



# **BioComplete<sup>TM</sup> Compost**

Lecture 3 – Thermophilic Composting (Part 1)

# BioComplete™ Compost With All The Biology

## BioComplete™ Compost

- **Fully aerobic**
- **Full food web**
- **With all the benefits**
  - **Nutrient retention**
  - **Nutrient cycling**
  - **Structure building**
  - **Water retaining**
  - **No diseases, pests, or parasites**



# How to Make BioComplete™ Compost

- **Hot or Thermal Composting**
  - Commercial, back-yard, household
- **Worm or Vermicomposting (cold composting)**
  - Batch or flow-through
- **Static Composting**
  - Anaerobic middle, aerobic surface, leave alone for 1 – 2 years, hope for worms



# **The Conditions Needed**

**High temperature is still needed to kill seeds that may be in the compost.**

**Thermal piles need to maintain aerobic conditions in order to reduce high temperature damage to beneficial organisms.**



# Existing Regs: Thermal Compost

Regulations are slightly different state-to-state, in general:

**Temperature above 131 F** in the center of the pile for a full **10 – 15 days**, during which time, the pile must be **turned 5 times**.

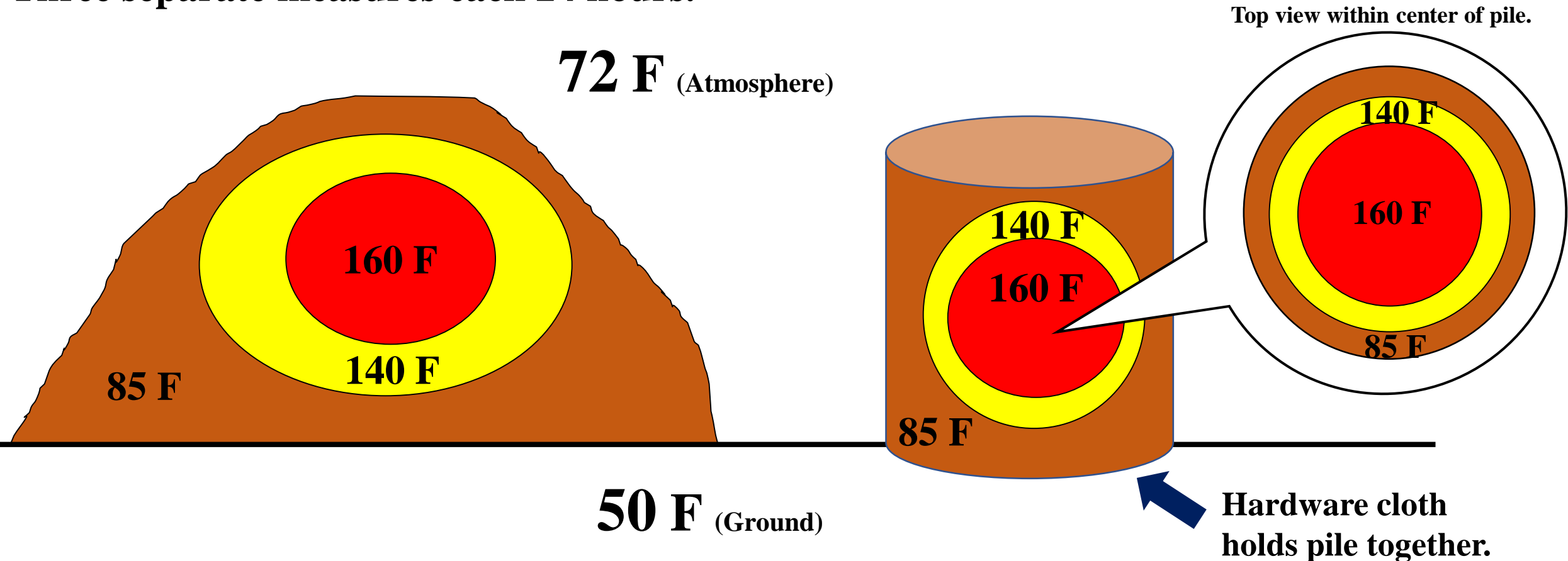
Define “center”

Define “a turn”

When is temperature measured after a turn?

# The Center

Piles or hardware cloth cages, the hot center is where we want to place the thermometers.  
Three separate measures each 24 hours.





**Buckets,  
water hose,  
shovels, pitch  
fork, wire  
frames,  
starting  
materials**

Small scale thermal composting

Sonoma Mountain Institute

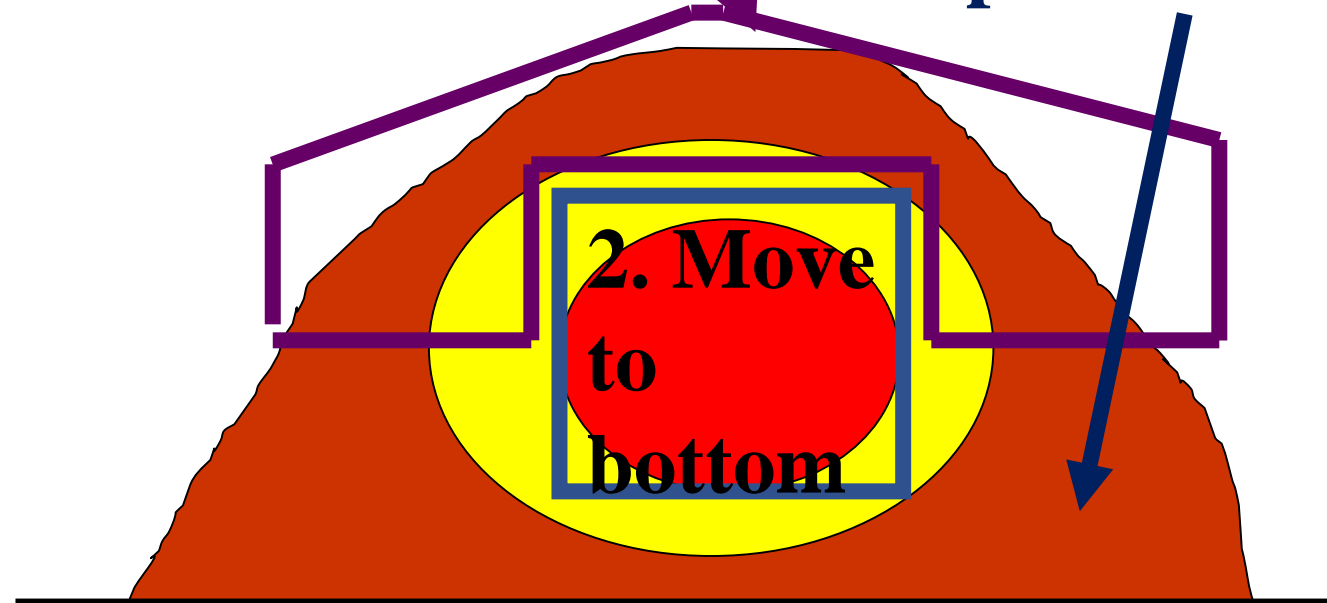
Summer 2006

# Turning BioComplete™ Compost by Hand (see hands-on demonstration)

**1. Place top on a tarp; when hot center is placed in bottom position, put this in center**

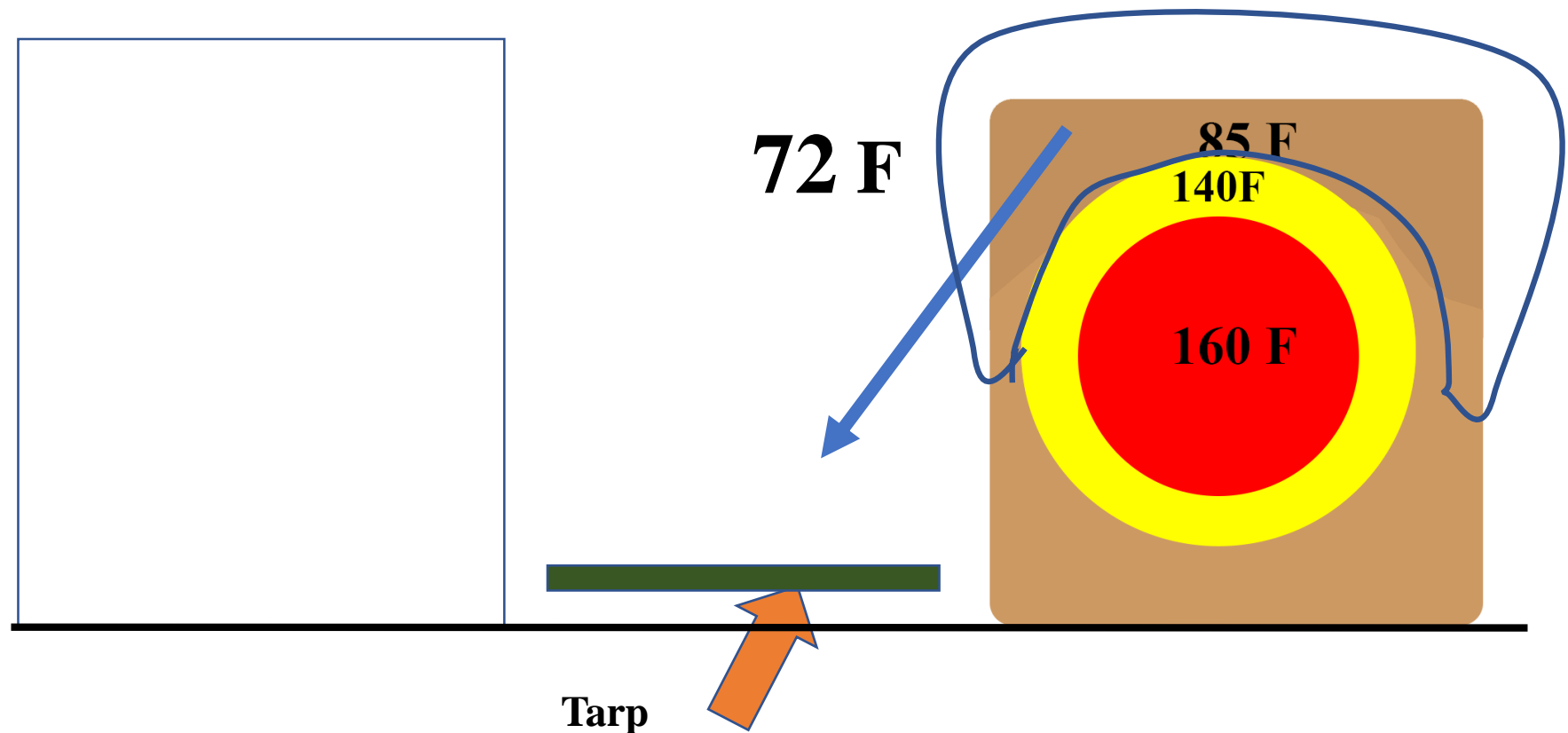
**3. Put the bottom on the top and sides**

**ALL the organic matter eventually must be in the hot center**



# Turning

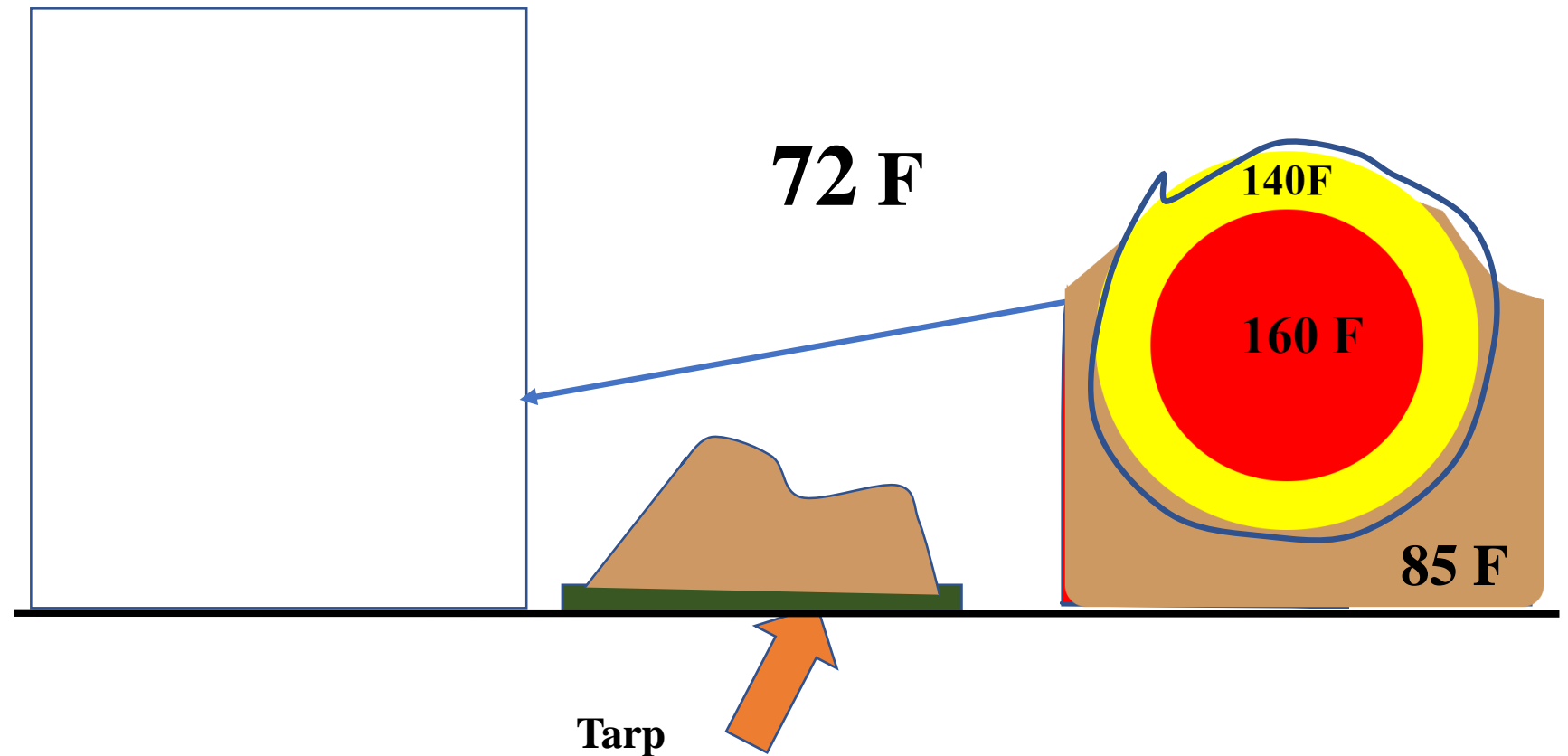
1. Remove wire enclosure, set up close by
2. Top goes on the tarp, make sure to aerate well





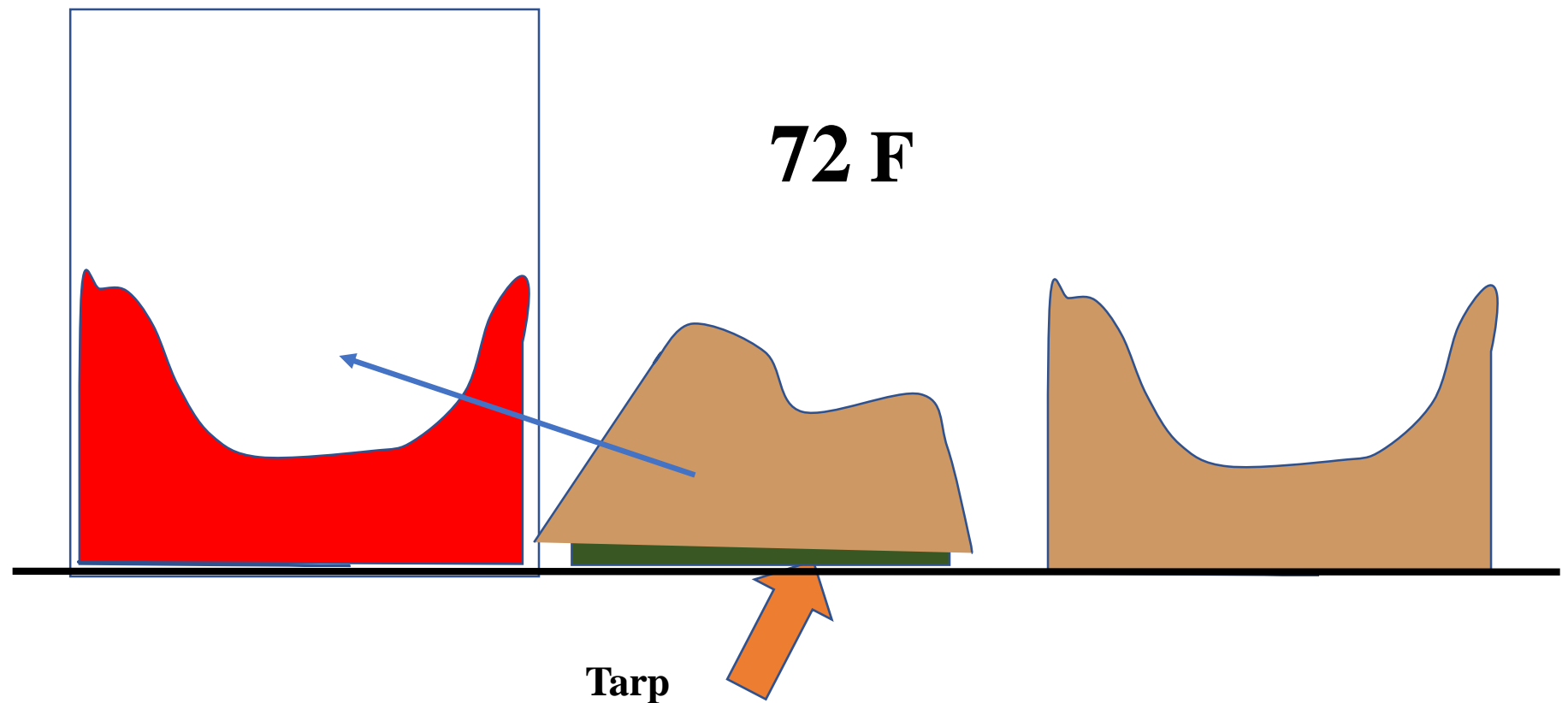
# Turning

**3. Hot  
Center goes  
in the bottom  
– aerate well**



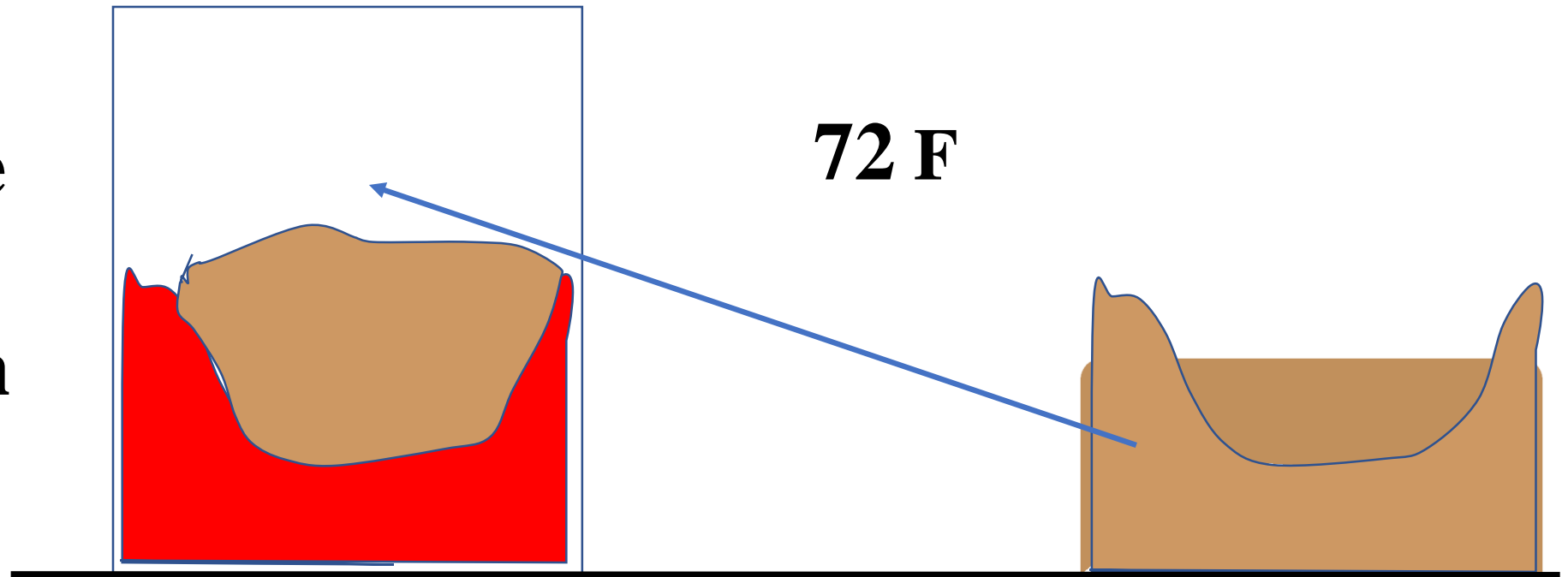
# Turning

**4. Cold top goes in the center of the new pile.**



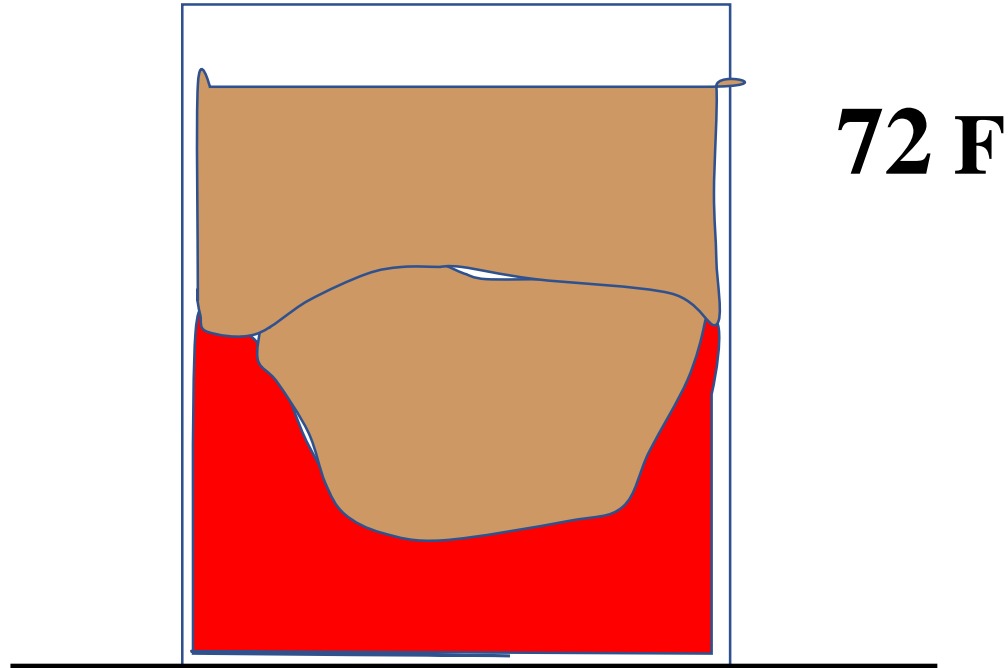
# Turning

- 4. Cold top goes in the center of the new pile.**
- 5. Cold bottom goes on top of new pile.**



# Turning

**What's the temperature in the pile now? Most likely lower than 131 F, although it depends on ambient temperature.**



When the middle has been hot enough, long enough, the same process is used to turn the pile. With the second turn, the last part of the pile is in the hot center ---- so dealing with bad guys is done!

# Temperature After Turning

**We know that pathogens may be able to recover if temperatures drop below 131 F.**

**So how long can temperatures be below 131 before recovery might start?**

**No answer on that, but certifiers say temperatures should be taken every 24 hours. So, you have 24 hours for the temperatures to get back above 131 F.**



# **What if temperature doesn't come back up after a turn?**

**If temperatures don't come back up, the high N added to the pile to get the party started and get rapid growth of the microbes, wasn't actually High N.**

**That means you need to adjust the recipe on the pile. This is why small piles are made first, to figure out the correct recipe.**

# **Food Microbiology shows:**

**Problem organisms are killed if temperatures are:**

- Above 131 F for 3 days (72 hours)**
- Above 150 F for 2 days (48 hours)**
- Above 165 F for 1 day (24 hours)**

**Previously, we said if temps reached 165, it was best to turn. But we've found that this isn't the best approach.....**

# **It's the alcohol that's the problem**

**We found out the “trick” is to keep things aerobic.**

**As long as no alcohol is produced, there is no danger. Punch “chimneys” in the compost pile to keep everything aerobic and hold temps from increasing.**

**Turn when the temps have been high enough for the correct amount of time.**

**Track the hour that the pile moves into a higher temp range as well as total hours above 131 F.**



# USDA requires pathogen testing in the final product

## Thermal compost-

- Fecal coliforms: High levels allowed because many fecal coliforms are not pathogenic.
- *E. coli*: also not truly a pathogen, but a good indicator that the habitat is one that allows disease organisms to thrive. 800 CFU/gram.
- Possibly Salmonella or Shigella.

Send samples into a Plate Count lab (water treatment)

# National Organic Program Regulations

**Temperature must be above 131 F in the center of the pile for a **full 15 days**, during which time, the pile must be turned 5 times.**

**The organic view is that if the process is done correctly, there is no need to test the product.**

**But the regulations do not assure the process will be done right. No mention of organisms, what the mix of organic material needs to be to get heat, but stay aerobic.**

# **These benefits are desired so biology is needed:**

- **Fully aerobic**
- **Full food web**
- **With all the benefits**
  - **Nutrient retention**
  - **Nutrient cycling**
  - **Structure building**
  - **Water retaining**
  - **No diseases, pests, or parasites**

# The Steps to Achieve Benefits

- 1. Diversity of starting materials = diversity of organisms, unless.....**
- 2. Recipe: High N, Green, Woody - How can you tell how much high N?**
- 3. C:N**
- 4. Moisture: Maintaining moisture**
- 5. Structure: Aerobic Conditions**
- 6. Temperature: Turning without destroying**
- 7. Storing**

# Where do the organisms in the pile come from?

- **From the surfaces of the plant materials.**
- **Diversity of plant materials increase diversity of the microorganisms in the pile.**
- **So that hundreds, if not thousands, of species will be able to function in each and every combination of conditions that might occur.**

# Temperature and Oxygen

- **The heat evolved in a thermal BioComplete™ Compost pile comes from the rapid growth of bacteria and fungi decomposing the organic matter in the pile.**
- **Microbes use up oxygen rapidly when they grow rapidly.**
- **When temperature gets too high (160 to 165 F), you may need to turn the pile too soon. Bacteria, fungi, protozoa, and nematodes need to be mixed evenly through the pile.**



# All organisms need water....

- **50% moisture for thermal BioComplete™ Compost piles**
  - Free-water, not gravimetric water
  - Edges can be drier, since the pile will need to be turned so all parts of the pile get into the high temperature middle
- **70% moisture for BioComplete™ Vermicompost**
  - Worms need more water,
  - Worms lay eggs in 75% - 80% moisture

# Starting Materials

- **Hi N:** C:N 10:1 “Party Food”
  - Stimulates bacterial and fungal growth
  - Rapid growth generates heat
  - If a million microbial cells per gram reproduce, temperature will be raised at least a degree.
  - Legumes, Manures, Seeds, Meat, Blood
- **Green:** C:N 30:1 “Maintains Temperature”
  - Simple, not-complex sugars; Feeds bacteria
  - Any green plant, bacteria, algae, lichen
- **Woody or Brown:** C:N > 60:1 “Structure”
  - Feeds fungi; Woody plant material, paper



# Univ. of California Study

<b>Material</b>	<b>C:N Ratio</b>
<b>Sandy loam (fine / coarse sieved)</b>	<b>7:1/25:1</b>
<b>Humus / Compost</b>	<b>10:1</b>
<b>Food scraps (lettuce? Hot dogs?)</b>	<b>15:1</b>
<b>Alfalfa hay</b>	<b>18:1</b>
<b>Rotted manure</b>	<b>20:1</b>
<b>Vegetable trimmings</b>	<b>25:1</b>
<b>Straw</b>	<b>80:1</b>
<b>Pine Needles</b>	<b>60:1 to 110:1</b>
<b>Farm Manure</b>	<b>90:1</b>
<b>Newspaper</b>	<b>170:1</b>

# Handout on C:N

**Many plant materials start out with high N or “Party food” designation (10:1) because the first flush of nutrients into the new plant growth contains all the stored-through-the-winter nutrients.**

**As photosynthesis kicks in, the nutrients are diluted and bacteria win (30:1).**

**As the plant goes into reproductive mode, the plant pulls nutrients from its body to provide for the seed, and fungi win (80 to 300:1).**