The Wonderful World of Compost

Iowa Waste Reduction Center
IWRC
University of Northern Iowa

UNI / University of Northern Iowa

What is composting?

Composting is an aerobic, biological process that mimics natural mechanisms in a controlled setting, using microorganisms to recycle nutrients in a closed loop system.

Benefits of Composting

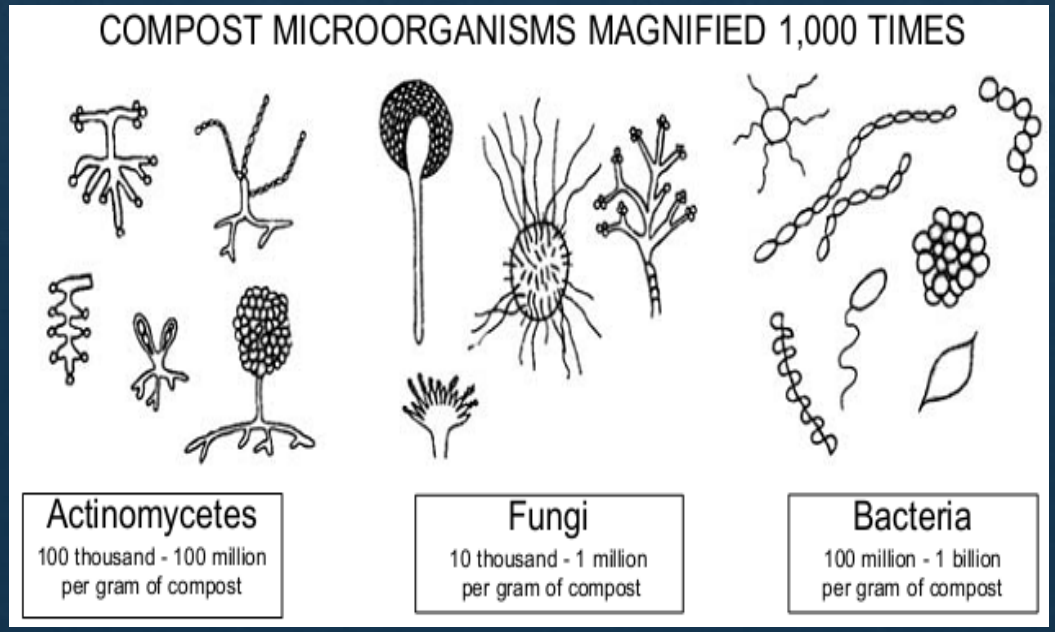
- **Rebuilds** healthy soil structure
- **Diverts** food waste
- **Transforms** 'waste' into a valuable soil amendment
- **Reduces** methane emissions
- **Sequesters** carbon
- **Lowers** costs of conservation, restoration & public works projects
- **Improves** water quality & stormwater management
- **Conserves** water & retains moisture
- **Increases** the number of beneficial microorganisms
- **Helps** plant growth & root development
- **Reduces** the use of chemical fertilizers

The Composting Process

- **Biological** – Directed by microorganisms
- **Organic Material** – Inputs of feedstock & bulking agents
- **Decomposition** – Controlled, managed, & accelerated
- **Aerobic** – Utilizes microorganisms that require oxygen
- **Meso- & Thermophilic** – Reduces pathogens & weed seeds
- **Curing** – Stabilizes carbon & creates a finished compost

The Microbes of Compost

- Bacteria – Smallest living organism
- Actinomycetes – Bacteria with a filament structure
- Fungi – Molds, yeasts, & mushrooms



Bacteria

- Make up to **80-90%** of a compost pile's biology
- About **100 million - 1 billion per gram** of compost
- Responsible for **heat generation & decomposition**

Bacteria in Leaf Compost

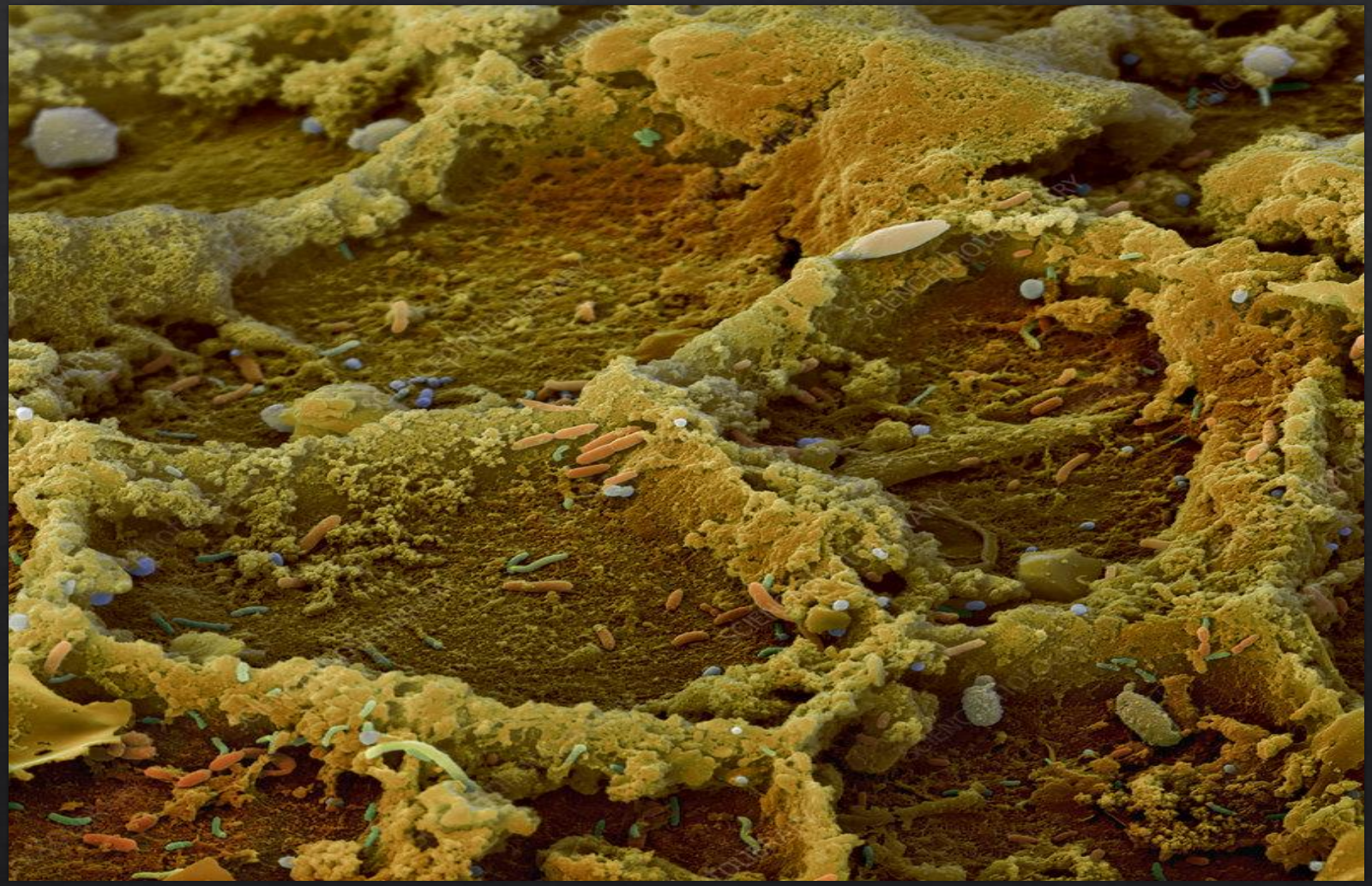


Image Credit: Science Photo Library

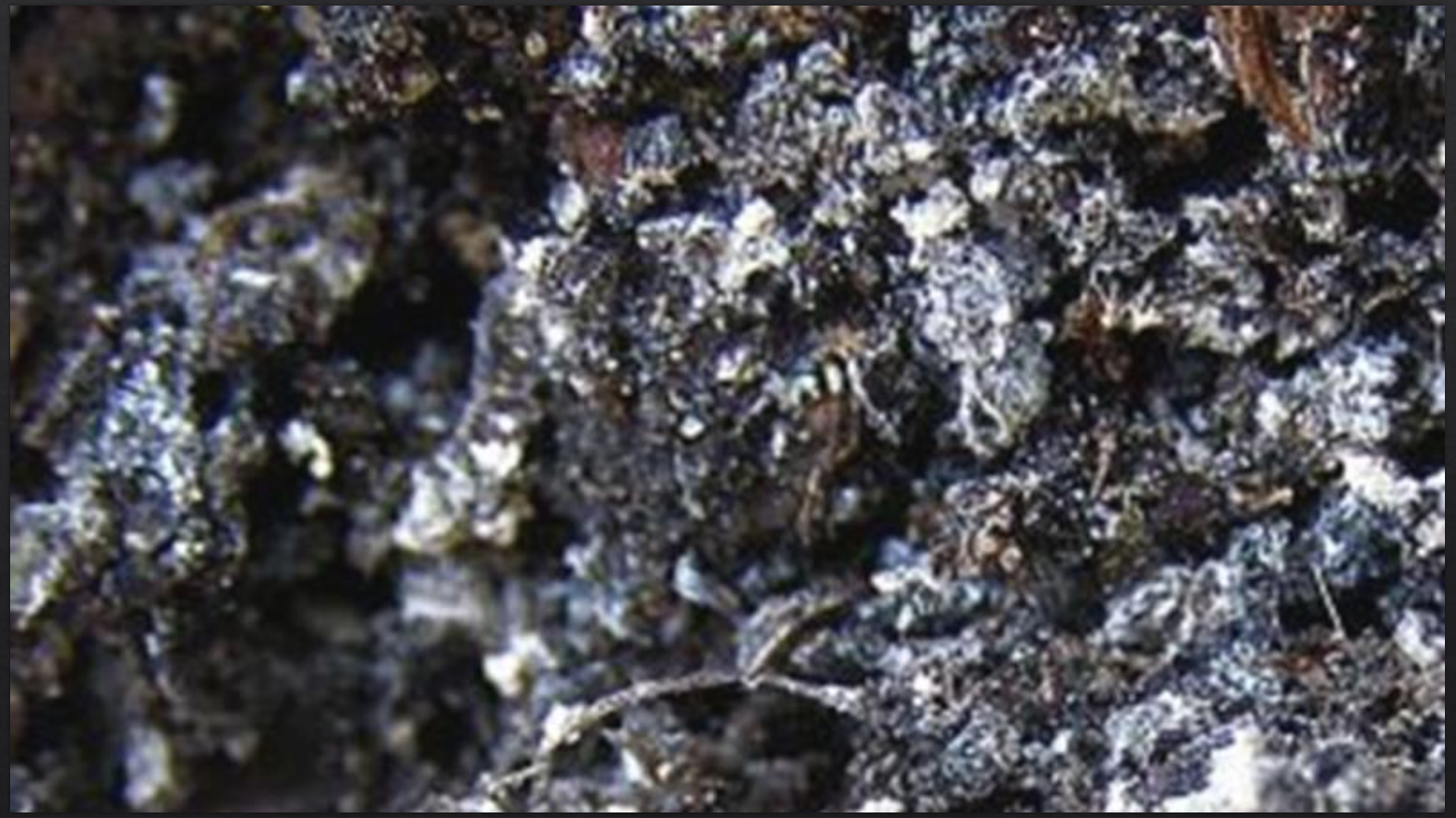
Actinomycetes

- Bacteria with filaments that look like fungal mycelium
- Appears like a gray or white 'cottony' structure
- Helps to breakdown cellulose, lignin, chitin & protein

~Like bark, woody stems & paper~

- Tolerates a wider range of pH than most bacteria
- Active in thermophilic phase, some in the curing phase

Actinomycetes



Fungi

- Molds, yeasts, & mushrooms
- Most prolific during the mesophilic phases & curing
- Tend to live on the outer surfaces of the compost
- Decomposes difficult organic material that can't readily be broken down by bacteria
- Fungi are great for carbon sequestration

Photo Credit: Reddit Mycology Forum, /mycology

Microbes Eat Organic Material

Deriving Nutrients & Energy

Create Organic Matter

Become Part of the Compost

The Other Workers in Our Compost Pile

Level 1 Decomposers Eat Organic Material	Level 2 Decomposers Eat Level 1 Microbes	Level 3 Organisms Eat Level 2 Organisms

Key Components to a Good Compost Pile

- Organic Materials or Feedstocks
- Carbon to Nitrogen Ratio (C:N)
- Moisture
- Air
- Temperature
- Time

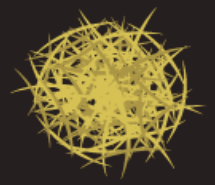
Organic Material / Feedstocks

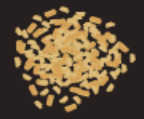
- The raw materials that make up your compost mix
- Diversity in type & size of feedstocks is good
- Always contains Carbon
- Contains varying amounts of Nitrogen, Phosphorous, Oxygen, Hydrogen, Calcium, etc.

Carbon & Nitrogen

Sources for Compost

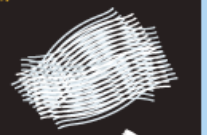
Carbon Materials







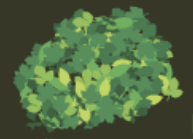



Aged Hay
Oat Hay
Cardboard
Dry, Shredded Leaves
Sawdust
Chipped Wood
Newspaper
Cardboard Egg Cartons
Wrapping Paper
Paper Towels
Straw
Toilet Paper Rolls
Wood Ash (not coal)
Dried Grass
Shredded Paper
100% Cotton Fabrics (small pieces)

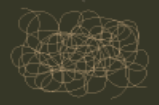
Nitrogen Materials









Vegetable Trimmings
Algae
Green Leaves
Grass Clippings
Kelp or Seaweed
Green Shrub Prunings
Tea Bags
Alfalfa Meal/Hay
Coffee Grounds/Filter
Animal Manure (herbivores only)
Houseplants
Weeds (without seed heads)
Old Flower Bouquets
Human/Animal Hair
Aquarium Water (freshwater only)

Image Credit: https://www.fix.com/blog/how-to-start-a-compost-pile/

30:1

Carbon : Nitrogen

Considered the ideal overall balance of nutrients

All organic material has its own unique C:N ratio

$$\frac{(\text{Carbon Value Feedstock A} \times \text{Weight of Feedstock A}) + (\text{Carbon Value Feedstock B} \times \text{Weight of Feedstock B})}{\text{Weight of Feedstock A} + \text{Weight of Feedstock B}}$$

Wood chips (A)	[C:N = 400:1]	50 lbs.
Food Waste (B)	[C:N = 20:1]	2000 lbs.

$$\frac{(400 \times 50) + (20 \times 2000)}{50 + 2000}$$

$$\frac{20{,}000 + 40000}{2050}$$

C:N = 29:1

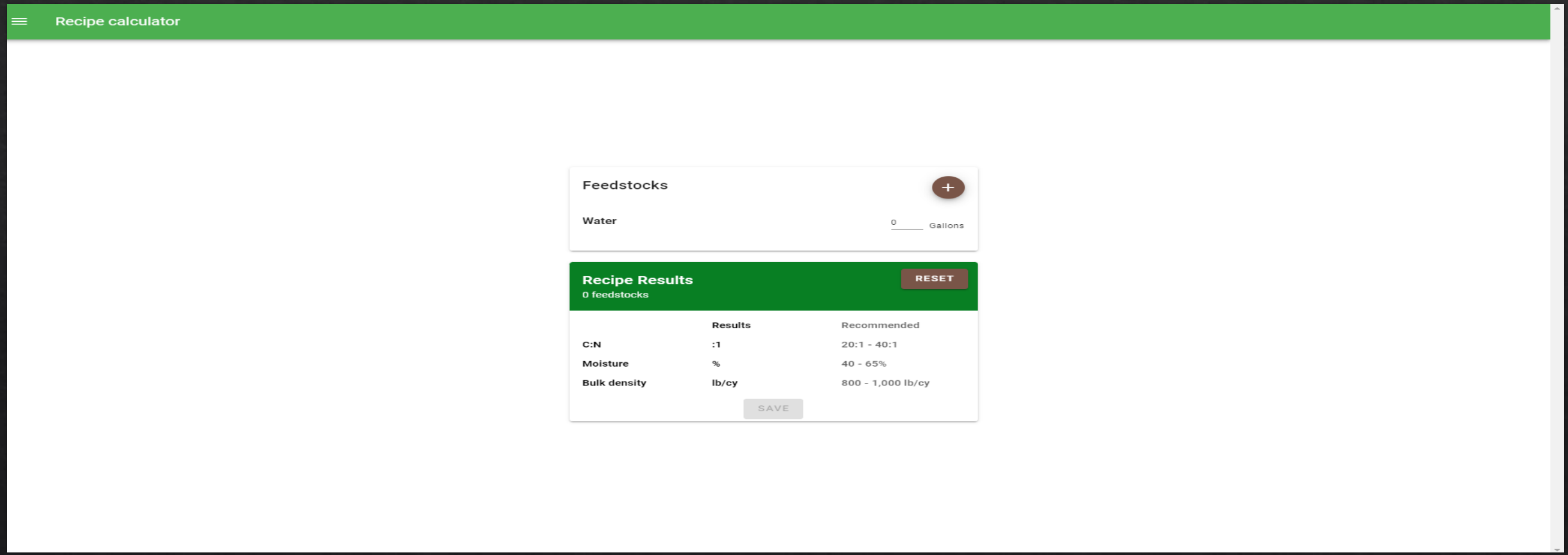
Estimated Carbon to Nitrogen Ratios

Browns / High in Carbon	
Leaves	60:1
Corn Stalks	75:1
Straw	75:1
Pine Needles	80:1
Office Paper	129:1
Newspaper (shredded)	175:1
Sawdust	325:1
Wood Chips	400:1
Twigs	500:1
Corrugated Cardboard	600:1

Greens / High in Nitrogen	
Hair/Fur	10:1
Manures	15:1
Seaweed	19:1
Food Waste	20:1
Grass Clippings	20:1
Coffee Grounds	20:1
Vegetable Scraps	25:1
Clean Wood Ash	25:1
Finished Compost	25-30:1
Fruit Waste	35:1

The Compost Calculator

https://app.compostcalc.com/calculator



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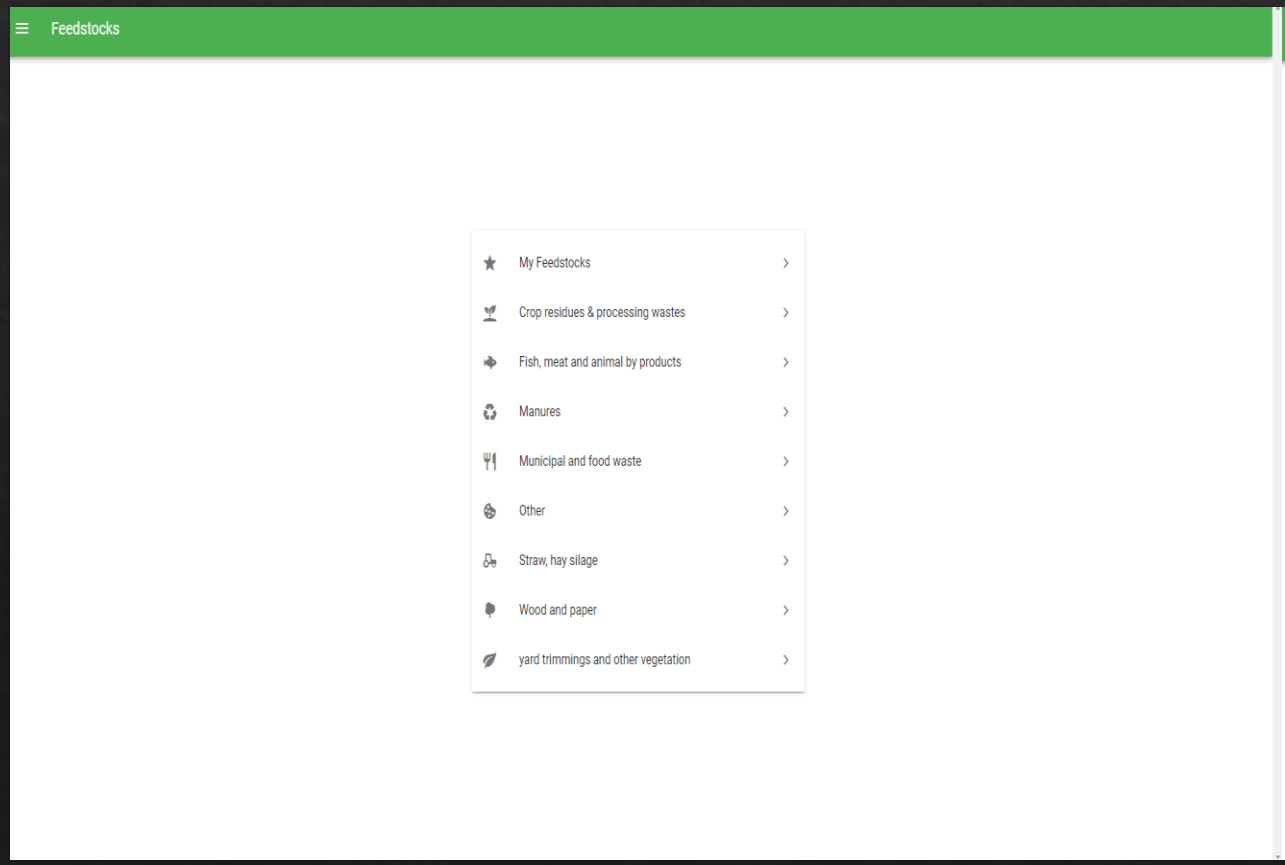
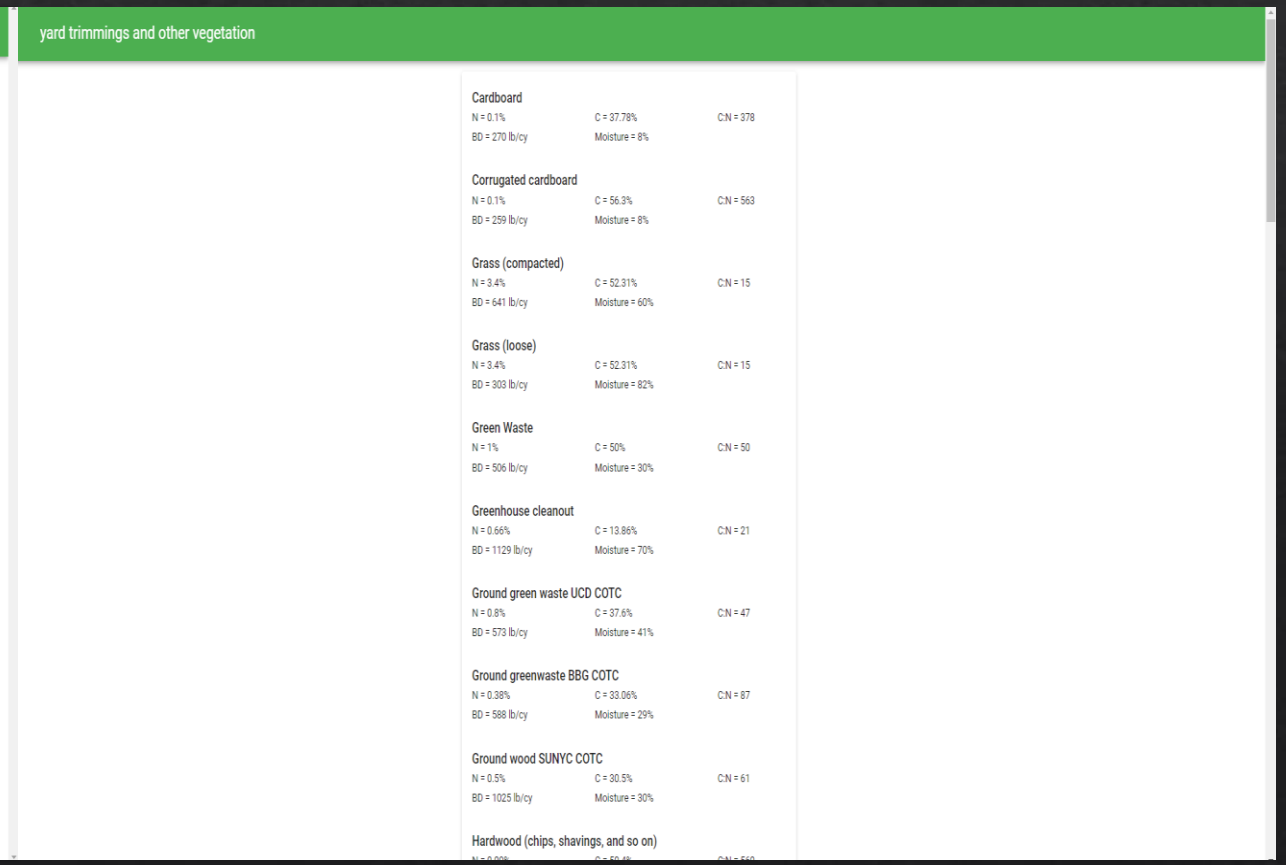




Moisture

40% - 60%

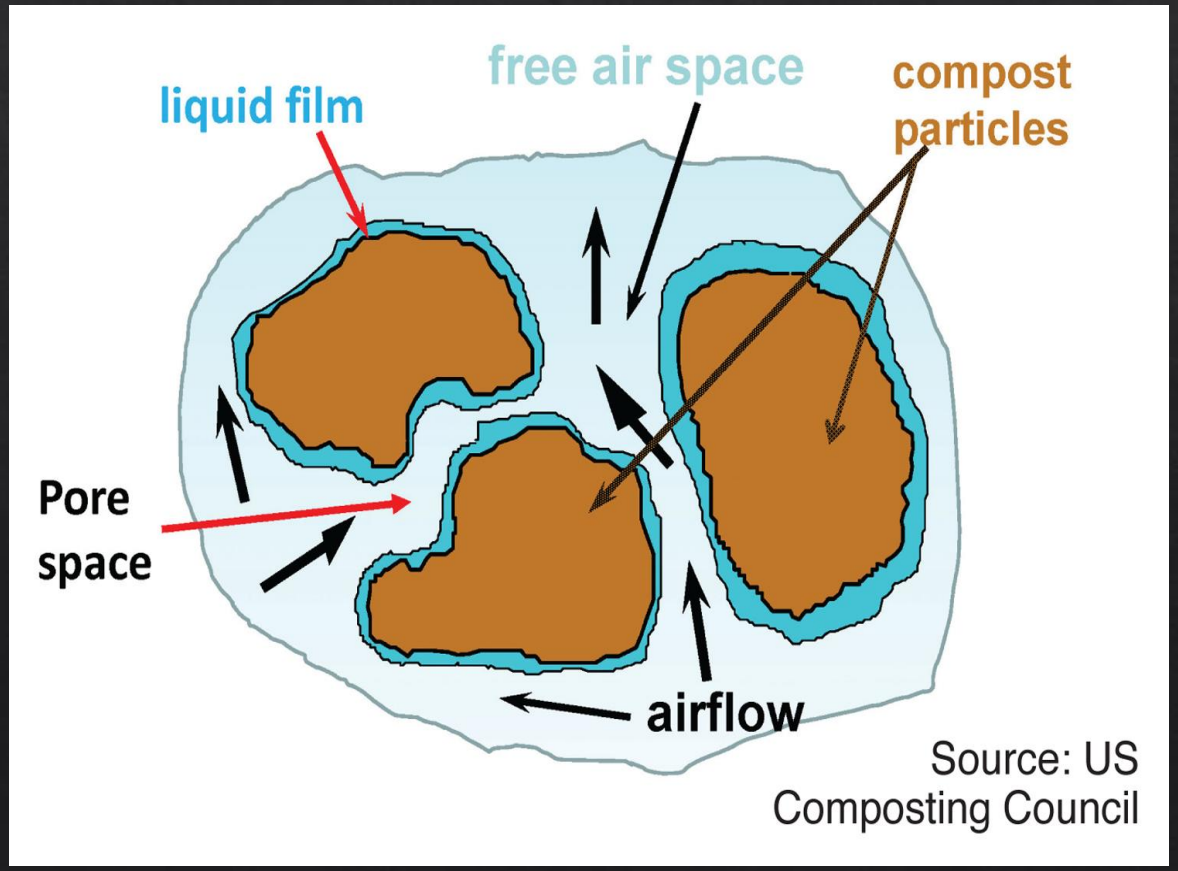
- Less will slow microbial activity
- More can cause anaerobic conditions & odors
- Easy Hand Squeeze Test

Air

Pile Structure & Porosity

Bulk Density
- Measurement of compaction

Free Air Space
- Available pore spaces where air flow can keep your microbes alive



Temperature

131˚F (55˚C)

- 131 ˚F for 1-2 weeks will kill most pathogens & weeds
- Temps +160 ˚F can cause decreased microbial activity & diversity
- Can reduce temps by adding a bulking material or turning
- Lowering temps can indicate compost is maturing

Temperature

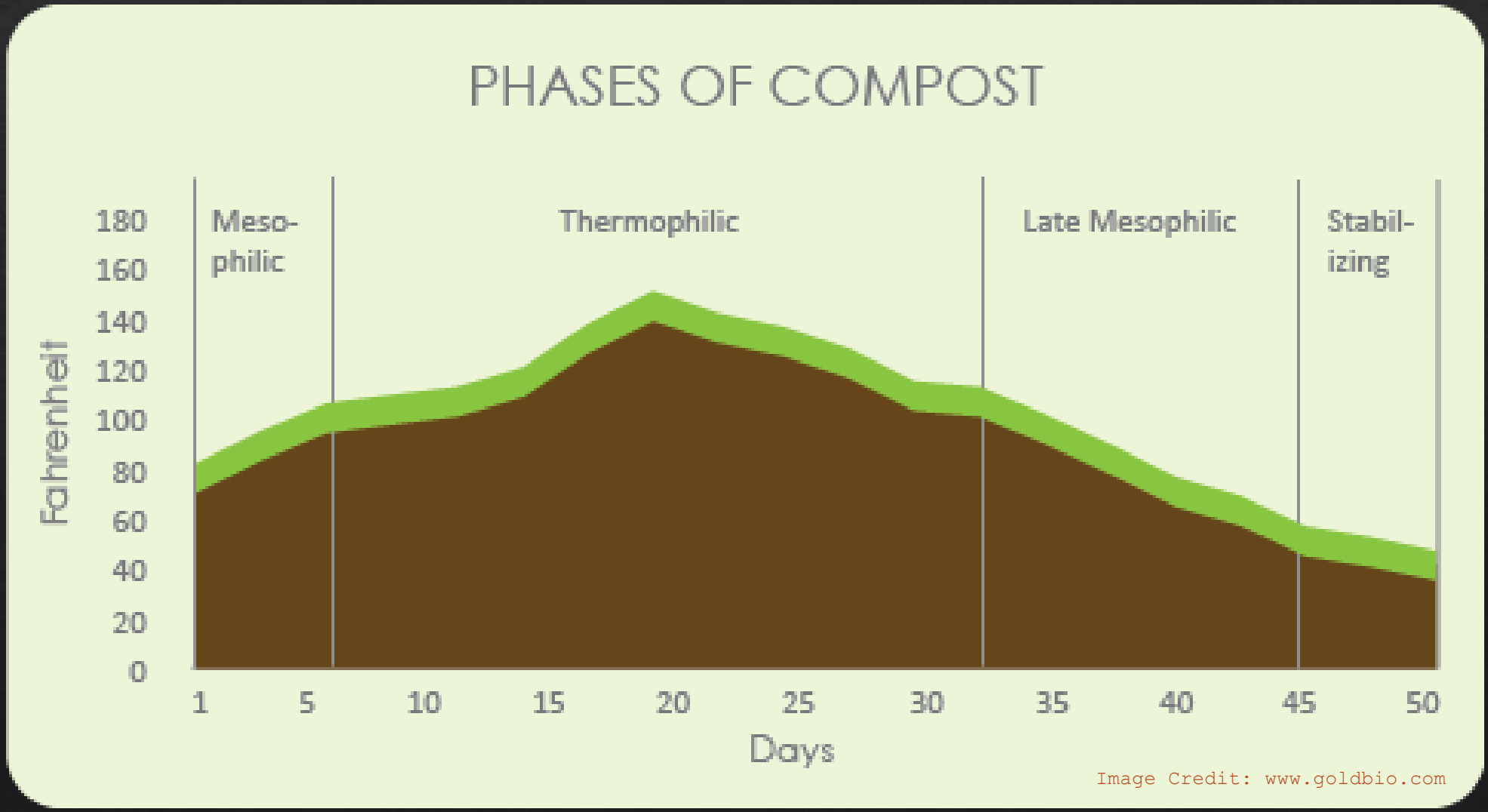


Image Credit: www.goldbio.com

Time

3 – 9 months

- Can take weeks to years
- Depends on variables
  - Intended use
  - Feedstocks
  - Pile Management
    - -Environmental conditions
    - -Attention & turning
    - -Aeration & temp control

Summary

- Carbon to Nitrogen 25-30:1
- Moisture 40% - 60%
- Bulk Density 800 -1200lbs/cy
- Free Air Space 50%
- Temperature 135 - 165 °F
- Time 3 - 9 months

Compost Bins

Vermicompost

Photo Credit: North Carolina State University

What is Vermicomposting?

"Vermicomposting, or worm composting, is the decomposition & humification of organic waste via an ecosystem of microbes & earthworms."

-The Urban Worm Company, "The Ultimate Guide to Vermicomposting"

The Ecosystem of Vermiculture

- Worms! -7 suitable species of around 9000 known species*
- Bacteria - Smallest living organism
- Fungi - Molds, yeasts, & mushrooms
- Nematodes - Feed on bacteria & other microbes

*The Urban Worm Company, "The Ultimate Guide to Vermicomposting"

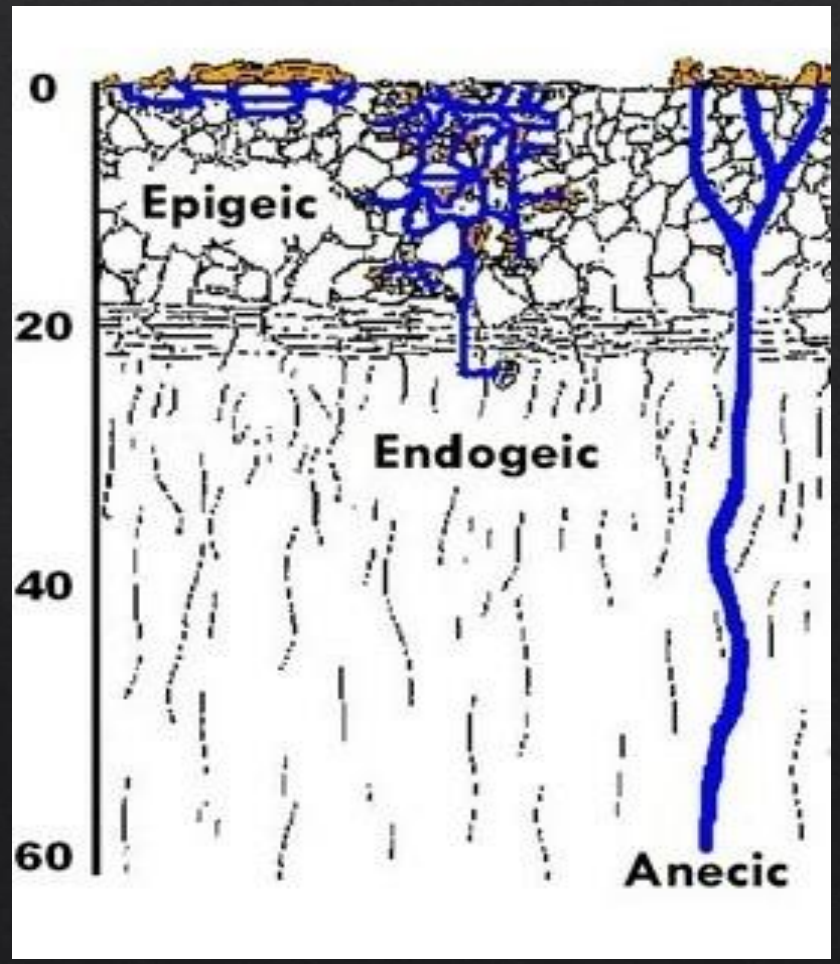
Benefits of Worm Composting

- **Rebuilds** healthy soil structure
- **Diverts** food waste
- **Transforms** 'waste' into a valuable soil amendment
- **Adds** in soil aggregation & porosity
- **Delivers** carbon back to depleted soils
- **Conserves** water & retains moisture
- **Increases** the number of beneficial organisms
- **Helps** plant growth & root development
- **Reduces** the use of chemical fertilizers

Edwards, Clive (ed.), et al., Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management, 2011.

The Composter

- **Epigeic** – lives in loosely-packed soil surfaces that are rich in organic matter
- **Endogeic**– lives in the first few inches of topsoil & burrows horizontally
- **Anecic** – deep-borrowing, known as "nightcrawlers", forages on the surface but retreats to deep burrows



Common Composting Worms

- **Red Wiggler (eisenia fetida)**
  - Most common composting worm
  - Tolerates a wide range of temps
  - Great for those starting out
- **European Nightcrawler (eisenia hortensis)**
  - Larger than the red wigglers
  - Slower reproduction
  - Prefers cooler temps
  - Lives deeper than red wigglers

Image Credit:
www.redwormcomposting.com

Getting Started

- Choose Your Worm Bin
- Select Your Worm Bedding
- Pick Your Worms

Worm Bins

- DYI Bucket or Bin
- Stackable Tray System
- Flow-Through or Continuous Flow Bag Systems

DIY Bin

- Easy to get started
- Easy to build
- Affordable
- 1-2 bins with lids, drill, & optional screen

Photo Credit: https://www.instructables.com/Make-Black-Gold-With-DIY-Worm-Compost-Bins/

Plastic Stackable Trays

- Easy to get started
- Not cheap compared to DIY
- 3+ trays with lid, includes a leachate spigot

Flow-Through Bags

- Great for handling more food waste
- Easy to maintain
- Cost is higher compared to others
- Flow-through system, finished worm compost comes out the bottom

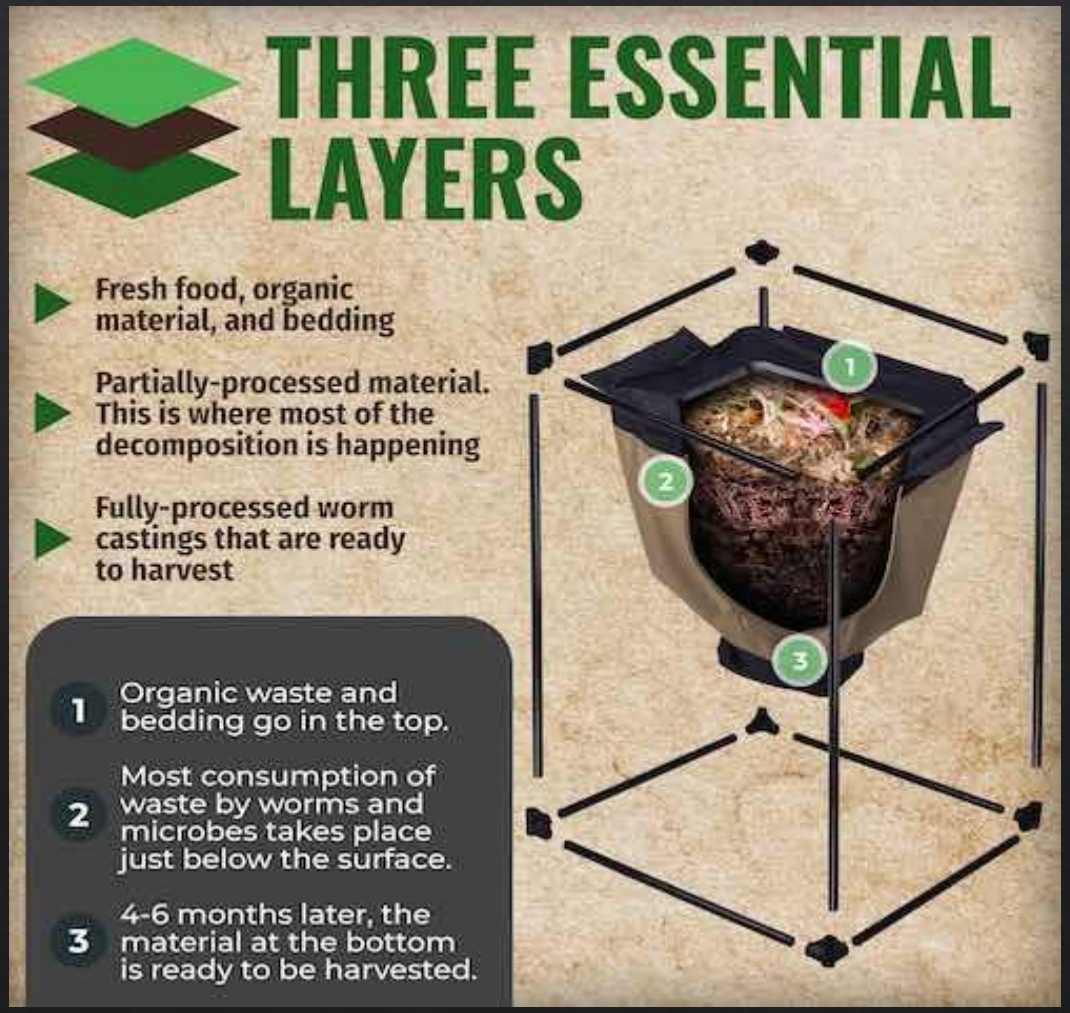


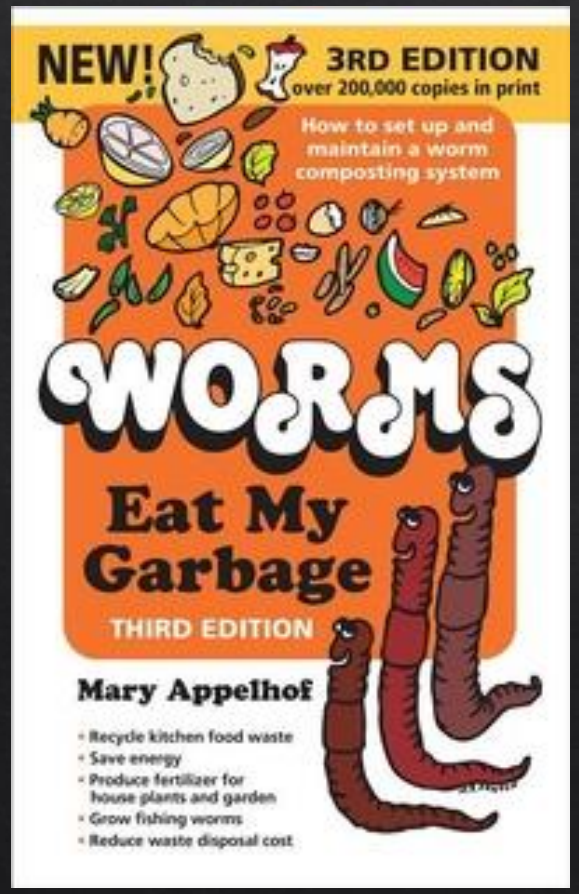
Image credit: www.IowaWormComposting.com

Worm Bedding

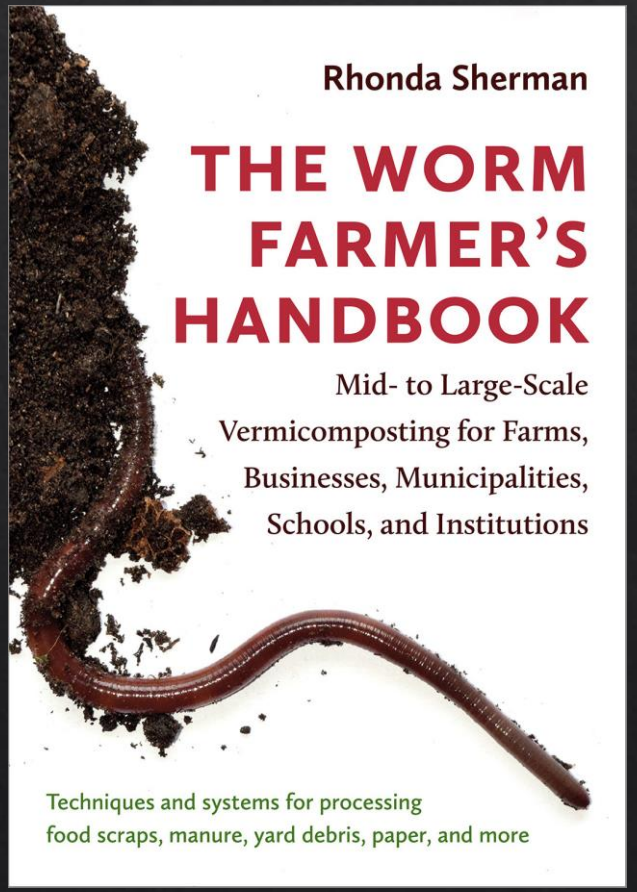
- Finished Compost
- Coco Coir
- Paper or Newsprint
- Straw
- Cardboard
- Leaf Litter & Other Yard Waste

Pick Your Worms!

Sources for worms, bedding, feed & instructional materials



- Iowa Worm Composting
  - www.IowaWormComposting.com
- Urban Worm Farm
  - www.UrbanWormCompany.com
- Meme's Worms
  - www.MemesWorms.com
- Uncle Jim's Worm Farm
  - www.UncleJimsWormFarm.com



Worm Care Basics

- **Temperature**
  55°F – 90°F (72 °F)
- **Moisture**
  60% - 70%
- **C:N Ratio**
  25:1 – 35:1
- **Feeding** (don't overfeed!)
  25% - 33% of worm weight/daily

Concluding Thoughts

- Food Waste Diversion
- Food Pantries & Pantry Gardens
- Rebuild Depleted Soils & the Soil Food Web
- Food System Resiliency
- Grow a Healthier Garden
- Conserves Water
- Reduces the Use of Chemical Fertilizers
- Reduces Our Ecological Footprint
- Builds Community Connections - Learn & Engage

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Thank You!

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