Basic Composting

Klickitat County Solid Waste

in cooperation with

The Washington State Department of Ecology

Credits To:

Northeast Regional Agricultural Engineering Service

On-Farm Composting Handbook

Composting to Reduce the Waste Stream

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under a grant from the Washington State Department of Ecology.

Topics We Will Discuss

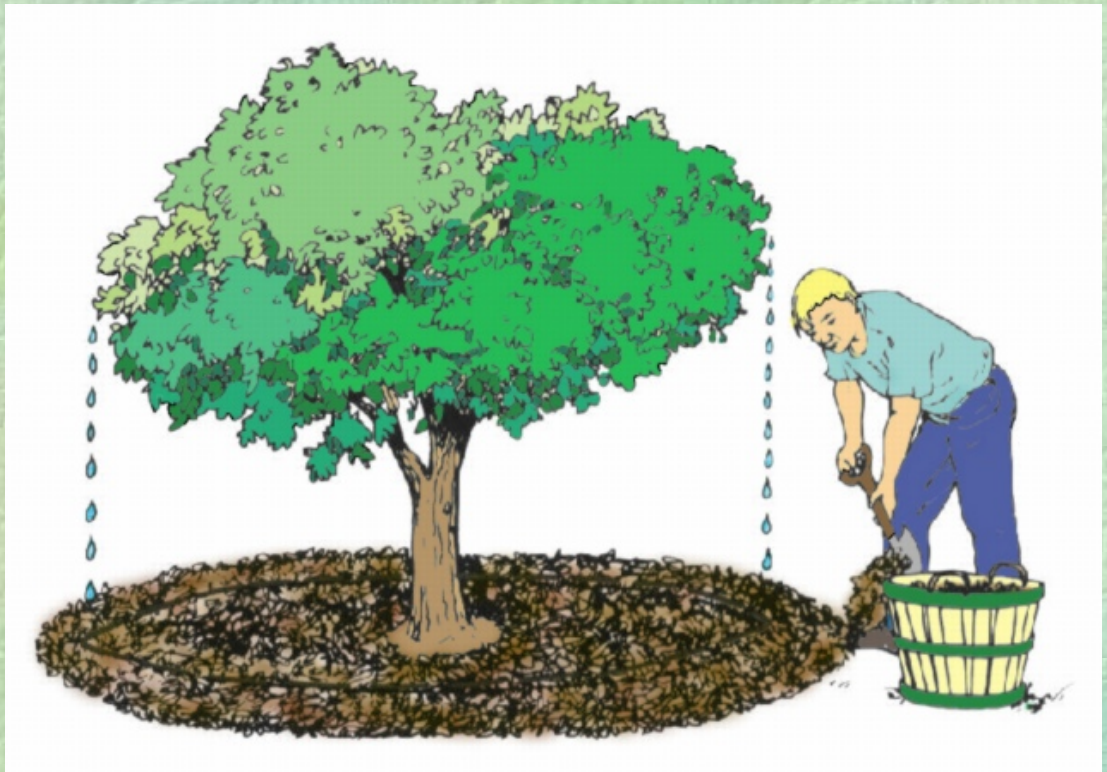
- Methods of Composting
- The Biology of Composting
- Building and Maintaining Environment
- Using Compost
- Health, Safety and …
- Resources

Methods of Composting

- Grass-Cycling
- Mulch
- Heaps
- Soil Incorporation
- Holding units
- Turning units
- Worm Bins

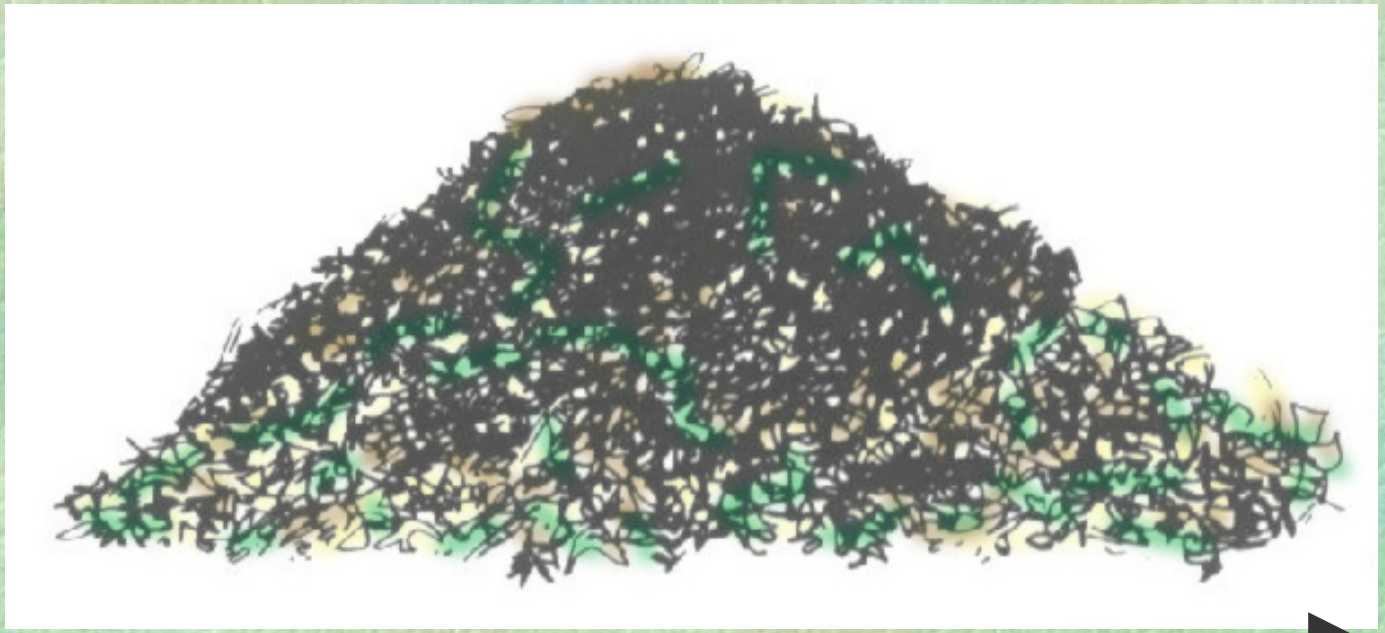
Mulching

- Mulching works best around trees and perennials.
- Benefits include:
  - control of weeds
  - reduced evaporation
  - soil temperature moderation
  - reduced erosion.



Heap

- Approximately three feet high and five feet wide.
- Cover with layer of soil, yard waste or mulch to conserve moisture.



Soil Incorporation

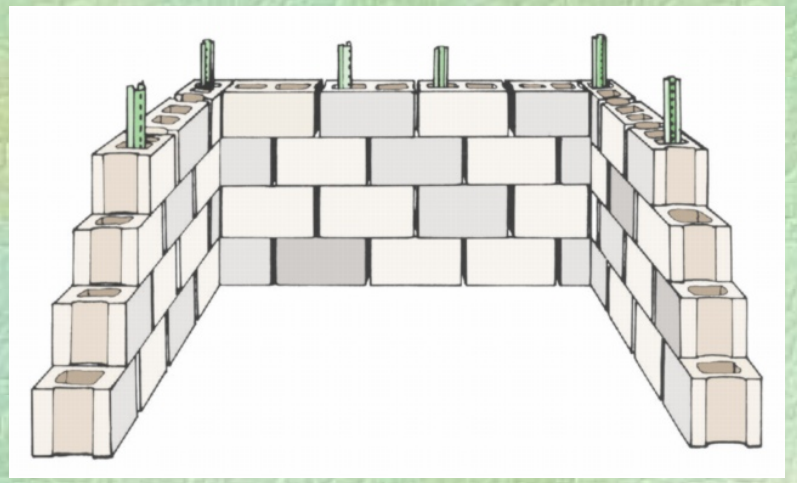
Hole or trench must be deep enough so at least 8 inches of soil can be placed on top of compost material.

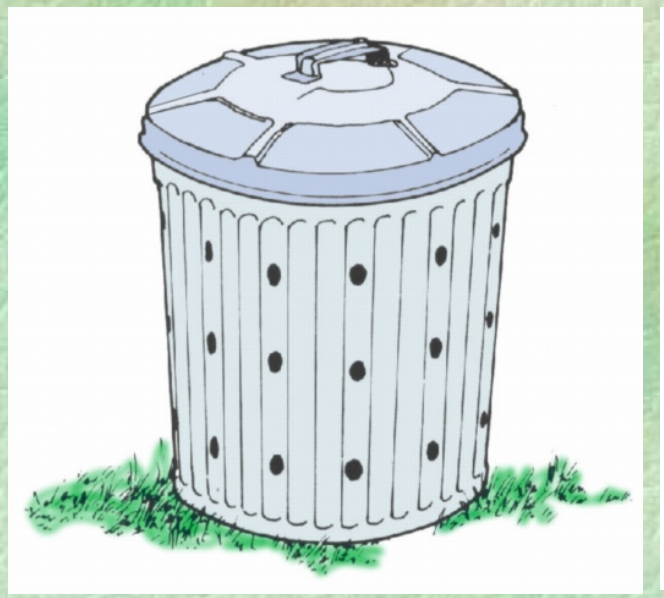
Works for non-fatty wastes.

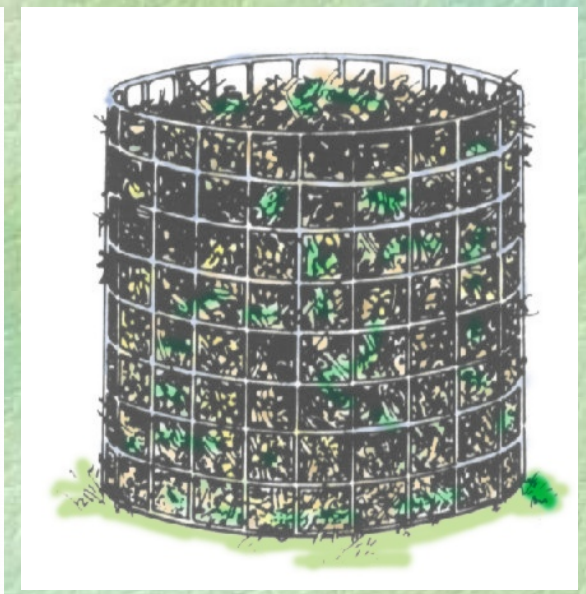
Decompose in 1 month to 1 year.

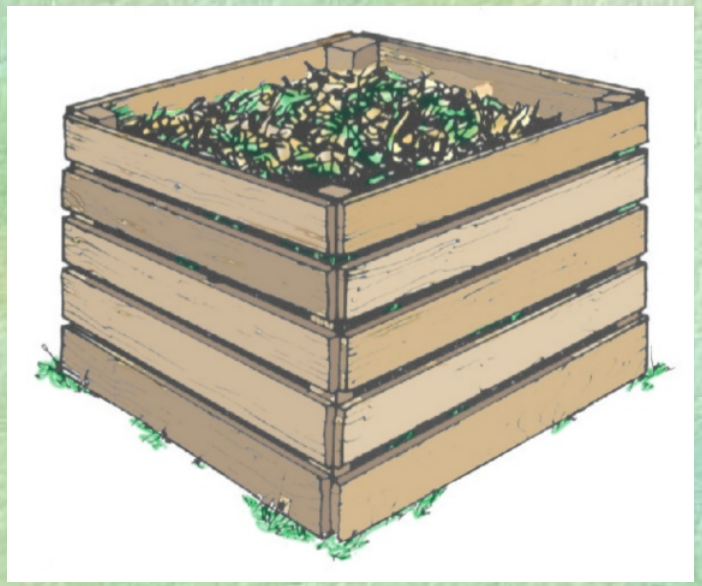
Holding Units

- Slow Method
  - Add waste as it is generated
  - 6 months to 2 years for finished compost.



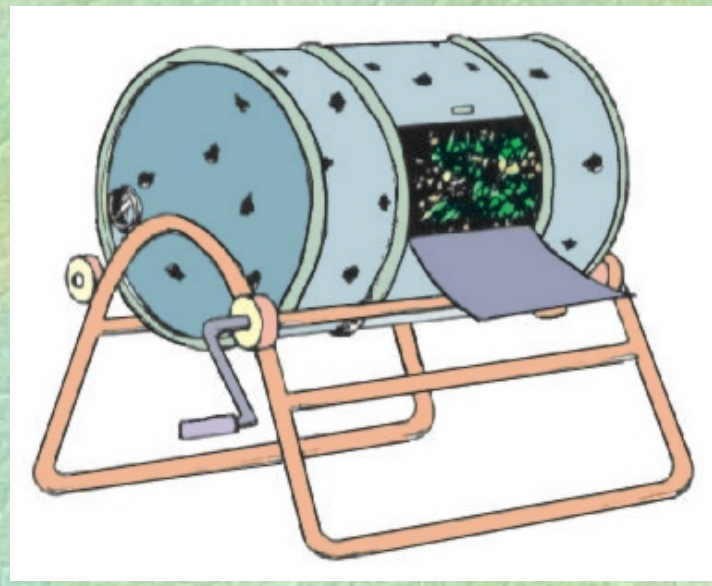


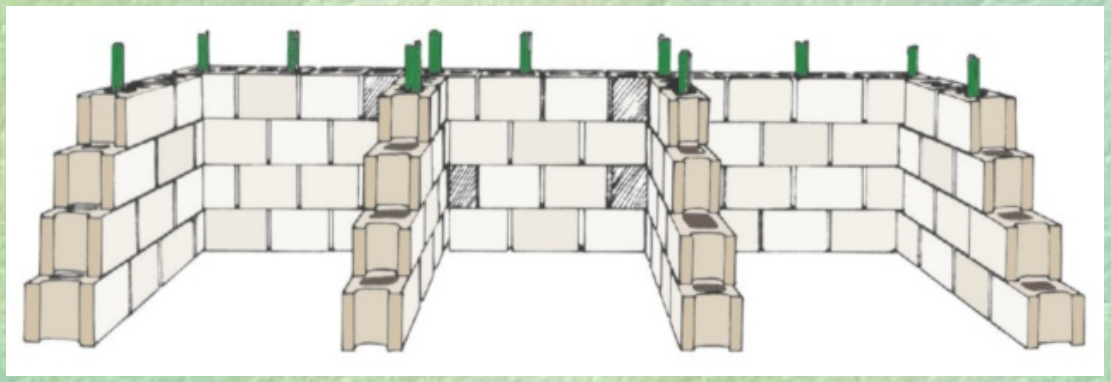


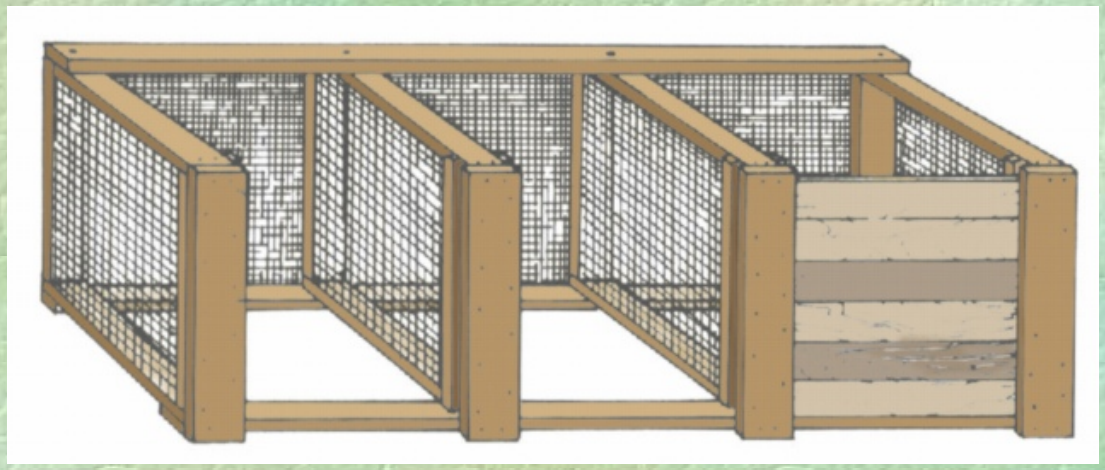


Turning Units

- Fast composting
  - best for batch composting

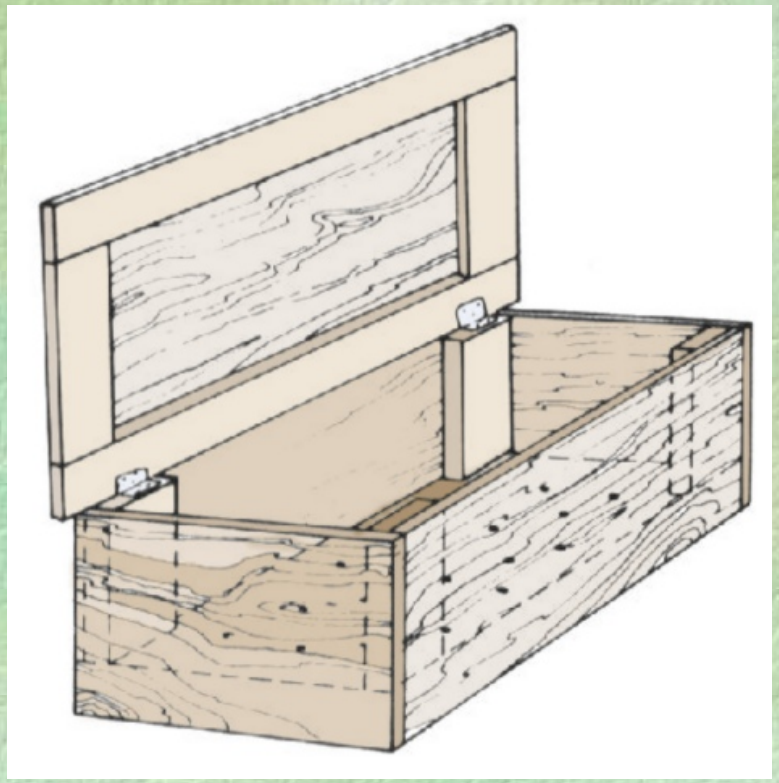






Worm Bin

- Works best for food waste



Biology of Composting

Two Types of Decay

PHYSICAL DECAY

Break up waste into smaller particles and transport microbes

- Mites
- Millipedes
- Sowbug
- Worms
- Snails

CHEMICAL DECAY

Break down waste at the molecular level

- Bacteria
- Mold
- Fungi
- Actinomycetes
- Protozoa

Food Web of Compost

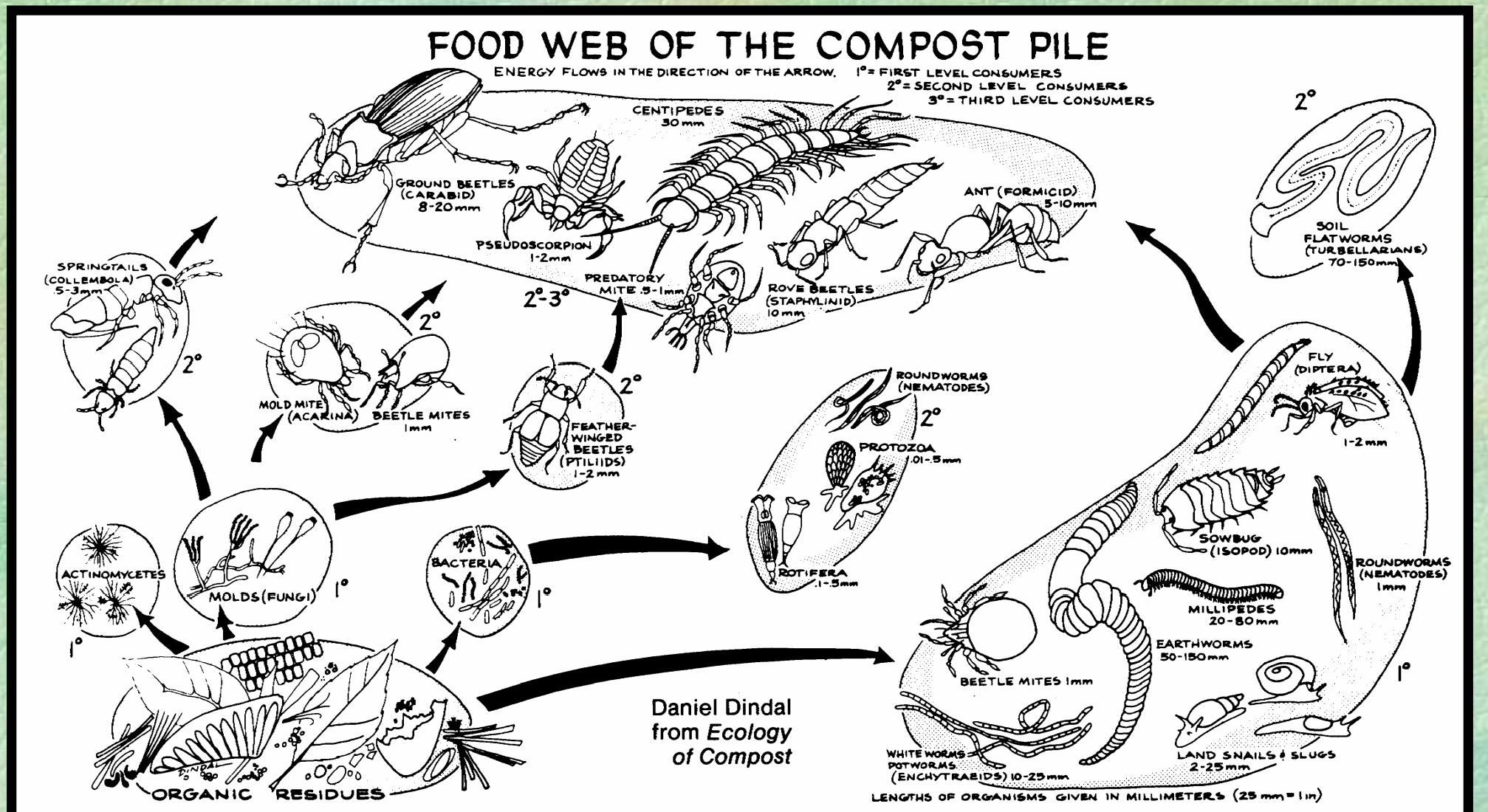


Figure 3. Organisms commonly found in compost. Energy flows from organism to organism as one is eaten by the other in a natural recycling system. Snails, beetles, millipedes, centipedes, and ants are less likely to find their way to worm bins set up with shredded corrugated and paper beddings.

Anaerobic Decomposition

Dominates when oxygen drops below 5%

- Process is slow and more nutrients lost
- By-products harmful to plants:
  - Acids
  - Alcohol
- Odors:
  - Hydrogen sulfide (rotten egg)
  - Cadaverine
  - Putrescine

Aerobic Decomposition

Dominates when oxygen above 15%

- Faster than anaerobic decomposition
- pH tends to self regulate in a safe zone
- Odor tends to be less offensive
- More nutrients are stabilized

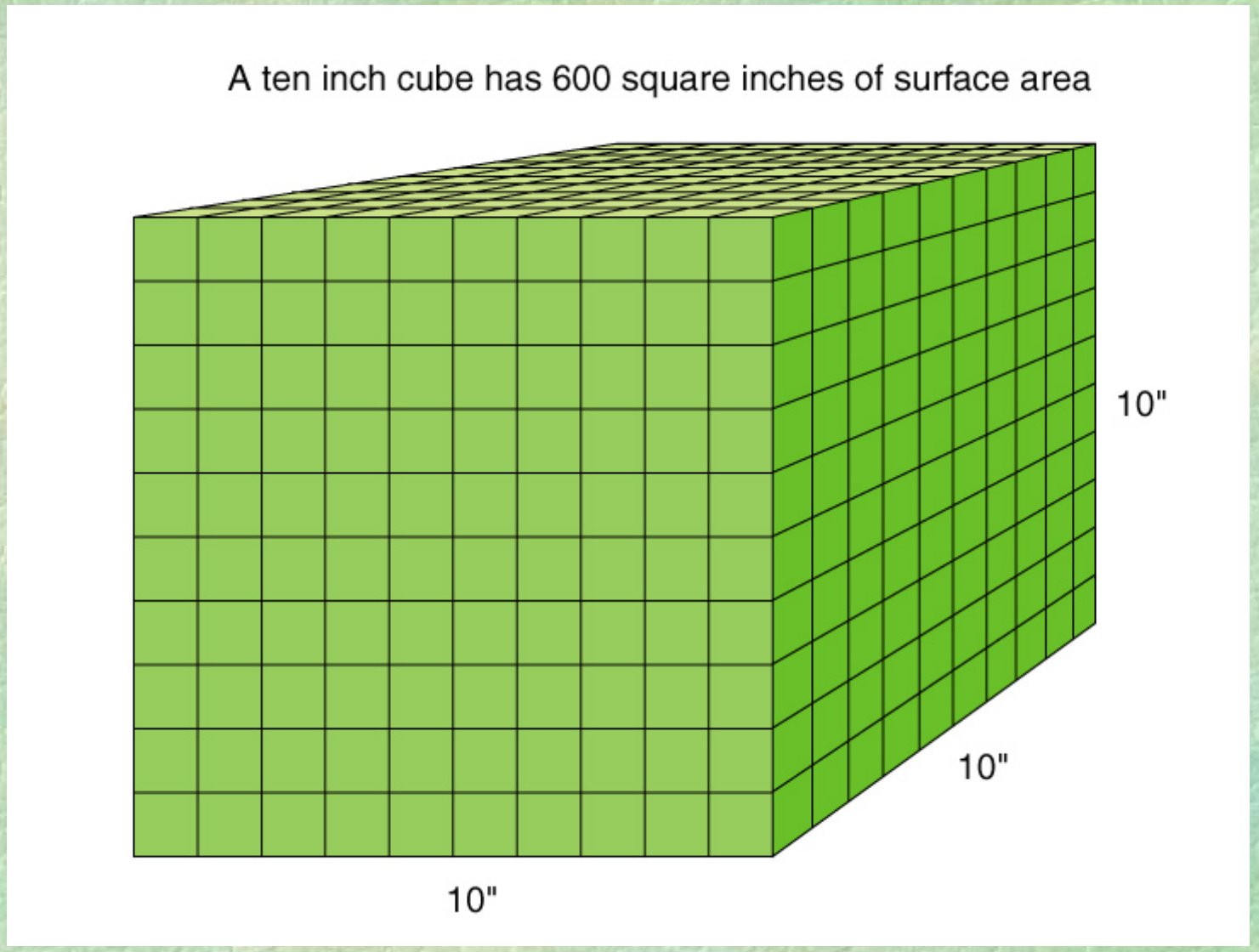
Factors Affecting the Process

- Surface area and particle size
- Aeration
- Moisture
- pH
- Carbon/Nitrogen ratio
- Time
- Composting Method Chosen

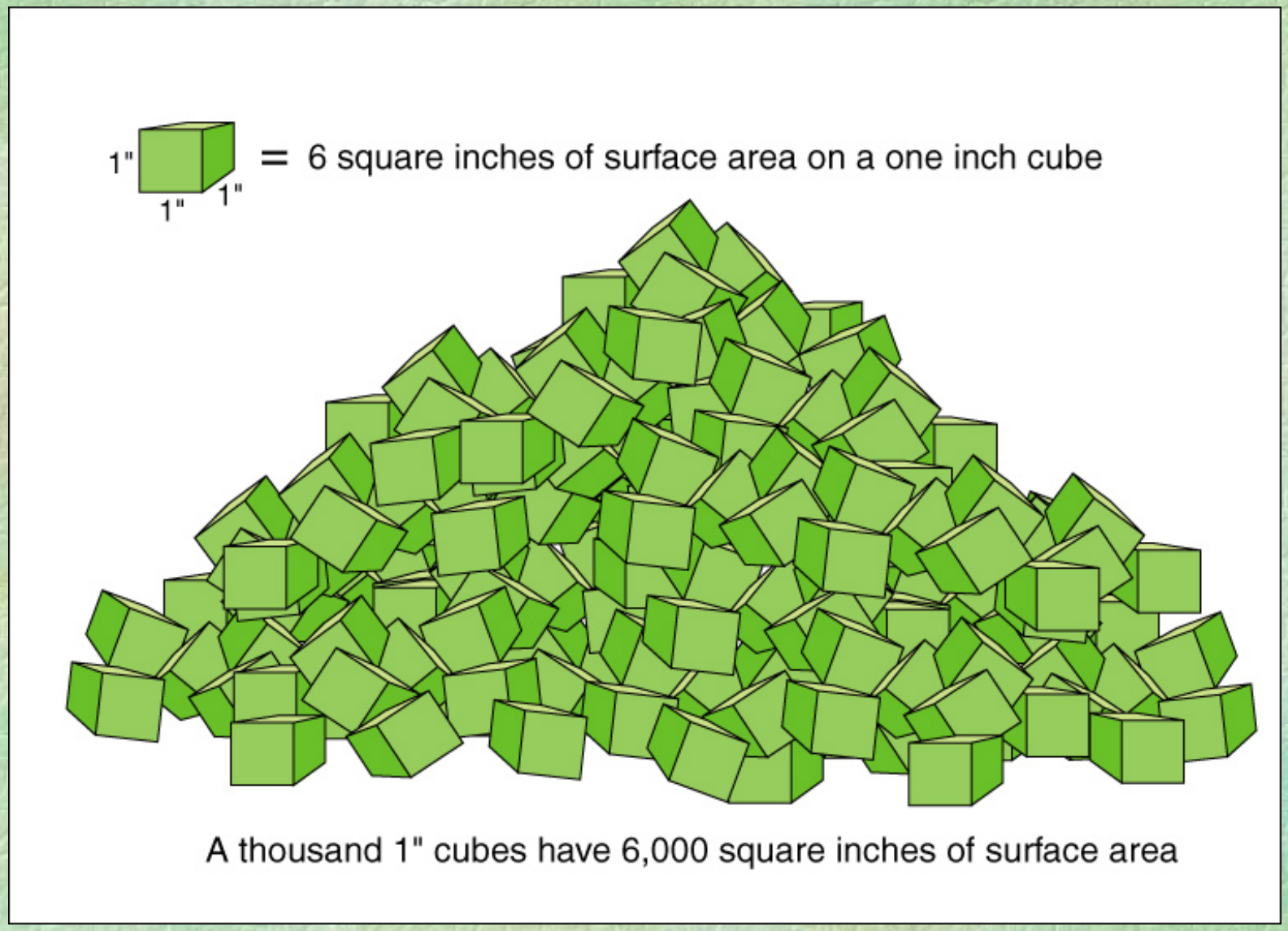
Surface Area and Particle Size

- Smaller particles provide more surface area.
- Microbes do their work on the surface of the material.

Surface Area and Particle Size



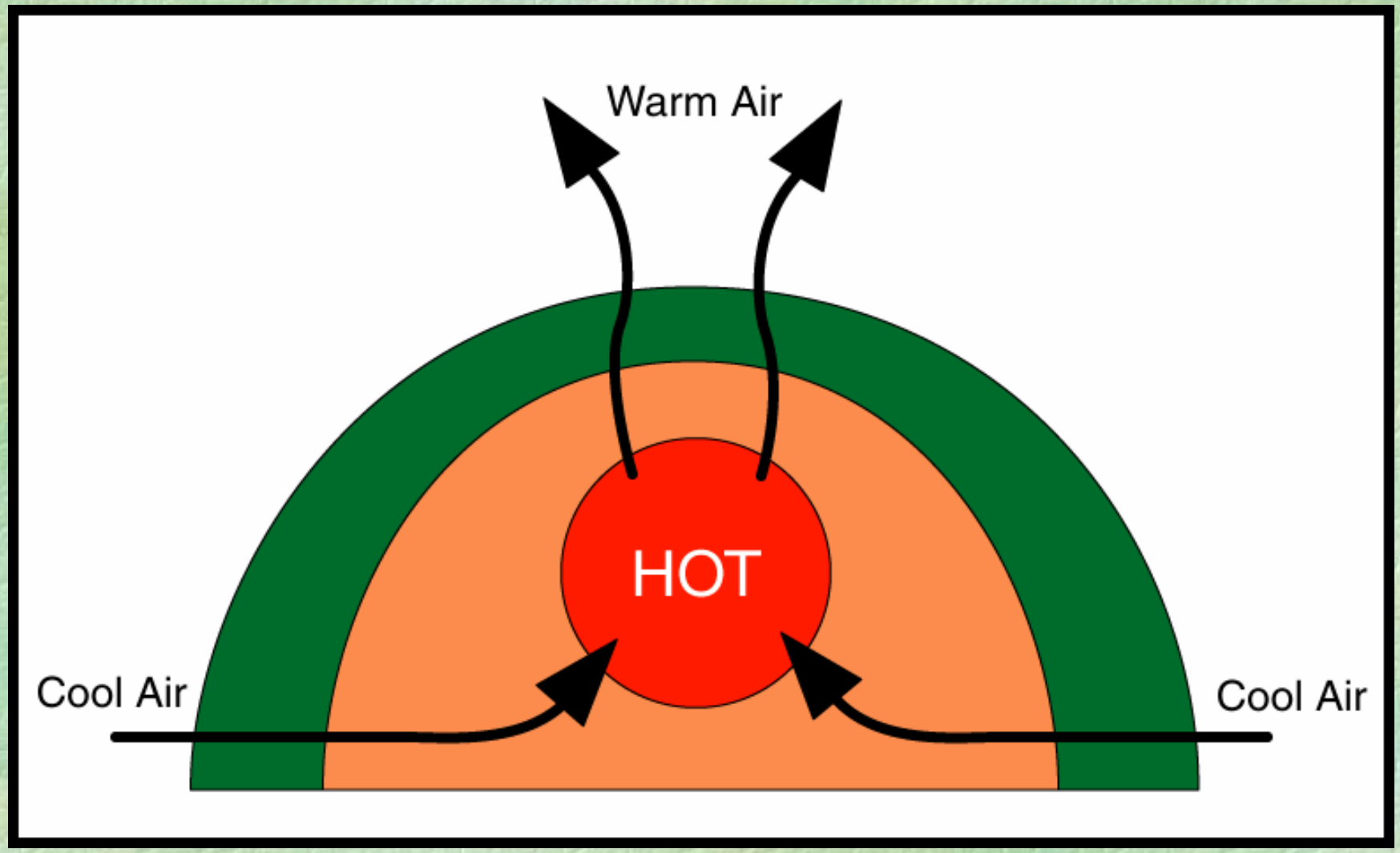
Surface Area and Particle Size



Aeration

- Factors affecting air flow
  - Aerobic microbes consume available air.
  - Particle sizes need to be large enough to allow passage of air into center of the pile.
  - Excessive moisture can block air flow.
  - Compaction can block air flow.
  - Materials with good structure like straw, wood chips, corn stalks and leaves will enhance circulation of air.
  - Turning the pile will improve circulation.

Natural Air Flow

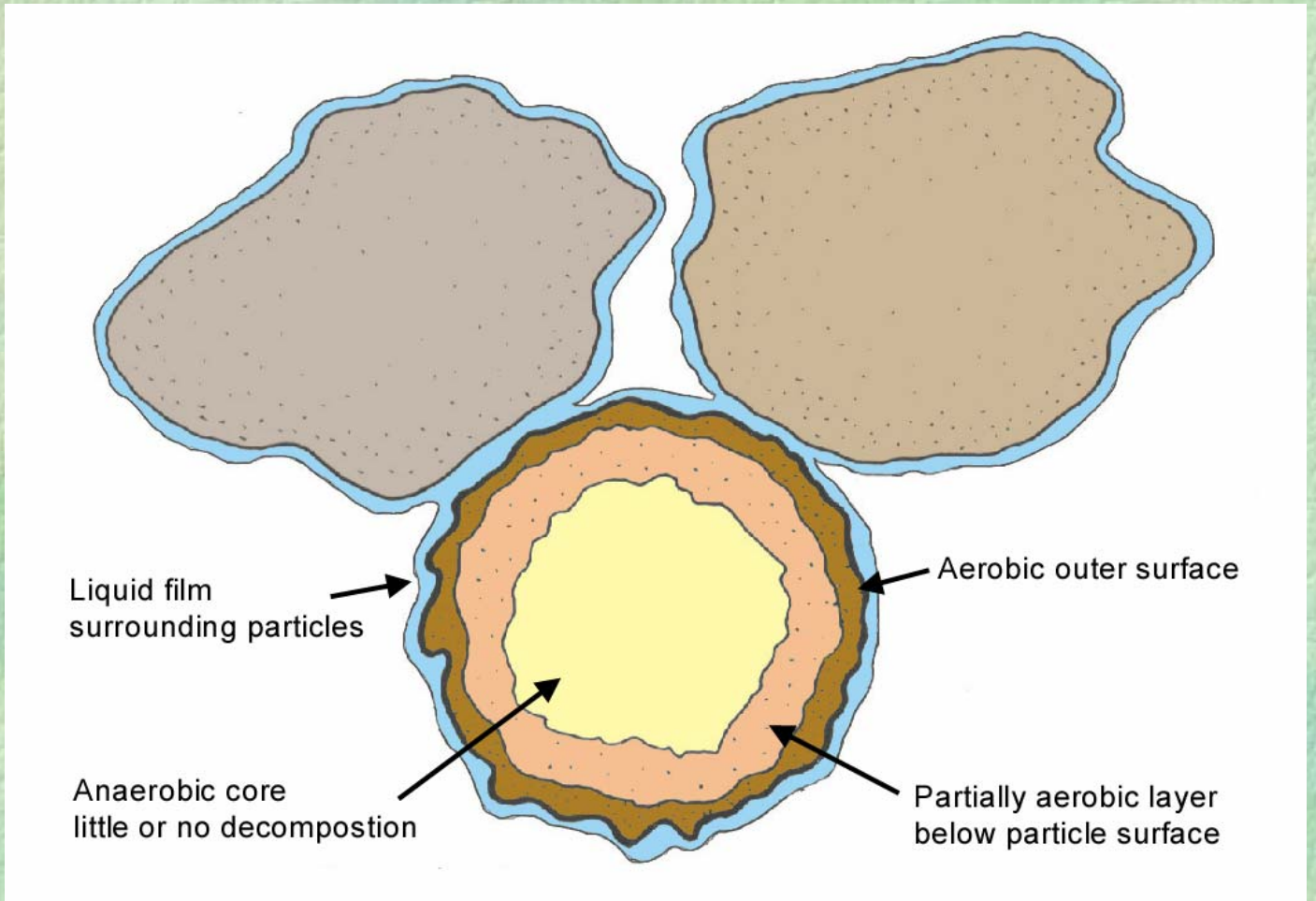


Moisture

- Microbe activity occurs in a thin liquid film on the surface of particles.
- Optimum: 40-60% moisture

Too dry will stop activity.

Too wet will block air and leach nutrients.



Temperature

- 90-140°F is optimum range for a heap or batch compost pile
  - over 140°F inhibits microbe activity
- The size or volume of the pile affects the ability of the pile to hold heat
- Ambient air temperature affects rate of heat dissipation

pH

- Compost process is relatively insensitive to pH.
  - In normal compost cycle, early release of acids will temporarily lower the pH.
  - Later stages of compost cycle will raise pH
  - Addition of lime or ash is not recommended
    - can cause loss of nitrogen in the form of ammonia
    - may interrupt the natural cycle
    - compost should be tested after curing if pH effect on plants is a concern

Time

- Time required for finished product depends upon the intended end use.
  - Potting soil needs to be completely cured.
  - Mulch compost can be relatively unstable.
- Factors that lengthen required time:
  - low moisture
  - high C:N ratio
  - low ambient temperature
  - compaction of material
  - large particle size
  - woody materials

Composting Time

Effect of compost method on length of composting time

Method	**Material**	**Time**	**Curing**
Passive	Bedded Manure	6-24 months	-
Pile infrequent turning	Manure + amendments	4-8 months	1-2 months
Pile frequent turning	Manure + amendments	1-4 months	1-2 months
Worm Bin	Food Waste	4-6 weeks	-
Rotating drum	Solid Waste	3-8 days	2 months

Carbon/Nitrogen Ratio

- Microbes need both in a ratio of about 30 parts carbon to one part nitrogen.
  - Carbon is a source of energy for the microbes
    - About 2/3 of available carbon is used for energy
  - Carbon and Nitrogen become part of the microbe cell structure
    - This is how nitrogen is stabilized in compost

Making and Maintaining a Compost Pile

- Materials
- Location
- Construction
- Maintenance
- Troubleshooting

Common Compost Materials

High Nitrogen	High Carbon
Bread	Leaves
Coffee grounds	Paper
Egg shells	Sawdust
Evergreen needles	Straw
Fruit	Sod
Fruit peels and rinds	Tea leaves
Garden waste	Vegetables
Grass clippings	Wood ash
Manure: Cow-Horse-Sheep	Wood chips

Don’t Try to Compost These...

Butter
Bones
Cat manure
Cheese
Chicken
Dog manure
Fish scraps
Lard
Mayonnaise
Meat
Milk
Oils
Peanut butter
Salad dressing
Sour cream
Vegetable oil

General Rule: avoid meat, fat, oil, dairy products, or manure from carnivorous animals.

Important Characteristics of Materials

- C:N Ratio: optimized for organism's needs
- Moisture: 40-60% by weight – squeeze test
- Porosity/bulk density: air flow and particle size
- Degradability: banana vs wood chip
- Odor potential: 2 week old bagged grass clippings
- Cleanliness: inorganic matter

Choosing Amendments

- Most Important Characteristics
  - Total C:N ratio of mix
  - Total percent moisture of mix
- Amendments:
  - **Bulking agents**: for structural qualities, include wood chips, corn stalks, straw or tire chips.
  - **Carbon sources**: to balance C:N ratio
  - **Nitrogen sources**: to lower C:N ratio
  - **Compost**: to inoculate pile with microbes

The Math and the Mix

- Data required for each material:
  - moisture content
  - percentage of nitrogen (dry weight)
  - percentage of carbon (dry weight) or C:N ratio
  - bulk density

Formulas for mixed ingredients:

$$\text{Moisture Content} = \frac{\text{weight of water A} + \text{weight of water B} + \text{weight of water C} + \ldots}{\text{total weight of all ingredients}}$$

$$\text{C:N ratio} = \frac{\text{weight of Carbon A} + \text{weight of Carbon B} + \text{weight of Carbon C} + \ldots}{\text{weight of Nitrogen A} + \text{weight of Nitrogen B} + \text{weight of Nitrogen C} + \ldots}$$

Math for Individual Materials

Formulas for one ingredient:

Moisture Content = % moisture / 100

Weight of water = total weight x % moisture

Dry weight = total weight - weight of water

Nitrogen content = dry weight x (% N / 100)

% carbon = %N x C:N ratio

Carbon content = dry weight x (% C / 100)

= N content x C:N ratio

- Math for Availability of Carbon
  - additional data required
    - cell wall as a percentage of total solids
    - lignin as a percent of total solids

Formula for Availability of Carbon:

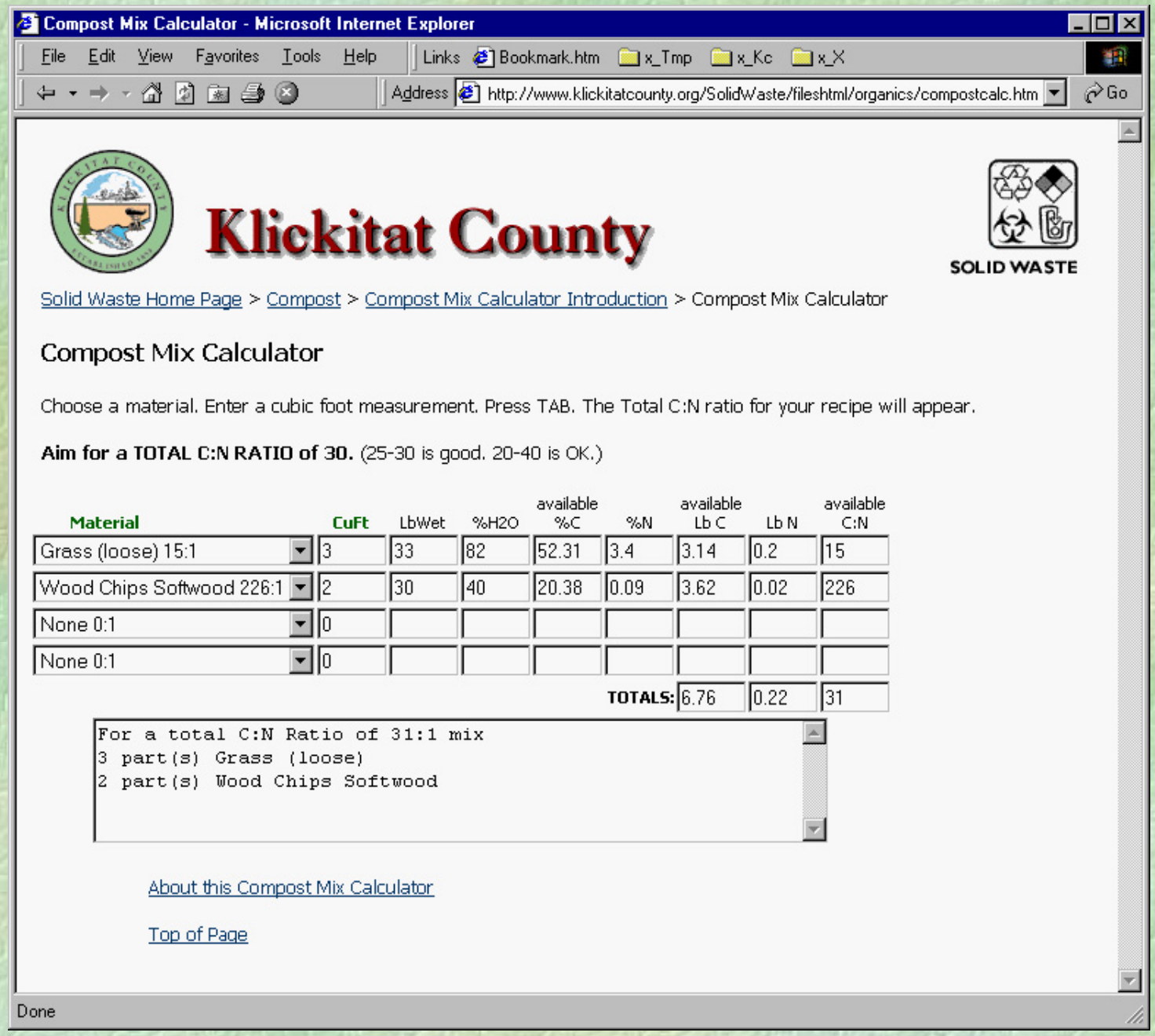
Available Carbon =

$$\text{total carbon} \times \left(\frac{\%\ \text{cell wall}}{100}\right) \times \left(1 - \left(0.0541 \times \left(\frac{\%\ \text{lignin}}{\%\ \text{cell wall} / 100}\right)^{0.76}\right)\right) + \text{total carbon} \times \left(1 - \frac{\%\ \text{cell wall}}{100}\right)$$

A Recipe without the Math

- Www.KlickitatCounty.org/SolidWaste/
  - click on Compost in the right hand column
  - Look for “Compost Mix Calculator”
  - Click on the link “…Click for Details”
  - Read the instructions
  - Click the “Compost Mix Calculator” link to create your recipe
  - Click the “Detailed Information” link to read more about Carbon Availability

The Compost Mix Calculator



Location

- Shade: conserve moisture
- Wind: conserve moisture
- Water: near water hose
- Storage: room for accumulated material
- Convenience: close to kitchen and garden
- Well and Surface Water: contamination
- Rain: avoid low spots and runoff channels
- Vehicle Access: hauling raw material

How to Construct a Batch Compost Pile

Step 1

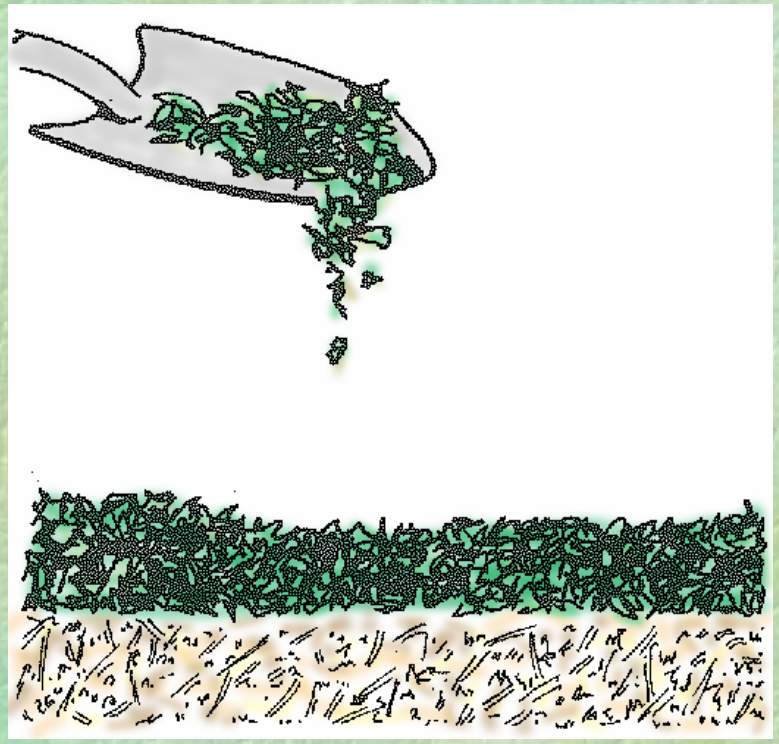
Collect enough material to create a 1 cubic yard pile.

Chop or shred coarse material to increase surface area.

Start the pile with a 4-6 inch layer of high-carbon material.

How to Construct a Compost Pile

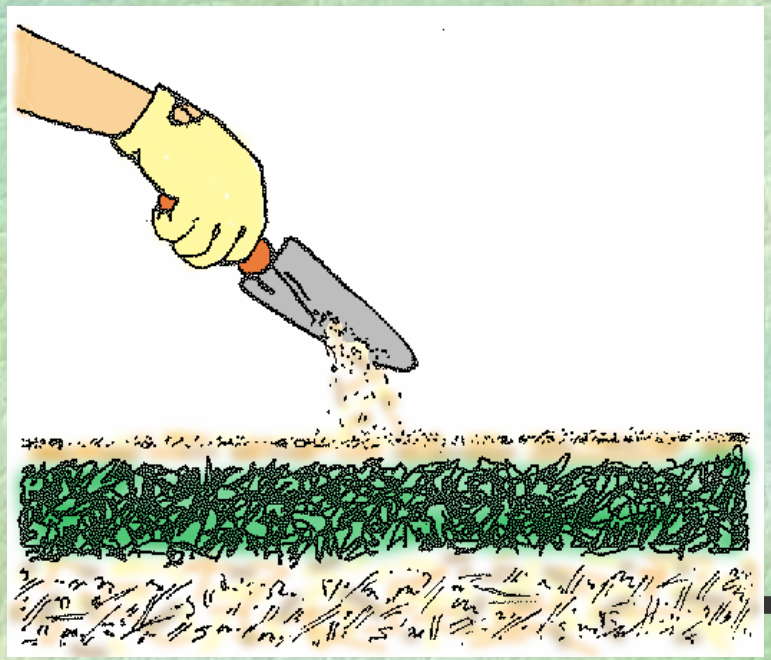
Step 2



Add a 4-6 inch layer of high nitrogen material

Vegetative kitchen waste should be added in this layer.

If food wastes are added, an additional thin layer of soil, sawdust, leaves, straw or compost should be added to absorb odors.



How to Construct a Compost Pile

Step 3

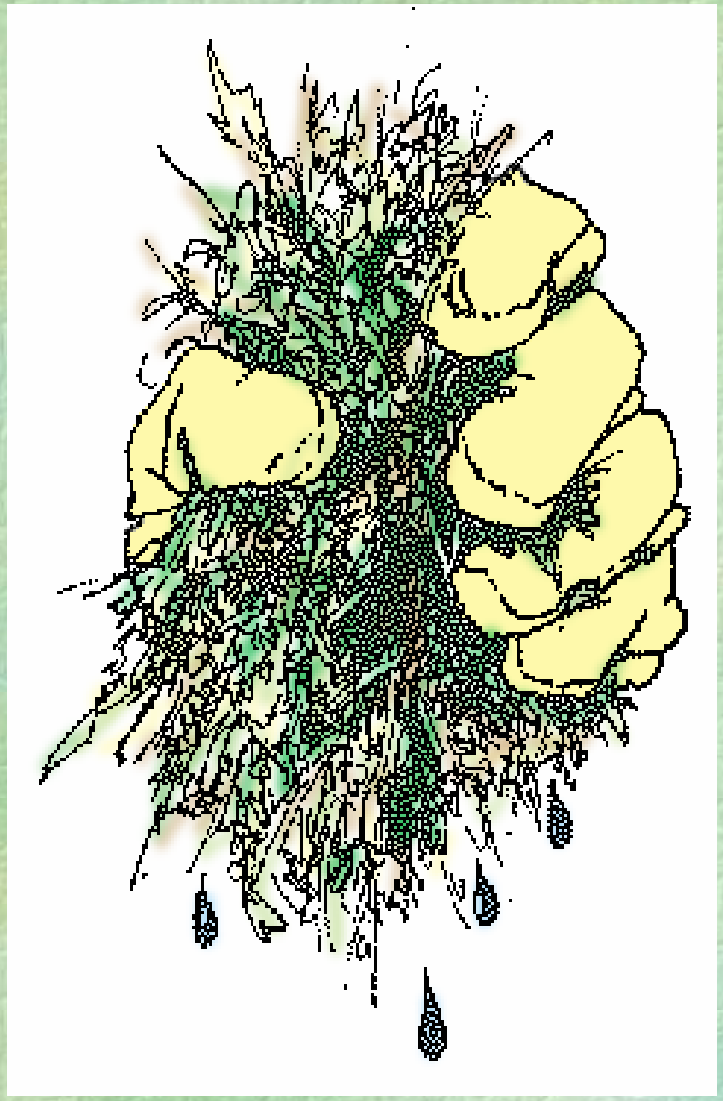
Mix the layers.

How to Construct a Compost Pile

Step 4

Conduct a squeeze test.

Add water until squeezing a handful will yield a couple of drops of water.



How to Construct a Compost Pile

Step 5

Continue adding layers,
mixing them as you go,
until pile is 3 or 4 feet high.

Pile Maintenance: 7th Day

- Temperature should be around 110°F
- Reconstruct pile placing top and side material into center
- Check moisture

Maintenance: 14th Day

- Temperature 120-140°F
- Original material coffee brown color
- Reconstruct pile placing top and side material in center
- Break up compacted material
- Check moisture

Maintenance: 21st Day

- Temperature 120-140°F
- Original material not recognizable
- Reconstruct pile placing top and side material in center
- Check moisture

Maintenance: Final Cure

- Temperature within 10°F of air temperature
- Dark crumbly texture
- Earthy odor

Notice how the thick fabric in the sweatshirt of the person in the photo makes it appear he has a weight problem.

Using Compost

- Mulch
- Top dressing
- Soil incorporation
- Potting soil

Benefits of Compost Use

- Improved soil structure
  - holds moisture in sandy soil
  - improves aeration and porosity in clay soil
    - improved water absorption
    - resistance to compaction
  - attracts worms that add humus to soil
- Slow release of nutrients over long period of time

When is it ready to use?

- Microbes in compost with a high C:N ratio will compete with plants for available nitrogen.
  - Can be used on top of the soil around shrubs to keep weeds from sprouting.

- Just after active composting most available nitrogen is in the form of ammonium.
  - It takes three months for ammonium-nitrogen to be converted to nitrate-nitrogen.

Usage by Plant Species

- Fresh Compost: ammonium-nitrogen
  - young plants absorb ammonium better than mature plants
  - Ericaceous species: blue berries, azaleas, rhododendrons, mountain laurel, andromeda and leucothoe absorb most nitrogen in form of ammonium-nitrogen.
- Aged Composts: nitrate-nitrogen
  - Grasses, flowering annuals, herbaceous perennials and vegetable plants absorb most nitrogen in form of nitrate-nitrogen.

Note: Most woody perennials not mentioned above absorb both.

Crop Gardens

- Use only fully cured compost.
- Use only well screened compost.
- Work into soil before seeding or planting.
  - If only small amounts of compost are available work compost directly into planting row.

Safety, Health and ...

- Pesticide and Herbicide
- Pathogens
- Pernicious weeds
- Diseased plants
- Insect infestations
- Pests:

Pathogens

- Active or unfinished compost worked into soil may provide nourishment to plant pathogens.
- Placing manure from cats, dogs and swine into compost pile may allow pathogens to be transmitted to root crops.
- Horse manure can carry encephalitis.
- Breathing dust from dry compost can cause reaction in some people.

Pernicious Weeds

- Weeds with rhizomatous root systems may survive compost process.
  - morning glory
  - buttercups
  - grasses (quack grass)

Diseased or Infested Plants

- Plants with diseases and harmful insect infestations should not be composted.
  - Landfill
  - Incinerate

Pests

- Addition of fatty foods, meat and bones will attract rodents, raccoons, dogs, cats, flies and other pests.

Environment

- Odors
  - raw materials in storage and poorly maintained compost can create obnoxious odors.
- Leaching
  - runoff from compost is high in nitrogen
    - negative impact on surface water plant and animal species
    - can contribute to high nitrate levels in well water

Internet Resources

- Information
  - www.KlickitatCounty/SolidWaste/
  - www.cfe.cornell.edu/compost/Composting_homepage.html
  - www.mastercomposter.com/
  - gardening.wsu.edu/text/libr.htm
- Worms
  - www.wormdigest.org/
- Tools
  - www.composters.com/

Local Resources

- Neighbors
- Klickitat County Solid Waste

The End