

Costs of Contaminated Animal Carcass Disposal

Under Trial Events

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Should a major outbreak of infectious animal disease, such as foot-and-mouth disease (FMD), occur it is likely to involve mass slaughter and disposal of animal carcasses. The choice of the optimal disposal method raises a number of concerns, including the availability and capacity of disposal facilities, and environmental and regulatory requirements. This paper describes carcass disposal concerns arising in association with simulated animal disease outbreaks in Texas.

We selected a number of disease outbreak scenarios from a set of disease outbreak simulations on hand. For each disease scenario simulations were conducted under three mitigation strategies. Hence, twelve simulations were selected based on results from a stochastic, state transition simulation model. Model output includes the daily carcass disposal load by animal type, infection status, and herd identification number. Table 1 shows the total number of livestock slaughtered and the epidemic length. Table 1 shows that the total carcass disposal load and the epidemic length varies depending on the disease introduction scenarios and mitigation strategy.

Table 1: Total mortality and epidemic period of scenarios used

Disease Scenario	Simulation No. ^a	Mortality (# of head)	Epidemic length (days)
1	1+M0	16,779	66
	1+M1	99,397	113
	1+M2	68,946	113
2	2+M0	2,411,272	46
	2+M1	1,578,505	46
	2+M2	1,702,368	46
3	3+M0	941,708	105
	3+M1	2,663,237	106
	3+M2	1,193,409	106
4	4+M0	2,182,192	75
	4+M1	8,466,082	76
	4+M2	6,863,900	76

^a Simulation numbers, i+Mj, for disease scenario i=1, 2, 3, 4, and mitigation strategy j=0,1 and 2:

Based on these simulated disease outbreaks and the daily carcass disposal load, we provide variable cost estimates in Table 2 and disposal operation time in Table 3 for different disposal methods (including incineration, burial, compositing, rendering, alkaline hydrolysis,

anaerobic digestion, and acid fermentation). Lactic acid fermentation destruction seems to result in the lowest variable cost, burial is the next cheapest disposal method, and anaerobic digestion is generally the most expensive disposal method. However, the fixed cost by disposal facility for each method varies. For example, lactic acid fermentation requires a high fixed cost. The least-cost disposal method varies depending on the outbreak scale and mitigation strategies. This finding extends to the operation time table as well.

Table 2: Estimates of variable disposal cost (\$1000) by disposal method ^a

Simu.No	Burial	Incineration	Composting	Rendering	Alkaline Hydrolysis	Anaerobic digestion	Lactic acid fermentation
1+M0	234	692	758	642	706	820	211
1+M1	1,945	5,747	6,296	5,330	5,859	6,803	1,751
1+M2	992	2,932	3,212	2,719	2,989	3,471	893
2+M0	36,169	106,867	117,067	99,103	108,941	126,495	32,552
2+M1	25,526	75,421	82,619	69,941	76,884	89,273	22,973
2+M2	23,812	70,358	77,358	65,246	71,723	83,280	21,431
3+M0	14,125	41,736	45,719	38,704	42,546	49,402	12,713
3+M1	39,730	117,391	128,595	108,861	119,669	138,951	35,757
3+M2	17,689	52,265	57,253	48,467	53,279	61,864	15,920
4+M0	32,732	96,714	105,945	89,688	98,591	114,477	29,459
4+M1	125,569	371,106	406,427	344,060	378,216	439,159	113,013
4+M2	102,958	304,208	333,242	282,106	310,111	360,080	92,662

^a The average variable disposal cost for each method is collected from the followings: (1) The Sparks Companies provide Livestock Mortalities and cost of burial and rendering; (2) <http://www.ianrpubs.unl.edu/epublic/pages/publicationD.jsp?publicationId=193> for composting cost; (3) http://www.wr2.net/sales/cost_calculator.html for alkaline hydrolysis cost; (4) anaerobic digestion from An Economic Comparison of Two Anaerobic Digestion Systems on Dairy Farms at 2003 ASAE Annual International Meeting, Las Vegas, Nevada, 27-30 July 2003; (5) The Kansas report gives the cost estimates of lactic acid fermentation.

Table 3: Estimates of operation time (months) by disposal method ^a

Simu.No.	Incineration	Composting	Rendering	Alkaline Hydrolysis	Lactic acid fermentation
1+M0	0.109	0.180	1.092	0.718	1.005
1+M1	21.04	34.83	21.12	13.89	19.45
1+M2	38.045	62.960	38.178	25.117	35.164
2+M0	0.265	0.438	0.266	0.175	0.245
2+M1	26.86	44.45	26.95	17.73	24.83
2+M2	25.047	41.452	25.135	16.536	23.151

3+M0	14.958	24.589	15.910	9.801	13.733
3+M1	42.02	69.54	42.17	27.74	38.84
3+M2	18.829	31.161	18.896	12.431	17.403
4+M0	34.430	56.979	43.551	22.731	31.823
4+M1	130.77	216.41	131.23	86.33	120.65
4+M2	105.489	174.578	105.861	69.645	97.504

^a The average operation time for each disposal method is estimated based on labor hours as if the disposal facility can run 24 hours per day, seven days a week using 100 laborers.

Another disposal issue is distance to disposal facilities. Using spatial data we are able to calculate the distance between any pair of potential disposal facilities (see Table 4). This allows us to estimate additional transportation cost if one disposal facility can not handle the carcass disposal load. There is substantial distance between facilities. When distance is coupled with the long epidemic length and disposal operation time, there is substantial need for either imported portable facilities or long hauling distances.

Table 4: Distance (km) between any pair of disposal locations in the study area

	rendering								composting			incinerator				
Km	# 1	# 2	# 3	# 4	# 5	# 6	# 7	# 8	# 1	# 2	#1	# 2	# 3	# 4	# 5	
# 1	0	4.2	11.1	12.1	18.4	18.9	90.9	134	112.8	134.2	41	126	173	134.2	177.8	
# 2		0	10	10.7	18.8	18.5	90.1	134	112	133.4	40	125	172	133.4	177	
# 3			0	5.5	13	13.1	84.8	128	106.7	128.1	35	120	167	128.1	171.7	
# 4				0	9	12	82.1	126	104	125.4	32	117	164	125.4	169	
# 5					0	11.1	71.4	115	93.3	114.7	21	106	153	114.7	158.3	
# 6						0	73.3	117	95.2	116.6	23	108	155	116.6	160.2	
# 7							0	105	65.1	2	50	38.1	85.2	107	152	
rendering # 8								0	59	43.6	94	121	96	1.5	42.3	
# 1									0	58.9	72	80.7	101	59.1	102.9	
composting # 2										0	93	121	95.1	1.1	43.7	
# 1											0	84.9	132	93.4	137	
# 2												0	47.1	142	185.6	
# 3													0	95.9	139.5	
# 4														0	43.6	
incinerator # 5															0	

Several main findings arise from these data

1. Disposal costs can be large running into the 100's of millions of dollars and can run about 50 dollars per head.
2. Certain disposal techniques particularly anaerobic digestion is more expensive than others in term of variable costs.

3. Some disposal methods look to be infeasible with scale of operation with all taking nearly ten years of facility time under the largest outbreak.
4. There are substantial distances between existing facilities and under large events there would be great need for either imported portable facilities or long hauling distances and associated hauling costs/quarantine zones would arise.