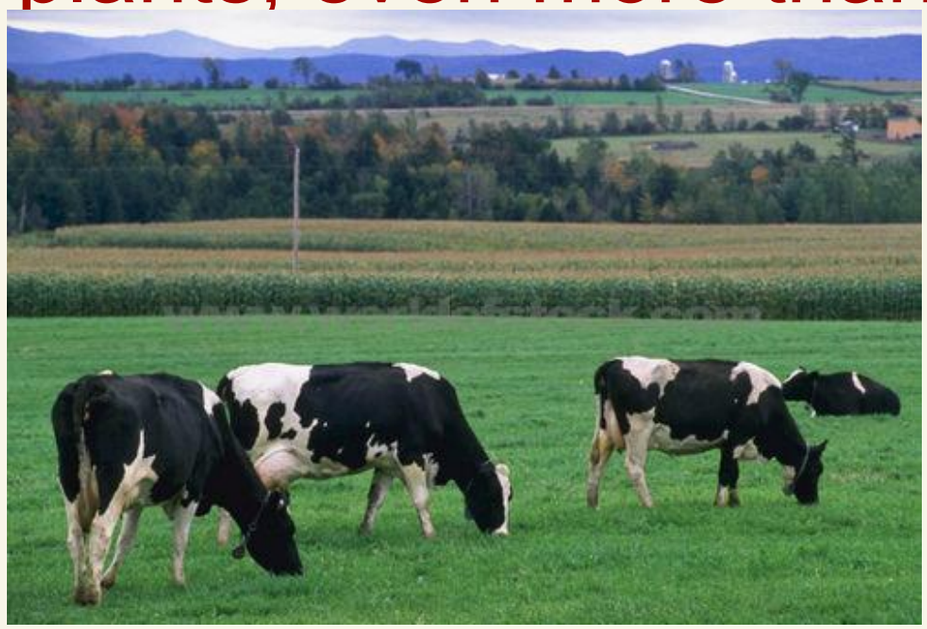
Plant Disease

- Humus & decomposing organic matter have controlling effect on plant pathogens, harmful fungi, nematodes, harmful bacteria
- More vigorous plants able to fight off disease
- HOWEVER, some plant viruses can survive composting process, so avoid composting diseased plants

Compost helps neutralize environmental toxins

- Organic matter can bind (fix) heavy metals in soil into stable compounds, making them unable to harm plants or pollute waterways.
- Holds heavy elements necessary for growth and release as needed to plants.

NOTE: “Certain herbicides (e.g., aminopyralid, clopyralid, picloram, triclopyr, fluroxypyr) used to kill broadleaf weeds in lawns, pastures, and hay fields may NOT be completely degraded by composting...the herbicide can pass through animal digestive systems and into their manure. If the grass, hay, straw, or manure is subsequently included in a compost pile and later spread in a garden or landscape bed, the affected compost could harm or kill many plants, even more than a year later.”



http://pubs.ext.vt.edu/HORT/HORT-49/HORT-49-PDF.pdf

What's Happening Inside the Heap?

- Complex community of animal, vegetable, and mineral matter, working together to break organic matter into humus.
- Decomposition via enzymatic digestion of plant & animal material by soil microorganisms.
- At the same time, chemical processes going on and their products are used by microorganisms for further breakdown.

How Is Compost Produced?

- Chemical processes of oxidation, reduction, hydrolysis occur
- Bacteria use the products of these processes for energy and nutrients to grow and reproduce
- The heat in the pile is the result of this “burning” or oxidation

Decomposers: Who lives in the heap?

- *Microscopic (Chemical):* Bacteria (aerobic), actinomycetes, protozoa, fungi. Change the chemistry of organic wastes.
  - Psychrophilic: 50-70°
    Mesophilic: 50-113° F
    Thermophilic: 113-158° F
- *Physical:* Larger fauna (mites, millipedes, centipedes, sow bugs, snails, slugs, spiders, beetles, ants, maggots, earthworms, etc.)

Bacteria are busy.

- Aerobic do most of the decomposition work
- Use carbon to make energy (to eat more), and nitrogen to build protein (to grow, reproduce)
- Populations differ depending on raw materials, temperature, air, moisture, geography...
- They can adapt to produce specific enzyme needed to digest what's available
- *Anaerobes produce hydrogen sulfide (aroma like rotten eggs), cadaverine, and putrescine.*

Actinomycetes Are Aromatic

- Higher form bacteria, similar to fungi and molds
- May work many feet below surface
- Cause earthy smell
- Liberate carbon, nitrogen, ammonia, making available for plants
- Replace other bacteria by producing antibiotic; late-stage decomposers

Actinomycetes

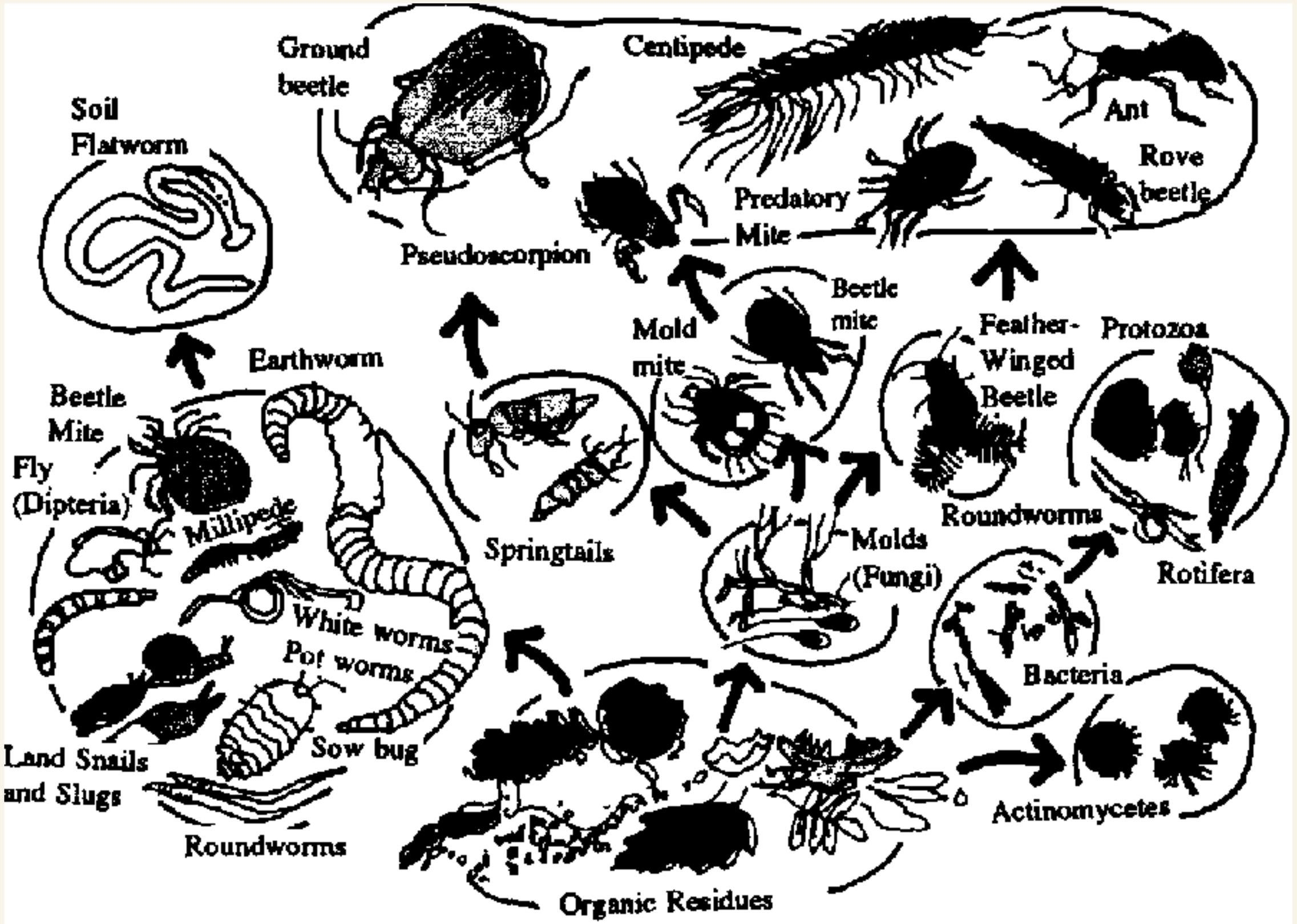
- Long, thread-like filaments
- Break down woody stems, bark, paper
- If you stop turning pile during cool phase, encourages growth

Fungi finish.

- Primitive plants
- Lack chlorophyll, so can’t make own carbs
- Most get energy by breaking down tough debris in dead plants and animals.
- Late-stage decomposers, like actinomycetes, most like 70-75 deg. F

Physical decomposers

- Larger, higher-level organisms that chew and grind their way through the compost heap
- 1st, 2nd, and 3rd level consumers
- 1st: Bacteria, sow bugs, some mites, slugs, snails, **earthworms...**
- 2nd: protozoa, mites, ants, beetles...
- 3rd: Centipedes, ants, spiders, beetles...



Compost Food Web (Daniel L. Dindal)

A word about maggots...

- Fly larvae
- To discourage pest flies, keep a layer of dry leaves or grass clippings and cover garbage
- But not all flies are pests!

Black soldier fly

(*Hermetia illucens*)

The Biopod

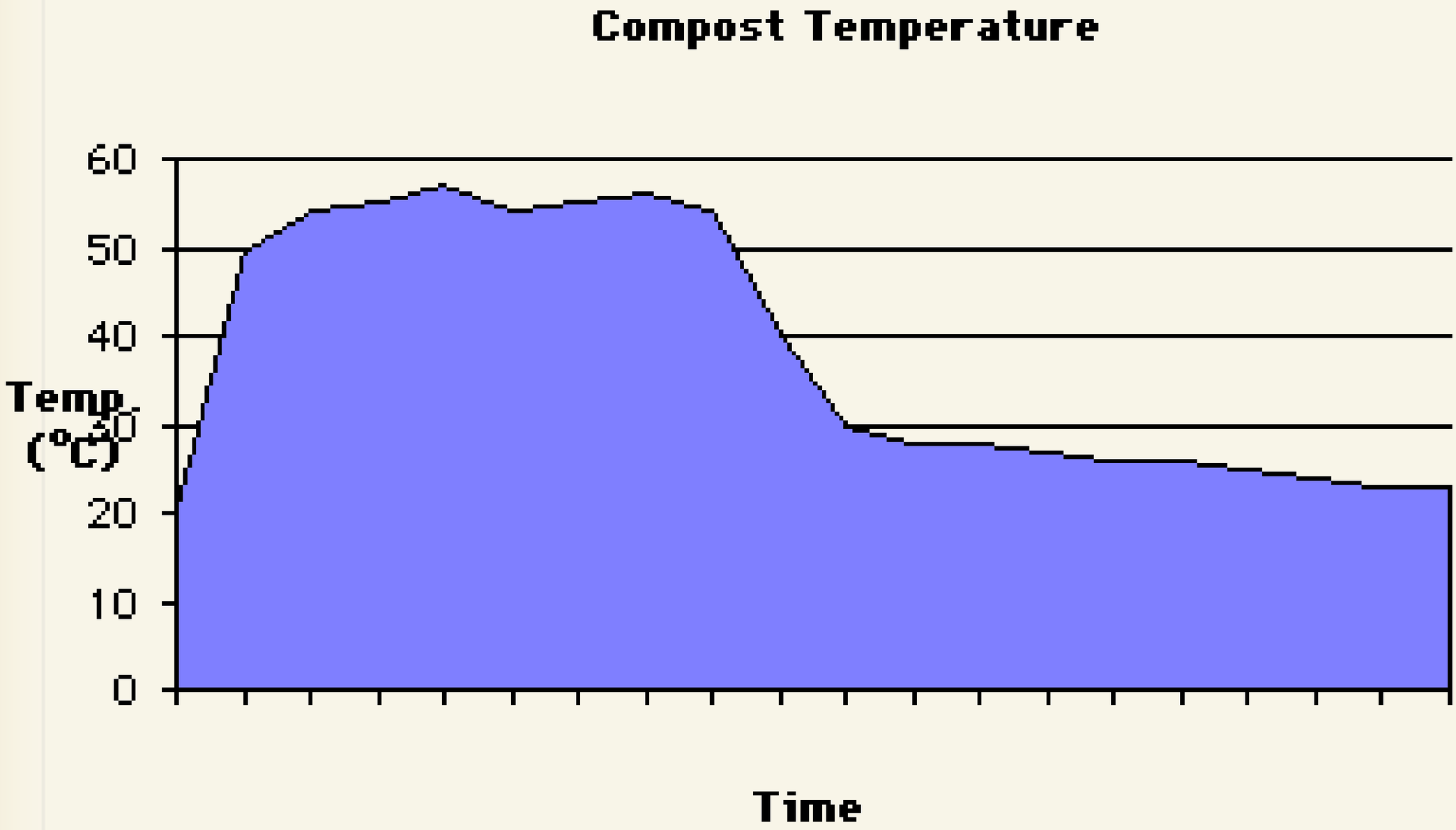
www.thebiopod.com

Ham
1:44 p.m.

9:42 a.m.
(20 hrs
later!)

Compost Pile Temperature

- First: Mesophilic (med. temp.) bacteria and fungi predominate (a few days)
- Next...Pile heats up, giving way to thermophilic bacteria (mostly *Bacillus*)
- Over 145°, they wall themselves off and wait for better times...(>160° may sterilize)
- With lower, more stable temperatures, actinomycetes and fungi come in from cooler edges and dominate



http://compost.css.cornell.edu/microorg.html

Materials

- 3 things: Balanced diet, water (“damp sponge”), and air.
- Balanced diet for microbes = carbon + nitrogen
- Smaller particles will break down faster

“Browns:” Carbon-rich (sugar for energy)

- Dried leaves
- Twigs
- Newspaper
- Straw
- Sawdust
- Paper

“Greens:” Nitrogen-rich (protein)

- Grass clippings, other green plant debris
- Kitchen food scraps
- Manure
- Seaweed

C-N ratio

- Ideally (for speed) between 15:1 and 30:1
- *Chemical ratio, not weight or volume*
- Easiest way is to add 1 part green to 1 to 3 parts brown (ex: 1 bucket of kitchen scraps, 1-3 buckets leaves)
- For the mathematicians, add the carbon rating of your sources and divide by # of equal parts.
- Too much C, slows down; excess N smells

Activators

- High in nitrogen, jumpstart process
- Ex: Cottonseed meal, bonemeal, bloodmeal, manures...
- Might need them if small pile, cool weather, not enough green materials

Manure

- < 20% of nutrients in manure goes back into agricultural soil
- High in nitrogen and beneficial bacteria
- Urine also valuable (bedding)
- Vary in nutrient value (chicken and horse manure esp. “hot”)
- May contain weed seeds (temps >131 degrees will kill)
- May contain herbicides that pass through animal

Comparison of animal manures, by percent

	N **Nitrogen (veg. growth)**	**P** **Phosporus (root/shoot)**	**K** **Potassium (vigor)**
Chicken	1.1	.80	.50
Dairy cow	.25	.15	.25
Horse	.70	.30	.40
Steer	.70	.30	.40
Rabbit	2.4	1.4	.60
Sheep	.70	.30	.90

Sources: *Rodale's All-New Encyclopedia of Organic Gardening*, *An Illustrated Guide to Organic Gardening*, by Sunset Publishing, and the *Rodale Guide to Composting*. *(*http://www.plantea.com/manure.htm)

What not to compost

- Cat & dog waste (pathogens)
- Large amounts of unshredded materials (will slow process)
- Diseased plants
- Walnut leaves -- large quantities (juglone)
- Grease, oil in large amounts (inhibits biological processes)
- Meat, dairy (may attract critters)
- Pesticide/herbicide-treated material (*manure, hay)
- Coal/charcoal ashes (toxic sulphur oxides); wood ashes okay
- Glossy paper (inks may be toxic)

Methods: Things to consider

- Time and effort: Passive vs. managed
- How soon do you need the compost?
- Bins: Homemade vs. purchased
- Site selection: convenience, legalities, aesthetics, climate, drainage, waterways
- Outdoor vs. indoor

Building a pile

- Alternate layers of green and brown materials, in approx. 1:1 to 1:3 ratio
- You can mix layers as you add
- Dampen pile as you build it
- Build all at once (faster composting), or as you have materials ready

Managing your pile

- Turn the pile (moving outside material to center) when temp. exceeds 140 degrees for 3-5 days.
- If no thermometer, don’t worry! Just turn pile every so often. The more turning, the faster it will compost.
- Keep moist
- Stability reached when no longer heats up when turned.
- Let cure for a few months to outside temp. before using

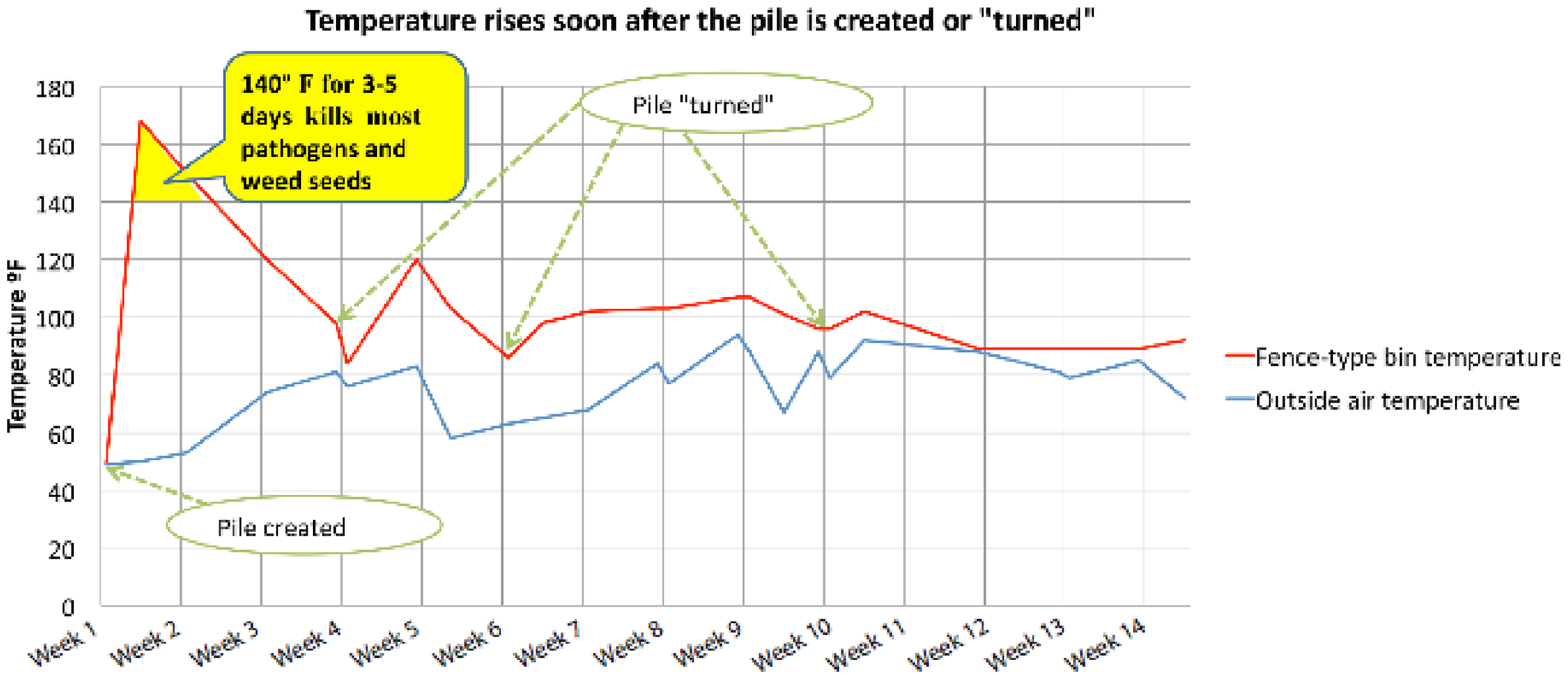


Figure 3. Temperature changes as a compost pile processes plant material. The opportunity to kill most pathogens and weed seeds is soon after the pile is created and temperatures are sufficient (above 140°F) for three to five days.

Troubleshooting

SYMPTOM	CAUSE	SOLUTION
PROBLEM: Odor		
Ammonia smell	Too much nitrogen (GREEN matter) in pile (possibly too many grass clippings) Or pile is too alkaline (possibly too much limestone, or ash and poplar/cottonwood tree leaves added to pile)	***If nitrogen problem:*** **Turn pile and add more BROWN material** (carbon) ***If alkaline related:*** **Turn pile and add acid material** like sawdust, oak leaves, vegetable scraps
Putrid smell (like rotten eggs)	Pile is too wet: not enough oxygen (is putrefying, not decomposing!)	**Turn pile to aerate it and add dry carbon** (BROWN) materials to absorb excessive moisture

Troubleshooting

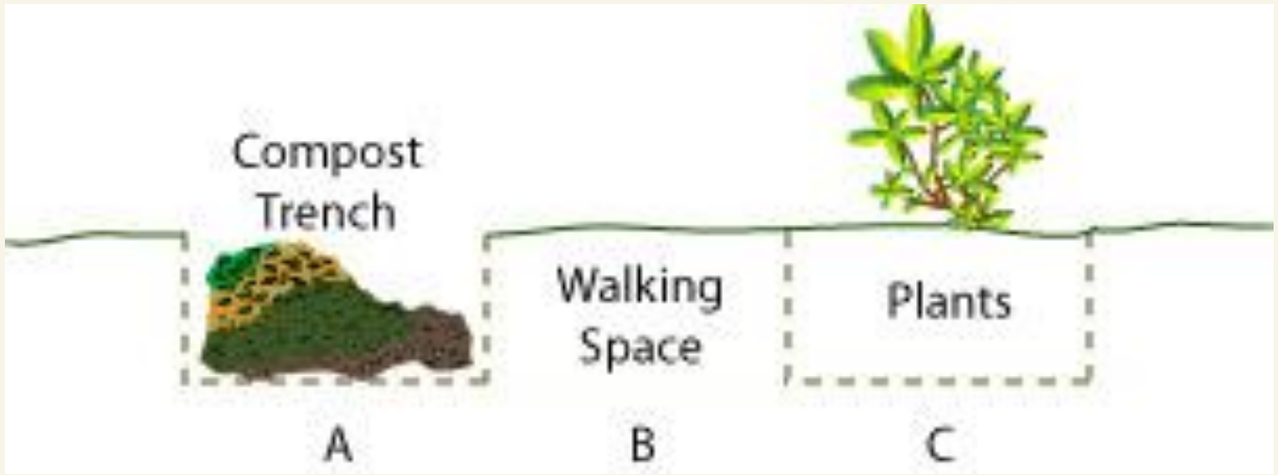
SYMPTOM	CAUSE	SOLUTION
PROBLEM: Compost pile does not heat up		
Too Wet	Compost materials are soggy: there is not enough air	**Turn the pile**, adding dry absorbant material (BROWN-carbon)
Too Dry	Not enough moisture	**Moisten the pile** without saturating it: use a spray nozzle Should have the consistency of a damp wrung-out sponge
Pile is moist but isn't decomposing; or it is only damp and warm in the center	Too much carbon (brown) material, not enough nitrogen (green) matter	**Turn pile**, adding nitrogen-rich materials such as manure, grass clippings, fresh leaves, vegetable or fruit wastes Consider adding an activator

Other methods

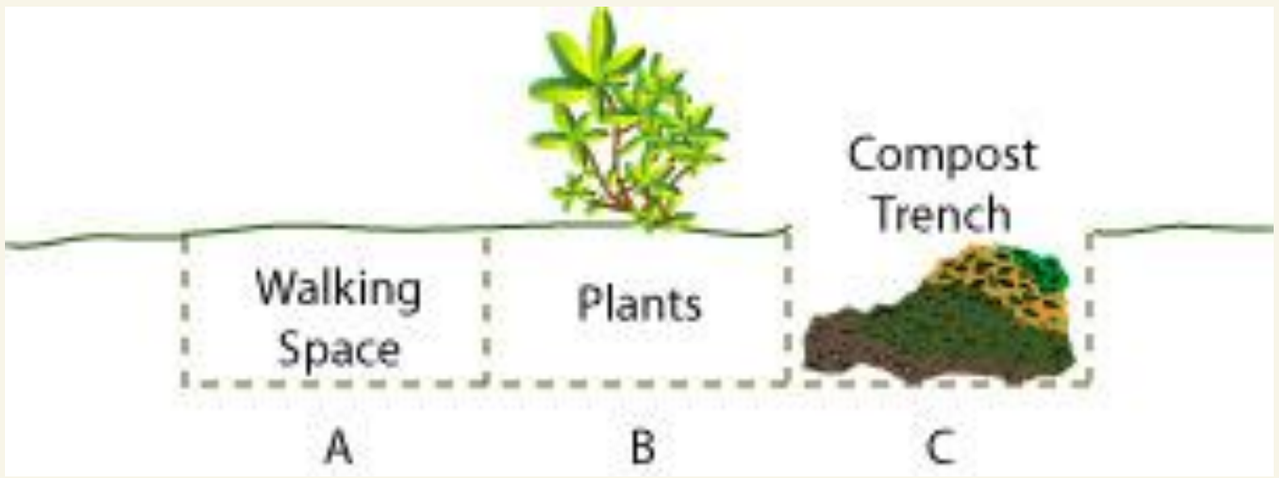
- Cold composting/add as you go pile
- Leaf mold bin
- Sheet composting
- Pit composting

Pit or Trench Composting

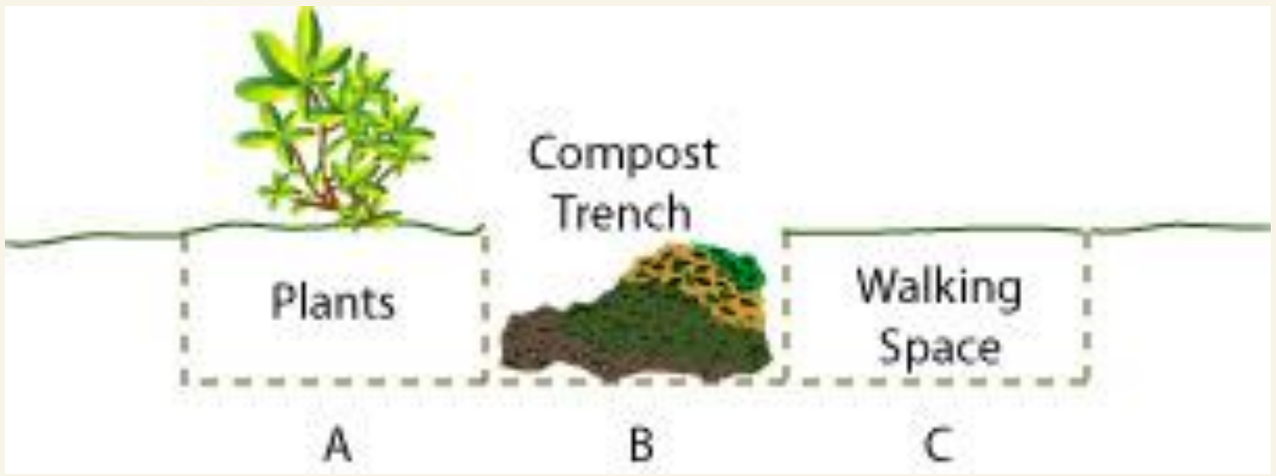
Year 1



Year 2



Year 3



http://web.extension.illinois.edu/homecompost/methods.cfm

Sheet composting

- Mulch
- Spreading kitchen scraps over garden
- Green manures (legumes: clover, cowpeas, winter peas...)

Compost Bins

- (A simple pile will work!)
- For efficiency, 3’ X 3’ X 3’ ideal
- Shady location helps prevent drying out

Homemade outdoor systems

- Less expensive than manufactured
- Pile
- Pallets
- Cinder blocks
- Wire
- Garbage can

Virginia Cooperative Extension

PUBLICATION HORT-49P

Backyard Composting

Ed Rishell, Master Gardener, Virginia Cooperative Extension

Turning “trash” into gold: “Yorktown Compost Company”

Compost moved to new working pile

Step 3: The usable pile, and starting over

Manufactured outdoor systems

- Attractive, may fit neighborhood covenants
- May be easier to contain odors
- Ease of turning (tumblers)
- Can be pricey
- May require activators to get started

Green Culture 65-gallon stationary bin

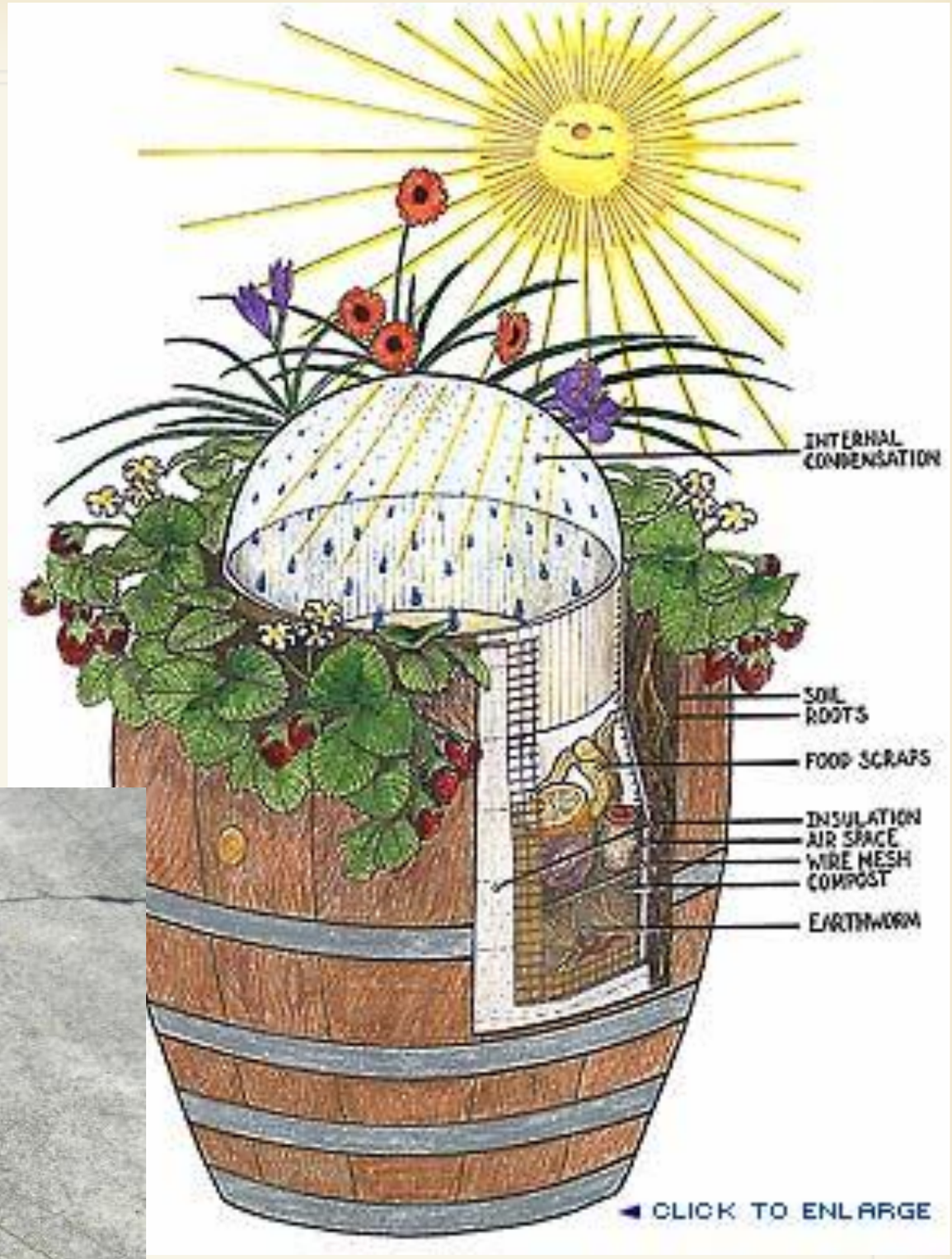
(http://www.redmonusa.com/

Compost Wizard tumbler/rain barrel combo

http://www.goodideasinc.com/products/composters/compost-wizard-hybrid/

Sun Frost Scrap Eater

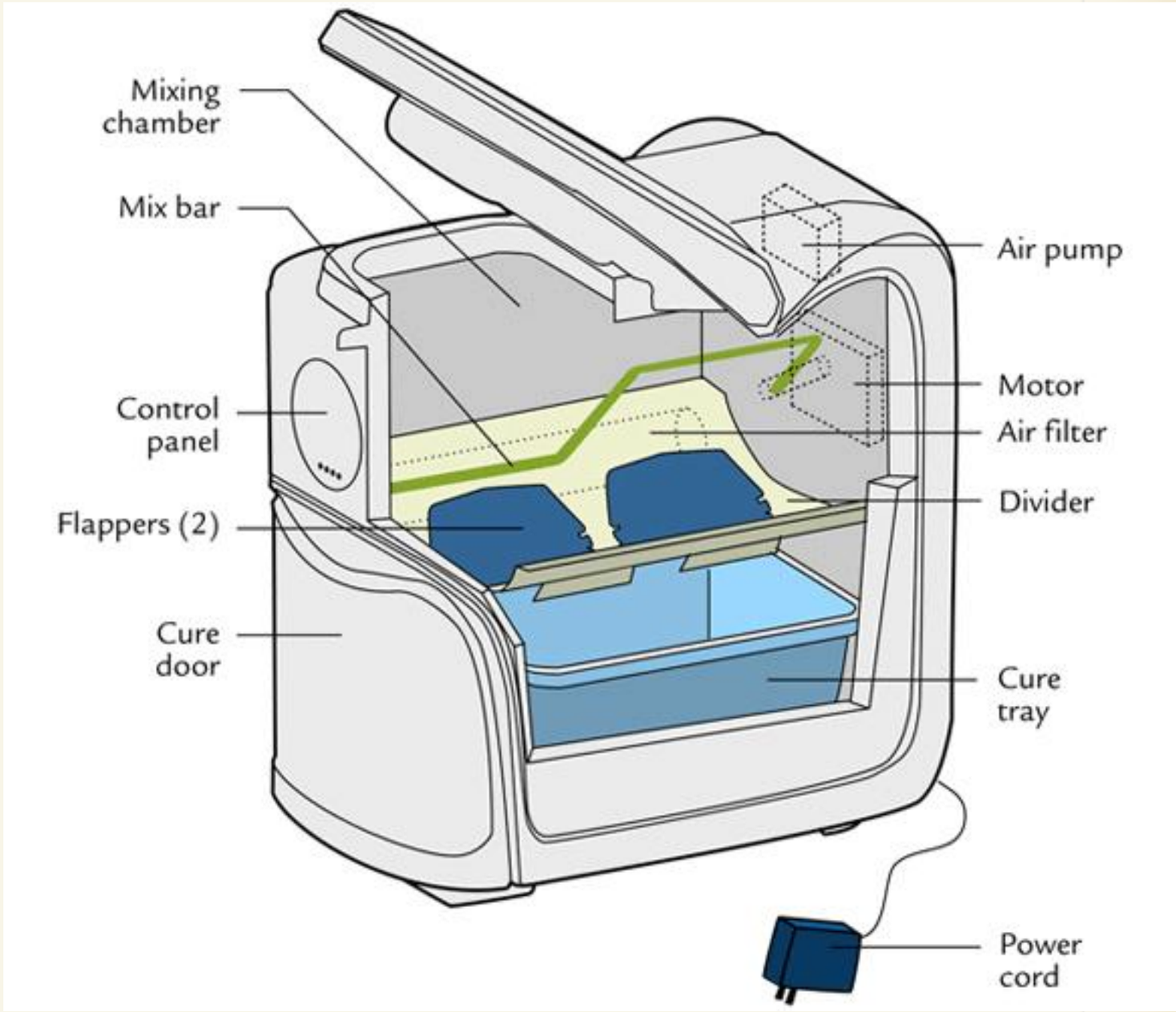
http://www.sunfrost.com



Indoor alternatives

- Convenient
- Efficient
- Year-round
- Less physical effort
- Pricey
- Types: Aerobic, anaerobic, worms

Nature Mill Automatic Compost Bin



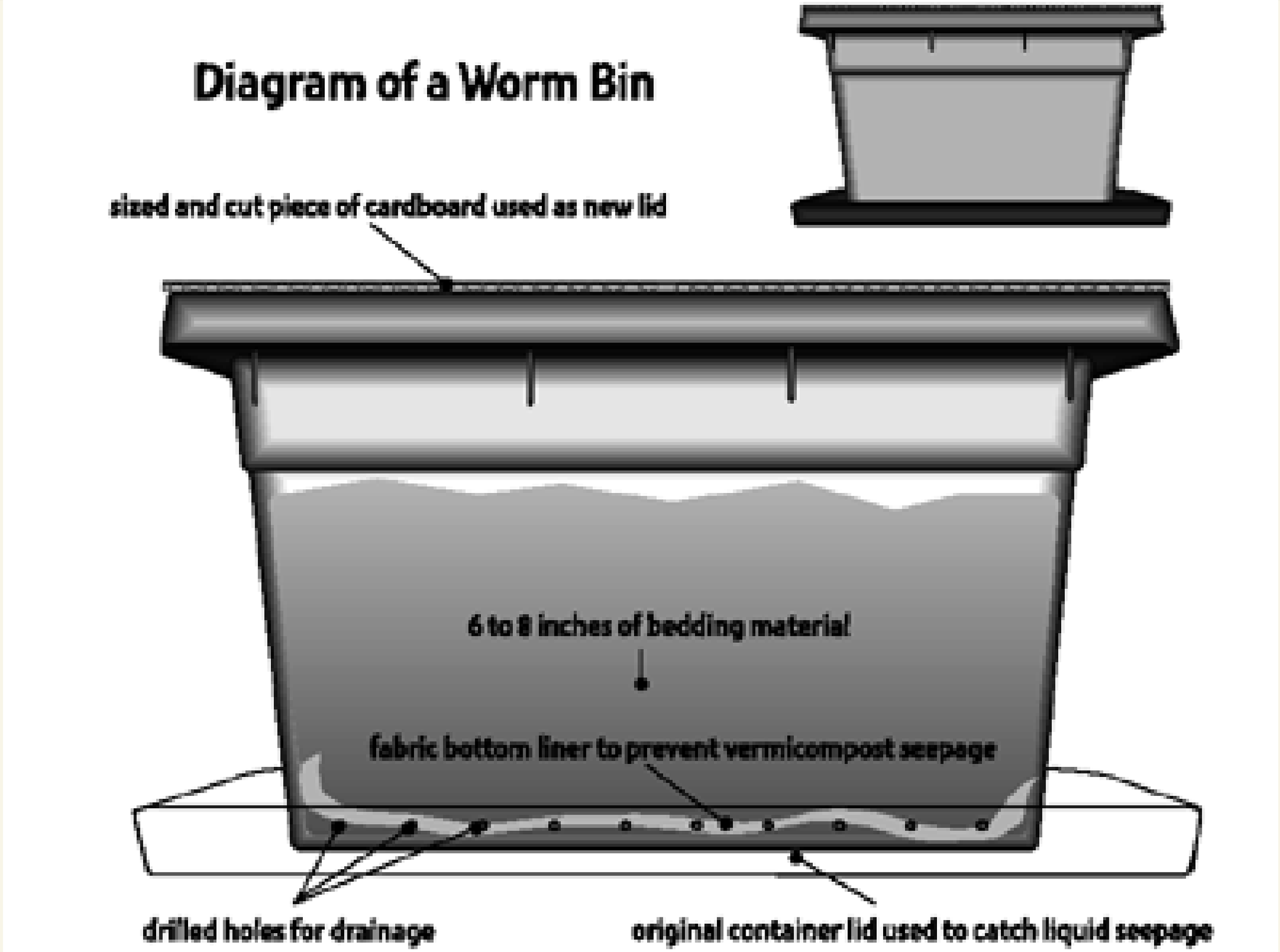
http://www.naturemill.net/

Bokashi Bucket anaerobic (fermenting) composting system

http://store.bokashicycle.com/

Vermicomposting

- *Eisenia fetida:* Tiger worm, brandling worm, red wiggler, manure worm
- Worm castings
- Bedding: shredded newspaper, office paper, cardboard
- Feed a wide variety of kitchen scraps (no meat, oil, dairy; go easy on citrus)



VCE publication 442-005

Homemade

The Worm Factory

http://www.naturesfootprint.com/worm-factory

Using Compost

- Ideally, apply in garden about 1 month before planting
- 1/2” to 3” finished compost per year
- Can apply unscreened compost in fall for spring planting
- Little danger of burning plants

Uses, cont'd

- Mulch: screened in lawns, flower beds
- Lawn: Aerate and rake compost into holes
- Soil amendment: for new plantings, no more than 25% compost
- Compost tea

http://web.extension.illinois.edu/homecompost/benefits.cfm

Screened compost

- Seed starting
- Potting soil

Thinking Outside of Your Pile

- Start small: Mulching mower
- Shred leaves, don’t bag
- Give your kitchen scraps to your friends
- ...or go BIG! Master Composters

'We've been together for 12 years now. I think it's time we thought seriously about composting.'

Resources

- Basic Composting: All the Skills and Tools You Need to Get Started. Ebeling, Eric, editor. 2003.
- “Composting for the Homeowner.” http://web.extension.illinois.edu/homecompost/intro.cfm
- Composting Inside & Out. Davies, Stephanie. 2011.
- “Compost Microorganisms.” Trautman and Olynciw. http://compost.css.cornell.edu/microorg.html
- Easy Composting. (Ortho Books). Putnam, Cynthia, editor. 1992.
- The Rodale Book of Composting: Easy Methods for Every Gardener. Martin, Deborah L., and Gershuny, Grace, editors.1992.

The End