Economic Issues of Animal Carcass Disposal

AGEC689: Economic Issues and Policy Implications of Homeland Security

Yanhong Jin

Outlines

- Part 1: Cost components of carcass disposal
- Part 2: Estimating Cost of Simulated Animal Disease Outbreak in Texas
- Part 3: Spatial Analysis of Carcass Disposal
- Part 4: Spatial and Economic Modeling of Carcass Disposal
- Part 5: Other Economic Research on Carcass Disposal
UK Experience and the Lesson

UK outbreak led to death/disposal of 6.6 million animals with peak backlog of about 200,000

Extensive media coverage of the mass slaughter/disposal through incineration hurts British tourism.

- Estimated direct loss of tourism £4.5 to £5.4 billion;
- Estimated indirect loss of £2.7 to £3.2 billion to business directly affected by tourist and leisure activities

Far exceeded animal losses and disposal costs
Suggests great need for careful planning
Carcass Disposal Methods

- Thermal destruction
- Landfilling
- Composting
- Rendering
- Alkaline hydrolysis
- Digestion
- Anaerobic digestion
- Other innovative disposal methods like ocean disposal

Part 1: Cost Components of Carcass Disposal

Joint work by Jin, McCarl, and Gao
Factors Affecting the Choice of Disposal Methods

The “best” method for carcass disposal depends on the circumstances at hand and must be considered on a case-by-case basis. The choice is also subject to considerable uncertainty as most of the information that has been developed arises from small carcass disposal cases not the potentially large ones that might exist under a major outbreak.

- disease control/management
- daily carcass disposal load
- event size
- availability of disposal facilities
- budget/cost constraints
- environmental considerations
- public reaction

Input Factors Considered for Each Disposal Method

Best Practices & Guidelines:
- Thermal
- Burial
- Composting
- Rendering
- Alkaline Hydrolysis
- Digestion
- Anaerobic digestion
- Ocean disposal

Biosecurity and Safety Factors

- Site safety (29 CFR 1910)
- Personal protective equipment
- Decontamination of equipment
- Zoomates
- Plant and animal biosecurity

Environmental Factors

- Spatial and temporal availability
- Climate, terrain, and water impacts
- Air quality considerations

Regulatory and Legal Factors

- Environmental regulations
- Disease considerations
- Disposal regulations
- Movement restrictions
- Jurisdictional coordination

Logistical and Infrastructure Factors

- Transportation needs
- Infrastructure requirements
- Energy consumption
- Disposal of wastes

Economic and Cost Factors

- Disease management costs
- Transportation costs
- Operation and maintenance costs
- Loss of business
Example of Cost Components of Carcass Disposal

Each disposal method has different inputs and by-products and, hence, the cost components are different across disposal techniques. One example is that Anaerobic digestion has benefit from heat/energy saving.

Direct Costs: Operation

- Cost of the usage of energy, labor, chemicals and other items directly needed in day-to-day operations.
- In addition, one must acquire sanitary suits and other decontamination equipment/chemicals.
- It is possible that these costs are partially offset by revenue gained from sale of disposal activity byproducts. For example ash that is generated during thermal combustion may be able to be sold as a source of nutrients for agricultural production.
Direct Cost: Transportation

- Needs for carcass transport to offsite disposal areas:
  - Larger scale disease related incidents and/or the limited availability of suitable on site disposal sites/capacities in near proximity to outbreaks
- The costs of such operations include truck related costs of loading, unloading, leasing/ownership, gasoline, labor, and the site exit decontamination.
- There also is a set of costs that may are shared by the carcass disposal, including
  - the cost of any expansions in disease incidence due to spread from the carcass disposal related trucks
  - the cost of any activities undertaken along the transport route to reduce the possibility of disease spread including the costs of relocating or vaccinating livestock along the route
  - the costs of losses by businesses that might be placed within any quarantine zone due to their location along the selected transport route,

Direct Costs: Storage

- Needs to store carcasses for some amount of time until they can be placed in the disposal facility.
- The costs of such activities include any
  - operations costs (in the categories discussed above) involved with maintaining the carcasses in the storage facility or location.
  - security costs to avoid disease spread and keep out wildlife.
  - environmentally related costs to keep down odors and make the landscape more presentable.
Direct Costs: Facilities, Permitting, and Other Capital Equipment

- Disposal activities require facilities for digging pits, backhoes, combustion chambers and other types of buildings and equipment.
  - Contacts for portable facilities if it is adopted (need to subtract the altered value resulting from other uses).
  - The net cost of establishing new disposal facility if needed (need to subtract the altered value of installed capital resulting from other uses).
  - Hauling costs to being in facilities.
  - Permits to dispose at a particular site including the permit fees and legal costs involved in obtaining them.

Direct Costs: Security

- One will encounter security related costs in the forms of labor, fencing, site entry/exit and other inputs for activities such as
  - Site exit decontamination
  - Wildlife control
  - Isolation
  - Covering carcasses awaiting treatment
## Components of Direct Disposal Costs

<table>
<thead>
<tr>
<th>Operation costs</th>
<th>Facilities, permitting &amp; other capital equipment</th>
<th>Security costs</th>
<th>Transportation costs</th>
<th>Storage costs</th>
</tr>
</thead>
</table>
| *Energy*        | • Permit fees and legal costs for obtaining disposal sites  
|                 | • hauling costs to bring in facilities         | • labor       | • Transportation associated costs  
|                 |                                                | • fencing, site entry/exit | including security costs | • maintaining the carcasses or plants awaiting disposal  
|                 |                                                |               | • Loading/unloading cost  
|                 |                                                |               | • leasing/ownership  
|                 |                                                |               | • educating truck operators/drivers/supervisors | • security cost to keep out wildlife |
| *labor*         |                                                | • procedures/decontamination | • costs of preventative activities along the transport route that reduce the possibility of disease spread including the costs of livestock relocation along the route | • odors control  
| *chemicals*     |                                                | • wildlife control |                                                | • Landscape appearance maintenance. |
| *sanitary suits*|                                                |               | • Permit fees and legal costs for obtaining disposal sites | *sanitary suits* |
| *decontamination equipment/chemicals* |                                                |               | • hauling costs to bring in facilities | *sanitary suits* |

## Indirect Costs: Disease Related

- Indirect disease related costs will be incurred if either the carcass disposal activity enhances the size of the outbreak or if compromises are made in disease management in order to lower the carcass disposal cost.
  - It is possible because of leakage during carcass transportation, incomplete decontamination or incursion of wildlife into the carcasses awaiting disposal that the disease may be further spread causing a greater cost in terms of lost animals and disease management operations.
  - Because of the potential for large environmental or public perception damages due to the backup of carcasses it is likely that vaccination or similar alterations in disease management be chosen to slow down the flow of carcasses. Such choices would reduce costs if the extra cost of the disease management side are more than offset by the reduce costs in terms of the environment and/or public perception.
Indirect Costs: Environment

- Short or long run environmental damages may occur, including
  - Air may be polluted either with particulate matter from burning animals and with odors from animals awaiting disposal or under particular disposal activities.
  - Water may be polluted in the short run from runoff from areas where carcasses are stored or from direct runoff from the carcass those of activities as well as from varied in decomposing carcasses.
  - One may lose future productive capacity of land for disposal if the disposal activity or if safety dictates that the land be left undisturbed for some period of time.
  - Landfill capacity may be used at an enhanced rate if a substantial amount of landfill capacity is used by disposed carcasses requiring alternative landfills to be developed more rapidly than they otherwise would have arisen.

Indirect Cost: Public Perception

- Carcass disposal activities may contribute to alterations in public opinions regarding the desirability of visiting a particular region and or the safety of meat consumption.
  - Costs of reduced tourism and regional income may be incurred.
  - Cost may be incurred from reduced domestic meat demand if highly prominent and publicized carcass disposal activities may lead to alterations in public perceptions of meat safety.
  - Cost of reduced international demand may be stimulated by choice of particular joint disease management/carcass disposal strategies.
Indirect Costs: Indirect Income

- The operation of carcass disposal may also cause losses in regional income.
- The region surrounding highly visible carcass disposal activities businesses may encounter reduced customer levels and business income either due to quarantines or just perceptions.
- Businesses located along carcass transport routes may also lose customers and income due to quarantine zones and/or perceptions.

Components of Indirect Disposal Costs

<table>
<thead>
<tr>
<th>Disease related indirect costs</th>
<th>Added costs of infections spread by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>leakage during carcass and contaminated plant transportation</td>
</tr>
<tr>
<td></td>
<td>incomplete decontamination</td>
</tr>
<tr>
<td></td>
<td>wildlife incursion into disposal operation</td>
</tr>
<tr>
<td></td>
<td>Extra costs of disease management activities (like vaccination) incurred to reduce disposal related costs environment and/or public perception costs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental costs</th>
<th>Air pollution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water pollution</td>
</tr>
<tr>
<td></td>
<td>Loss of future returns to land employed for disposal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Public perception</th>
<th>Changes in income because of shifting public opinions resulting from disposal activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>reduced tourism and</td>
</tr>
<tr>
<td></td>
<td>regional economic activity</td>
</tr>
<tr>
<td></td>
<td>reduced domestic meat sales</td>
</tr>
<tr>
<td></td>
<td>reduced international meat export sales</td>
</tr>
</tbody>
</table>

| Indirect income loss           | Loss of business in areas where disposal activities are undertaken or on transport routes pass through. |
Part 2: Estimating Cost of Simulated Animal Disease Outbreak in Texas

Joint work by Jin, McCarl, Qao, Ward, and Highfield

Statistic Summary of Simulated Cases

- Average total mortality range: 16,000 to 8,500,000 heads
- Average epidemic length range: 46 to 106 days
- Average daily mortality range: 1 to 80,000 heads
Severity of Carcass Disposal Loads of Simulated Cases

<table>
<thead>
<tr>
<th>Mortality (heads)</th>
<th>Miles of 8' carcasses</th>
<th>Width San Antonio to Los Angeles</th>
<th>Cubic Yards of 0.5 cu yd carcasses</th>
<th>Height in a Football stadium 100x53 yards</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000</td>
<td>15</td>
<td>0</td>
<td>5000</td>
<td>3 ft</td>
</tr>
<tr>
<td>100,000</td>
<td>152</td>
<td>0.1</td>
<td>50000</td>
<td>28 ft</td>
</tr>
<tr>
<td>1,000,000</td>
<td>1515</td>
<td>1.1</td>
<td>500000</td>
<td>283 ft</td>
</tr>
<tr>
<td>8,000,000</td>
<td>12121</td>
<td>8.9</td>
<td>4000000</td>
<td>2264 ft</td>
</tr>
</tbody>
</table>

Last case is close to all stadiums in Big 12 and a 9 animal wide coverage of I 10

Carcass Disposal Costs of Simulated Cases

<table>
<thead>
<tr>
<th>Mortality (# of head)</th>
<th>Burial</th>
<th>Inciner -ation</th>
<th>Com -post</th>
<th>Render</th>
<th>Alkaline Hydrolysis</th>
<th>Anaerobic digestion</th>
<th>Lactic acid ferment</th>
</tr>
</thead>
<tbody>
<tr>
<td>15,000</td>
<td>0.2</td>
<td>0.7</td>
<td>0.8</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>100,000</td>
<td>1.9</td>
<td>5.7</td>
<td>6.3</td>
<td>5.3</td>
<td>5.9</td>
<td>6.8</td>
<td>1.8</td>
</tr>
<tr>
<td>1,100,000</td>
<td>17.7</td>
<td>52.3</td>
<td>57.3</td>
<td>48.5</td>
<td>53.3</td>
<td>61.9</td>
<td>15.9</td>
</tr>
<tr>
<td>8,500,000</td>
<td>125.6</td>
<td>371.1</td>
<td>406.4</td>
<td>344.0</td>
<td>378.2</td>
<td>439.2</td>
<td>113.0</td>
</tr>
</tbody>
</table>

The total disposal cost can be much bigger than this even for the trial events if all the other direct/indirect costs are included. Not all disposal practices have the same cost that gives insights of the choice of disposal techniques.
Estimated Number of Disposal Facilities Needed to Finish Carcass Disposal by One Month after Disease Event

<table>
<thead>
<tr>
<th>Mortality (head)</th>
<th>Length of event (month)</th>
<th>Incineration</th>
<th>Composting</th>
<th>Render</th>
<th>Alkaline Hydrolysis</th>
<th>Lactic acid ferment</th>
</tr>
</thead>
<tbody>
<tr>
<td>15,000</td>
<td>2.2</td>
<td>1</td>
<td>0.0015</td>
<td>1</td>
<td>8</td>
<td>54545</td>
</tr>
<tr>
<td>100,000</td>
<td>3.8</td>
<td>3</td>
<td>0.0042</td>
<td>2</td>
<td>21</td>
<td>363636</td>
</tr>
<tr>
<td>1,000,000</td>
<td>3.5</td>
<td>131</td>
<td>0.17</td>
<td>100</td>
<td>870</td>
<td>6181818</td>
</tr>
<tr>
<td>8,500,000</td>
<td>2.5</td>
<td>432</td>
<td>0.57</td>
<td>332</td>
<td>2878</td>
<td>30909090</td>
</tr>
</tbody>
</table>

Big events problematic
Disposal at a timing manner requires many facilities or long hauling
Large scale makes composting burial as most feasible option

Part 3: Spatial Analysis of Carcass Disposal
Work by Raghavan Srinivasan, Jennifer Jacobs
Spatial studies of carcass location possibility

Developing spatial data and methodology to support decision making on land suitability in terms of environmental impact of disposal

National level
Developing an index based vulnerability ranking method
Exclusionary Criteria

<table>
<thead>
<tr>
<th>Exclusionary Criteria</th>
<th>Distance (ft.)</th>
<th>Other criteria</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth to water table</td>
<td>2</td>
<td>--</td>
<td>NRCS</td>
</tr>
<tr>
<td>Drinking wells</td>
<td>500</td>
<td>--</td>
<td>NRCS</td>
</tr>
<tr>
<td>River and stream networks</td>
<td>300</td>
<td>--</td>
<td>TCEQ*</td>
</tr>
<tr>
<td>100 yr. flood plains</td>
<td>--</td>
<td>Not allowed</td>
<td>NRCS</td>
</tr>
<tr>
<td>Lakes and ponds</td>
<td>300</td>
<td>--</td>
<td>TCEQ</td>
</tr>
<tr>
<td>Slope</td>
<td>--</td>
<td>&lt;6%</td>
<td>NRCS</td>
</tr>
<tr>
<td>Property lines and residences</td>
<td>200</td>
<td>--</td>
<td>TCEQ</td>
</tr>
<tr>
<td>Soils</td>
<td>--</td>
<td>Catastrophic animal mortality management index</td>
<td>NRCS</td>
</tr>
</tbody>
</table>
Can we find suitable area?

Human factors aside, the map indicates areas unsuitable for mass burial but within any grazing livestock county studied so far, complying area can be found.

Part 4: Spatial and Economic Modeling of Carcass Disposal

Joint work by Gao, Jin, and McCarl
Research Question

- Model an economic transportation framework to determine
  - the optimal disposal methods
  - the optimal number of portable disposal facilities needed
  - the optimal daily disposal operational load using fixed and/or portable disposal facilities

Methodology: Linear Programming Model

- Minimize the disposal costs subject to the following constraints:
  - total number of disposal using fixed and mobile facility at $t=1$ plus the number of storage at $t=1$ equals to total animal disposal at time $t=1$.
  - total number of disposal using fixed and mobile facility at $t=2$ plus the number of storage at time $t=2$ subtract the storage at time $t=1$ equals to total number of animal disposal at time $t=2$.
  - total number of disposal by fixed and mobile facility at $t$ plus the number of storage at $t$ subtract storage at $t-1$ equals to total number of animal disposal at $t$, for $t=3, 4, \ldots, T$.
  - Capacity constraints for mobile facilities as well fixed facilities
Part 5: Other Economic Research on Carcass Disposal

Joint work by Jin and McCarl

Economic studies of carcass disposal

- Effects of rate of accumulation of carcasses
- Strategy to slow down slaughter rate (vaccination)
- Environmental impacts
- Strategy cost estimation
- Welfare slaughter and carcass disposal
- Regulatory considerations
Some Preliminary Findings of Economic Research on Carcass Disposal

- Vaccination or strategies that reduce carcass flow can reduce disposal cost by as much as 15% in a case study.
- Carcass disposal concerns turn vaccination in cases from being undesirable to being a desirable control effort.
- If we can salvage some animals for lower valued uses it greatly reduces cost.
- Welfare slaughter is a big deal in some cases 30-40% of animals slaughtered.