Fundamentals of Composting

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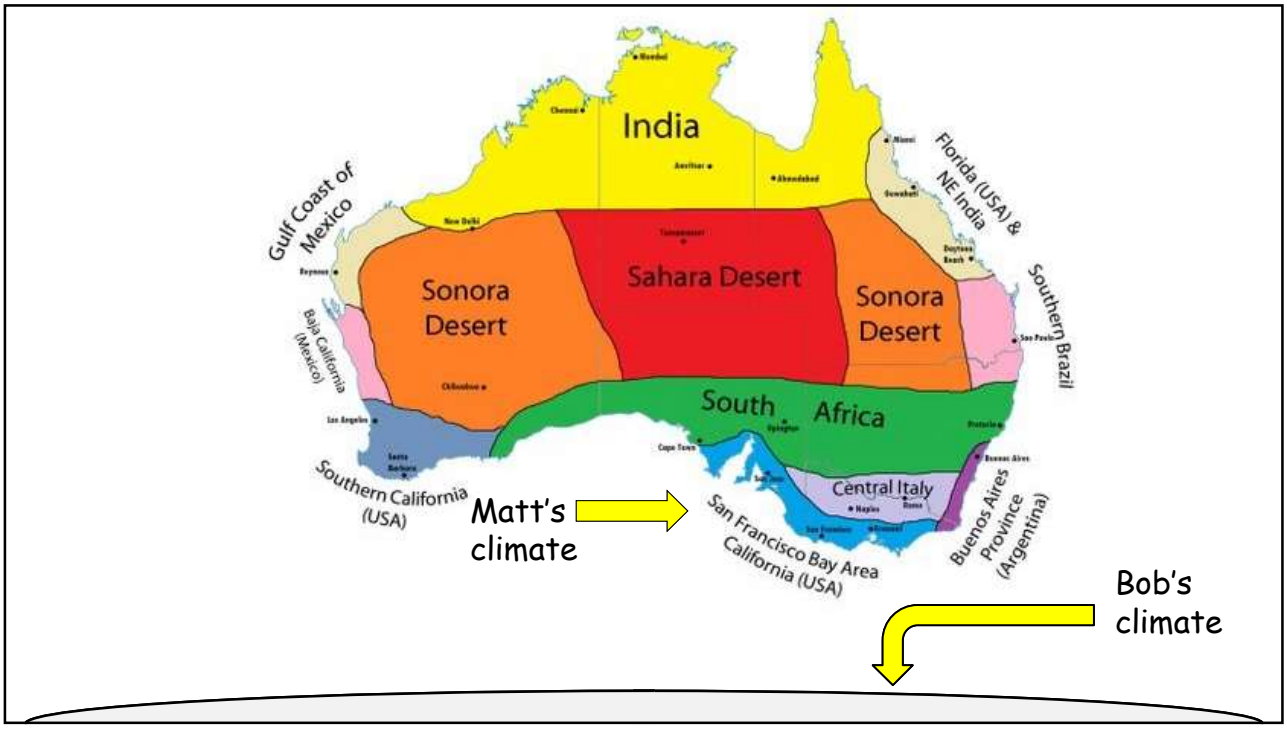

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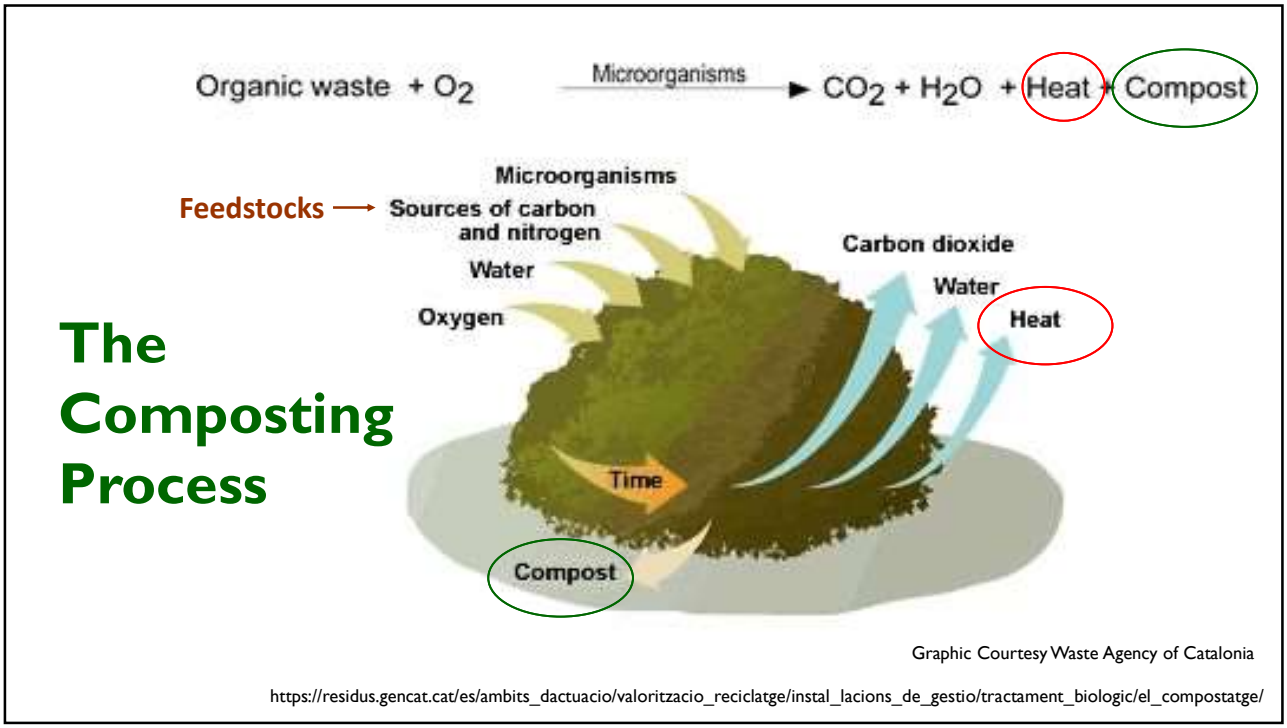

The Composting Process

Graphic Courtesy Waste Agency of Catalonia

https://residus.gencat.cat/es/ambits_dactuacio/valoritzacio_reciclatge/instal_lacions_de_gestio/tractament_biologic/el_compostatge/

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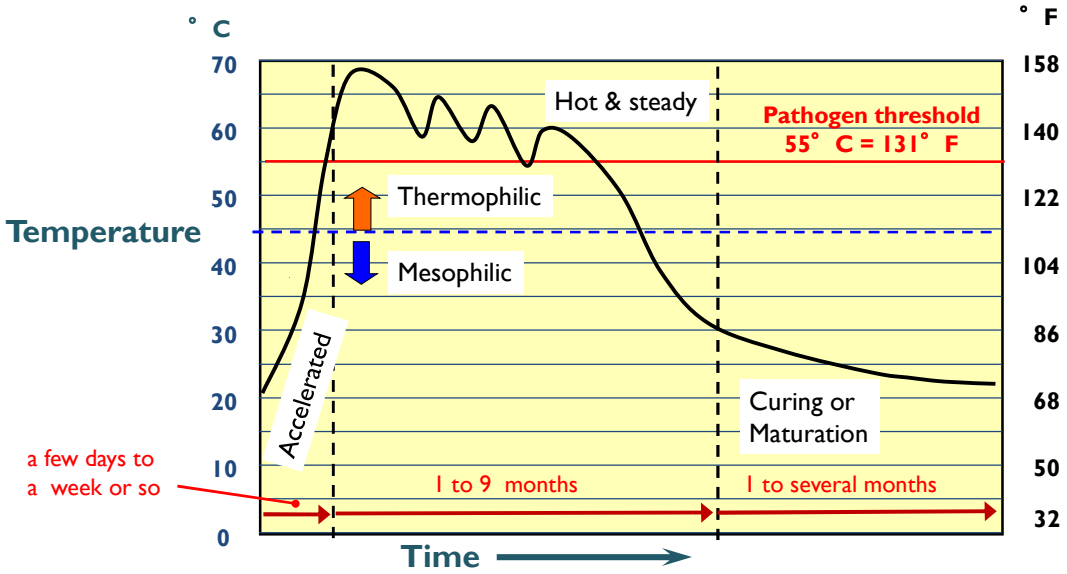
Phases of *typical* aerobic composting

A story of Temperature and Time



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The Key Factors

1. **Moisture**
2. **Oxygen (and aeration)**
3. **Pile "mechanics" – density, porosity, particle size, structure, and shape**
4. **Feedstocks and their mix**
5. **Temperature**
6. **Time**

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1. MOISTURE

Too dry!

Beef feedlot manure

Too wet!

Fish manure (from aquaculture)

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Moisture Range

Sweet spot

- 65%
  - Too wet
  - Wet, heavy, pores filled with water
- < 50%
  - A little dry
  - Process slows
- < 40%
  - Too dry
  - Process slows appreciably
- < 35%
  - Really dry
  - Process nearly stops, rewetting difficult

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Moisture – Squeeze Test

Just right! → 50 to 60% water by weight

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Managing Moisture

Composting generally consumes water

- Better to start on high end
- Adding water is difficult
- Need 200 liters to raise 1 tonne from 40% to 50%; need 500 liters to raise 1 tonne from 40% to 60%
- Can you get paid to take non-hazardous liquids?

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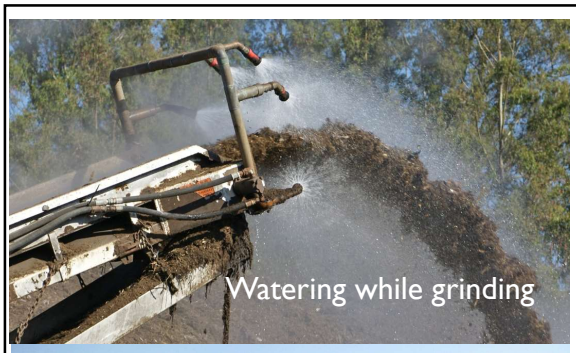

Photo source: Peter Hasen, J.H.P. Equipment

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Adding high moisture feedstocks For $$(AU)?

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2. OXYGEN (O_2)

- O_2 required for *aerobic* respiration
- O_2 easily exhausted by microbial organisms
- 5% O_2 considered the MINIMUM operational threshold
- Many suggest O_2 levels > 10% ; even > 16%
- Ambient air is 21% O_2
- O_2 is delivered via *AERATION*
- 2 modes of aeration → forced and passive

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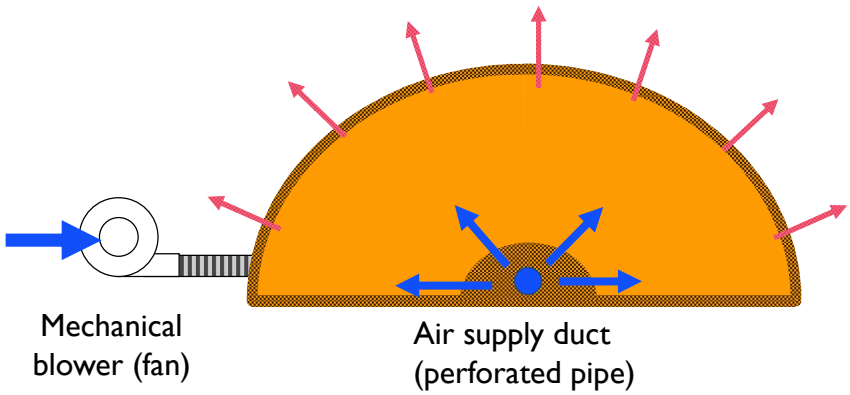
Forced Aeration -- Positive



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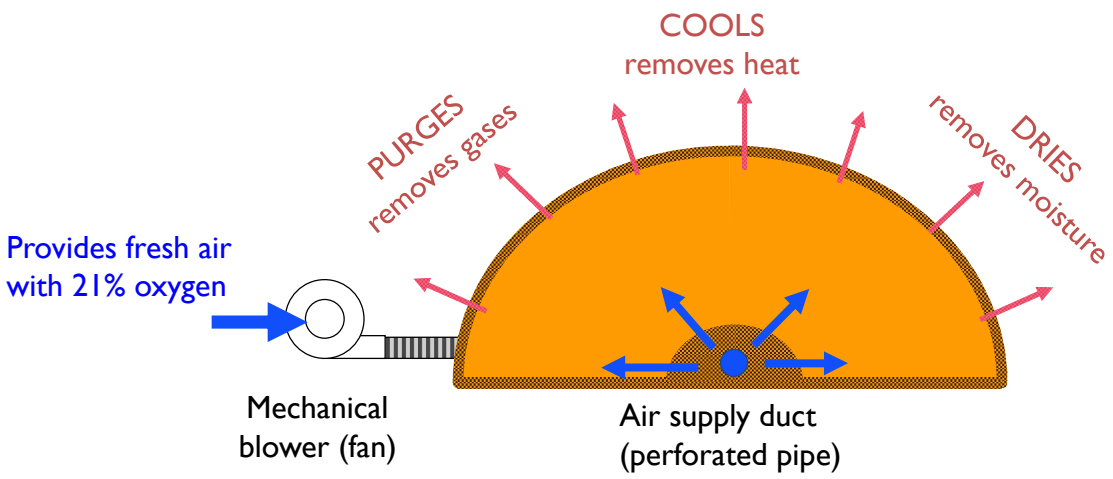
What does aeration do?



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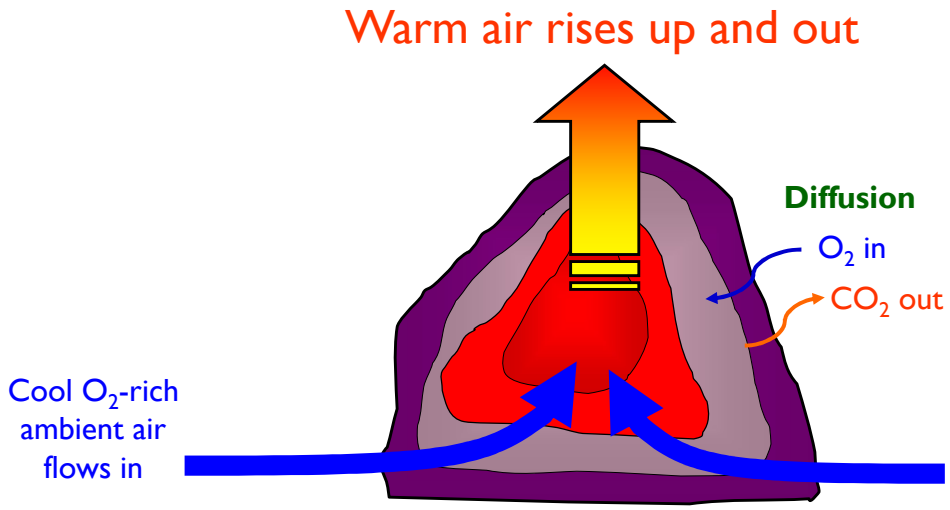
"Passive" Aeration



Adapted from slides by Rick Stehouwer, and Cary Oshins

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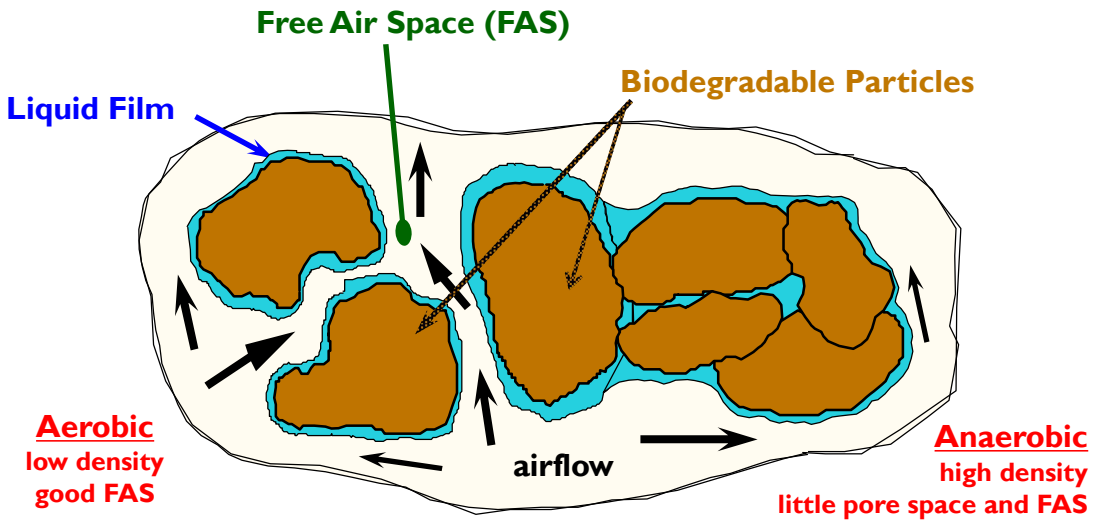
3. Pile Mechanics



Slides courtesy of Rick Stehouwer, Penn. State Univ.

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Bulk Density

Best single measure of pile mechanics

- < 400 kg per cubic meter
- Light and fluffy

- 400 – 600 kg per cubic meter
- About right

- 600 – 700 kg per cubic meter
- Dense, little pore space, challenge to aerate,

- > 700 kg per cubic meter
- Too dense, very difficult to aerate

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Measuring Bulk Density – *Easy Peasy*

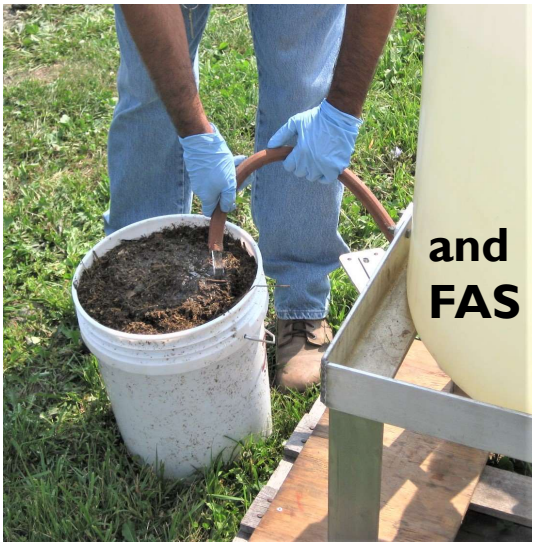

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Photo source: David Toal, Skala

Pile/windrow size depends on machine dimensions and capabilities

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4. FEEDSTOCKS

- Your raw materials, "ingredients"
- Where composting starts
- Greatly influence the process, and impacts (e.g. odors)
- Have the biggest impact on the characteristics of the finished compost (including contamination)
- A given feedstock may be composted alone or combined with others

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Feedstocks are Organic – once living

- Always contains Carbon
- Contains various amounts of other elements
  - Nitrogen
  - Phosphorous
  - Oxygen, Hydrogen
  - Sulfur
  - K, Mg, Cu, Cl, etc.

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Carbon to Nitrogen ratio (C:N)

- Ratio of total mass of carbon to total mass of nitrogen
- Reflects the overall balance of nutrients
- *General* gauge of feedstock balance, including nutrients AND moisture, bulk density, etc.

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C:N Ratio by the Numbers

>50:1
- Not enough N
- Process slower but almost no N loss

If you ask Bob, aim high (35-40)

30:1
- Considered ideal
- Manageable decomposition rate and N conservation
- Localized lack of N and excess N

Matt says: Too little C causes most problems, adding C solves many.

20:1
- Abundant N
- Rapid decomposition. Moderate loss of N

<20:1%
- Excess N
- Rapid decomposition. Much loss of N

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Sometimes feedstocks are adequately balanced

Mixed yard trimmings

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Sometimes not.

Too much N,
too wet,
and not enough structure

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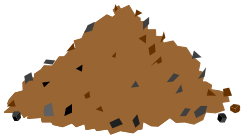
Mix ingredients together to create a better balance

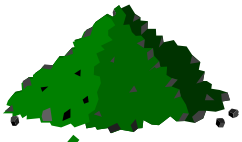
"Carbon"

About 3 or 4 volumes

"Nitrogen"

About 1 volume





Wood residuals
Low N
Dry
Bulky
"BROWNS"

Unbedded manure
High N
Wet
Dense
"GREENS"

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5. TEMPERATURE

- The "heartbeat" of composting
- Both *affects* and is *affected by* the process
- Higher temps result in faster breakdown, up to a certain point, (maybe 60˚C?)
- At temps > 70˚C, lose microbial diversity, composting slows
- Most weeds and pathogens killed at temps >55˚C
- Moisture moderates temperature fluctuation

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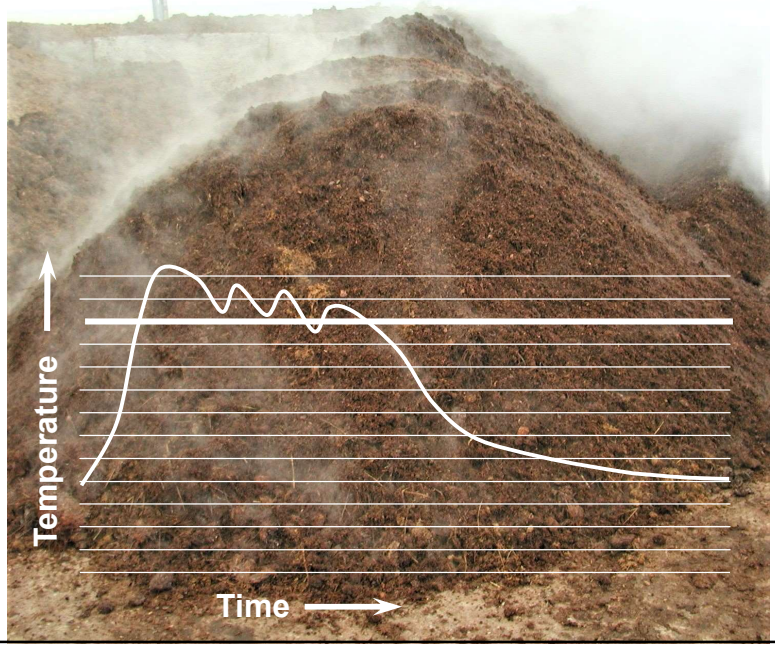
Temperature tells us what's goin' on inside



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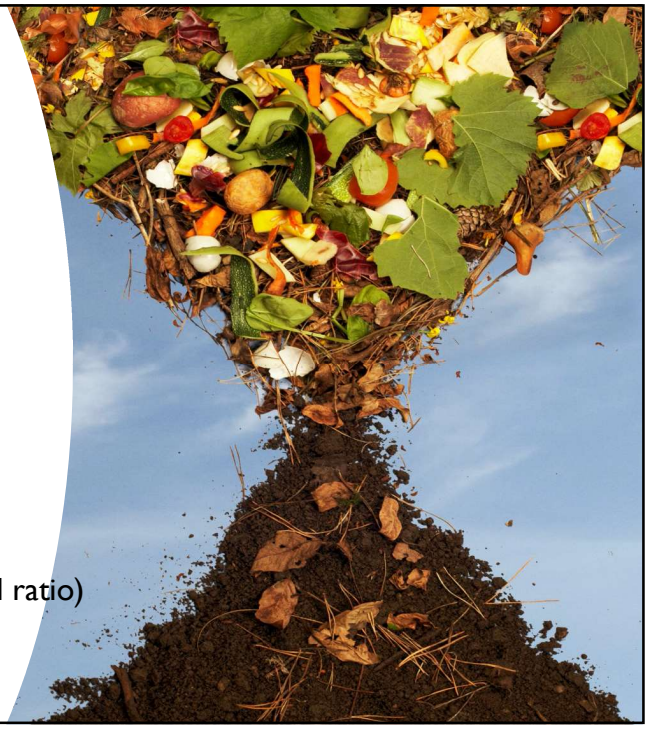
6. Composting takes TIME

How Much Time?

- 2 months to 2 years
- More typically 3 to 9 months
- Depends on:
  - Intended use
  - Feedstocks
  - Management Intensity
    - Conditions (e.g. moisture, temp., C:N ratio)
    - Attention (e.g. frequency of turnings)
    - Effectiveness of aeration



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Quick Tour of Composting Methods

Most common: turned windrows and aerated static piles

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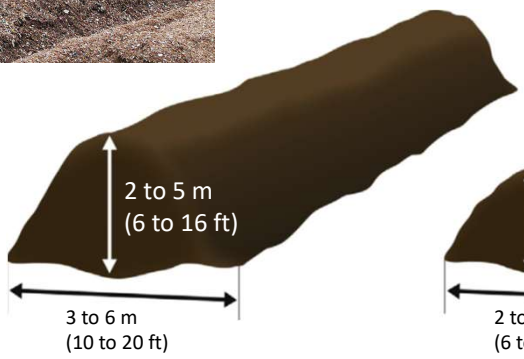
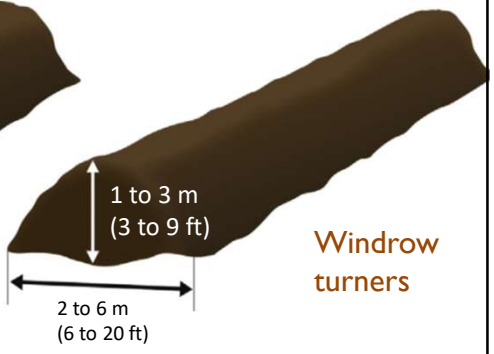
Photo source: Komptech

Typical windrows dimensions

They depend on the *specific* turning device

Bucket-loaders and excavators





Windrow turners

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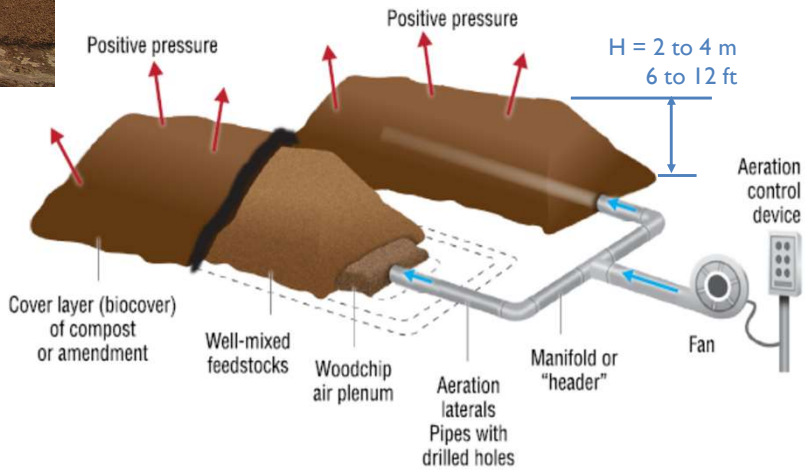
Fans, manifold and timer behind block wall

ASP Primary Features
Individual Piles



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Passively Aerated "Static" Piles
(e.g. turned once per month with a loader)

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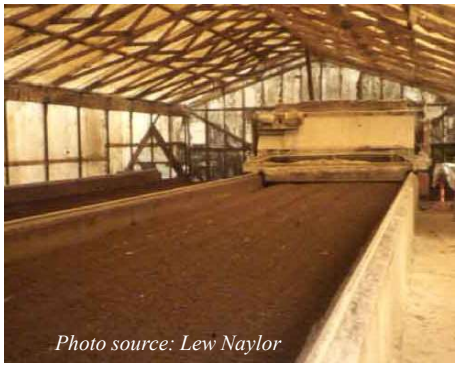
Agitated Bays
Used more for poultry manure



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In-Vessel Systems

Silos

Continuous flow

Photo source: Jonathan Purvis, Big Dutchman

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In-Vessel Systems

Aerated Tunnels

Batch operated

Photo source: Tim O'Neill, ECS

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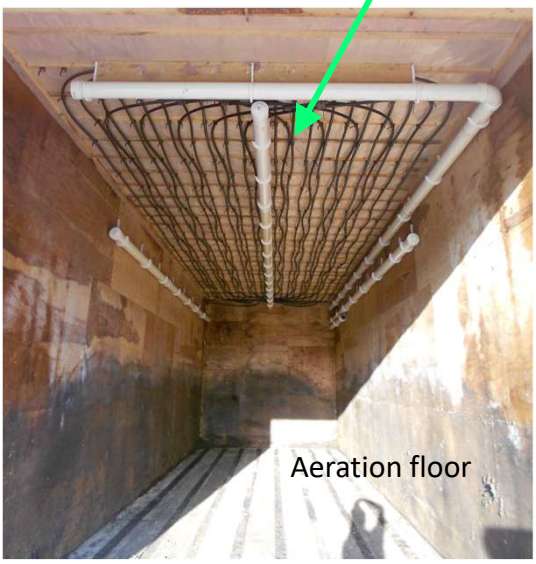
Farm-built aearted tunnel

Water pipes for heat recovery



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Remember: Composting is simple …

BUT, it needs attention and care.

Want to learn more?

Photo source: Bruce Fulford or Martin Van der Kamp.

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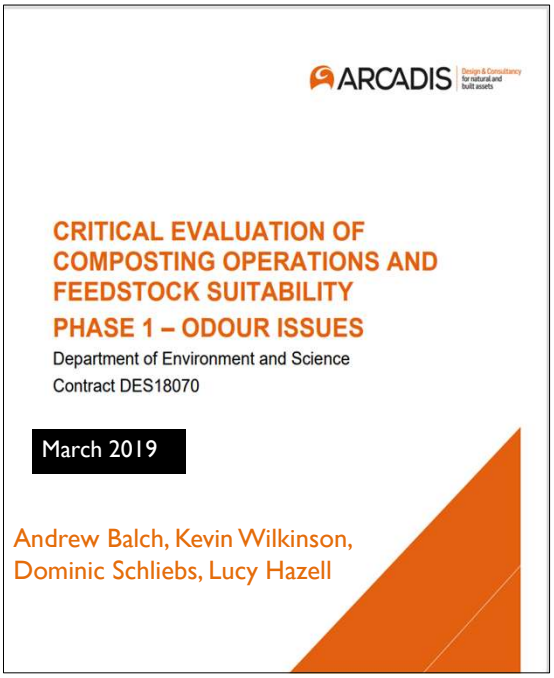
There is a lot of information available

For instance, check out this report from Queensland



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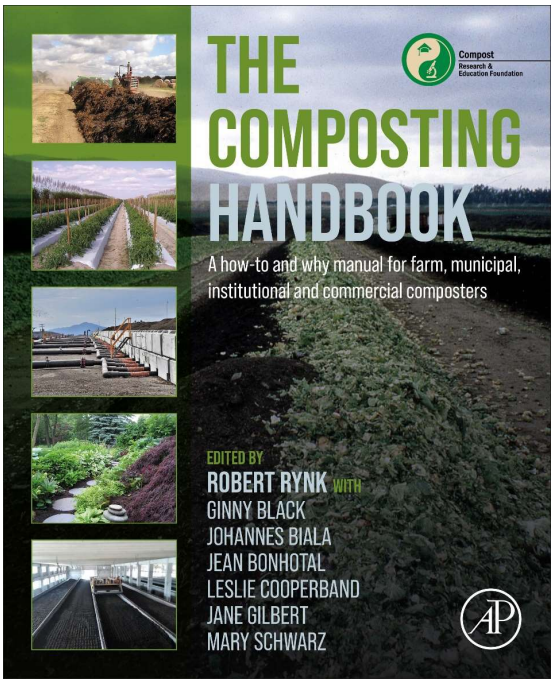
And then, of course, there's this:

Available from:

www.crown-compost.com.au



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