Quality Assurance in Mortality Composting

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What Farmer Educators Need to Know about Mortality Composting – Beyond the Basics

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Carcass Disposal Options

Render – best option, where available but rules and regulations have made this more difficult resulting in insufficient capacity

Compost – uses resources found on-farm, cost effective, minimizes farm and public exposure, can be done on-site

Alkaline digestion – environmentally friendly, expensive, insufficient capacity

Burial – 6’ closer to water table, no leachate control

Incineration – costly, inefficient, air pollution

Landfill – expensive, insufficient capacity, worker trepidation

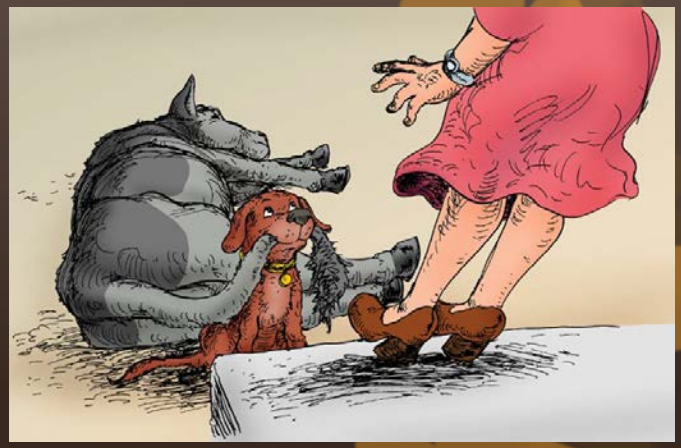
Carcass left outside for scavengers to decay – disease transmission risk

Low Risk

High Risk

Why Should Farms Compost?

- Pathogen kill in thermophilic composts
- Can be done with equipment available on most farms
- Odor reduction
- All sizes of animals can be composted
- Relatively low labor and management needed
- Placental membranes and other tissue can be composted
- Doesn't cost a lot of money
- Neighbor relations



What is composting?

It is the aerobic, or oxygen requiring, decomposition of organic materials by microorganisms under controlled conditions

Composting reduces both the volume and mass of the raw materials while transforming them into a valuable soil conditioner

The Composting Process

Microorganisms consume oxygen while feeding on organic matter and as a result, give off heat.

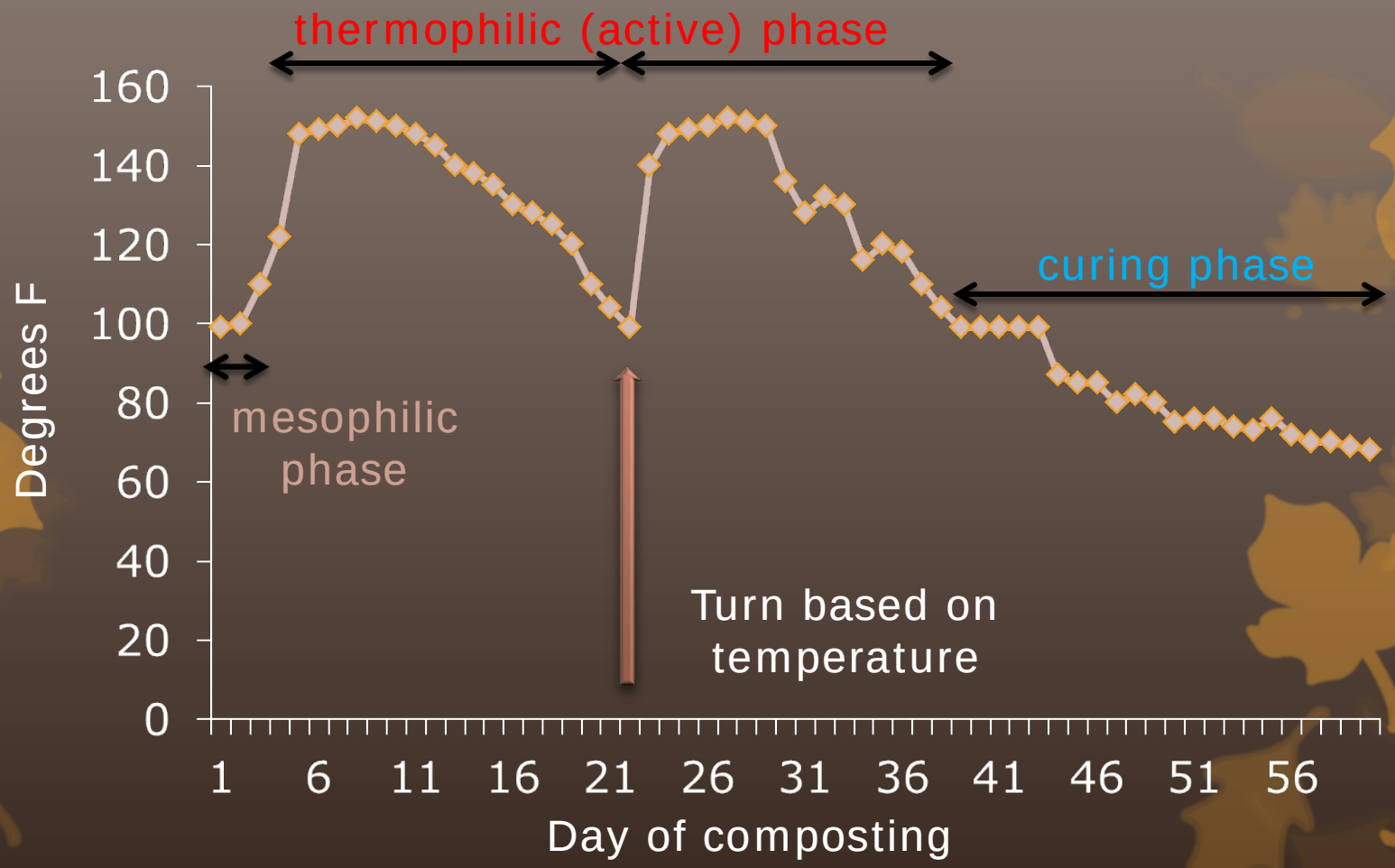
Composting Process Variables:

- ❑ Micro- and macro-organisms
- ❑ Diet
- ❑ Air
- ❑ Moisture
- ❑ Shelter

By managing these factors you can speed up the otherwise slow natural decay process

- Micro- and macro-organisms

Phases of Aerobic Composting



Aerobic composting and temperature

- Active composting occurs in the temperature range of 90ºF to 160ºF
- Pile temperature may increase above 160ºF but this is too hot for most bacteria and decomposition will slow until temperature decreases again.

Remember, Compost pile heat is the direct result of microbial metabolism!!!

Diet

Nitrogen comes from the GREEN material. Organisms use this as a source of protein to grown and reproduce.

Carbon comes from the BROWN material. organisms use this as a source of energy

What is C:N Ratio?

- Supply of total carbon compared to total nitrogen in compost feedstock
- If C:N is too high the compost process will slow
- If C:N is too low, more likely to lose Nitrogen as ammonia gas or in leachate
- Ideal initial C:N mixture range is 20 – 30:1.

Air

FEEDSTOCKS

MANAGEMENT

Shelter

Moisture

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What Happens in Mortality Composting?

- The Diet is all wrong (C:N about 50:1)
- Air flow occurs passively
- Moisture comes from the carcass as it decomposes

Mortality composting does not follow the rules of starting with a “mix” with the right moisture and C:N ratio. Instead, the envelope of carbon material simply allows the natural process of decomposition to occur in a manner that will absorb the moisture and odors emitted when carcasses decay.

Composting Methods

Static Pile – Passively Aerated OR Turned Windrow

In-Vessel – buildings, bags, cylinders

Carcass Composting Steps

- Select Site
- Prepare base
- Place animal and cover
- Layer young and/or small animals
- Let sit 4 to 9 months

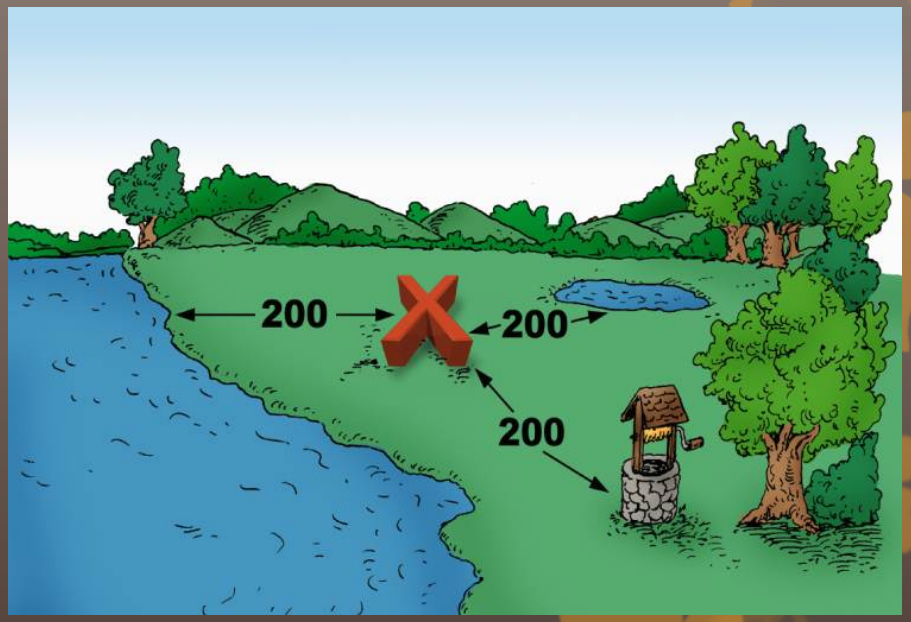
- Use the composted material
- Reuse bones/uncomposted material

Compost Siting

- Encourage proper composting procedure
- Environmental protection
- Ability to monitor and manage piles and site

1 Select a site

- Water
- Air
- Slope, soil conditions
- High and dry
- Amount and storage of feedstock
- Access to work on pile
- Population density



Make sure you are not close to wells, streams, water bodies. Check depth to groundwater. Look for plants that indicate wet areas.

Pads

- Vehicle/Equipment access
- Leachate absorption/collection
- Tidiness

Ground and Surface Water Protection

- Filter strips
- Compost berms and socks
- Berms for diversion off-site
- Grading/slope 1-2% and direction of piles
- Collection lagoons
- Collection tanks
- Site maintenance

Let's Explore

Let's Explore

2 Prepare a Base

Lay 24-in bed of bulky, absorbing organic material containing some sizeable pieces.

Feedstocks

Not all carbon sources are created equal

Feedstocks

Feedstock Characteristics

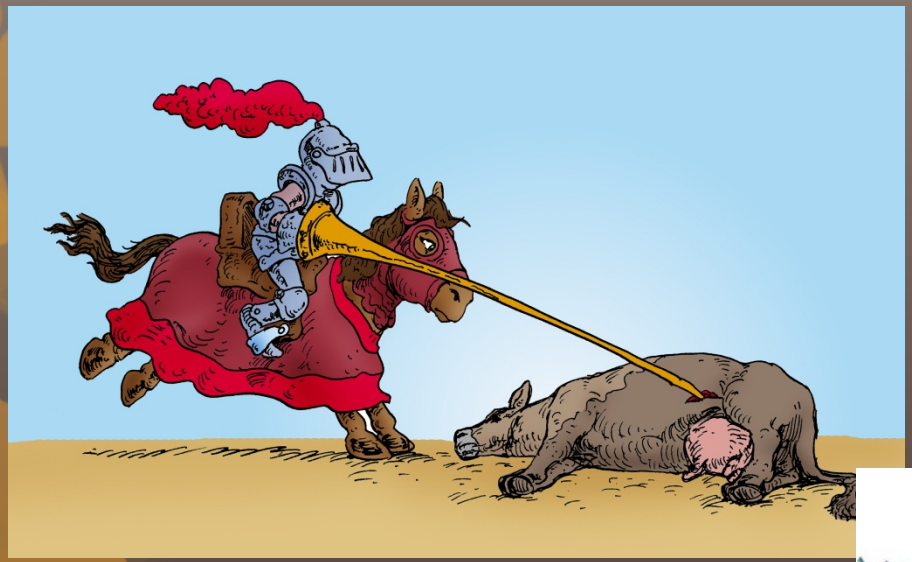
TEXTURE
MOISTURE
AMMONIA/ODOR POTENTIAL
BIOFILTER/ODOR CONTROL

Potential Farm Feedstocks

ANIMAL BEDDING
WASTE FEED
MANURE
STRAW
SPENT SILAGE/HAY/REFUSALS

Feedstock Storage

3 Place Animal and Cover



Lance the rumen.

Cover with dry, high-carbon material. Other materials?

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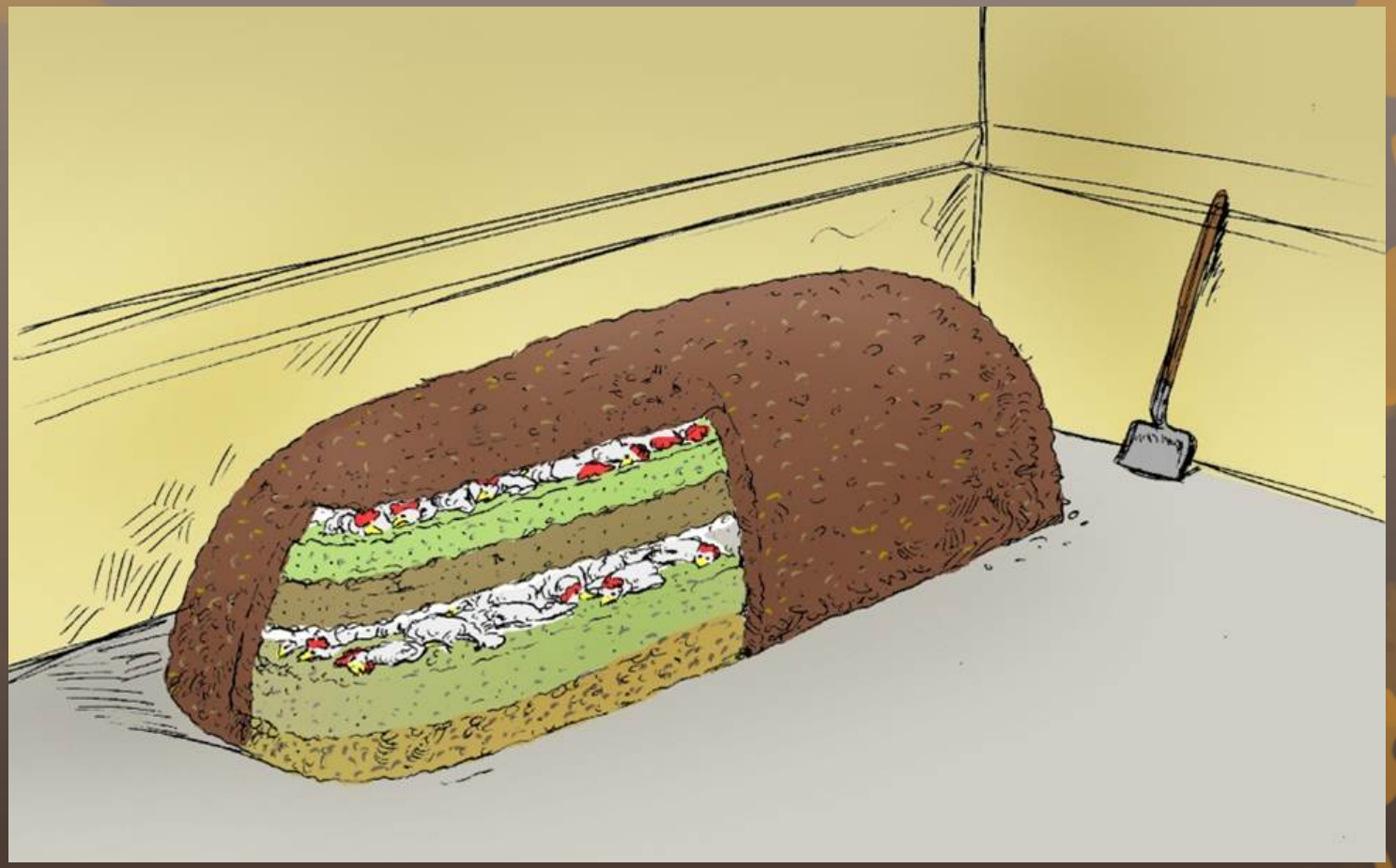
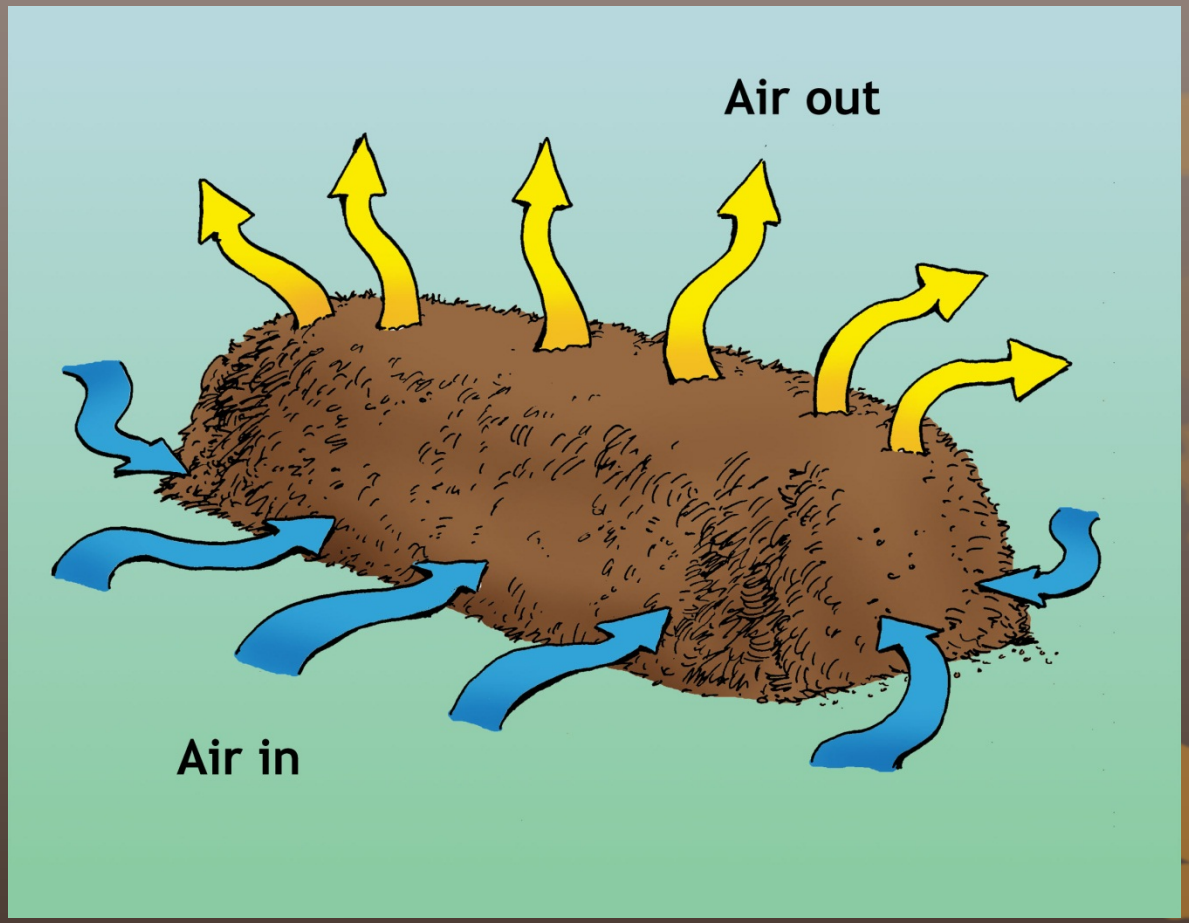
Layering



For young or small animals, layer mortalities with a minimum of 2 feet of carbon material between layers



Thermal air movement and diffusion in a well-built passively aerated static pile

Some Best Management Practices

Incorporate dead stock in a timely fashion.

Large, poorly shaped piles are not efficient.

Some Best Management Practices

Not enough cover

Forgetting to lance the rumen

Avoid driving on the pile/base

Let's Explore

POSITIVES?

NEGATIVES?

Let's Explore

NEGATIVES?

Not organized

Fine carbon

Dog attracted to pile

Let's Explore

NEGATIVES?

A little short?

Hard to get in to maintain?

POSITIVES?

Neat piles

Easy Access

How Long Does it Take?

- Well stacked piles should heat up in 12 – 24 hours
- **Month 1** – Cooked Meat
- **Month 2** – Meat is Digested
- **Month 3-4** – Clean Bones
- Mature Compost in **6 – 12 months**

How Long Does it Take?

Month 2 – Meat is Digested

Month 3-4 – Clean Bones

4 Let sit 4 – 6 months

Monitor pile, keep good records.
Check to see if carcass has decomposed

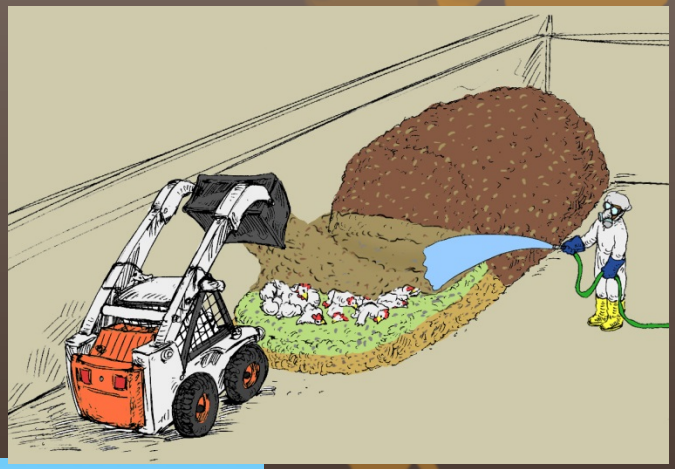
5 Use the Composted Material

Reuse Bones and Uncomposted Material

Worker Health and Safety

- Wash hands
- Remove contaminants – footwear and clothing
- Keep materials moist to avoid bioaerosols
- Proper PPE for compromised individuals and when disease is present
- Gaseous emissions – in vessel,

  early in process



Disease Issues – PPE: Hand Protection

Light-weight nitrile or vinyl disposable

Heavy-duty 18-mil rubber that can be disinfected

Avoid touching the face and mucus membranes, including eyes

Look for punctures, tears, other damage

PPE: Body, Head, Foot Protection

Disposable outer clothing; impermeable apron

Disposable head cover

Disposable shoe covers or boots that can be disinfected

PPE: Eye and Respiratory Protection

Safety goggles

NIOSH approved disposable respirator

Loose-fitting helmeted or hooded powered air-purifying respirator with HEPA filter – facial hair

Conduct seal check each time

Fit testing for non-disposable

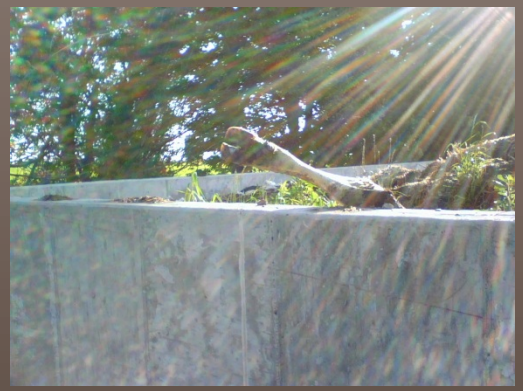
Do all of the options have the same environmental implications?

- Human/Animal Safety – Pathogens
  - Veterinary drugs
- Water – Nutrients
  - BOD
  - TOC
  - Pathogens
- Soil – Nutrients
  - Pathogens

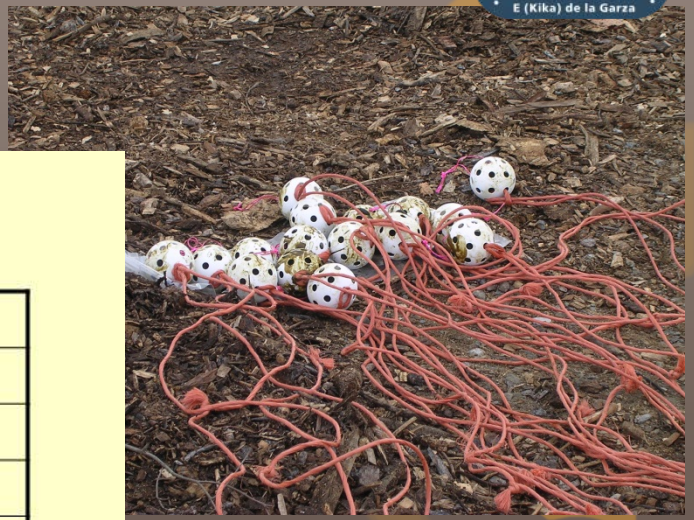
CWMI Research

Human/Animal Safety

Water and Soil



DOT Study



Relative Hardiness of Pathogens

	Hardiness Rating		
Pathogen	1	2	3
Salmonella spp.	*		
E. coli and *E. coli* O157:H7	*		
Campylobacter spp.	*		
Yersinia spp.	*		
Listeria spp.	*		
Leptospira spp.		*	
Streptococcus (enterococci)		*	
Clostridium perfringens			*
Mycobacterium			*

A rating of 3 indicates that there is sufficient data to suggest that an organism is capable of surviving when exposed to various stressors, while a rating of 1 would indicate that the organism would not be expected to survive when exposed to stressors (Smith, et al, 2005).

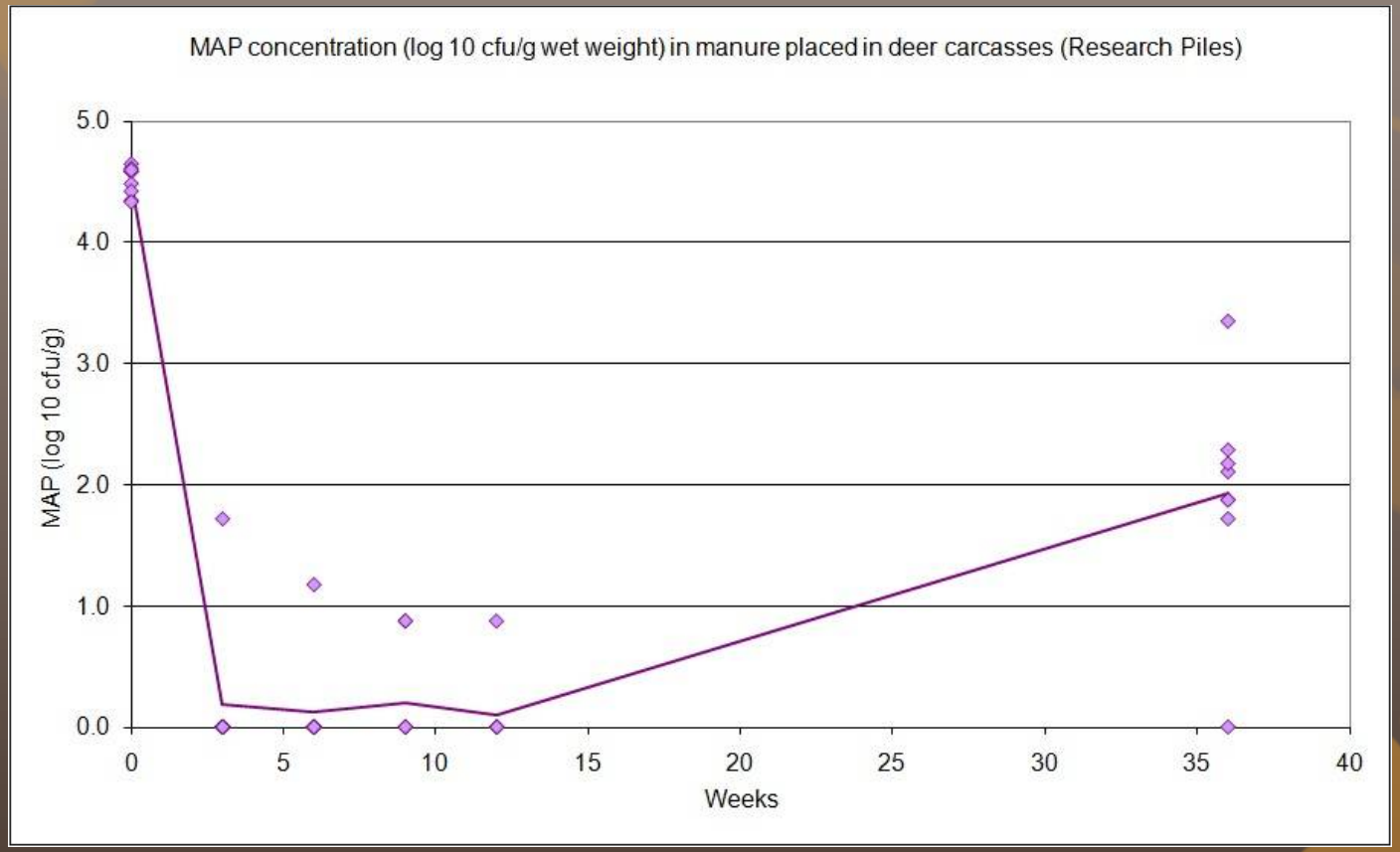
Results

Average pathogen levels in compost over time (log_{10} MPN/g solids)

Pathogen	Month 0	Month 3	Month 6	Month 9	Month 12
Fecal Coliforms	4.49^{a}	3.80^{ab}	3.48^{b}	1.00^{c}	0.22^{c}
E. Coli	3.57^{a}	2.81^{ab}	1.94^{b}	0.53^{c}	0.19^{c}
Fecal strep	7.37^{a}	5.00^{b}	4.24^{bc}	3.00^{c}	2.62^{c}
Enterococci	4.75^{a}	2.80^{b}	1.72^{bc}	2.20^{bc}	0.81^{c}

- Fecal coliforms and *E. coli* significantly reduced by month 6 down to essentially zero by Month 12.
- Initial 2 log_{10} reduction in fecal streptococci and enterococci by month 3 and an additional 3 log_{10} reduction by month 12

Results



- Immediate decrease from 4.5 $\log_{10}$ cfu/g at week 0 to 0.1 to 0.2 $\log_{10}$ cfu/g through week 12
- Week 36 – 6 samples at 2 $\log_{10}$ cfu/g (1-30 colonies) and one > 3,000 cfu/g (too numerous to count).

Veterinary Pharmaceuticals

Year 1 – liver samples

Year 2 - woodchips

2 grams pheynlbutazone
120 ml Fatal Plus

Veterinary Pharmaceuticals

Year 1 – leachate

Year 2 - leachate

2 grams pheynlbutazone
120 ml Fatal Plus

Results - Pentobarbtial

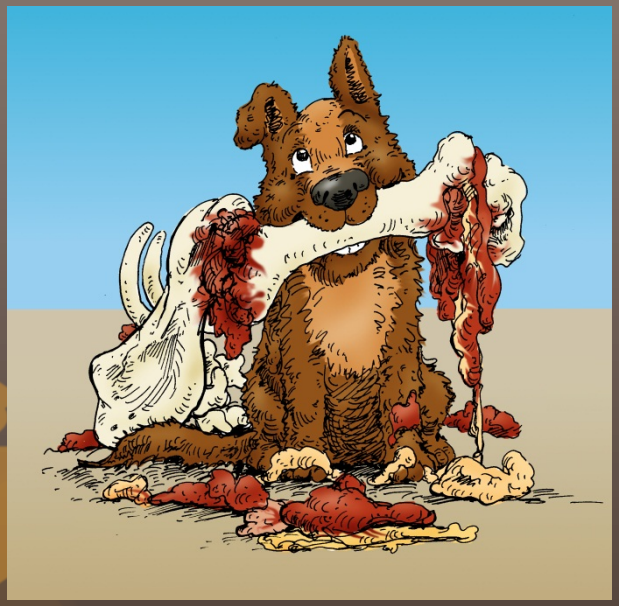
Year 1

- Original dose: 46,800 mg/455 kg horse = 102.9 mg/kg
- Below detection limit by day 83
- Significantly lower than at euthanasia by day 6 in the burial hole, but not until day 41 in the compost pile
- Exponential decay of 18.4%/day; 3.4 day half-life (burial hole); 2.2%/day; 30.9 day half-life (compost pile)
- In effluent, dropped 7-fold between day 6 and 15

Year 2

- Original dose: 46,800 mg/590 kg horse = 79.2 mg/kg
- Levels in woodchips (and compost) significantly lower (14-fold decrease) than in blood at all sampling dates, but not different from each other
- Total of 6.6 liters of leachate collected (about 1.7% of total fluids) due to C:N ratio
- Exponential decay of 35.2%/day; 1.6 day half-life

Conclusions



- Most cases of barbiturate poisoning occur from direct feeding of improperly disposed livestock
- Composting creates sufficient heat during the time in which the carcass would be most desirable – cover minimizes smell of decomposition
- Diverse community of microorganisms aids in the degradation and/or biotransformation of pentobarbital
- The resulting compost contains either no or very low levels of both NSAIDs and barbiturates

Environmental Quality

Leachate – Above ground burial versus composting

- NITROGEN and BOD
- NH_4-N may deplete dissolved oxygen
- BOD is a measurement of the polluting strength of waste in terms of the O_2 it will consume if discharged into surface waters
- Total organic carbon (TOC) is amount of carbon bound in an organic compound.
- Can cause problems in water due to color formation, taste and odor problems and O_2 depletion

Environmental Quality

30’ wide by 15’ deep with three 54” containment walls

The pad has a 1% slope to the west wall with four 4” pipes incorporated for draining leachate toward a vegetated filter strip

Very little carbon was used, and the containment was packed with carcasses

Environmental Quality

Set up 2 curbed plots with 6 mil black plastic and collection buckets

Woodchips only pile and compost pile with 4 road-killed deer

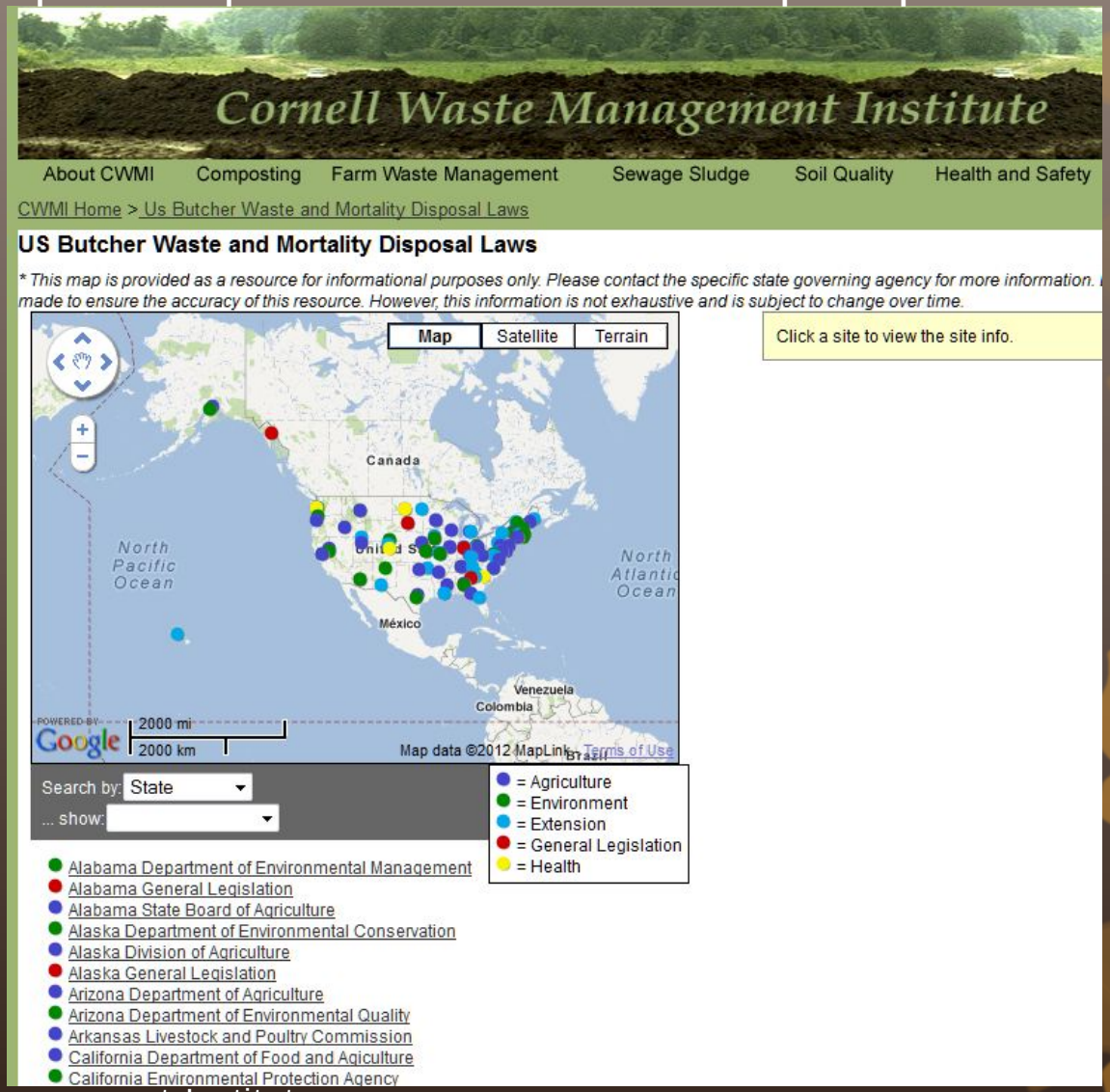
Collected effluent after rain events

Hygienic Quality and Nutrient Load of Leachate/Effluent

	Road-killed deer compost pile versus woodchips only pile					
	NH4-N (mg/l)		BOD (mg/l)		TOC (mg/l)	
Date	Deer	Chips	Deer	Chips	Deer	Chips
04/14/05	213	11	4,067	487	1,733	373
04/29/08	38	1	333	48	230	36
05/19/08	3	2	27	24	95	163
06/06/08	9	5	101	47	177	17
	Above-ground burial site					
06/02/08	1,100		4,700		7,700	
09/29/08	No data		930		4,600	
10/02/08	4,200		21,000		740	
11/12/08	1,800		3,500		8,100	

CWMI Resources

http://compost.css.cornell.edu/mapsdisposal.html



CWMI Resources

http://cwmi.css.cornell.edu/mortality.htm

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Mortality Composting

Materials address composting as a method to manage livestock mortalities (including mass mortalities resulting from avian influenza), butcher wastes and road killed animals. Also developed is a searchable map of US Mortality and Butcher Waste Disposal Laws.

Horse Mortality: Carcass Disposal

- 8p illustrated fact sheet "Horse Mortality: Carcass Disposal Alternatives" addressing disposal options for your horse. 2012.
- 5-minute video "Natural Rendering for Horses - Composting Horse Mortality" shows how to properly compost a dead horse. Download or view on YouTube. 2012
- "Quantification of Sodium Pentobarbital Residues from Equine Mortality Compost Piles" a paper written for presentation at the 4th International Symposium: Managing Animal Mortalities, Products, By-producs and Associated Health Risk: Connecting Research, Regulations and Response. 2012

Natural Rendering: Composting Livestock Mortality & Butcher Waste

- 12p illustrated fact sheet describing the process, cautions, problems, biosecurity issues, economics and more. 2002.
- 20-minute video describes mortality and butcher residual composting featuring eight operations. Download in English or Spansh. 2002.
- A set of 3 posters (English and Spanish) has been developed for educators:
  - Key Points of Static Pile Butcher Residual Composting. (English PowerPoint or PDF and Spanish PowerPoint or PDF). 2002.
  - Key Points of Static Pile Carcass Composting. (English PowerPoint or PDF and Spanish PowerPoint or PDF). 2002.
  - Potential Environmental and Biosecurity Risk of Dead Animal Disposal. (English PowerPoint or PDF and Spanish PowerPoint or PDF). 2002.
- A How-To On Livestock Composting. Article published in Northeast DairyBusiness, 10(11):18-19. 2008.
- Are Your Deadstock Piles and Disposal Costs Causing Your Farm Nightmares? Article published in Country Folks. Section B: 21-23. 2009.
- Natural Rendering: A Natural Solution for Mortality and Butcher Waste. Article published in Small Farm Quarterly. Fall 2003.
- On-Site Composting of Meat By-Products. 15p final report of a project exploring the economic viability and technical obstacles to on-site composting of meat by-products. 2001.
- The Space It Takes - Footprint Calculator for Composting Butcher Waste. 8pg document. 2010.

Composting Road Kill

- 12p illustrated fact sheet (PDF) on the "how to" of composting road kill deer. 2007.

CWMI Resources

http://cwmi.css.cornell.edu/mortality.htm

Composting Road Kill

- 12p illustrated fact sheet (PDF) on the "how to" of composting road kill deer, 2007.
- 8-minute DVD accompanies the 12p fact sheet (download), 2007.
- Illustrated poster (PDF), 2007.
- Effectiveness of Composting Road-Killed Deer in New York State. Article published in Compost Science & Utilization 18(4):232-241, 2011.
- Evaluating Pathogen Destruction in Road Kill Composting. Article published in BioCycle, 47(11):49-51, 2006.
- Composting Road Killed Deer in New York. Article published in BioCycle 45(5):25-26, 2004.
- Revalence and Persistence of Pathogens in Mortality Composting - a Literature Review.
- Environmental Effects of Mortality Disposal. Proceedings from the 3rd International Symposium: Management of Animal Carcasses, Tissue and Related Byproducts. 2009
- Links to project reports and photos.

Avian Influenza and Poultry Composting

- 12p illustrated fact sheet (PDF) for poultry composting and addresses the emergency response to disease control, 2008.
- 6-minute video "Composting Poultry Mortality" complements the fact sheet (download), 2008.
- Illustrated poster (PDF or Powerpoint), 2008.
- A literature review (PDF) of avian influenza and methods of disposal of affected poultry, 2008.
- Emergency Response Planning for Disposal of Avian Influenza Affected Birds in NYS. Proceedings from the 3rd International Symposium: Management of Animal Carcasses, Tissue and Related Byproducts. 2009..

Other Mortality Composting Resources

- **Webinars.** Current and archived webinars available for viewing. Click here.
- **Livestock Mortality Composting For Large and Small Operations in the Semi-Arid West**, EB0205. 28pg manual. English or Spanish. 2012.
- **Composting Mortality - How To** poster. 2010
- **US Mortality and Butcher Waste Disposal Laws**. A searchable map of rules, regulations and guidance of US disposal laws. 2009. (updated 2012)
- **4th International Symposium: Managing Animal Mortalities, Products, By-Products and Associated Health Risk: Connecting Research, Regulations & Response** May 2012
  - Symposium Proceedings, includes papers, posters and compendium (37 MB PDF file)
  - Symposium Presentations (50 MB PDF file)
  - Laws and Regulations Concerning Butcher Waste and Mortality Disposal in the US poster, Schwarz
  - Mortality Composting Outreach in Brasil/Education Exchange poster, Bonhotal
- **3rd International Symposium on Management of Animal Carcasses, Tissue & Related Byproducts** - July 21-23, 2009. Proceedings and Compendium are available.
- **Managing Mortalities for Beef and Dairy Producers** - webcast: A recent FDA rule is likely to impact the cost and/or availability of rendering services for cattle producers. What is this rule and how will it impact service? Are there other environmentally-responsible methods of carcass disposal? This presentation was originally broadcast on June 19, 2009.

Composting Mortality

DEER → COWS → **How To** ← HORSES ← CHICKENS

birds • goats • whales • butcher waste • pigs • fish

Keep compost piles a safe distance from homes, businesses and watercourses.

Windrows should be 6'-8' high x 8'-12' wide x as long as you have the space.

Static pile construction during a disease outbreak.

1. **Select a site that is well drained,** not subject to flooding, and at least 200 feet from homes, businesses, water courses, sinkholes, seasonal seeps or other landscape features that indicates the area is hydrologically sensitive.

2. **Prepare base**: Lay 24-inch bed of bulky, absorbent organic material; chips from tree chipping operations 2-inches or larger work well. Ensure the base is large enough to allow for a 2-foot clearance around the carcasses on all sides.

3. **Building piles**: Lay animal(s) in the center of the bed. Lance the stomach of large animals if the carcass is bloated. This will prevent a build-up of gases which could result in an explosion that will create odor problems and blow the cover material off the pile.

4. **Layer animals under 150 pounds** with a 12-inch layer of wood chips in between. This seems to create conditions where the carbon and nitrogen levels are in balance and provides the mass needed to reach thermophilic temperatures.

Make sure carcass is well covered to keep odors down, generate heat and keep vermin or other unwanted animals out of the pile.

5. **Check temperatures** to be sure the composting process is active.

6. **Let pile sit for 4 to 6 months.**

7. **Reuse the composted material** as a bed for additional carcass compost piles or spread on land used to grow feed for animals.

8. **Site cleanliness** is the most important aspect of composting. It deters scavengers, helps control odors and keeps good neighbor relations.

Don't drive on the base or the pile.

Cover with 24-inches of chunky carbon source.

Benefits of Composting

- Can be done any time of year, even when the ground is frozen.
- Can be done with equipment already in place on most farms.
- All sizes of animals can be composted.
- Relatively low requirements for labor and management.
- Pathogen kill occurs in thermophilic composts; helps control bacterium, viruses and spore forming organisms in disease outbreaks.
- Egg waste and hatching waste can be composted.
- Paunch manure and other parts not accepted in rendering will compost.
- Placental membranes and other tissue can be composted.
- Relatively odor-free.
- Economical.

Moisture Management in Different Climates

Shape pile to accept or reduce moisture input.

1. Wet climates - Peaked piles allow the least input.

2. Dry climates - Flat topped windrows accept the moisture that fall on them.

3. Very dry climates - Add water to carbon source while building pile and trench windrow to allow moisture to collect and be absorbed.

A Northern Right Whale composted at the Paleontological Research Institute, Ithaca, NY.

For more information about mortality composting go to: http://cwmi.css.cornell.edu/mortality.htm

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