Environmental Aspects of Carcass Disposal

Brent W. Auvermann
Texas A&M University System
Amarillo, TX

Citation

Engels, B., K. J. Lim, J. Y. Choi and L. Theller. 2004. Chapter 14: Evaluating environmental impacts. In: *Carcass Disposal: A Comprehensive Review*. Literature review prepared for USDA-APHIS by the National Agricultural Biosecurity Center Consortium, Carcass Disposal Working Group, March 2004 review draft.

Conclusions of Iowa Study

- Signals of carcass presence persist; complete decay takes 2 years or more
- Elevated Cl, TDS, BOD and NH_4^+ "within or very near" burial zones
- Extent of contamination depends on local groundwater velocity field; was found only within 2 m of trenches in two case studies

Ground Water Quality: Burial's #1 Threat

- "Burial of carcasses is likely to have the greatest impact on water quality of the carcass disposal techniques discussed."
- UK: 24% of incidents of surface and ground water quality impairments from 2001 carcass disposal events due to burial in high-water-table areas
- Leachate quality needs to be assessed early in the disposal event
- Recommended analytes: Cl, NH_4, NO_3, conductivity, total coliforms & *E. coli*

Ground Water Risks of Other Disposal Techniques

- Incineration
  - Atmospheric deposition of fumes and smoke
  - Residue (ash) requires disposal or beneficial use
  - Introduces fuel-borne contaminants (e. g., metals)
- Alkaline Hydrolysis
  - Requires disposal of digestate
  - Land application may require monitoring if ground water is shallow or soils are fractured
- Composting
  - Requires subsequent disposal
  - May generate leachate
  - Varmints may distribute carcass parts before they are stabilized

Air Pollution (cont'd)

- Composting: main threats are odors and bioaerosols
  - Good management mitigates both
  - Most enteric pathogens do not persist long as viable organisms when aerosolized

Conclusions

- Most so-called "disposal" techniques are actually "treatment" or "stabilization" techniques
  - Alkaline hydrolysis
  - Composting
  - Incineration
  - Processes generate other waste streams with environmental or ecological significance
  - Environmental risks associated with waste streams and final beneficial use or sequestration

TABLE 1. Percent of operations using (percent of mortalities disposed by) various disposal methods. Note values may not total 100% as operations may use more than one disposal method.

Disposal Method	Feedlot Cattle[a]	Dairy Cows[b]	Weaned Pigs[c]	Sheep[d]	Layer Hens[e]
Buried on operation	10.7 (5.3)	22.7	37.8 (11.5)	51.7 (27.1)	--
Landfill	1.6 (0.5)	1.9	--	7.5 (6.9)	--
Rendering	94.4 (94.1)	62.4	45.5 (68.0)	2.3 (4.2)	32.0 (41.4)
Incineration/Burn	--	2.2	11.6 (6.0)	12.9 (7.5)	9.0 (10.4)
Composting	--	6.9	18.0 (12.7)	6.9 (5.0)	15.0 (11.7)
Leave for scavengers	--	--	--	25.3 (47.4)	--
Covered deep pit	--	--	--	--	32.0 (17.9)
Other	0.4 (0.1)	3.9	2.5 (1.8)	2.6 (1.9)	16.1 (18.6)

[a](USDA, 2000a)
[b](USDA, 2002a)
[c](USDA, 2001a)
[d](USDA, 2002b)
[e](USDA, 2000b)

TABLE 5. Costs associated with on-farm trench burial of daily mortalities (Adapted from Sparks Companies, Inc., 2002).

Species	Total Annual Mortalities	Labor Required for Burial per Mortality[a]	Total Hours Required for Burial	Estimated Costs			Estimated Cost Per Mortality[b]
				Total Labor Cost ($10/hr)	Equipment Cost ($35/hr)	Total Cost	
Cattle (over 500 lbs)	1,721,800	20 min ea	573,930	$5,739,300	$20,087,670	$25,827,000	$15.00
Calves	2,410,000	10 min ea	401,660	$4,016,600	$14,058,330	$18,075,000	$7.50
Weaned hogs	6,860,000	10 min ea	1,143,330	$11,433,330	$40,016,670	$51,450,000	$7.50
Pre-weaned hogs	11,067,700	10 min per group of 10	184,460	$1,844,610	$6,456,100	$8,300,780	$7.50 per group of 10
Other	832,700	10 min ea	138,780	$1,387,830	$4,857,300	$6,245,250	$7.50
TOTAL	22,892,200		2,442,160	$24,421,670	$85,476,070	$109,898,030	

[a]Labor = time in minutes to excavate trench, deposit carcass, and backfill trench.
[b]Estimated Cost per Mortality = Total Cost / Total Annual Mortality.

TABLE 4. Approximate time required to excavate burial trenches of various volume using three equipment types (adapted from Lane, 2003).

Carcass Units @ 1000 lbs ea	Approx. Excavation Volume Required[a]	Approx. Alternative Trench Dimensions (L x W x D)	Approximate Excavation Time (Hours)		
			13 yd scraper (78 cu yd/hr)	15 yd scraper (103.3 cu yd/hr)	27 yd scraper (162.03 cu yd/hr)
5,000	7,500 cu yd (202,500 cu ft)	450 ft. x 45 ft x 10 ft 250 ft x 81 ft x 10 ft	96.2	72.6	46.3
10,000	15,000 cu yd (405,000 cu ft)	450 ft x 90 ft x 10 ft 250 ft x 162 ft x 10 ft	192.3	145.2	92.6
25,000	37,500 cu yd (1,012,500 cu ft)	450 ft x 225ft x 10 ft 180 ft x 562 ft x 10 ft	480.8	363.1	231.5
50,000	75,000 cu yd (2,025,000 cu ft)	450 ft x 450 ft x 10 ft 180 ft x 1125 ft x 10 ft	961.5	726.2	462.9

[a]Assume 1.5 yd^3 of excavation area required per 1000 lb carcass unit.

Design and Operation

- Decomposition of carcass slows by two orders of magnitude in burial as compared to carcasses exposed to the elements
- When relying on natural attenuation of noxious products, optimal soil texture is sand/clay mix with low porosity

Why I Prefer Composting

- On-site method for routine, average mortality
- Accelerates decomposition by >3 orders of magnitude as compared to burial
- Above-ground method – remains visible, harder to ignore or pretend "problem solved"
- Environmental impact can be seen or smelled rather quickly
- Mostly subject to known, controllable risk factors
- Land application may diffuse environmental risk
- Persistence of resistant organisms is an unknown – *but the same is true with burial!*

How to Fail (Miserably!) at Composting Large Animal Mortalities

Brent W. Auvermann, Texas A&M University System
Western Dairy Management Conference
Reno, NV

You've Got Other Options

- Burial (tut, tut)
- Incineration ($$$, air quality regs)
- Biological and chemical digestion
- Pitch 'em out back

The ABCs of Messing Up a Compost Pile

Do Bacteria Really *Have* Knees?

- Screwing it up means *cutting off the thermophilic aerobes at the knees*
  - Imbalanced diet
  - Not enough insulation
  - Too much water (or not enough)
  - Not enough air (or too much)

Atkins™ vs. South Beach™

- Carbon-to-nitrogen ratio (C:N) of 30.00000:1

10 30 50

- Low-carb diet favors NH_3 release

Air and Water

1. Screwing up a pile means getting air and water out of proper balance
2. Water displaces air in a pile
3. Too wet goes anaerobic; too dry goes dormant
4. Too wet = >60%; too dry = <35%

Optimal Moisture Conditions

Microbial Activity Decreases

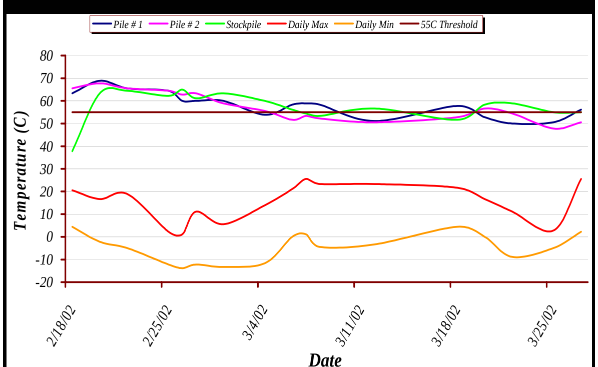
Pore Space Begins to Fill; Anaerobic Conditions Predominate

40%

60%

Some Like it Hot

- The cooler the pile, the easier the screw-up
- Small piles can't insulate themselves
- Oversized piles reduce O_2/CO_2 transfer
- Optimal pile size depends heavily on the distribution of pore sizes



Try *This* at Home!

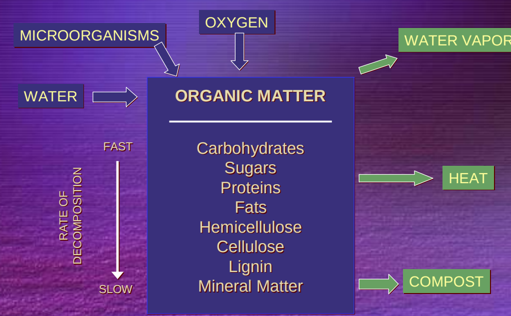
A Few Relevant Lessons from the Taiwanese

- Left to their own devices, large, intact carcasses will rot from the inside out
- Rotting carcasses generate lots of nasty gases
- Intact skin makes a decent balloon
- The larger the carcass, the more spectacular the failure

Tool Time™

- Carbon-rich materials
  - Variety of pore sizes
  - Total C is not the same thing as available C

So…how might we *mess up* a compost pile?



C:N Ratios of Some Carbon Sources

Feedstock	N (%db)	C:N Ratio	C (%db)
Fruit wastes	1.5	35	52.5
Yard wastes	1.3	23	29.9
Paper	0.3	173	51.9
Sawdust	0.1	511	51.1
Grass clippings	3.7	15	55.5
Leaves	0.9	48	43.2
Produce waste	2.2	20	44.0
Food wastes	3.2	16	49.9
Pine wood shavings	0.1	723	72.3
Oat straw	1.1	48	52.8
Wheat Straw	0.3	128	38.4

Tool Time™

- Carbon-rich materials
  - Variety of pore sizes
  - Total C is not the same thing as available C
- Big, nasty, masculine, exhaust-belching machines
- Reliable water source
- Long-stemmed thermometer
- Weaponry

Building for Failure

- Site selection
  - Right next to the road or other critical stuff
  - Bare, sandy soils
  - Sheltered from the wind
- Base material
  - Hydrophobic
  - Thin
  - Easily compressed

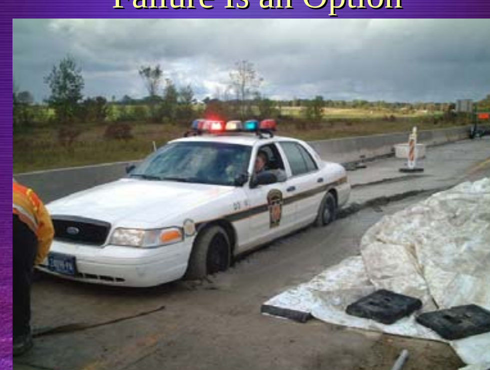
Nature Can Help You Blow It

- Rain, snow and cold are the enemies
- Easterners and Southerners have one set of concerns
- Westerners have another
- Northerners have still another
- To shed or not to shed?

Animal House™

- Microbes need supervision, not micromanagement
- The larger the carcass, the longer the composting time
- Think twice about marketing this stuff to your neighbors

Failure Is an Option



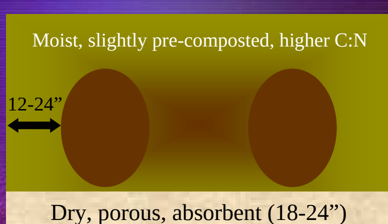
Wrapping It Up

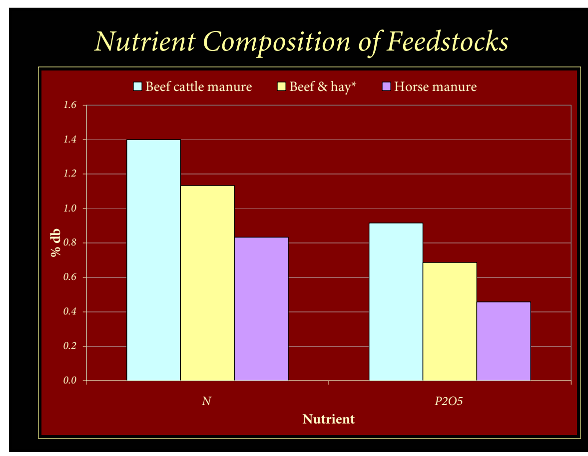
- Failure is an option
  - Choose a location with bare, sandy soil
  - Use whatever nasty waste materials you have on
  - Soak 'er good
  - Show off those body parts
  - Walk away
- Get region-specific advice
  - Regulations
  - Carbonaceous feedstocks
  - Land application guidelines

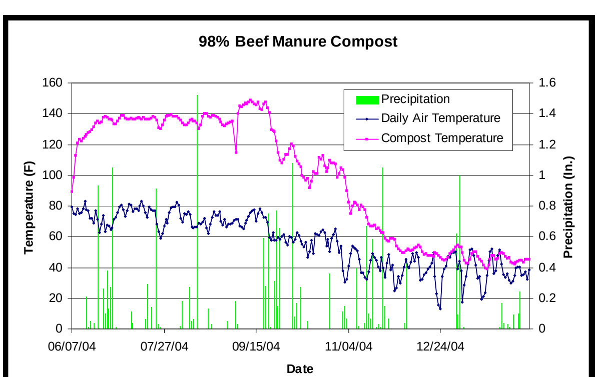
A Tale of Five Carcasses

1. 98% beef manure with hay, 450-lb calf, started 6-7-04
2. 100% beef manure, 400-lb calf, start 4-16-04
3. Horse manure and bedding, 400-lb calf , start 4-16-04
4. 50/50 beef manure/hay, 600-lb calf, start 4-16-04
5. Beef manure and hay, 400-lb calf, start 6-23-04

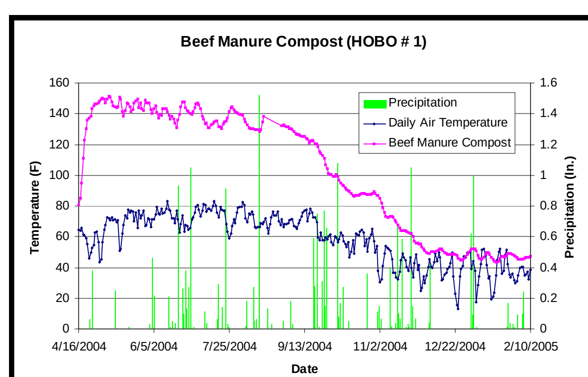
"Ideal" Carcass Pile



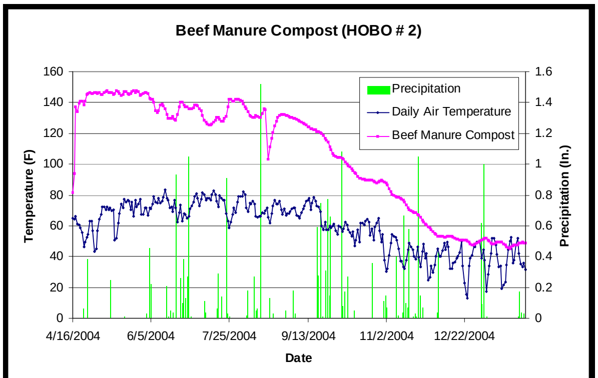

Nutrient Composition of Feedstocks
Beef cattle manure
Beef & hay*
Horse manure
% db
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
N
P2O5
Nutrient


98% Beef Manure Compost
Precipitation
Daily Air Temperature
Compost Temperature
Temperature (F)
Precipitation (in.)
160
140
120
100
80
60
40
20
0
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
06/07/04
07/27/04
09/15/04
11/04/04
12/24/04
Date

Pile #1


Beef Manure Compost (HOBO # 1)
Precipitation
Daily Air Temperature
Beef Manure Compost
Temperature (F)
Precipitation (in.)
160
140
120
100
80
60
40
20
0
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
4/16/2004
6/5/2004
7/25/2004
9/13/2004
11/2/2004
12/22/2004
2/10/2005
Date

Pile #2



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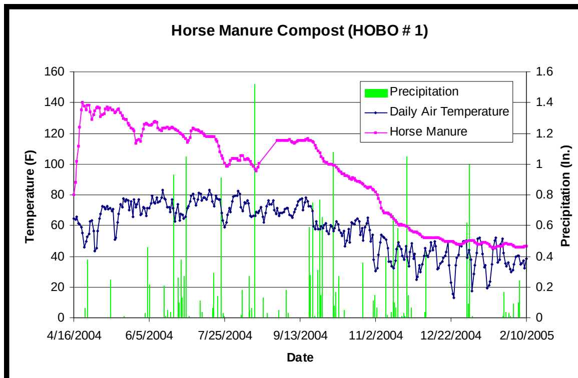
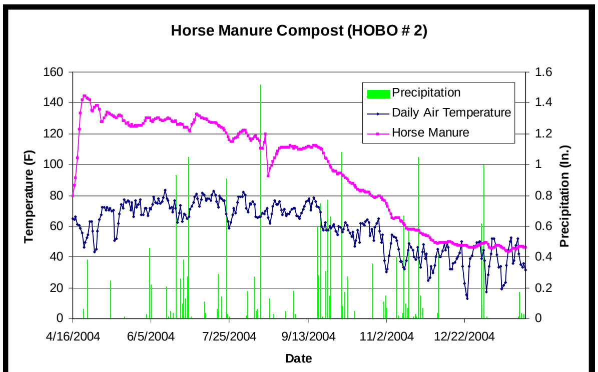
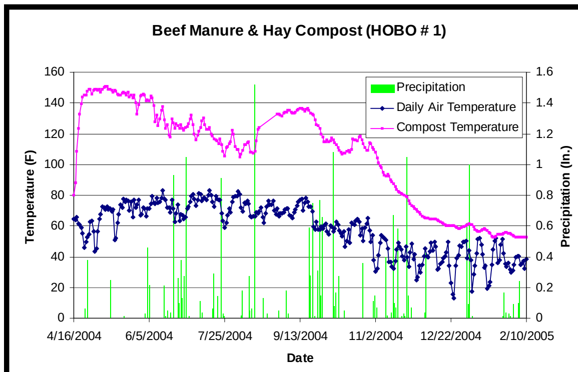


Pile #3



Pile #3



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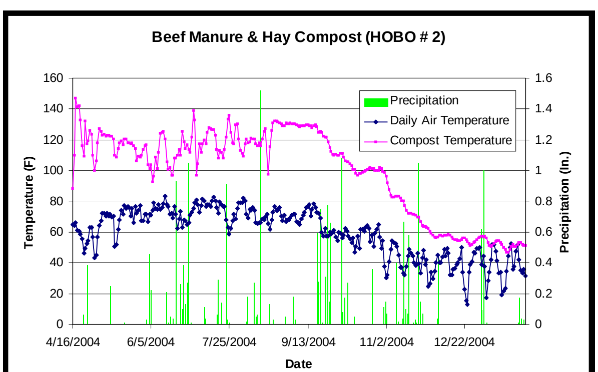

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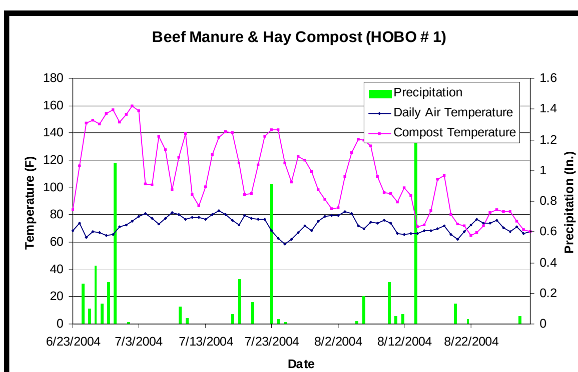

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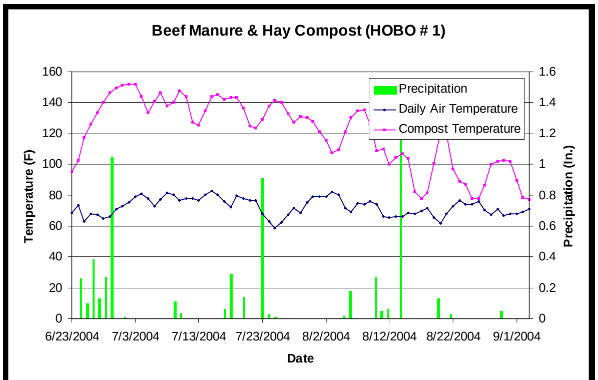

Pile #5

Other Relevant Data

- Ending moisture contents ranged from 32-47% wet basis
- C:N ratio "conventional wisdom" needs to be reconsidered, or at least taken with salt grains
  - Excellent results in rainy weather even with C:N of 11 or 12 (manure only; manure + hay)
  - C:N ratio and porosity distribution show some interactions in overall pile performance
  - "OK, it works in practice, *but does it work in theory*?"

Questions?