Lesson 7: Operations – Active Composting

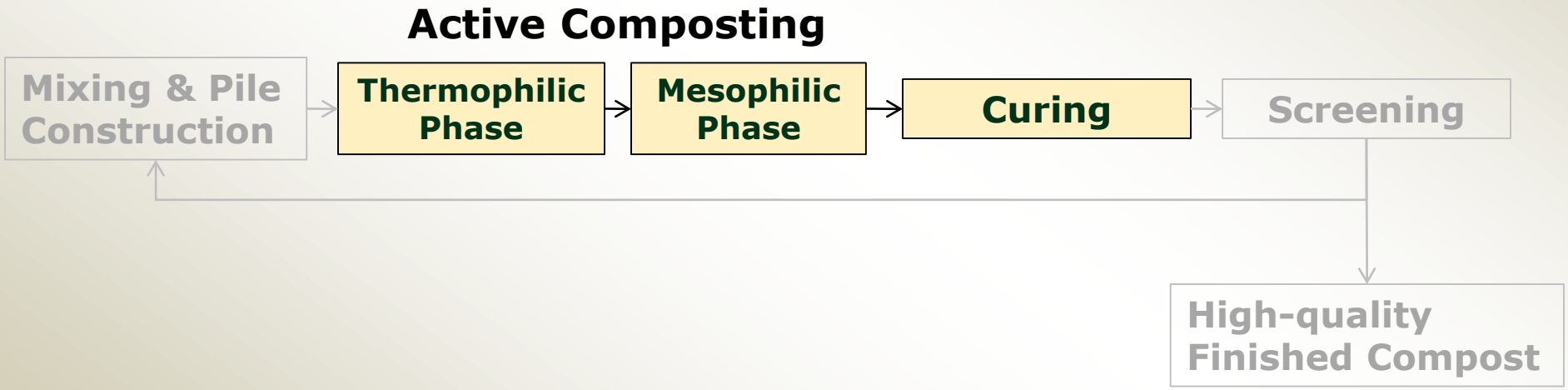
Learning Objectives:

- Know the three stages of composting and their function
- Understand proper compost monitoring procedures
- Be familiar with proper windrow management to optimize composting
- Be clear on how to diagnose and correct common problems

Three Stages of Composting Process

- Thermophilic (high temperature) composting
- Mesophilic (moderate temperature) composting
- Curing (stabilization and maturation)

Three Stages of Composting



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Thermophilic Composting

- Occurs at 35ºC - 65ºC (95ºF - 150ºF)
- Thermophilic bacteria do the work
- Most rapid and efficient composting method – organic materials decompose in several weeks to two months
- 55ºC (131ºF) is needed to destroy weed seeds, human and plant diseases and parasites
- Avoid temperatures above 65ºC (150ºF)

Mesophilic Composting

- Occurs at 20ºC - 35ºC (70ºF - 95ºF)
- Mesophilic bacteria, actinomycetes, fungi, earthworms & insects do the work
- Follows thermophilic stage and allows further decomposition
- Does not destroy weed seeds, diseases or parasites

Pathogen Reduction Requirement

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- Option 1:
  - Pathogens: Fecal coliform <1,000 MPN/gm Or Salmonella sp. <3 MPN/4gm

    and
  - Time, temperature & turnings regime

- Option 2:
  - Pathogens: Fecal coliform <1,000 MPN/gm Or Salmonella sp. <3 MPN/4gm, And Enteric virus <1 PFU/4gm, And Helminth ova <1/4gm

Time and Temperature Regimes

- Turned Windrow
  - 15 consecutive days with temperature ≥55°C with 5 turnings
- Aerated Static Pile
  - 3 days with temperature ≥55°C (insulated pile)
- In-vessel
  - 3 days with temperature ≥55°C

Controllable Variables

- Pile size and mechanics
- Temperature
- Aeration
- Moisture
- Porosity
- Residence time

Windrow Turning

- Do not compact windrows
- Move materials from surface to center of windrow and vice versa
- Thoroughly mix materials
- Turning subjects all materials to +55ºC temperature to kill pathogens and weed seeds

Photo source: FORCE Reedy Creek

Windrow Turning

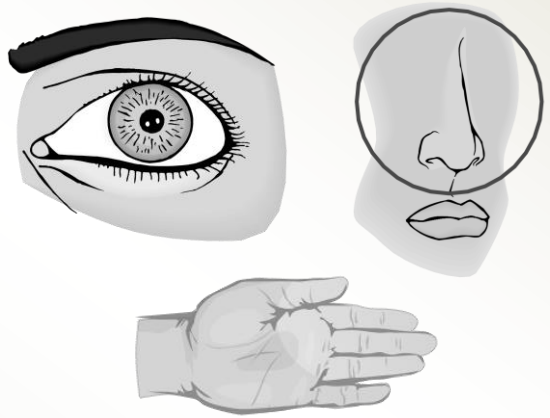
(continued)

- When turning with front end loader, lift material and let it cascade to maximize aeration and porosity
- Re-shape the windrow for consistent dimensions and smooth sides

Photo source: FORCE Reedy Creek

Compost Monitoring

- Observations of temperature, moisture, porosity, oxygen, odor, and ambient conditions are basis for maintaining optimum composting conditions
- Observations are the basis for decisions & actions:
  - Windrow turning
  - Moisture adjustment
  - Correcting problem
  - When composting is complete



Temperature Monitoring

- Overall indicator of other factors: moisture, oxygen, progress of biological process
- Measure temperatures at least 2x weekly at various depths (e.g., 1 & 3 ft) at least every 75 feet along the windrow

Photo source: FORCE Reedy Creek

Compost Thermometer

- 3 – 4 ft. long pointed steel stem
- Minimum 3/8 inch thick stem
- Measurement range from 0°C – 100°C (~30°F - 200°F)
- Calibration screw

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Moisture Monitoring

- Ideal moisture content for composting is 50% - 60%
- Use the “squeeze test” described in Lesson 6
- Moisture meters are also available however they require regular calibration

Photo source: biconet.com

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Moisture Analysis

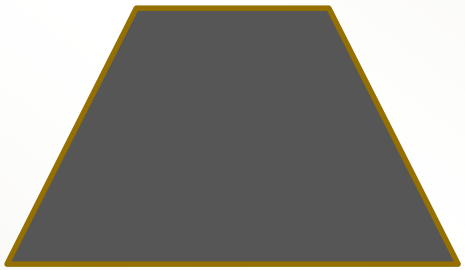
- One methodology to measure moisture content quantitatively:
  - Collect 100 g (3.5 ounces) sample of material and measure weight (wet weight)
  - Dry sample in a microwave oven (using short intervals and mixing) until weight difference is <1 g
  - Measure dry weight and calculate moisture content

Moisture Management

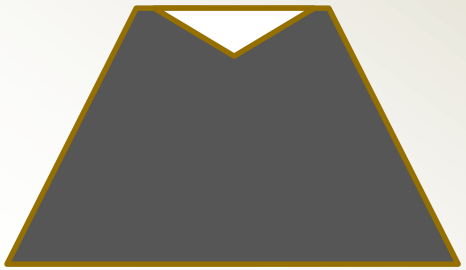
- If windrow is too dry:
  - Add water when turning and rebuilding
  - Moisten exterior before mixing into the core
  - Shape windrow to increase rain infiltration
- If windrow is too wet:
  - Turn it to release excess water vapor
  - Turn it on a dry sunny day
  - Mix in more dry carbon material when turning
  - Shape pile to minimize infiltration

Windrow Shapes to Control Rain Infiltration

Peak Shape
Sheds Water



Trapezoid Shape
Traps Some Water



Concave Shape
Traps Most Water

Oxygen and Pore Space Monitoring

- Oxygen level in active compost pile should be ≥5% (ambient O_2 = 21%)
- Oxygen meters are available
- Lab procedures exist to measure pore space
- Monitoring these can be beneficial but is not essential

Photo source: woodsend.org

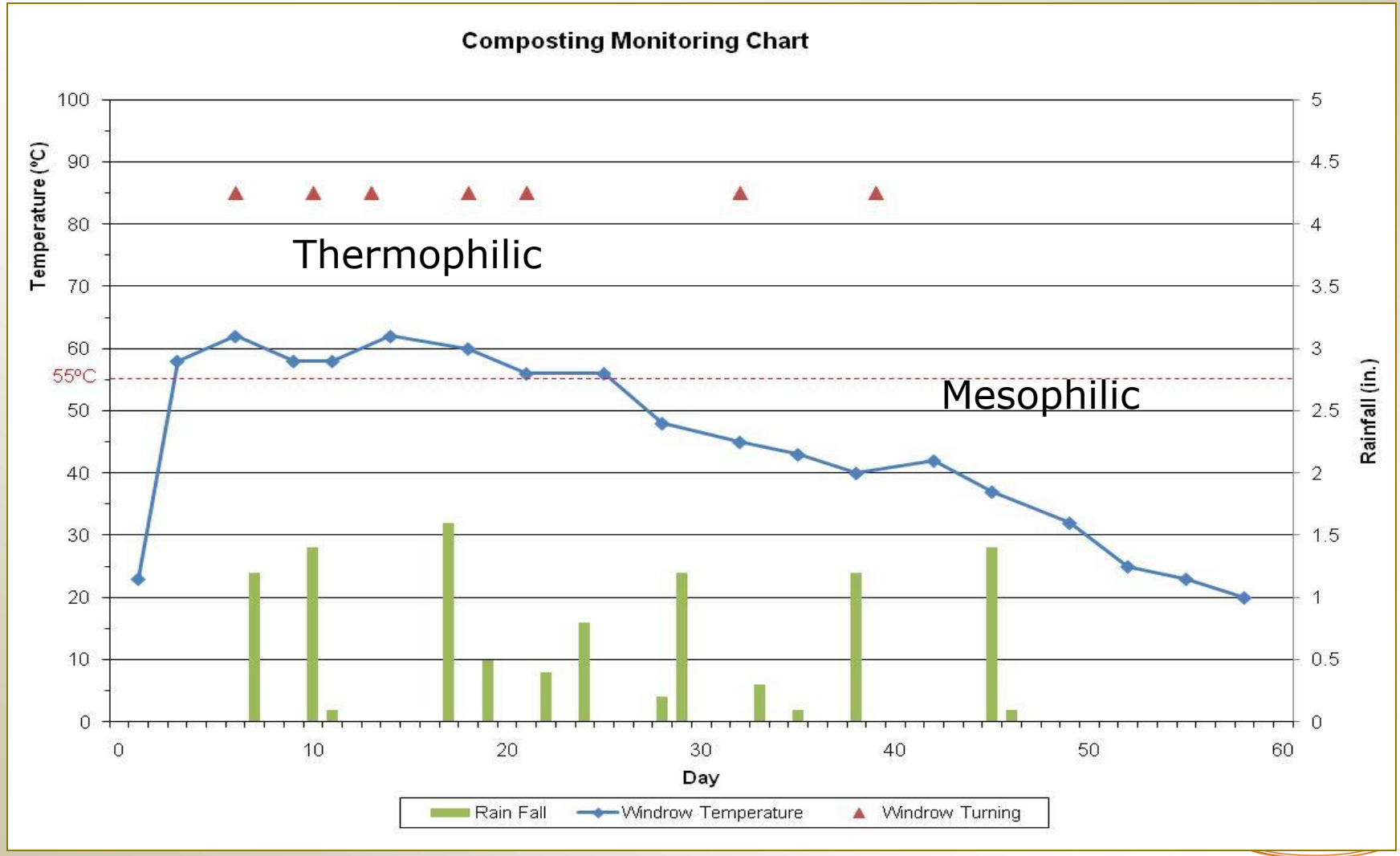
Weather Monitoring

- Wind direction
- Wind speed
- Temperature
- Cloud cover
- Precipitation

Photo source: FORCE Reedy Creek

Putting It Together

(and reading between the lines)



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Vector and Pest Prevention and Control

- Immediately mix wet putrescible materials to correct C:N ratio and moisture content, and move into compost windrow
- Cover windrow with >6 inch layer of well-aged mulch or coarse compost
- Do not turn windrows during initial 10-14 days
- Maintain integrity and slope of working surfaces and prevent standing water

Odor Prevention and Control

In addition to vector control practices…

- Build windrows with good porosity and not too large
- If odors from turning are unavoidable, turn windrows when wind is blowing away from sensitive receptors
- Do not turn windrows during early morning or evening
- Understand basic principles of atmospheric dispersion

Monitoring and Recordkeeping

- Ambient conditions : Daily
  - Precipitation, high temperature, sky conditions (wind speed & direction if necessary)
- Odor conditions: Daily
- Windrow Temperature: 2x weekly
- Windrow Moisture: 1x weekly

Diagnosing and Correcting Problems

Windrow Does Not Get Hot	
Possible Cause	**Solution**
If windrow is moist and has earthy smell, it may not have enough nitrogen	Mix in fresh nitrogen (grass, food waste, manure)
If windrow is very wet or smells sour, it may need more dry matter and/or air	Turn and aerate – mix in dry carbon (yard trimmings, straw, sawdust)
If windrow is dry, it needs more water	Spread out and add more water, mix well, and rebuild windrow
Windrow may be too small to retain heat	Gather enough material to make windrow 6-8 ft tall

Diagnosing and Correcting Problems
(continued)

Pile Smells Bad (garbage, rotten eggs, or vinegar)	
Possible Cause	**Solution**
Windrow has too much nitrogen	Mix in dry, rapid source of carbon (leaves, straw, sawdust)
Nitrogen & carbon not fully mixed	Break apart clumps of nitrogen material (food scraps, grass, manure) and mix with carbon material
Windrow is anaerobic	Turn the pile and mix in coarse dry material (yard trimmings, straw, wood chips); protect pile from rain

Diagnosing and Correcting Problems
(continued)

Pile Smells Bad (ammonia)	
Cause	**Solution**
Too much nitrogen and pH is <7.5	Turn and mix in dry carbon (yard trimmings, straw, sawdust)

Diagnosing and Correcting Problems
(continued)

Windrow Attracts Animals or Flies	
Cause	**Solution**
Windrow contains un-decomposed putrescible materials	Place a 12-18 inch layer of well-aged mulch or compost over the entire windrow Ensure proper C:N ratio, moisture and porosity, then turn the pile several times after it reaches high temperature Remove problem materials (dairy, meat, oils, feces)

Fire Prevention

- Well-managed compost windrows will not spontaneously ignite
- Fire is a possibility if moisture is <40%, piles are very large (i.e. anaerobic) and very hot, i.e. >230°C (>450°F)
- Other potential for fire is very dry material and open flame or spark
- Site design elements:
  - Access for fire-fighting vehicles
  - Source of water
  - Secure site access to prevent vandalism

Protecting Workers

- Personal protective equipment
- Health screening for immune & respiratory conditions
- Health and safety standards, training and enforcement
- Proper signage where applicable
- Clear communication and ownership