Composting Horse Stable Manure

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Compost

"The product of a managed process through which microorganisms break down plant and animal materials into more available forms suitable for (beneficial) application to the soil."

-USDA NOP

Compost is not a fertilizer, but a soil amendment with soil fertility and soil quality enhancing characteristics.

A 1,000 lb. Horse Can Generate:

30-lbs of manure plus 20-lbs of urine/day

or

8-10 tons or 12-15 cubic yards

annually

Bedding…

At an average 0.75 cubic feet per day, bedding can add an additional 10 cubic yards of waste materials, per horse, to the waste stream annually.

Typical nutrient content of horse manure (dry weight)

Nutrient	Manure		W/ Bedding
	%	lbs./ton of material	
Nitrogen (N)	0.95	19.0	11.0
Phosphorus (P)	0.30	6.0	2.20
Potassium (K)	1.50	30	1.30

Guidelines for Handling Manure

- Regular removal of manure
- Keep stalls and paddocks clean and dry
- Leave behind usable bedding

Average storage volume

No. of Horses	Manure		Manure w/Bedding	
	250 days	Year	250 days	Year
	cubic yards			
1	7	10	12-14	17-20
5	35	50	60-70	85-100
15	105	150	180-210	255-300
25	175	250	300-350	425-500
40	280	400	480-560	680-800

*Assumes 0.75 cu. ft. manure/day and 0.50 to 0.75 cu. ft. bedding/day.
A cubic yard is 27 cu. ft. and occupies a cube 3ft x 3ft x 3ft.

Land Application Guidelines

Average manure application and land base area requirements for pasture crops.*

Forage Crop	Annual Manure Application	Land Area Required
	tons/acre	acres/horse/yr
Red Clover	10	0.8
Ryegrass	11	0.8
Tall Fescue	13	0.6
Wheat Grass	2	3.8

*Adapted form Davis and Swinker, 1996 (assumes 8 tons manure/yr).

Why Compost?

RESOURCE CONSERVATION AND

SOIL AND WATER QUALITY!

Land Application

- Is an acceptable disposal method,

  but may not address pathogens or water quality

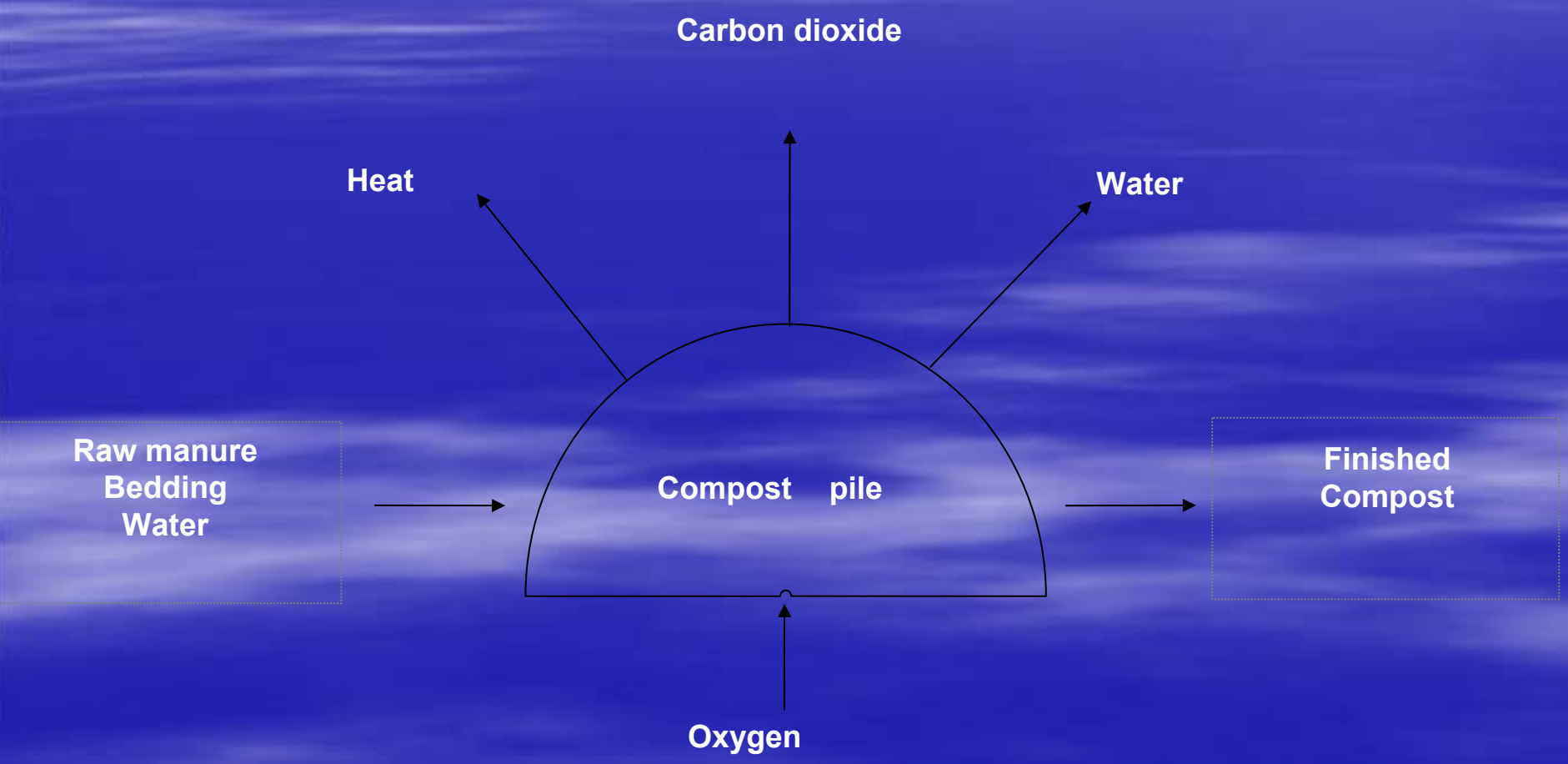
Advantages of *Aerobic Thermophilic* Composting :

- **Pathogens exposed to thermophilic temperatures (>131°F) for a sufficient period of time are destroyed (E.coli, SOD, etc.)**
- **Most weed seeds are killed**
- **Decomposition is rapid; volume reduction occurs quickly**

Composting can Reduce Risks To Water Quality posed by Manure :

- ***Reduction and elimination*** **of microbial pathogens**
- ***Reduction*** **of ammonia N-levels**
- ***Reduction*** **in water-soluble phosphorus**
- ***Reduction*** **of Biological Oxygen Demand (BOD)**
- ***Reduction*** **in total soluble salts**

Aerobic Composting Process



Aerobic Composting Requirements

- Carbon and Nitrogen Ratio: 25/1 – 50/1
- Air: optimize oxygen
- Water: 50-60% moisture
- Temperature: 131° F minimum

Carbon to Nitrogen Ratio

- Relative amount of carbon and nitrogen
- Horse manure alone has C/N ratio of 25-35/1; optimum for composting
- Carbonaceous bedding has a C/N ratio of 50-100/1, unfavorably increasing the C/N ratio of stable manure compared with manure alone.

C/N Ratio: 25/1 – 50/1

Aeration Methods

- **Turned windrow:** base turning frequency on temperature profile and pathogen reduction phase requirements (5 turnings, 15 days).

- **Static pile, forced aeration:** excessive aeration is possible; cooling, N volatilization, overheating, drying.

- **Static pile, passive aeration:** aeration is typically inadequate to achieve complete breakdown in the short term.

- **Daily temperature readings** required during Pathogen Reduction Phase (EPA, CIWMB).

Pathogen Reduction Phase

USDA NOP
US EPA
CIWMB

"… between 131 and 170 degrees (F) for 3 days using an in-vessel or aerated static pile, or …

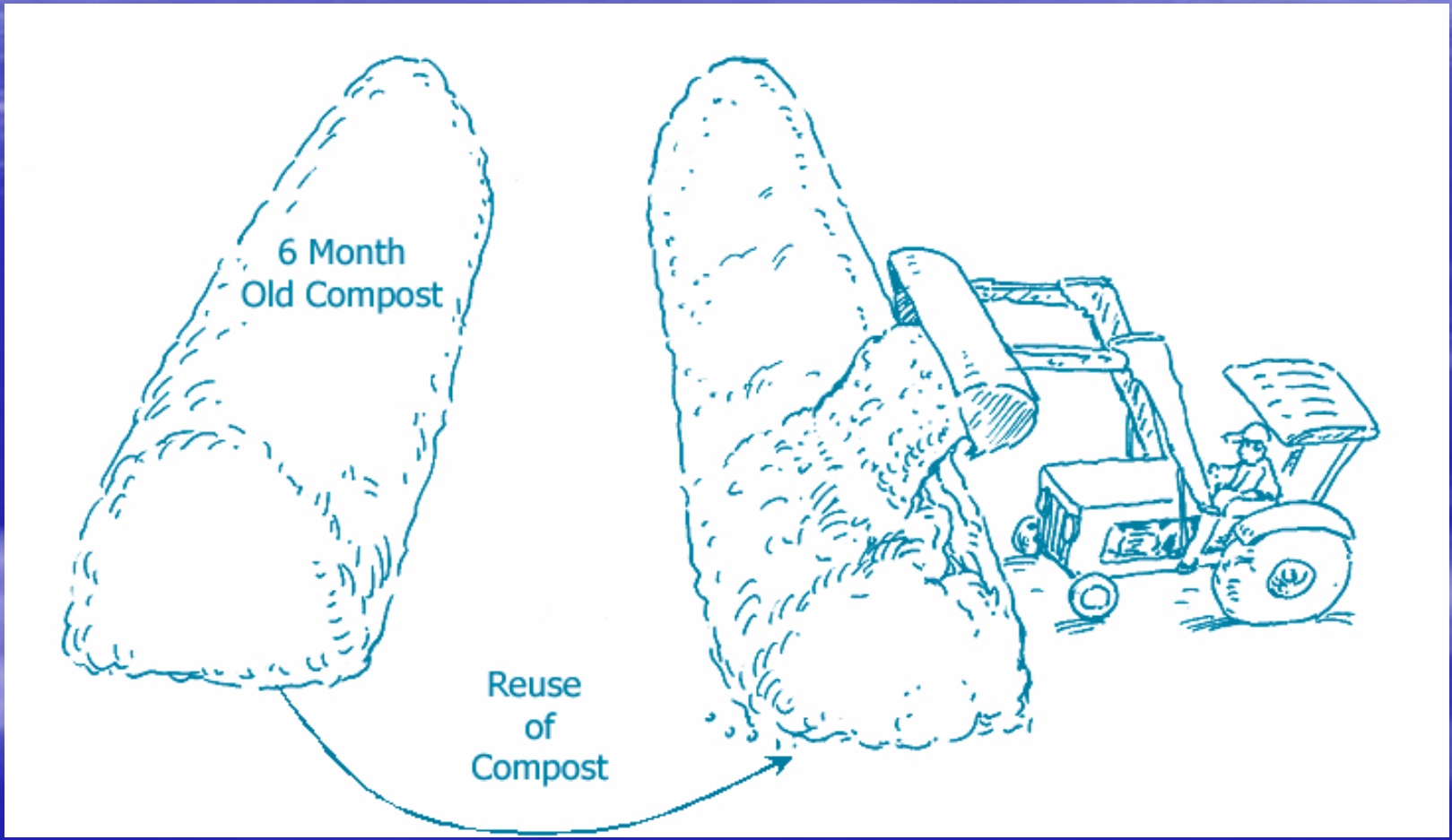
…for 15 days using a (turned) windrow system, during which …it…must be turned a minimum of 5 times."

-NOP/CIWMB

- **Animal materials (NOP vs CIWMB)**
- **Organic Preharvest Interval**

Passive Aeration/Static Pile

Static Pile: Requires an insulating layer of finished compost



Compost Recipes: C/N + Water + Air

Horse manure

Stable shavings

Green waste

Etc.

Aerobic Composting Parameters

- Optimum Carbon/Nitrogen Ratio:

  25/1 – 50/1
- Air: optimize oxygen (bulk density < 40 lbs/ft^3)
  - Wet dairy manure bd = 65 lbs/ft^3
  - Horse bedding bd = 20 lbs/ft^3
- Water: 50-60% moisture- "wrung-out sponge"
- Temperature: 131° F minimum (pathogen reduction phase)

Water

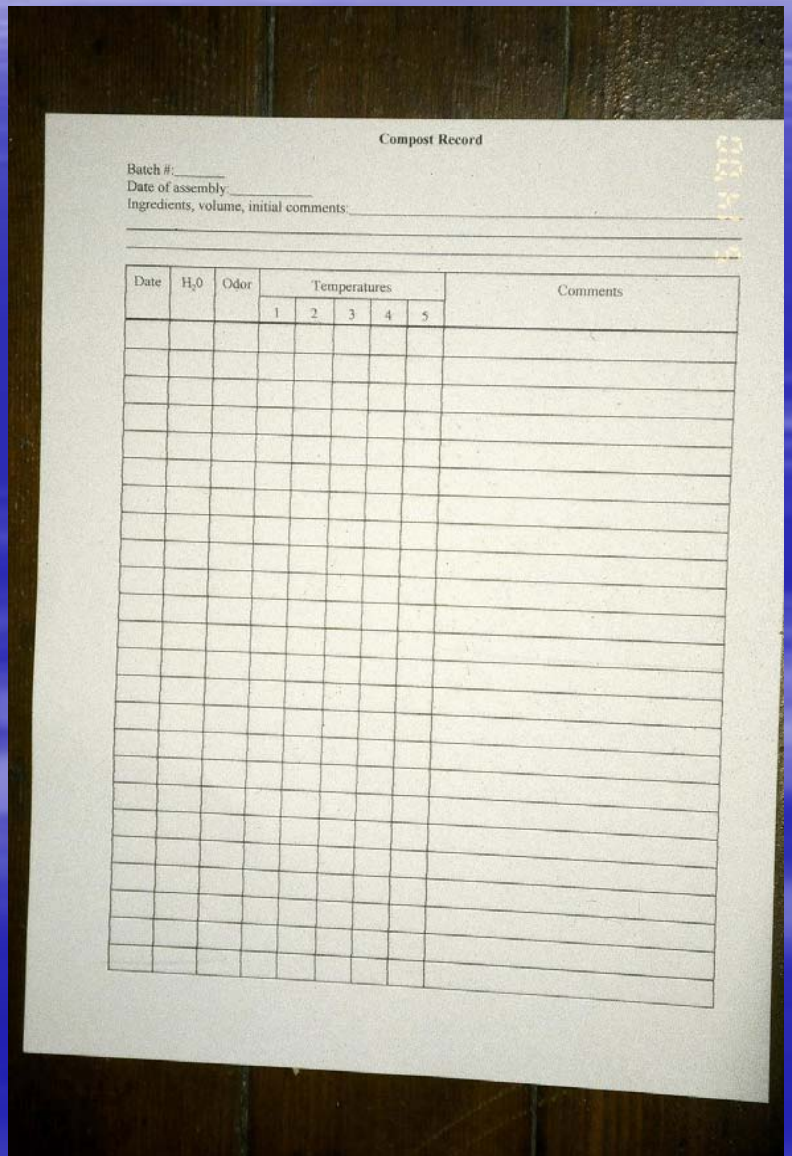
Checking Compost Temperatures

- Temperatures usually will increase within 24 hours of pile assembly, and may reach 155°F or more within 2-3 days
- A compost thermometer (24-48”) and record keeping are essential equipment

Check temperature at several points at a depth of 24”

Why Keep Records?

- Process monitoring
- Organic certification
- LEA



Compost Record

Batch #:_____

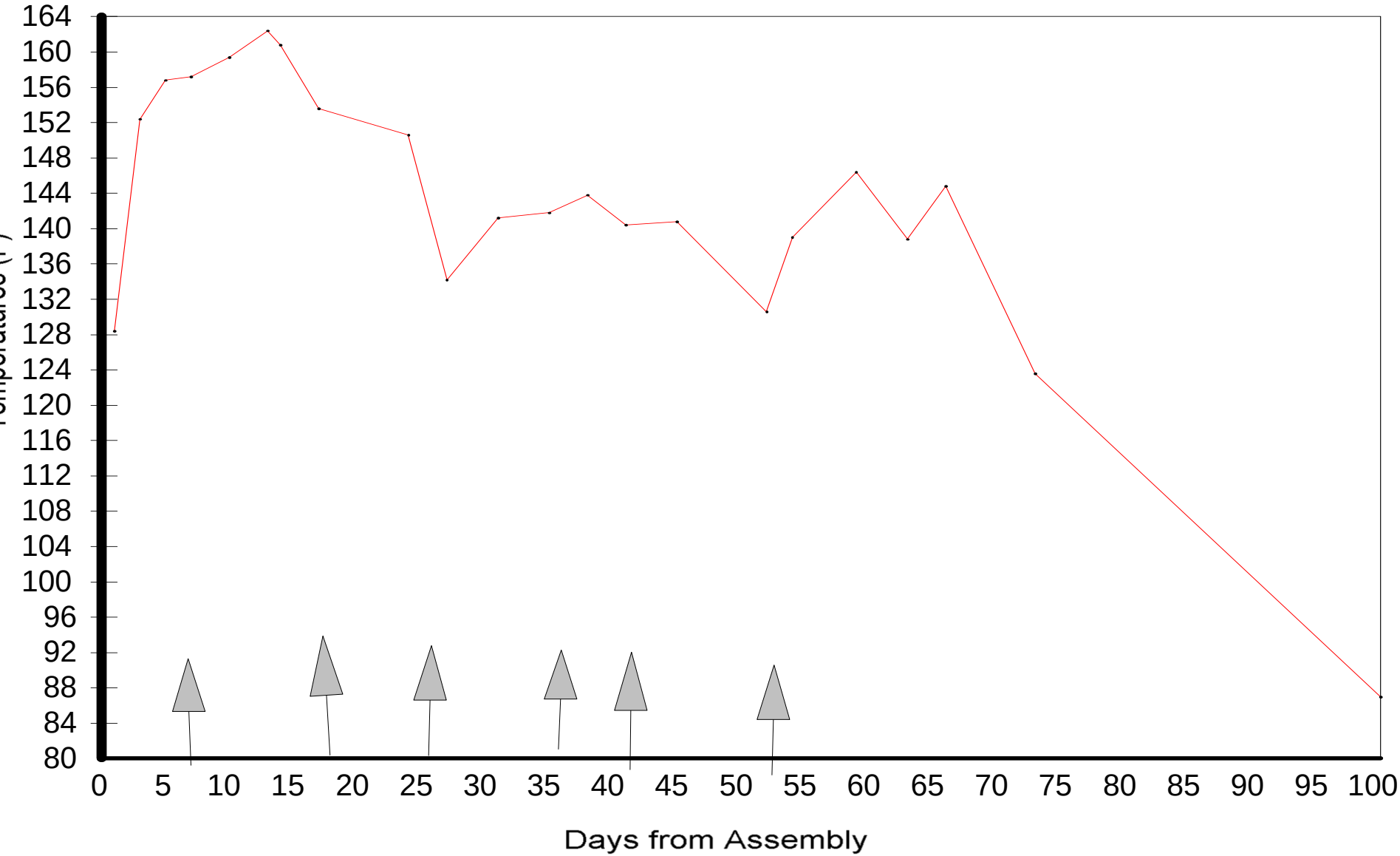
Date of assembly:_____

Ingredients, volume, initial comments:_____

Date	H_2O	Odor	Temperatures					Comments
			1	2	3	4	5	

Typical Compost Temperature Profile

Green Waste, Horse and Dairy



Site Selection and Construction

Operation Size Determines Site and Technology Requirements

There must be adequate space to:

- *store the anticipated volume of manure and bedding*
- *provide equipment access and working area*
- *accommodate active composting and temporary storage of final product*

Most importantly:

- ***The site design must protect water quality***

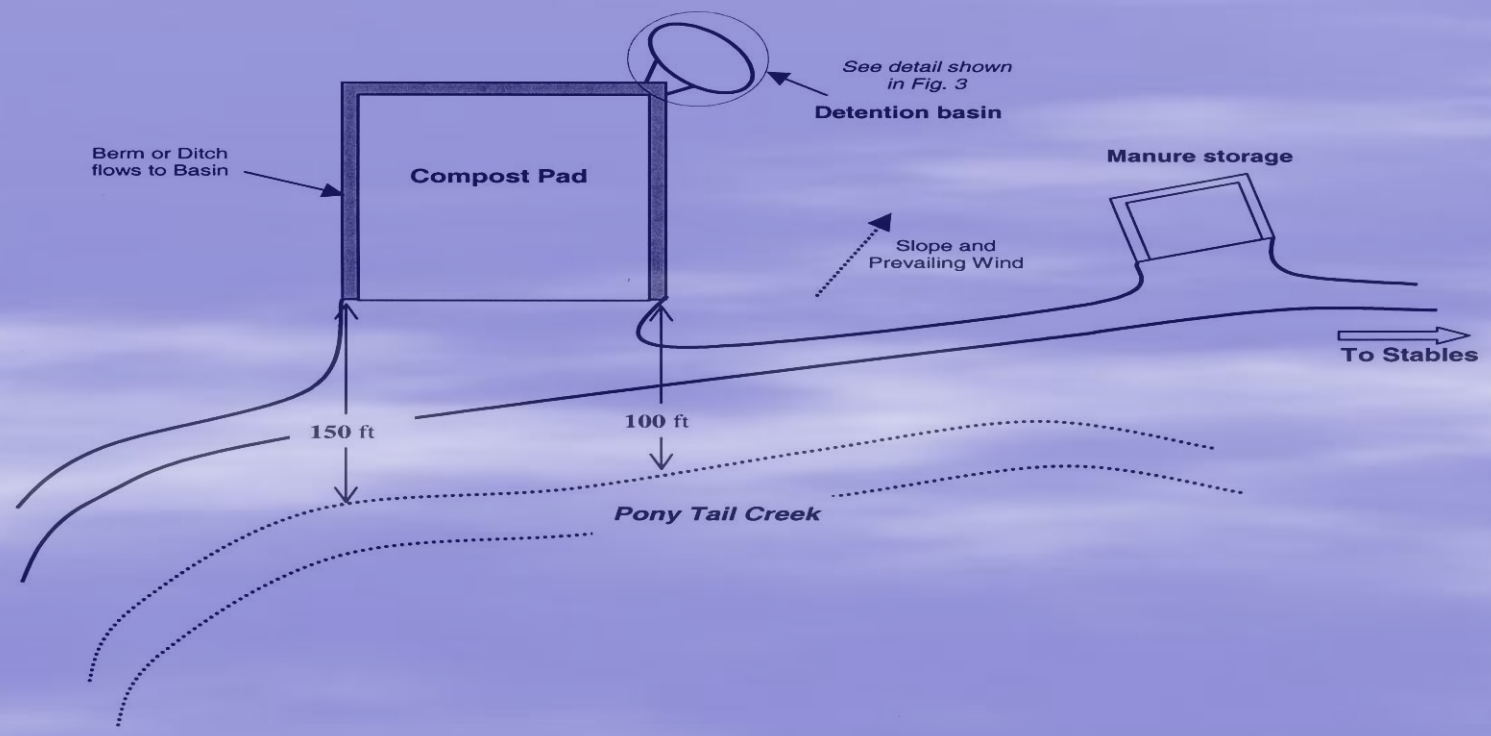
Basic Components of an On-Farm Composting System

- **Located away from creeks and drainage;**
- **Bins or piles large enough to maintain temperatures (> 1 yd^3):**
- **A mechanism for aerating the bins or piles;**
- **Temperature monitoring**
- **Available water**

No single design for an on-farm composting system is appropriate for all sizes and types of facilities.

Basic Site Requirements……

Figure 2. Example of idealized compost site details



All Weather Access

All Weather Compost Pad

Control Runoff

- **Controlling runoff and drainage from the compost site is essential**

Compost Regulations

"When the country is confused and in chaos, loyal ministers appear" - Lao Tzu

- **CIWMB**
- **LEA (SOP)**
- **NOP**
- **RWQCB**

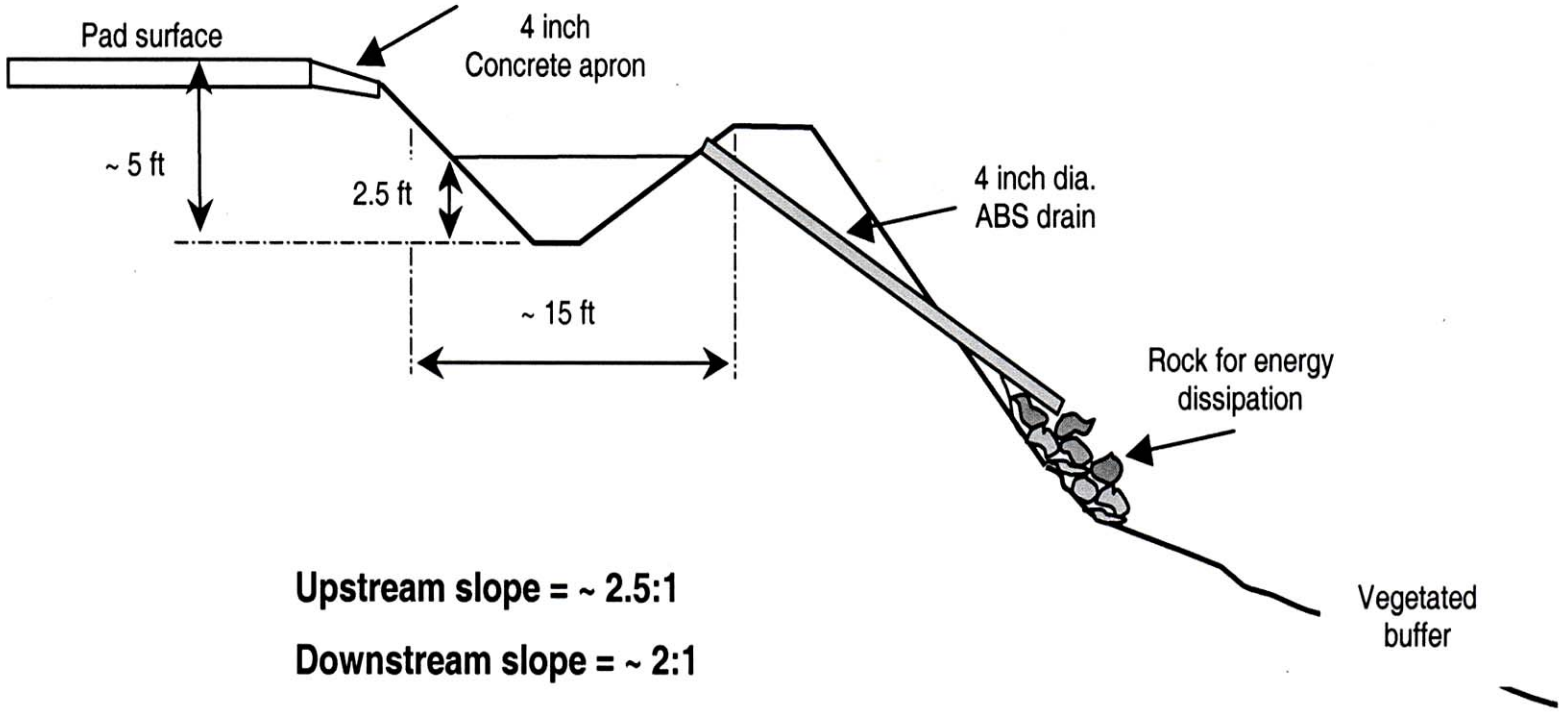
"An activity is excluded (from CIWMB regulation) if it handles agricultural material derived from an agricultural site, and returns a similar amount of the material produced to that same agricultural site, or an agricultural site owned or leased by the owner, parent, or subsidiary of the composting activity. No more than an incidental amount of up to 1,000 cubic yards of compost product may be given away or sold annually". - CIWMB

Water Quality Regulations

- CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
- REPORT OF WASTE DISCHARGE
- BMP's
- WAIVER
- http://www.waterboards.ca.gov/

Compost Leachate

Cross Section of an Example Detention Basin



Detention Basin and Energy Dissipator

A detention basin should be included in the design at the low end of the compost pad to capture and temporarily hold storm water

Grassed waterway for safe disposition of runoff


Vegetated filter
between compost pad and surface water

Bins

O2 Compost Micro-bin

- Photo: Peter Moon, 02Compost

Windrows


KUBOTA LA950A
L4850
KUBOTA
EC

Compost Covers

Pellet Bedding

- May reduce volumes by 20-25%
- Requires less time to compost
- Results in a final product with a lower C:N ratio

When is Compost Done?

- Temperature: 90-120° F
- Odor pleasant; no ammonia or off odors
- Material is dark in color and uniform in texture
- Bioassays

Germination Index

(Zucconi et al, 1981)

$$G.I. = \frac{\text{Rootlet's length in OMW}}{\text{Rootlet's length in water}} \times \frac{\text{Germination in OMW}}{\text{Germination in water}} \times 100.$$

From: Tsioulpas, et al, 2002

- Relevance depends upon use of final product:
  - seedbed vs permanent pasture.
- Garden Cress (most sensitive)
- Roquette
- Rapini

Compost Use

- 300 cubic yards of bedding manure will produce 150-200 cubic yards of compost
- Which will cover one acre of land with about 1 inch of compost

2” of compost per acre is about 300 cubic yards or 150 tons

Composting Economics

- *Site Development Costs: materials and labor*
- *Quantity of manure with bedding generated (per day, week, month, and year)*
- *Labor required to collect, store, transport to site, compost and manage*
- *Equipment needed (loader, watering system, transport, thermometer)*
- *Equipment maintenance expenses*
- *Other costs (lab sample, permitting, other)*
- *Compost use (on site, trucked away or sold – could be a cost or a return*
- *Present manure disposal costs*
- *Avoided environmental and regulatory costs*

Composting Summary

- Prepare your site to ensure the compost area drains well and does not threaten water quality.
- Collect manure from corrals and pens carefully - conserve bedding.
- Monitor temperature and moisture regularly.
- Make provisions for turning and adding supplemental water when needed.

Composting Summary, Cont…

- Keep the composting area clean and well maintained.
- Use the finished product in your landscapes, planters, and gardens.
- Have laboratory analysis performed on compost samples initially and if compost procedures change.

Carbon Sequestration

- If we ended all greenhouse gas (GHG) emissions tomorrow, atmospheric CO2 would take a hundred years to return to 1985 levels. [IPCC, 2007].
- Even the most effective GHG emissions reductions program will not be enough to avoid catastrophic changes in global ecosystems.
- Such programs ***must*** be accompanied by *carbon sequestration* on a global scale.

Good News: Compost can Reduce Atmospheric CO2

'… every one tonne increase in soil organic carbon represents 3.67 tonnes of CO2 sequestered from the atmosphere and removed from the greenhouse equation.'

'For example, a 1% increase in organic carbon in the top 20 cm of soil (with a bulk density of 1.2 g/cm3) represents a 24 t/ha increase in soil OC which equates to 88 t/ha of CO2 sequestered.'

-Dr Christine Jones (2006), Australia

Acknowledgements

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