Environmental Aspects of Carcass Disposal

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

Conclusions of Iowa Study

- Signals of carcass presence persist; complete decay takes 2 years or more
- Elevated Cl, TDS, BOD and NH₄⁺ “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, NH₄⁺, NO₃⁻, 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

Citation

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

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!

| 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. |

<table>
<thead>
<tr>
<th>Disposal Method</th>
<th>Bovine (10)</th>
<th>Bovine (20)</th>
<th>Equity-Pan &amp; Upland (10)</th>
<th>Bovine (20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Bovine (20)</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Equity-Pan</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Upland (10)</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Upland (20)</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

- *Bovine, 2008
- *Bovine, 2010
- *Equity, 2010
- *Upland, 2008

| TABLE 2. Costs associated with on-farm fecal burial of daily mortalities. (Adapted from Sparks, Companies, Inc. 2020) |

<table>
<thead>
<tr>
<th>Species</th>
<th>Total Animals Disposed</th>
<th>Total Labor Cost ($)</th>
<th>Estimated Costs ($)</th>
<th>Total Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bovine</td>
<td>17,950</td>
<td>2,698,000</td>
<td>20,730,000</td>
<td>23,428,000</td>
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<tr>
<td>Cattle</td>
<td>2,490</td>
<td>1,003,500</td>
<td>11,021,000</td>
<td>12,024,500</td>
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<tr>
<td>Hog</td>
<td>2,490</td>
<td>1,003,500</td>
<td>11,021,000</td>
<td>12,024,500</td>
</tr>
<tr>
<td>Other</td>
<td>2,490</td>
<td>1,003,500</td>
<td>11,021,000</td>
<td>12,024,500</td>
</tr>
</tbody>
</table>

- *Labor = time it takes to excavate trenches, dig open carcass, and backfill trenches
- *Estimated Cost per Mortality = Total Cost / Total Annual Mortality
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

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%

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
- Low-carb diet favors NH₃ 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

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>N (% db)</th>
<th>C:N Ratio</th>
<th>C (% db)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit wastes</td>
<td>1.5</td>
<td>35</td>
<td>52.5</td>
</tr>
<tr>
<td>Yard wastes</td>
<td>1.3</td>
<td>23</td>
<td>29.9</td>
</tr>
<tr>
<td>Paper</td>
<td>0.3</td>
<td>174</td>
<td>51.9</td>
</tr>
<tr>
<td>Sawdust</td>
<td>0.1</td>
<td>511</td>
<td>51.1</td>
</tr>
<tr>
<td>Grass clippings</td>
<td>3.7</td>
<td>15</td>
<td>55.5</td>
</tr>
<tr>
<td>Leaves</td>
<td>0.9</td>
<td>48</td>
<td>43.2</td>
</tr>
<tr>
<td>Produce waste</td>
<td>2.2</td>
<td>20</td>
<td>44.0</td>
</tr>
<tr>
<td>Food wastes</td>
<td>3.2</td>
<td>16</td>
<td>49.9</td>
</tr>
<tr>
<td>Pine wood shavings</td>
<td>0.1</td>
<td>723</td>
<td>72.3</td>
</tr>
<tr>
<td>Oat straw</td>
<td>1.1</td>
<td>48</td>
<td>52.8</td>
</tr>
<tr>
<td>Wheats Straw</td>
<td>0.3</td>
<td>128</td>
<td>38.4</td>
</tr>
</tbody>
</table>

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
Moist, slightly pre-composted, higher C:N
12-24”
Dry, porous, absorbent (18-24”)

“Ideal” Carcass Pile

“Ideal” Carcass Pile

“Ideal” Carcass Pile
**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?”

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**Questions?**