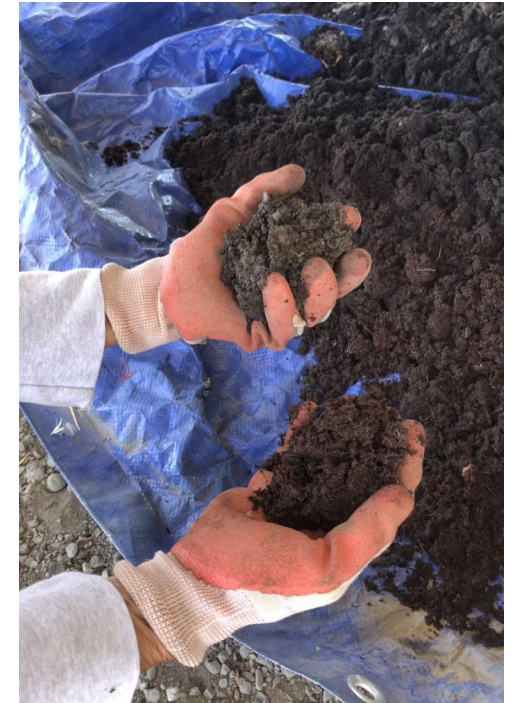


Compost Basics

UCCE Composting Education Program
Santa Clara County

What is Composting?



The bio-oxidative degradation of organic materials under controlled conditions

Large scale composting: Commercial composting facilities, farms

Small scale composting: Homes, schools, offices

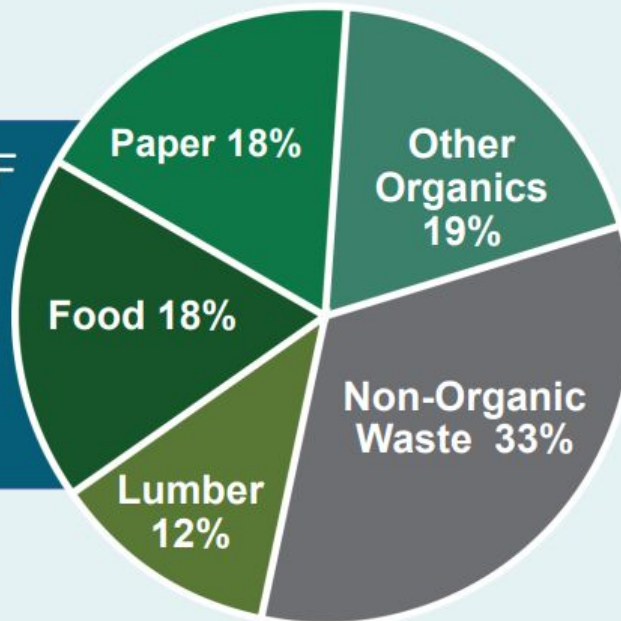
Why Compost?

- Waste Diversion
- Soil Fertility
- Water Retention & Quality
- Carbon Sequestration



Organic Waste: Largest Waste Stream in California

CALIFORNIA DISPOSED OF APPROXIMATELY 27 MILLION TONS OF ORGANIC WASTE IN 2017



California's Waste Stream

IN CALIFORNIA, MILLIONS ARE
FOOD INSECURE

1 IN 8 CALIFORNIANS
1 IN 5 CHILDREN



CALIFORNIA THROWS AWAY
MORE THAN 6 MILLION TONS
OF FOOD WASTE EVERY YEAR!

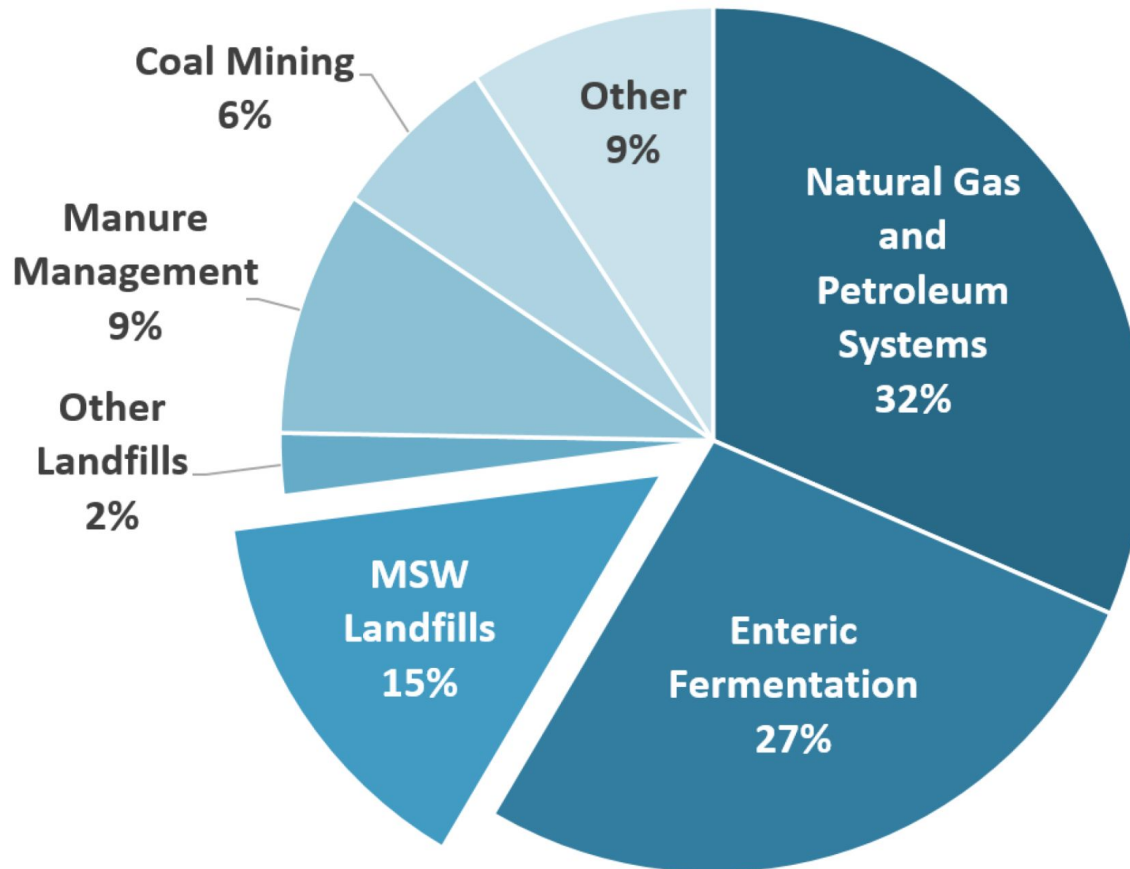


METHANE



LEACHATE

2020 U.S. Methane Emissions, By Source



Note: All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020*. U.S. EPA. 2022.

CLIMATE CHANGE NEGATIVELY IMPACTS CALIFORNIA

Landfilled Organic Waste Emits
**Methane Gas—
A Super Pollutant**
More Powerful than CO₂

Methane Gas Contributes to
Climate Change in California



CALIFORNIA
is already experiencing
the impacts of
CLIMATE CHANGE

IN 2015 THE DROUGHT COST THE
AGRICULTURE INDUSTRY IN THE
CENTRAL VALLEY AN ESTIMATED
\$2.7 BILLION & 20,000 JOBS



SB 1383

Reducing Short-Lived Climate Pollutants in California

An Overview of SB 1383's
Organic Waste Reduction
Requirements



1383 Requires California Jurisdictions to:

**Provide Organics
Collection Services to All
Residents and Businesses**



**Provide Education and
Outreach to Community**



**Confirm Capacity for
Organic Material Recycling
and Edible Food Recovery**



**Establish Edible Food
Recovery Program**

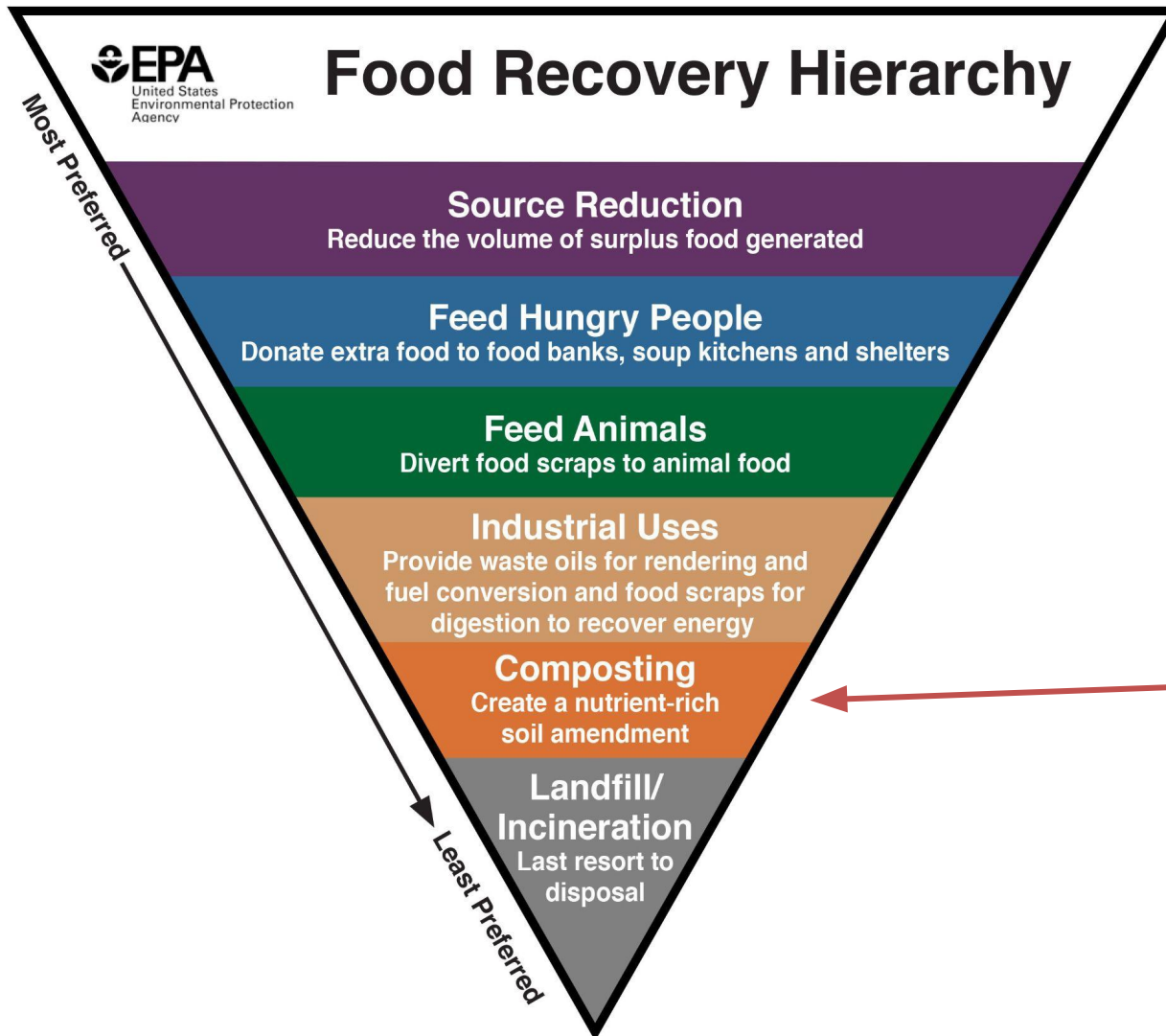


**Buy Recyclable and
Recovered Organic
Products**



**Monitor Compliance
and Enforce Ordinances**

CalRecycle 



SB 1383 IN ACTION

JURISDICTION REQUIREMENTS



Provide organics collection service to all residents and businesses

Organic Waste Collection Services



One to Three-Container Collection to keep Organics Out of Landfill

- Organics prohibited from grey container
- OR sent to High Tech sorting facility
- Educate Residents about waste reduction and contamination
- Required contamination monitoring



Each Jurisdiction has adopted a new Solid Waste Ordinance, and many are revising their Collection Franchise Agreements to meet SB 1383

CalRecycle 

Composting
Education
Program 
COMMUNITY • HOME • CLASSROOM

University of California
Agriculture and Natural Resources

Home Composting Advantages

- Reuse valuable nutrients to feed your plants & trees
- Use less water and fertilizer in your garden
- Grow healthy plants
- Good exercise
- Fun and rewarding
- Get in touch with nature
- Reduces carbon emissions
- Promotes a more sustainable lifestyle



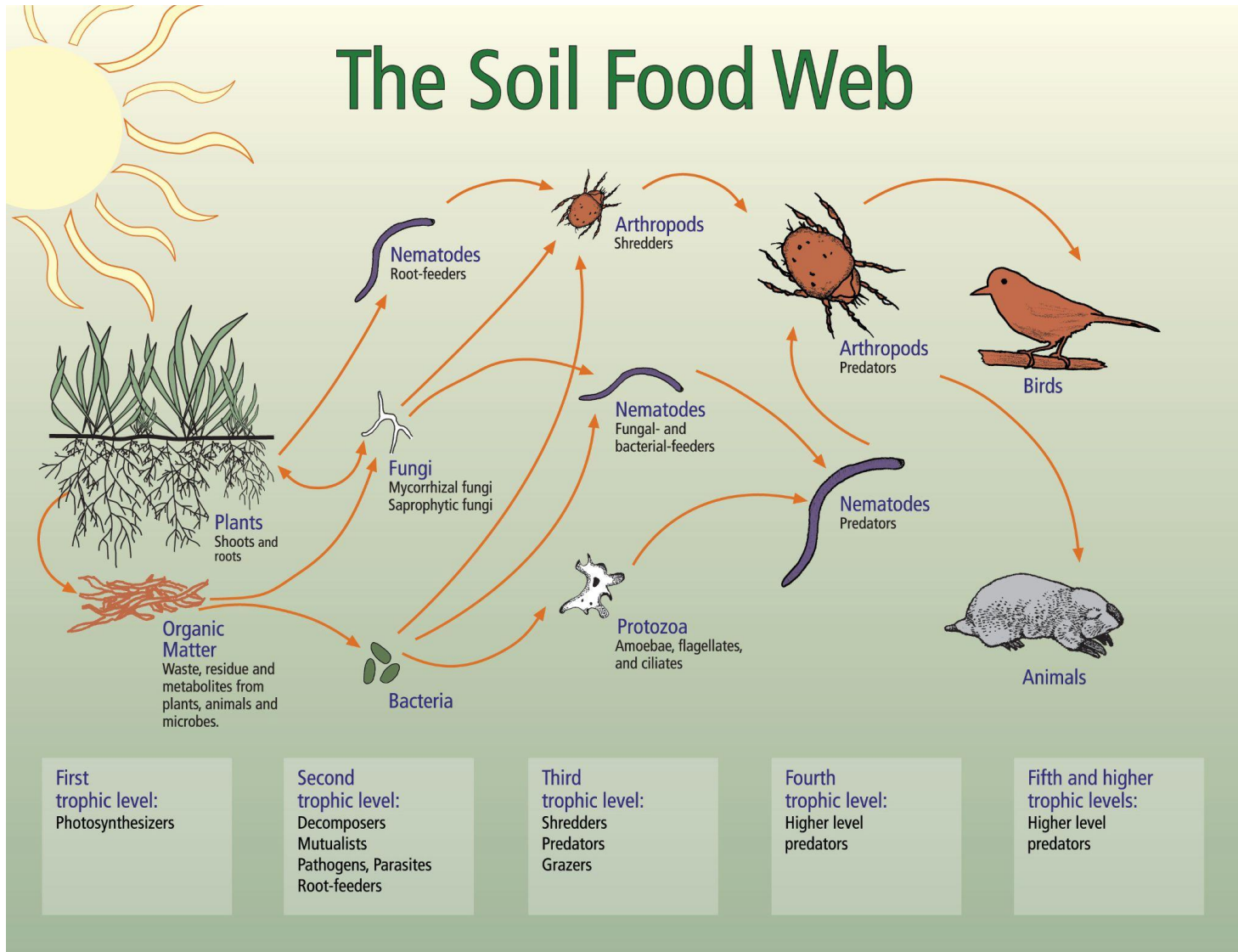
Soil Fertility

Compost is a source of organic matter in soil

- Macro- and micronutrients
- Microbiology
- Water retention
- Structure
- Stability



The Soil Food Web



- First trophic level:** Photosynthesizers
- Second trophic level:** Decomposers, Mutualists, Pathogens, Parasites, Root-feeders
- Third trophic level:** Shredders, Predators, Grazers
- Fourth trophic level:** Higher level predators
- Fifth and higher trophic levels:** Higher level predators

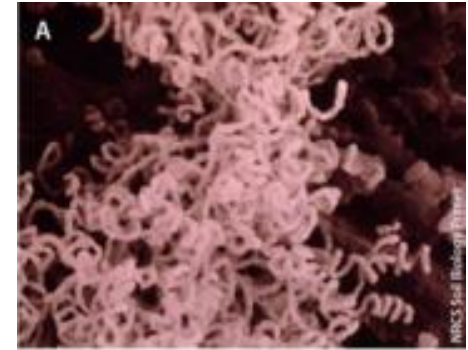
Source: Elaine Ingham, NRCS USDA

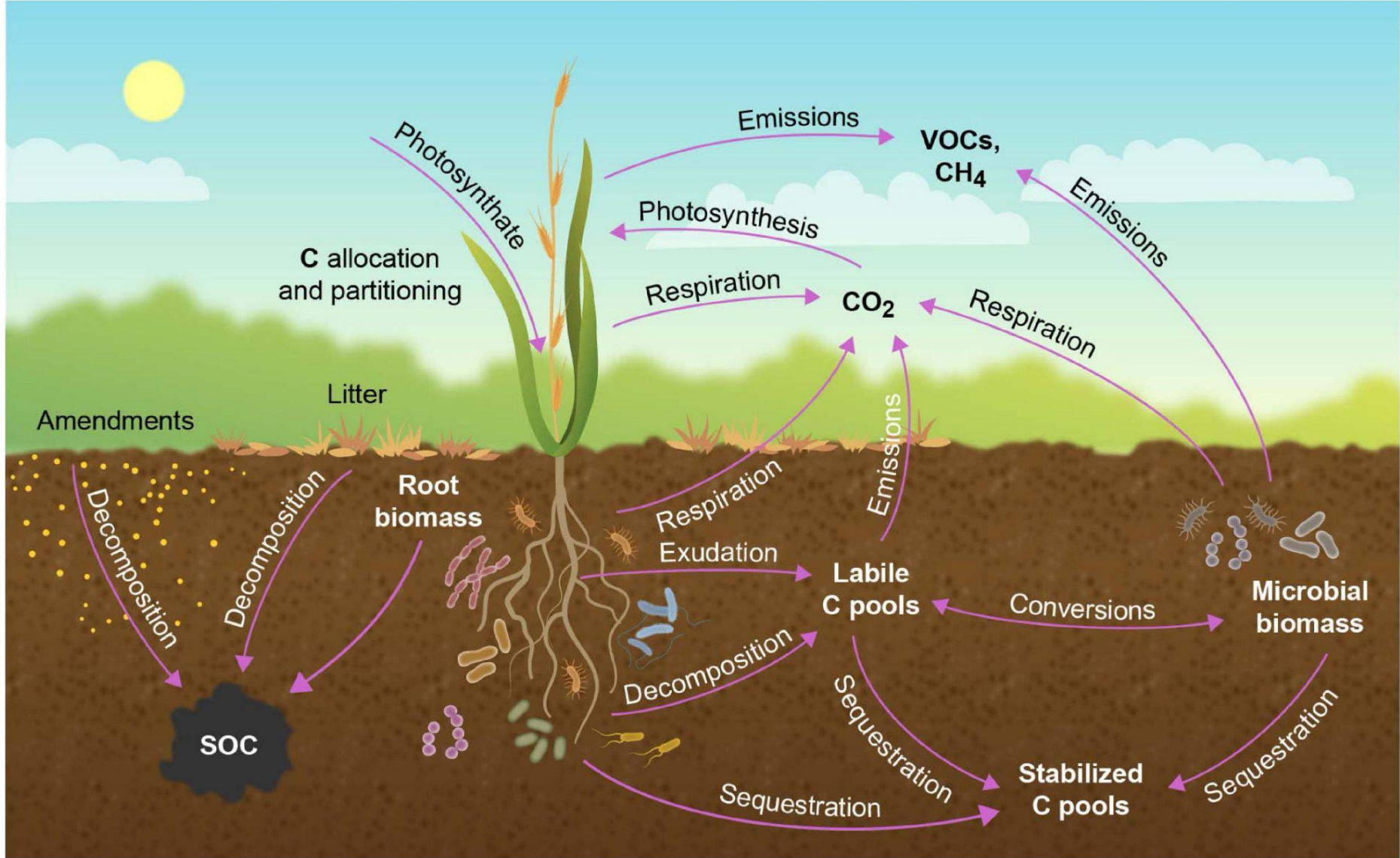
Compost Microorganisms

(A) actinomycete bacteria, which decompose organic matter into compost (0.0005 mm)

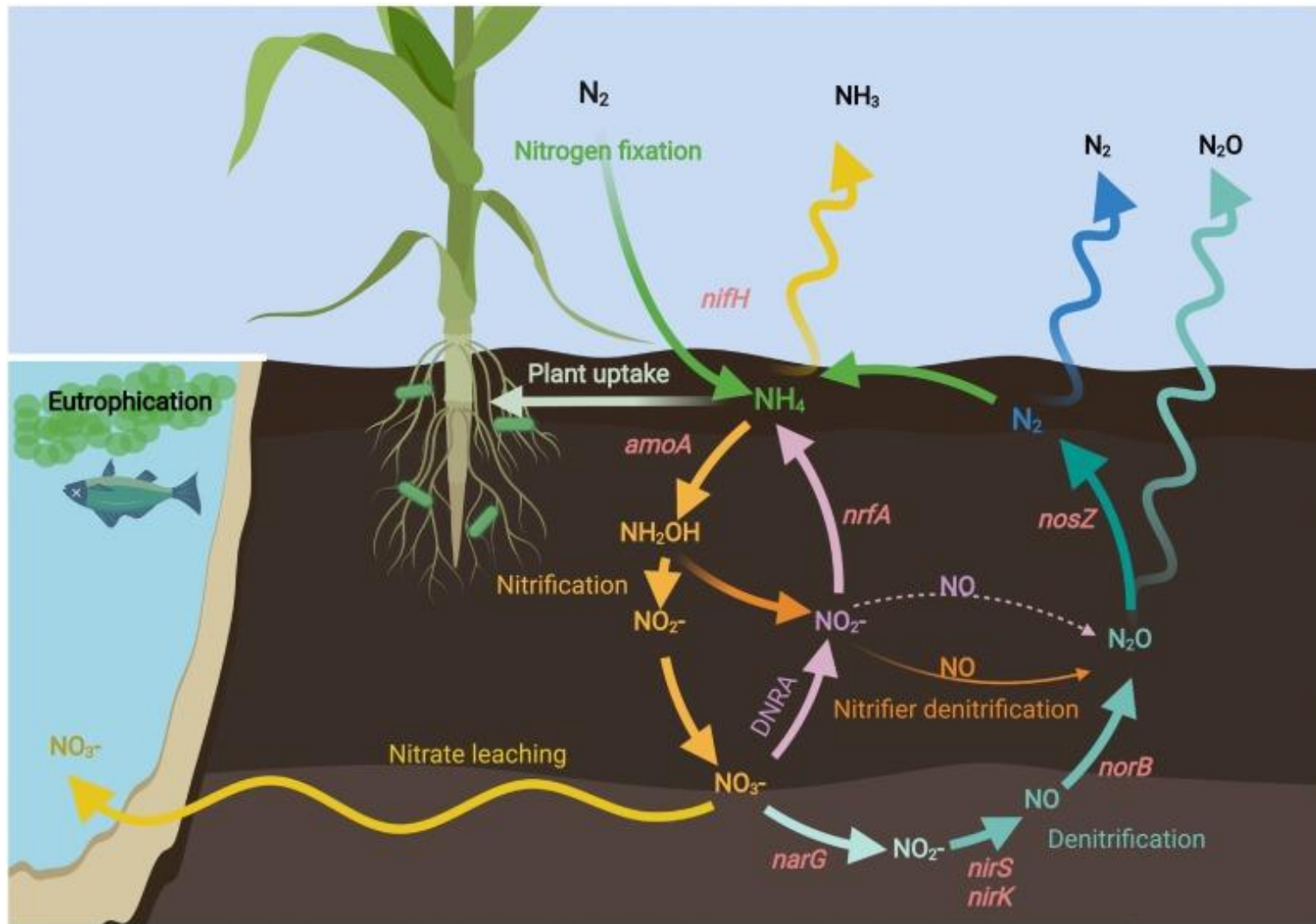
(B) turtle mites (*Orobatidae*), which shred plant material into pieces, facilitating decomposition (0.05 mm)

(C) predatory nematodes (*Monochidae*), which regulate populations of pest nematodes (3 mm)





Source: Jansson C, Faiola C, Wingler A, Zhu X-G, Kravchenko A, de Graaff M-A, Ogden AJ, Handakumbura PP, Werner C and Beckles DM (2021) Crops for Carbon Farming. *Front. Plant Sci.* 12:636709. doi: 10.3389/fpls.2021.636709

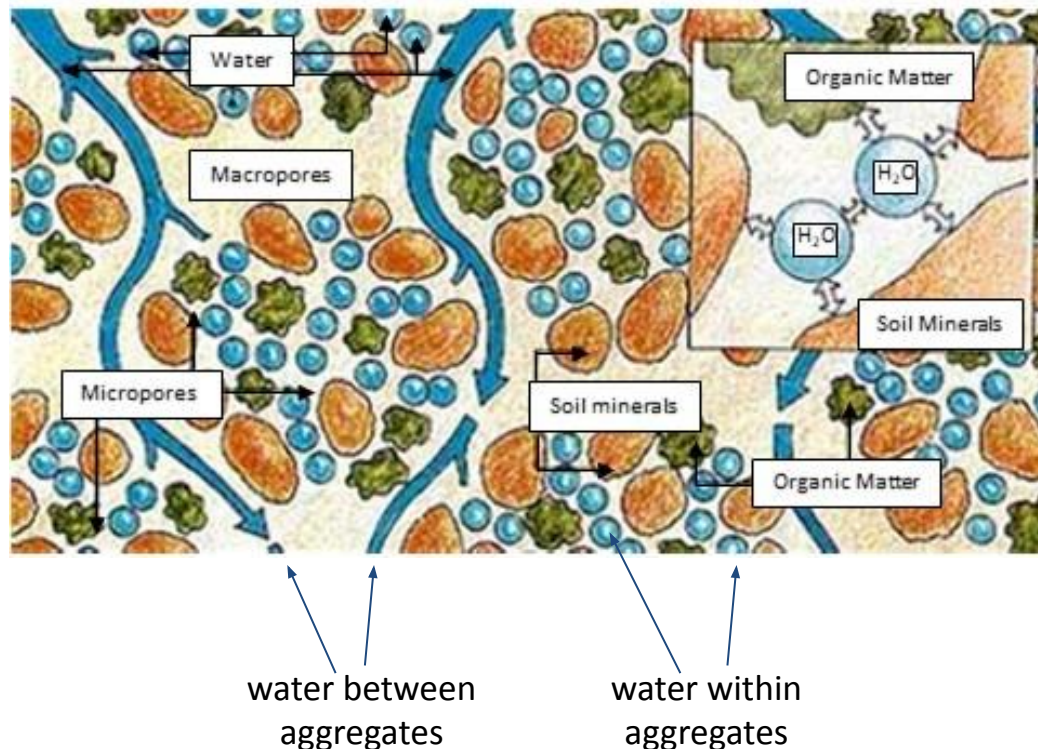


Source: Klimasmith, IM, Kent, AD (2022). Micromanaging the nitrogen cycle in agroecosystems. Trends in Microbiology, <https://doi.org/10.1016/j.tim.2022.04.006>. Trends in Microbiology

Water & Compost

- Increased water holding capacity
- Reduced irrigation demand
- Bio-filtration

Source: FAO



Composting & Climate Change

- Uptake of both CO₂ and CH₄
- Long term carbon storage
- Reduced emissions



Let's Get Building!

Compost Ingredients

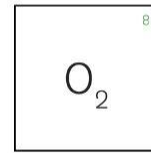
Greens



Water



Air



Soil Organisms



Browns



Ingredient #1: Greens (~50%)

Nitrogen-rich organic material

- The majority of our kitchen waste
- Green yard waste
- Nitrogen is food for fungi and bacteria

Examples:

- Disease-free green leaves and stems, grass clippings, weeds (before they go to seed), vegetable/fruit peels and scraps, coffee grounds, tea bags, flowers, fleshy roots, leguminous plants
- Herbivore manures: cow, poultry/bird, rabbit, horse droppings and cage cleanings (none from meat-eating animals)



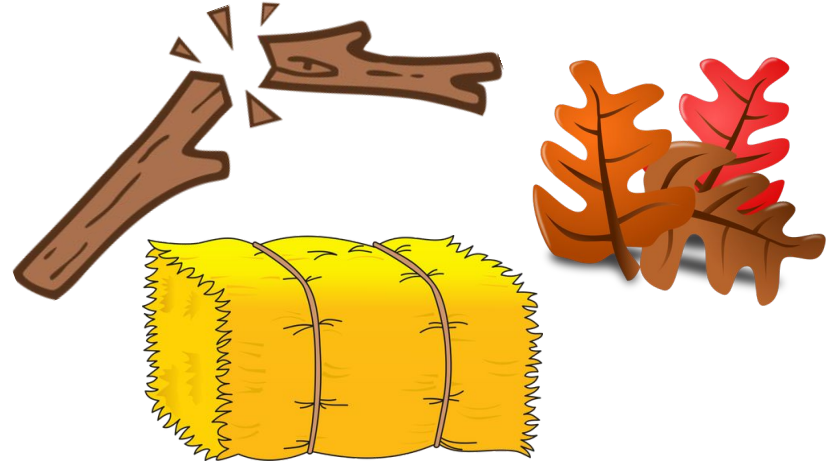
Ingredient #2: Browns (~50%)

Carbon-rich organic material

- Dry, dead yard waste
- Brown, woody plant material
- Carbon is food for fungi and bacteria

Examples:

- Dried leaves, evergreen needles, straw, coir (coconut husk), shredded woody stems/stalks/branches, dried tree/shrub prunings (a few stalks and thin branches provide good air pockets)
- Also, dryer and vacuum lint, wood chips, sawdust (from untreated wood) and shredded paper/cardboard — use sparingly



C/N Balance



Ingredients #3 - #5

Air

Ingredient #3 Air

- Air is necessary for microorganisms to thrive and to breakdown the organic materials into compost.
- A compost pile needs aeration by turning or fluffing.



Ingredient #4 Water

- Moisture allows microorganisms be active and to move around.
- Moisture is easier to regulate in bins that are contained and have lids.
- Your pile should be kept as moist as a wrung-out sponge.

Ingredient #5 Soil Organisms

- Microorganisms are the hard workers in the composting process. They are introduced into your pile from the materials you add and from the ground and air.



What to Avoid

- No animal products - meats, bones, fish
- No dairy products: cheese, milk, yogurt
- Be careful with breads (because of molds)
- No pet wastes or litter from carnivores (e.g. cat or dog feces)
- No oils or plastics
- No wood ash or charcoal
- No diseased plants
- No plants treated with herbicides

Egg shells are OK

No toxic materials!

Ingredient Tips

These items may spread undesirable plants or have negative effects when using your compost:

- Bermuda grass
- Bind weed (wild morning glory)
- Oleander or any weed with seed heads or persistent roots (ok if hot composting higher than 140°F)
- Ivy (ok if dried and finely chopped)
- Thorny plants (ok if finely shredded)

Location

- Site Assessment
 - Too Wet
 - Too sunny or dry
 - Rodents
 - Traffic & access



Compost Bins – Build Your Own



These images are all from our demonstration site at Martial Cottle Park

Compost Bins – Many Designs



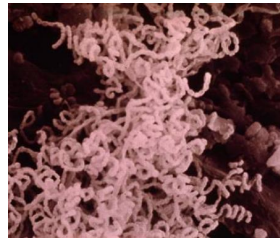
This is the one we are offering right now:
The FreeGarden Earth compost bin



Inside a Compost Bin



Bacteria



Actinomycete



Fungus



Sow Bug



Mite



Springtail



Ant



Worm



Nematodes



Green June
Beetle Larvae

Two Basic Backyard Pile Types

Hot Pile

- Super-active microbes generate heat in proper conditions
- All materials must be available at the same time, chopped ($\frac{1}{2}$ " - $1\frac{1}{2}$ ") & mixed
- Minimum volume: 3'x 3'x 3' (1 cubic yd. = 27 cubic ft.)
- Requires frequent turning
- Finished compost in one to three months

Cold Pile

- Slow decomposition of materials. Little heat produced
- Minimal chopping of materials
- Minimal concern with proper mixture of materials
- Add materials over time
- Occasional turning
- No minimal volume
- Finished compost in six months to two years

Trade-offs

Hot Pile

- Temperatures over 140° F kill most seeds and plant disease pathogens
- Compost is made quickly requiring minimal space
- Little concern with pests due to the heat
- Requires effort in chopping materials
- Requires pile to be built over a few days
- Frequent turning required!

Cold Pile

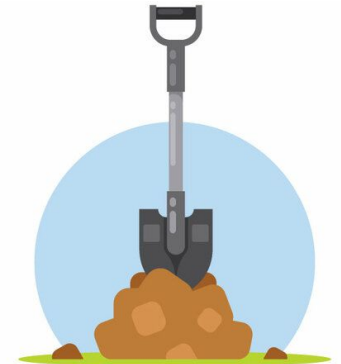
- Seeds and many plant diseases are not killed
- Requires more space than a hot pile for an equivalent volume of input material
- Must use rodent-resistant compost bins if food scraps are added to pile
- Piles can be built over months
- Minimal turning

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Building a Cold Compost Pile

- Materials can be added as they become available
 - Little or no chopping required
 - Stir new material into pile, mixing greens and browns
 - Add water as needed, keep it damp, not wet
 - Mix food scraps with dry browns, add mixture to center of pile and cover with non-food ingredients
 - Use a rodent-proof compost bin if adding food scraps to the compost pile
- Turn once per month, or when pile smells, or has zones that are too wet/too dry
- Perhaps add a little soil to the pile
- Produces compost in six months to two years
- Harvest compost from the bottom of the pile



Troubleshooting

Symptom	Problem	Solution
Smells like eggs	Too much moisture	Add dry ingredients
	Too compact not enough air	Mix more often, turn or aerate
Smells like ammonia	Too much nitrogen (green)	Add more browns (carbon) and mix, turn or aerate
Process is slow	Not enough surface area	Shred or break organics into smaller pieces
Large critters are interested in my compost pile	Wrong material has been added	Don't add any grains, meat or bones
	Vegetable scraps are exposed	Make sure food is covered with soil or 6" of material
Winter is coming – process has slowed	This is normal for cooler temperatures	Continue adding to your compost bin. Process will speed up again in the spring.

Building a Hot Composting Pile

Reminder: **Hot Composting**

A monitored compost pile that is turned frequently, reaches high temperatures and is ready for harvest in shorter time than cold composting.

Preparation:

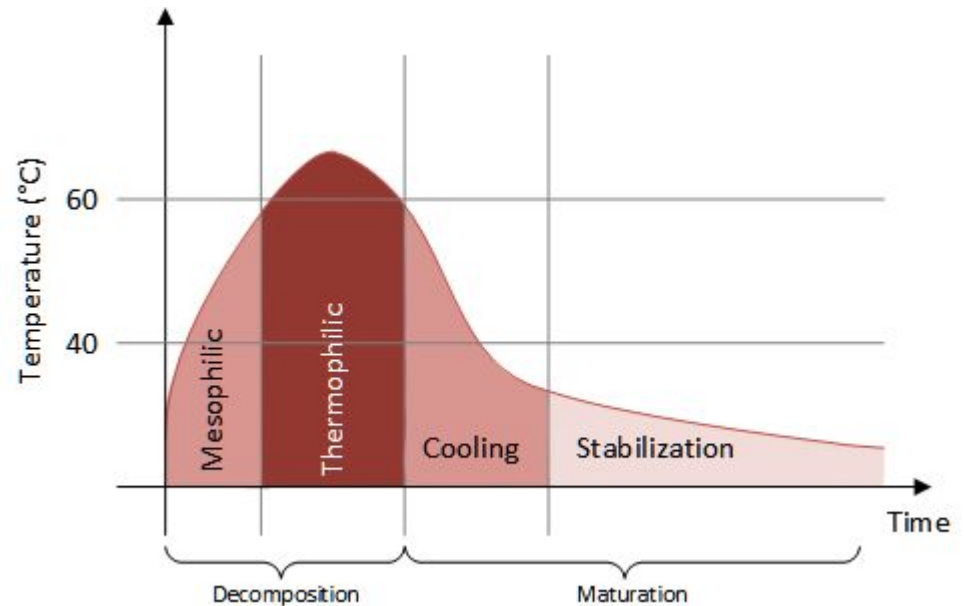
Accumulate enough organic material to fill the compost bin with shredded/chopped pieces (50% greens, 50% browns)

Day 1: Build the Compost Pile

- Chop or shred the organic material into pieces 1" – 3", or smaller.
- Layer 50% greens & 50% browns, 3" deep layers.
- Add water as pile grows. Make it "as wet as a wrung out sponge" -- not dripping wet, not dry.
- Leave air pockets to provide oxygen.
- Completely fill the bin. Hot composting needs a minimum size of 1 cubic yard (3' x 3' x 3' = 27 cubic feet).

Maintaining a Hot Composting Pile

- **Days 3 – 14:**
Monitor & Turn Often
Thermophilic Range,
140°F-150°F ideal
- **Days 15 – 30:**
Monitor & Turn
Thermophilic - Mesophilic
Range
100°F-140°F ideal
- **Days 31 – 60: Monitor & Turn Occasionally**
Mesophilic Range, 70°F – 90°F ideal
- **Days 61 – 90 or longer: Complete the Process**
Psychrophilic Range, 50°F – 70°F ideal



Maintaining a Hot Composting Pile

Days 3 – 14: Thermophilic Range

Check temperature in several locations. The ideal temperature is 140°F-150°F uniformly throughout the pile. Avoid temperatures exceeding 160°F (creates ash which is low in nutrients).

Turn compost pile a minimum of once per week with a spade or fork, ideally every 2-3 days for the first 2 weeks. If turning is not possible, use an aeration tool to allow oxygen and water to enter the pile. While turning, look for dry spots, add water as needed. Make it as wet as a wrung out sponge -- not dripping wet, not dry.

Days 15 – 30: Thermophilic - Mesophilic Range

Check temperature of compost pile. The ideal temperature is 140°F-150°F at the beginning, then approximately 100°F towards the end of 30 days (uniformly throughout the pile). If it's not, check moisture and air levels.

Turn compost pile a minimum of once per week. While turning, look for dry spots, add water as needed.

Maintaining a Hot Composting Pile

Days 31 – 60: Mesophilic Range

Turn the compost pile every 2 - 3 weeks. If turning is not possible, use an aeration tool to allow oxygen and water to enter the pile. The temperature should be between 70°F – 100°F. Add water as needed. The pile will not be steaming, but still warm to the touch. Bugs and worms may join in to assist the decomposition process.

Days 61 – 90 or longer: Completing the Process (Psychrophilic Range)

Let the compost mature. The temperature should be approximately 50°F – 70°F (depends on the ambient temperature). Use an aeration tool to allow oxygen to enter the pile. Add water if needed (normally not needed).

Adapt the “recipe” to fit your backyard, materials on hand, time available and how the composting process is progressing. It’s like cooking or baking, each time you do it -- you can get a different result.

Troubleshooting a Hot Compost Pile

Why Won't My Pile Get Hot?

- Not enough volume
 - A small yard/garden generates about 1 - 3 cubic ft. of material per week (varies by season).
27 cubic ft. is needed to initiate a hot compost pile.
- Materials not chopped fine enough
 - Ideal size for raw materials is 0.5" – 1.5"
- Improper C:N ratio (25-30:1 is ideal)
 - Too much nitrogen: Pile quickly burns out, cools, and becomes soggy.
 - Too little nitrogen: Pile never heats up.
- Not enough water
 - A dry pile decays very slowly, if at all.
- Not enough oxygen
 - All the oxygen inside the pile has been used up by the rapid decomposition process. Turn the pile to aerate it.

Composting Tools



Pitch Fork,
Shovel,
Spade



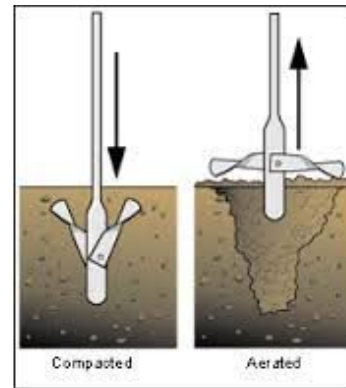
Compost
Thermometer



Shears, Pruners,
Chipper/shredder



Compost
Aerator



Harvesting Compost

- The pile is ready to harvest when:
 - Material has turned to a dark brown and original materials are no longer identifiable
 - The smell is mild and earthy
 - Little or no heat is being produced in a hot pile
- Screening can be used to remove large pieces that are not fully decomposed
 - Mainly needed for cold piles
 - It's easy to build your own screen



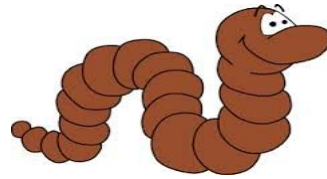
Using Compost

- Typical Applications:
 - Incorporate in soil prior to planting
 - Amend potting mixes
 - Mulch or “top dress” planted areas
 - Liquid extract or compost drench
 - Compost tea: Aerated liquid extract abundant in active bacteria and fungi
- Well-made compost is a nutrient-rich soil conditioner
- Benefits:
 - Improves soil structure by adding **organic matter** and **microorganisms**
 - Restores top soil
 - Inoculates soil with a wide variety of bacteria and fungi that feed the plants
 - Holds moisture
 - Saves money

Application

- Garden
 - ½ in. to 3 in. per year during spring
- Lawn
 - Work in to 6 in in depth
- Trees and Landscape
 - 1 to 2 in raked into topsoil





Vermicomposting a.k.a Worm Composting

Vermicomposting

Cultivating worms to eat our food and paper waste and produce the best “fertilizer” for our plants



Vermicomposting

- Worm composting is neat, easy, and odorless – when properly maintained
- A great way to recycle hard-to-dispose food waste and paper waste
- Can be done indoors, in garage, on the patio or porch, or in any moderate temperature place (50°F - 90°F)

Vermicomposting

- And...
the finished product, worm castings, is a nutrient-rich, organic “fertilizer” which can be used on plants both indoors and outdoors
- Reduces or eliminates the need for purchased fertilizer

Gardener’s Black Gold



Worms for Composting

- Thousands of worm species live in the soil, we find some in our gardens and compost piles
- Only a few species are feasible for vermicomposting, including the red wiggler, red tiger, and African nightcrawler.
 - Live in the uppermost layer of the soil that is rich in organic matter
- Best compost worm for our area is the *Red Wiggler, Eisenia fetida*

Bedding Material

- Shredded newsprint, brown packaging paper
- Shredded cardboard
- Shredded office and junk mail paper
 - Use sparingly, mix with shredded newsprint
- Coir (shredded coconut husk)
- No slick, shiny paper or plastic windows

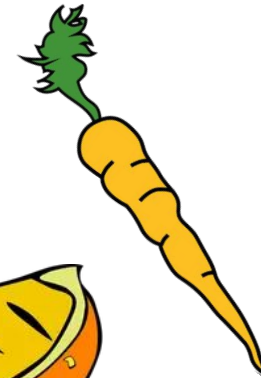


Worm Food

- Vegetable and fruit scraps
e.g., banana peel, apple core, lettuce, potato peel, carrot tops, etc.

Cut into small pieces, bruise/pierce hard skins to speed decomposition

- Pasta, cooked beans (minimize sauce/oil)
- Coffee grounds, including paper filters
- Tea leaves, tea bags
- Paper towels, napkins (food soiled)
- Egg cartons (paper mache)
- Human/pet hair!
- Egg shells (crushed) -
Worms need a small amount of grit!



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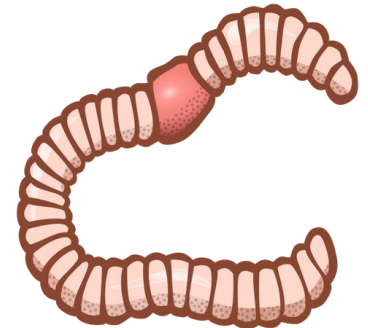
Agriculture and Natural Resources

What to Avoid

- No animal products - meats, bones, fish, etc.
- No dairy products - cheese, milk, yogurt, etc.
- No pet wastes (from carnivores)
- No oils or plastics
- Be careful with breads (for folks with mold allergies)
- Avoid seeds and nuts with hard hulls & shells – they break down slowly and may sprout later when conditions are right
- Avoid large amount of acidic or pungent produce, like citrus, ginger, onion, and garlic
- Yard clippings – may include herbicides, pesticides; branches & woody stems break down slowly

Egg shells
are okay!

Putting It All Together



Bedding + Moisture + Air + Food + Worms

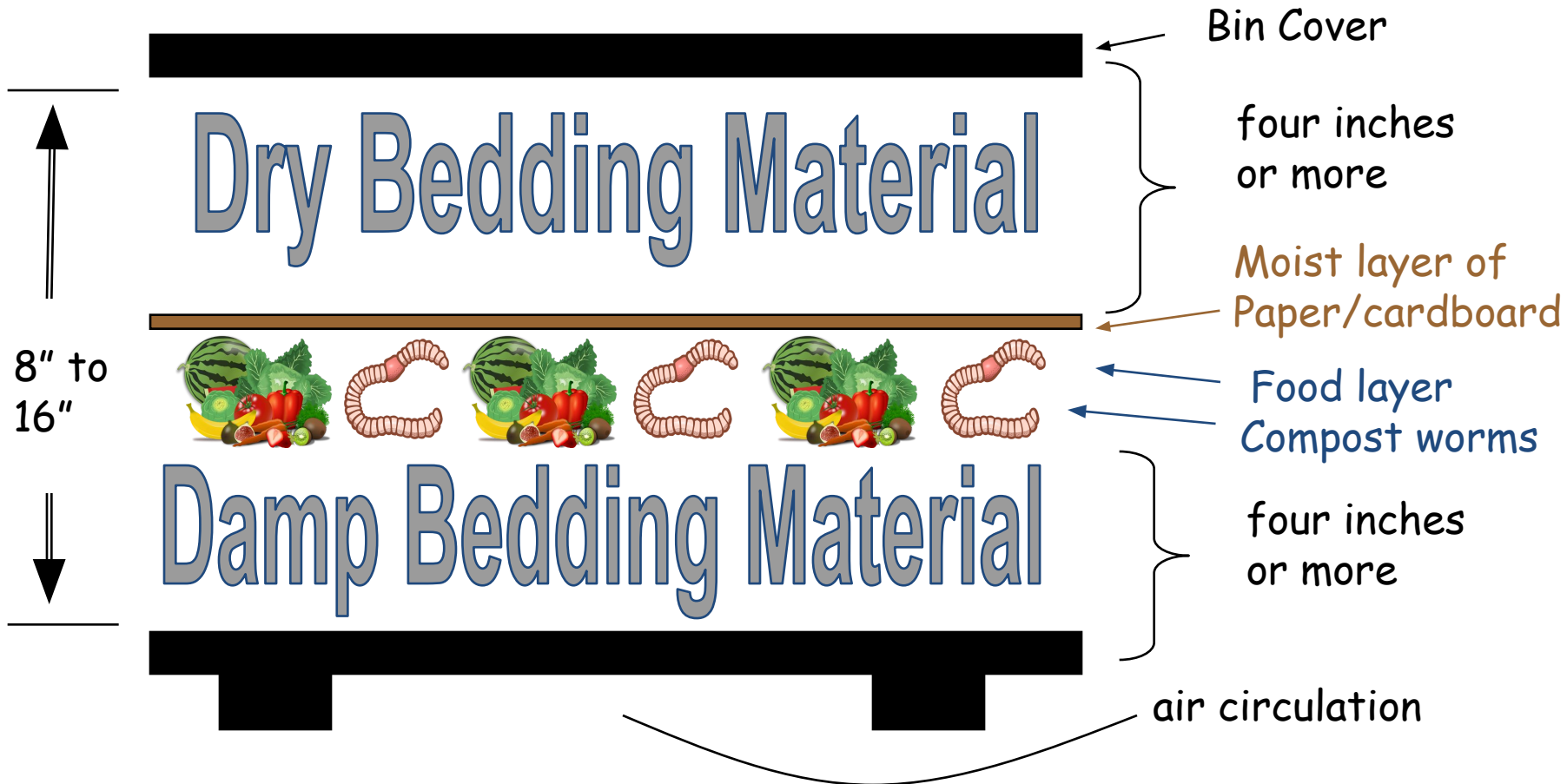
Q: How much water?

A: Keep bedding as damp as a wrung-out sponge
(moist, not dripping)

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Agriculture and Natural Resources

Inside a Worm Box



Where to Get Worms

Order worms for delivery!

Or ask a friend who has a worm bin for some extras!

Tips for starting a new worm bin:

- Set up the bin, add bedding & food
- If you can, wait 1 – 2 weeks before adding worms, so don't order your worms until the bin is set up
- The first tray or bin section will be ready to harvest in 6 months, then every 3 months thereafter

*Worms are safe to ship in mild temperatures



Sources for local worms



Where to Keep the Worm Bin

- Temperature range: 55°F - 80°F
- Temperature tolerance depends on moisture level and location of bin



Worms need:

- Plenty of air circulation
- Shade during summer, especially if a dark plastic bin is being used
- A sunny spot during winter, e.g., against stucco wall of house with southeast exposure



Maintaining Your Worm Bin

- **Check weekly** (more often if temperatures are very low or very high)
- Move to a different location if needed
- Add food if previous batch is being eaten (disappearing)
- Don't over-feed! Remove food if there's too much (smelly)
- If bedding is dry, sprinkle/spray with water
- If bin is too moist, add dry bedding & mix in to absorb
- Add moist bedding if bedding layer is thin
- Sprinkle a small amount of grit every month or so

Harvesting Worm Castings



Several methods:

- Horizontal migration
- Vertical migration
- Worm filter
- Tarp & sunlight

Use the one that works best for you!

Harvest when most of the bedding materials have become dark castings

Slow harvesting allows cocoons to hatch, baby worms to migrate

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Agriculture and Natural Resources 58

Using Worm Compost

- Slow-Release Nutrient-Rich Amendment
 - Use it instead of fish emulsion on bedding plants in greenhouse
 - Spread around potted plants
 - Spread around vegetables or flowering plants in the garden
 - Can be sifted onto lawns
 - Incorporate into soil around shrubs and trees
- Can be incorporated into a planting soil mix
- Preferred ingredient for brewing compost tea



Troubleshooting a Worm Bin

Worms Die

- Worm box overheated (more than 100°F) common with plastic bins
- Keep worm bin in shady area
- Add a few ice cubes for quick cooling
- Consider using a wood worm bin if adequate shade can't be found
- Bedding material has dried out
- Check moisture when feeding, add extra water on hot, dry days
- No food scraps have been added for long period of time (weeks/months)
- Don't be mean to your pets, feed them as required!

Fruit Flies in Worm Bin

- Food scraps not adequately covered
- Add four or more inches of dry or slightly moist shredded paper over food scrap layer
- Set a bowl of vinegar in the bin on top of the shredded paper
- Fruit flies already present in food scraps before adding to bin
- Store food scraps in covered container or freezer before adding to the worm bin

Thank You

UCCE Composting Education Program

Rotline: (408) 918-4640

Website: www.ucanr.edu/compost

