Basics of Composting Poultry Litter and Swine Bedding

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Composting Facts

- Compost: stable organic material with earthy smell
- Microorganisms convert less stable organic material into compost
- Similar to natural decay but faster due to better control of conditions

Composting Benefits

- Can generate revenues
- Safer & easier to handle vs. raw waste
- Can kill fly eggs and weed seeds
- Good soil amendment

Composting Benefits

- Amount reduced by 25 to 50%
- Greater forage palatability
- Less nitrate concern in forage
- Apply more per acre due to lower N content

Before we get started …

- *Swine waste and broiler litter are compostable materials!*
- *Piling up waste is not really composting!*
- *Composting requires management & costs money!*
- *Composting is both science and art!*

Factors Affecting Composting Process

1. Aeration
2. Moisture content
3. Carbon/Nitrogen ratio
4. Temperature
5. Time
6. Porosity, structure, texture & particle size
7. pH or acidity level

Aeration

- Supplies oxygen
- Removes excessive heat & moisture
- Reduces packing
- Turn, force air, or chimney effect
- Poor aeration causes anaerobic activity (bad) – smelly site
- Too much aeration cools compost (bad)

Windrow turner with watering attachment at CEFS

Moisture content (MC)

$$MC(\%) = \frac{Wt.of\ water}{Total\ wet\ wt.} \times 100$$

- Microbes require moisture
- Need MC for initial mix & periodic watering
- Desirable: 50% (range: 40-65%)
- Less than 40%: reduced microbial activity (spontaneous combustion risk)

Moisture content (cont.)

- Greater than 65%: anaerobic activity (poor aeration)
- Crude method: Squeeze compost ball in hand
  - only 1-2 drops: MC is just right
  - no water: MC too low
  - more water: MC too high

Moisture content (cont.)

- Microwave drying most accurate but need microwave, weighing scale ($120, Grainger), brown paper bags
- Need representative sample!
- Soil or hay moisture probes give indication faster but less accurate than drying method

Moisture content (cont.)

Reotemp ‘backyard moisture meter’, $40 (www.reotemp.com)

Reotemp ‘moisture meter’, $150 for 4-ft stem

Moisture meter from Grainger, $100

Moisture content calculation

Example: Farmer Joe wants to determine moisture content of compost sample. He takes a 54-gram compost sample plus brown paper bag (weight 4 grams) and places in microwave and heats it for 1 min. He weighs and the new weight is 42 grams. He again heats for another minute and the new weight is 36 grams. During the 3rd heating, he stops before 1 min. when the sample starts to singe. The final weight of bag plus sample is 28 grams.

- Total sample wt. = 54 grams
- Total wet wt. = Total sample wt. - Bag wt. = 54 – 4 = 50 g
- Solid wt. = Final wt. – Bag wt. = 28 – 4 = 24 g
- Wt. of water = Total wet wt. – Solid wt. = 50 - 24 = 26 g
- MC (%) = Wt. of water X 100/ Total wet wt. = 26X100/50 = 52%

Carbon/Nitrogen (C/N) Ratio

- Microbes require different proportions of C & N (also other nutrients)
- Desirable C/N: 30 (range 20-40)
- N loss with low C/N
- Slower composting with high C/N
- Composting stops when usable C used up
- Challenge is with multiple materials varying in C, N, and also moisture contents (example later)

Some C/N Ratios

Source	Average	Range
Horse manure (& bedding)	30	22-50
Broiler litter	14	12-15
Swine waste	14	9-19
Saw dust	442	200-750
Grain straw	80	48-150
Grass clippings	17	9-25
Non-legume Hay	32	

Source: NRAES 54

C/N Ratio (contd.)

- When possible, have raw material & compost samples analyzed instead of using literature values
- Need to ask NCDA to do C analysis for animal waste (no extra cost); C/N analysis on compost done automatically
- Mail samples same day to NCDA lab or refrigerate

  NCDA&CS Agronomic Division
  1040 Mail Service Center
  Raleigh, NC 27699-1040
  Phone: (919)733-2655
- Waste analysis results available online
  - Go to: http://www.ncagr.com/agronomi/pwshome.htm
  - Click on: <u>Find Your Plant, Waste, or Solution Report</u>
  - Report available in as little as 2 days

C/N ratio calculation problem

Example: Farmer John has 4,000 lb of broiler litter (MC = 35%, C = 26%, N = 20,000 ppm; all from NCDA analysis). He wants to mix it with spoiled hay (MC = 25%). From literature, hay has C/N of 32 and N of 1.3% on dry basis. If he wants to have a C/N ratio of 30 for his compost, how much hay should be mixed in with 4,000 lb of litter?

Note: 1% = 10,000 ppm

Important equation:

$$\frac{Wt.C_{litter} + Wt.C_{hay}}{Wt.N_{litter} + Wt.N_{hay}} = \frac{30}{1}$$

C/N ratio calculation problem (contd.)

Materials	Total wt., lb	MC, %	Dry wt, lb	Wt. of water, lb	N, %	Wt. of N, lb	C/N	Wt. of C, lb
Litter	4,000	26	(100 -26) *4,000 /100 =3,040	4,000 - 3,040 = 960	20,000 /10,000 = 2.0	3,040* 2.0/100 = 61	26/2.0 = 13	3,040*26/ 100 = 790
Hay	X	25	(100 - 25) *X/100 = 0.75X	X-0.75X = 0.25X	1.3	1.3*0.75X /100 = 0.00975X	32	0.00975X *32 = 0.312X
TOTAL	4000 + X		3,040 + 0.75X	960 + 0.25X		61 + 0.00975X		790 + 0.312X

$$\frac{790 + 0.312X}{61 + 0.00975X} = 30$$

X = 53,333 lb

So, we need to add 53,333 lb of hay to 4,000 lb of litter to get C/N of 30

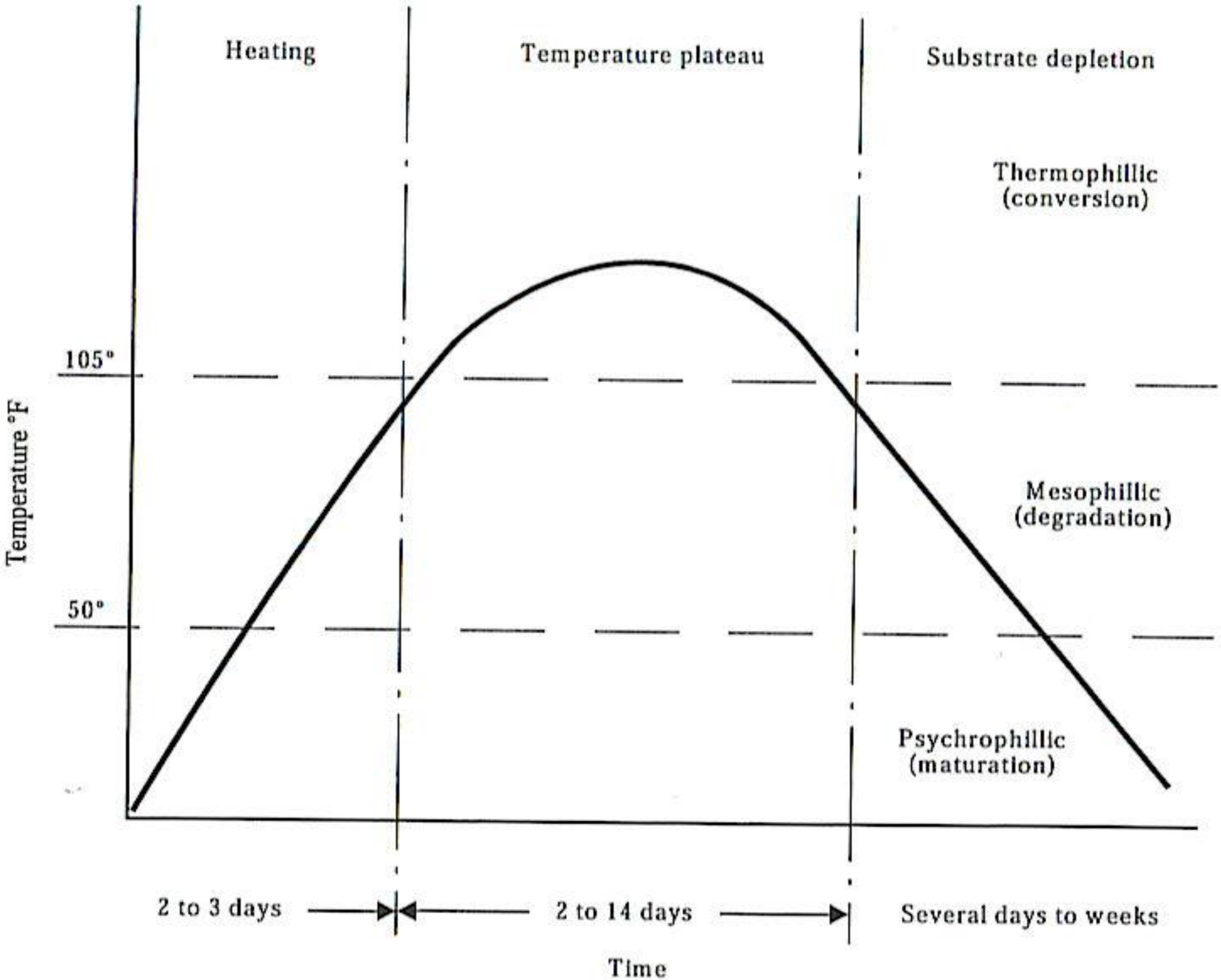
Temperature

- Temperature affects speed of composting & destruction of pathogens & weed seeds
- Composting at thermophilic (above 105 F) and mesophilic (50 to 105 F) ranges
- NC regulations: Need 131 F for 15 days (windrow) or 3 days (static pile or in-vessel) for pathogen reduction in Type 3 (manure) facilities

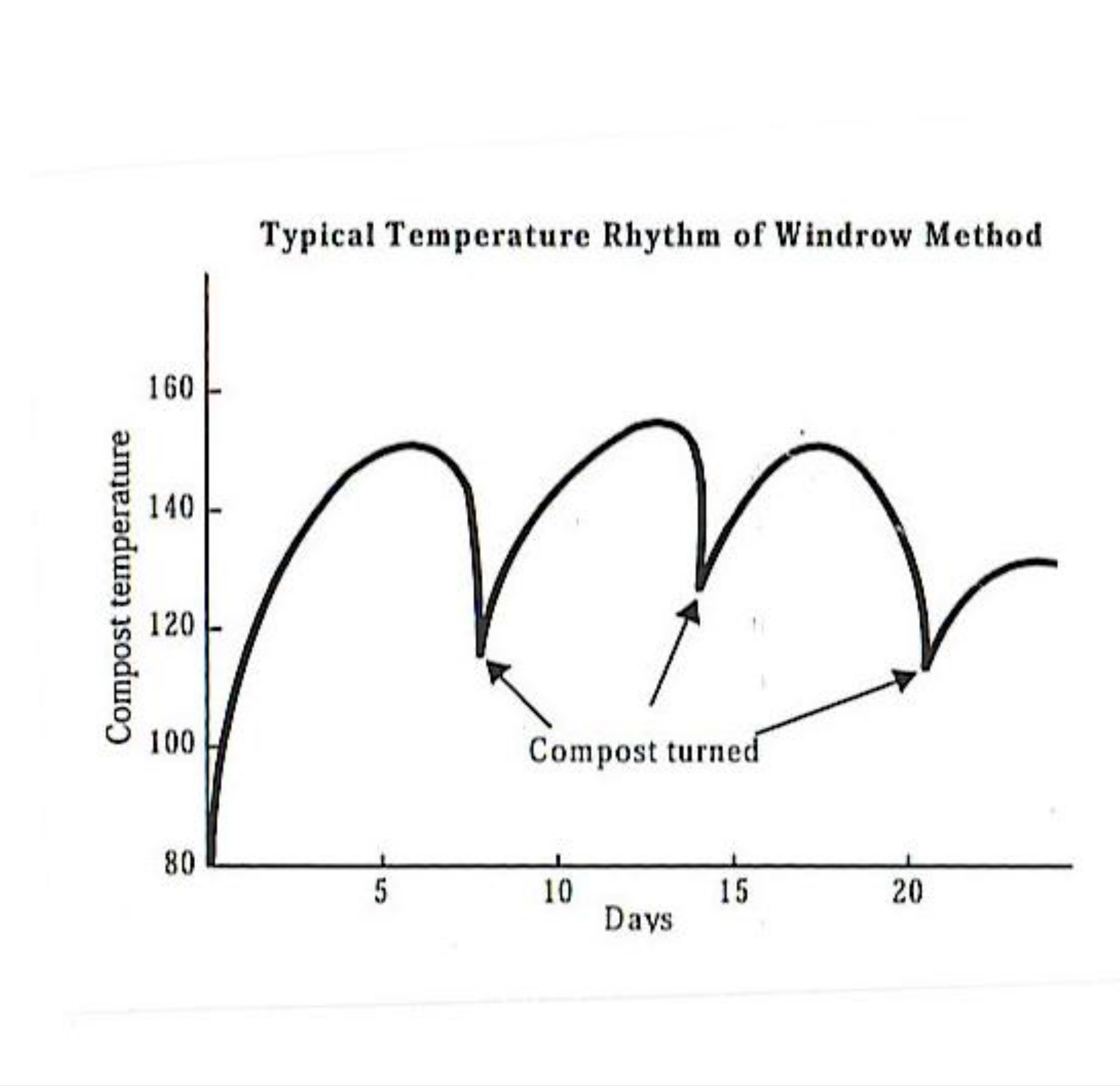
Temperature (cont.)

- 130-145 F kills many weed seeds & pest eggs
- Composting reduced above 150 F
- Aerate at 140 F
- Long-stem thermometer needed ($100-150)

Monitoring temperature in a composting bin



Source: National Engineering Handbook



Source: National Engineering Handbook

Time

- Depends on many factors, including method, management, source material, and weather
- Composting faster with proper moisture content and C/N and frequent aeration
- Composting delayed by dry material, high C/N, cold weather, and infrequent aeration
- Compost longer for dry & stable product
- Composting period shorter when applied to cropland

Impact of source and method on composting time

Source: NRAES-54

Table 2.2
Typical composting times for selected combinations of methods and materials

Method	Materials	Active composting time: Range	Active composting time: Typical	Curing time
Passive composting	Leaves	2–3 years	2 years	—
	Well-bedded manure	6 months to 2 years	1 year	—
Windrow—infrequent turning [a]	Leaves	6 months to 1 year	9 months	4 months
	Manure + amendments	4–8 months	6 months	1–2 months
Windrow—frequent turning [b]	Manure + amendments	1–4 months	2 months	1–2 months
Passively aerated windrow	Manure + bedding	10–12 weeks	—	1–2 months
	Fish wastes + peat moss	8–10 weeks	—	1–2 months
Aerated static pile	Sludge + wood chips	3–5 weeks	4 weeks	1–2 months
Rectangular agitated bed	Sludge + yard waste or Manure + sawdust	2–4 weeks	3 weeks	1–2 months
Rotating drums	Sludge and/or solid wastes	3–8 days	—	2 months [c]
Vertical silos	Sludge and/or solid wastes	1–2 weeks	—	2 months [c]

a For example, with bucket loader.
b For example, with special windrow turner.
c Often involves a second composting stage (for example, windrows or aerated piles).

Porosity, structure, texture & particle size

- All influence aeration
- Adjust by selection of raw materials, grinding or mixing
- Amendments (e.g., lime) or bulking agents (e.g., nuggets) can improve properties
- Particles 1/8 to 1/2 in. in size compost faster

pH or acidity

- pH (0-14): Acidic (less than 7); Neutral (7); Basic or alkaline (more than 7)
- Composting good near 6.5-8 pH
- pH changes due to chemical changes
- Properly done compost close to neutral
- Take care while adding lime to increase pH

Curing

- Critical but often neglected
- No turning needed but need natural aeration
- Microbial reactions slower
- Begin curing when pile no longer heats up after turning
- End curing when pile temperature near ambient
- Cure for at least one month

Small Composting Operations

1. Passive composting
2. Turned piles
3. Aerated static piles

(Source: Washington State University)

1. Passive composting

- Waste piles 5-7 ft wide, 3-4 ft high
- Build piles in bins, 8 ft × 8 ft & 4 ft height
- Extra bin for curing
- Turn piles when adding material
- One bin ready in 2-4 months

Bin composting of poultry mortalities. Note that gap between lumber allows aeration

2. Turned piles

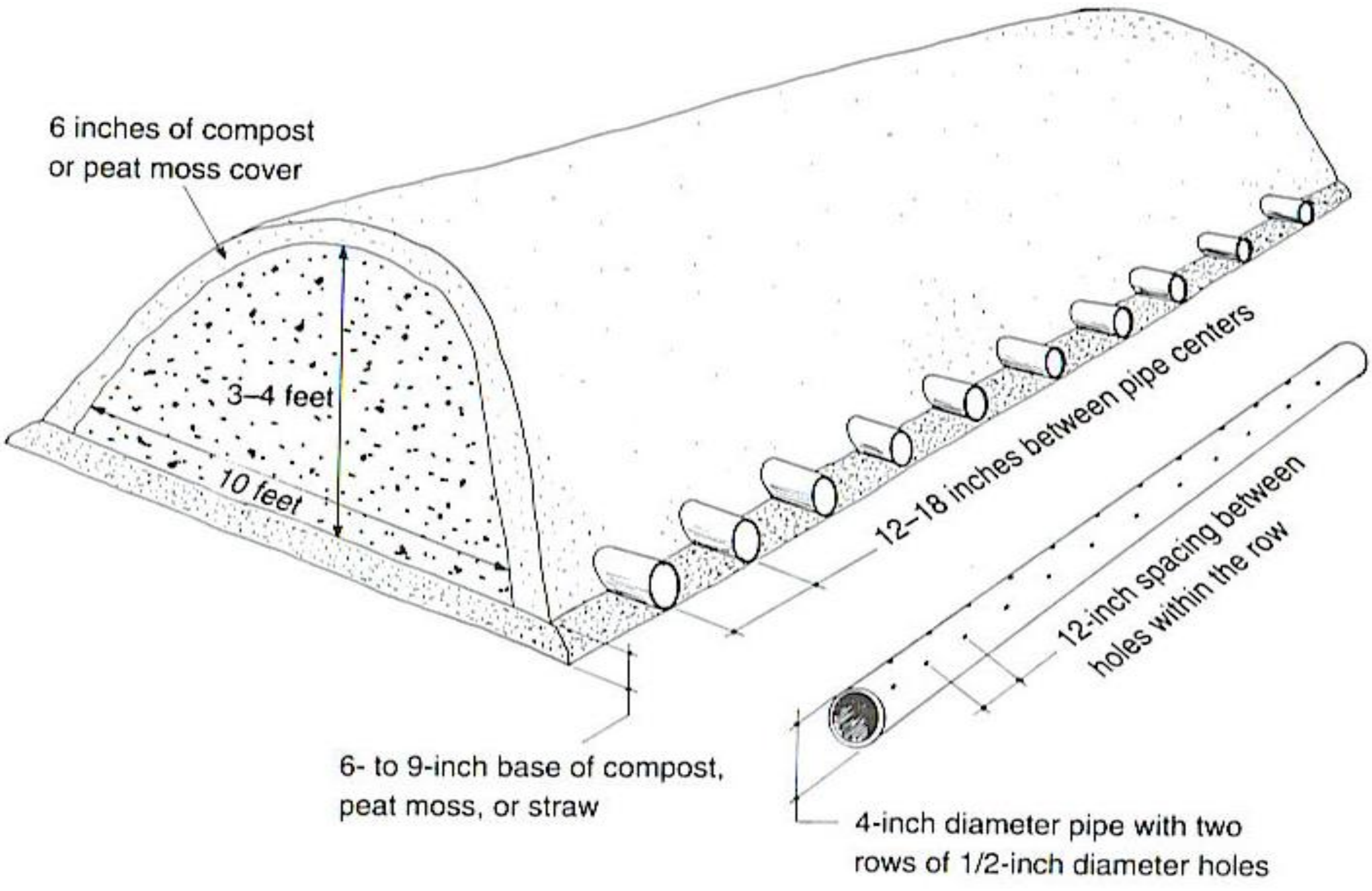
- Great if tractor available
- Concrete or graveled pad desirable
- Turning improves composting
- 30 ft × 30 ft pad adequate for 3 piles or windrows

3. Aerated static piles

- No need to turn
- Perforated plastic pipes
- Air may be pulled or pushed
- Higher initial investment but saves labor

Aerated static pile

Source: NRAES-54



Conclusions

- Composting a feasible waste management strategy
- Can help generate farm revenues
- Provides environmental benefits
- Requires management

Contact information and references

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<u>Good books on compost:</u>

1. On-farm composting handbook (NRAES 54) - $25
2. Field guide to on-farm composting (NRAES 114) - $14

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