SPARKS COMPANIES INC.

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Livestock Mortalities: Methods of Disposal and Their Potential Costs

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Prepared for:

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Foreword

The market for US meat and meat-based products requires the annual slaughter of roughly 139 million head of cattle, calves, sheep, hogs, and other livestock, as well as 36 billion pounds of poultry. The rendering industry supports this sector and the health of the environment in many important ways, especially by providing an outlet for the massive amounts of inedible byproducts that result from the production and slaughter of these animals. A proportion of these byproducts consist of livestock that die prior to slaughter, or are condemned at the time of slaughter and therefore cannot be used for human consumption. Although the proportion dying prematurely is very modest, the sheer size of the livestock sector results in several *billion* pounds of dead livestock annually that must be disposed of with minimal impact on the environment.

The rendering industry provides a valuable service by collecting livestock mortalities and processing them into products that in turn add value to various feed and industrial sectors. Importantly, this service minimizes the chance that these mortalities are disposed of in ways that could harm the environment, including polluting groundwater or spreading disease.

The Animal and Plant Health Inspection Service (APHIS) of USDA has suggested it will consider placing restrictions on rendering livestock mortalities in an effort to further reduce the already near zero risk of BSE entering North America. Sparks Companies has agreed to examine the potential impacts of such a regulation, including the possible costs and environmental risks that could arise if rendering mortalities was no longer an option.

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Livestock Mortalities: Methods of Disposal and Their Potential Costs

Executive Summary

The market for US meat and meat-based products requires the annual slaughter of roughly 139 million head of cattle, calves, sheep, hogs, and other livestock, as well as 36 billion pounds of poultry. But despite the best efforts of farm managers, veterinarians, and drug companies, millions of livestock succumb to disease or accidents that prevent their usage for human consumption. While the proportion is very modest, the sheer size of the US livestock sector results in the generation of several *billion* pounds of livestock mortalities annually, creating a disposal challenge for farmers, ranchers, and meatpackers. Disposing of these mortalities is complicated because of the need to minimize adverse environmental consequences, such as the spread of human and animal disease or the pollution of ground or surface water. Renderers play an important role in this process by providing an environmentally friendly disposal option and transforming this potentially harmful material into various useful and valuable compounds.

But the continuing role that renderers play in mortality disposal could be in jeopardy. The outbreak of BSE in Europe in the mid-1980s has forced many nations, including the US, to erect various safeguards to prevent similar outbreaks within their own borders. By all accounts, these measures have succeeded in preventing the introduction of BSE to the North American continent, where no indigenous case has ever been detected. And a recent analysis conducted by Harvard University's Center for Risk Analysis finds that the United States is highly resistant to BSE outbreaks. Nevertheless, attention has recently focused on ways to enhance existing safeguards, possibly including tight restrictions or a total ban on the process of rendering livestock mortalities. However, such an action could have substantial adverse economic and environmental consequences that must be fully weighed against the potential to further reduce the near-zero risk of BSE entering the North American livestock sector.

Livestock Mortalities in the US

Nearly 3 billion pounds of mammalian livestock mortalities was generated in 2000, plus another 346 million pounds of poultry mortalities. Ruminants (cattle, sheep, lamb, and goats) combine to account for about 22% of all mammalian livestock that die prior to slaughter each year (the balance being swine), but because cattle are so large and heavy, the volume (weight) of ruminant mortalities accounts for about 67% the total death loss each year. Beef cattle alone account for the largest proportion of mammalian livestock mortalities requiring disposal, at nearly 50% (by weight). The distribution of livestock mortalities by species has important implications, especially since ruminants tend to be a central focus of most regulations concerning the rendering industry and BSE.

Livestock Mortalities in the US, 2000

	Farm Mortalities		Percent of Farm Mortalities			
			Total		Mammalian	
Species	Number	Weight	Number	Weight	Number	Weight
	1,000	*1,000 lbs*	*Percent*			
Dairy Cattle	804.0	449,227.3	0.8	13.5	3.5	15.1
Beef Cattle	3,327.8	1,482,952.5	3.2	44.6	14.5	49.8
Hogs	17,927.7	981,655.2	17.0	29.5	78.3	33.0
Sheep	281.5	21,957.0	0.3	0.7	1.2	0.7
Lambs	486.2	37,923.6	0.5	1.1	2.1	1.3
Goats	65.0	4,225.0	0.1	0.1	0.3	0.1
Total Mammalian	22,892.2	2,977,940.6	21.7	89.6	100.0	100.0
Chicken	50,507.0	154,950.7	47.9	4.7		
Turkey	31,946.5	191,679.0	30.3	5.8		
Grand Total	105,345.7	3,324,570.4	100.0	100.0	100.0	100.0

In terms of cattle mortalities in particular, those over the age of 24 months account for less than 23% of cattle deaths, but since cattle gain weight rapidly as they age, these older, large animals account for more than 51% (996.1 million pounds) of the dead cattle that occur annually.

This distribution has important environmental implications. Large animals, such as mature cattle, tend to decompose slowly and generate substantial amounts of biological run-off, and their thick hides often remain even after the rest of the cadaver has been reduced to compost, soil, or ash. Therefore, rendering has traditionally been the preferred method of disposal for these mature species, and without this option the likelihood increases that producers could turn to unapproved methods that threaten the environment and worker safety.

Mortality Disposal Options

The methods generally approved for disposal of livestock mortalities include:

- Burying the carcass at least 4 feet below the surface of the ground (i.e. covered with at least 4 feet of earth) often with a layer of lime;
- Burning the carcass in a permitted incinerator;
- Composting the carcass in specialized facilities; or
- Removing it by a licensed rendering company.

Renderers process roughly 50% of all livestock mortalities, from which they produce more than 433 million pounds of meat and bone meal (approximately 6.5% of the total amount produced annually in the US), along with additional quantities of fats, tallow, and greases used in various feed and industrial sectors. While renderers typically charge modest fees to collect these mortalities, this option remains highly cost effective compared to the operating costs and possible fixed costs associated with most other methods. However, the ability for renderers to market products produced from livestock mortalities (including protein based feed ingredients and various fats and greases) keeps the collection fees relatively low; if these products could no

longer be marketed, renderers would be forced to charge much higher fees to cover collection and disposal costs. Estimates of the sector-wide variable costs of mortality disposal are presented below for each alternative method. However, it is important to note that for certain methods, such as incineration and composting, substantial fixed investment costs might be required to construct the necessary facilities, further raising the total costs of adopting these methods. Estimates of the total fixed investment necessary to adopt each disposal method are presented at the bottom of the table below.

Cost Estimates for Each Major Method of Mortality Disposal

	Rendering[1]				
Species	**MBM Sold For Feed**	**No MBM For Feed**	**Burial**	**Incineration**	**Composting**
	Total (Sector-Wide) Operating Costs ($1,000)				
Cattle & calves	34,088	99,619	43,902	38,561	125,351
Weaned Hogs	48,020	79,061	51,450	16,906	58,018
Pre-weaned Hogs	5,533	7,786	8,300	1,226	4,209
Other	5,828	8,003	6,245	1,184	4,063
Total Operating Costs	$93,470	$194,470	$109,898	$57,879	$191,643
	Operating Costs, Dollars per Mortality ($/head)				
Cattle & calves[2]	$8.25	$24.11	$10.63	$9.33	$30.34
Weaned Hogs	$7.00	$11.53	$12.45	$4.09	$14.04
Pre-weaned Hogs	$0.50	$0.70	$2.01	$0.30	$1.02
Other	$7.00	$9.61	$1.51	$0.29	$0.98
	Total (Sector-Wide) Fixed Costs for Specialized Facilities ($1,000)				
Beef Cattle	N.A.	N.A.	N.A.	797,985	1,241,310
Dairy Cattle	N.A.	N.A.	N.A.	333,630	518,980
Hogs	N.A.	N.A.	N.A.	158,031	245,826
Other	N.A.	N.A.	N.A.	90,000	140,000
Total Fixed Costs	N.A.	N.A.	N.A.	$1,379,646	$2,146,116

1. Assuming all dead stock were rendered
2. Under existing scenario, renderers are assumed to charge $10 per mature cattle, and $7 per calf

Implications

Selecting a mortality disposal system is an important decision, as it impacts animal and human health. The viability of alternative mortality disposal methods for individual livestock producers depends on several factors, including logistic factors, and the quantity of mortality, location of production facilities, soil type, topography, amount of labor available, and access to equipment. The estimated cost of alternative disposal methods for each operation will be driven largely by the producers' attitude toward environmental issues, as well as management preferences and government regulations.

For many producers, paying a modest fee to have a renderer remove dead carcasses is likely preferred to finding alternative on-farm disposal methods, which is fortuitous given the potential for environmental damage if this material is disposed of improperly. And, the rendering industry

is well equipped to safely and efficiently handle the volume of mortalities produced using its existing infrastructure.

However, new restrictions could result in large increases in renderer collection fees, or even the elimination of this option altogether. Producers would then respond by re-evaluating their costs and deciding which other livestock mortality disposal method is most cost effective. Of course, some methods could result in costs that are not solely incurred by the livestock producer, but instead by society as a whole through environmental degradation, groundwater pollution, or the spreading of disease. As the relative costs of "approved" methods of disposal increase, so does the likelihood that producers could turn to "unapproved" methods at greater risk to the environment. Furthermore, small operations will likely be at a disadvantage to adopting capital-intensive methods such as composting and incineration, putting them at a competitive disadvantage to large animal enterprises. Therefore, it is incumbent on regulators to carefully weigh the potential benefits of new restrictions on livestock mortality disposal against the full costs that could result, including the greater likelihood for the use of disposal methods that are unapproved and which could threaten to harm society or the environment.

I. Introduction

The market for US meat and meat-based products requires the annual slaughter of roughly 139 million head of cattle, calves, sheep, hogs, and other livestock, as well as 36 billion pounds of poultry. Rising incomes worldwide and evolving preferences toward animal-based protein sources continue to pressure the US livestock sector to increase meat production even further, requiring in turn even more intensive production of livestock on US beef, dairy, pork, poultry, and other livestock operations.

Like all living creatures, livestock are subject to the vagarious forces of nature, and despite the best efforts of farm managers, veterinarians, and drug companies, millions of livestock annually succumb to disease or accidents that prevent their usage for human consumption. Any animal that dies prior to slaughter cannot be used for human consumption, and living animals that do not meet certain minimum standards (including the absence of certain diseases or injuries) often must be euthanized and disposed of by some other means.

Traditionally, the rendering industry provides an important outlet for disposing of animals not suitable for slaughter. Diseased, dying, disabled, and dead animals ("4-D" animals; i.e. "livestock mortalities") are of no use to farmers or meat packers, but they can be an important source of raw material for renderers in the production of various products valued by the feed industry and other industrial sectors. However, compared to the enormous volumes of slaughter by-products renderers collect every day from meatpacking facilities, livestock mortalities account for a small proportion of the total quantity of material processed by renderers. Thus, perhaps the greatest value of renderers' services in the collection of livestock mortalities is not in the products they ultimately produce, but in providing an economical and environmentally sound method of disposal.

The outbreak of BSE in Europe in the mid-1980s has forced many nations, including the US, to erect various safeguards to prevent similar outbreaks within their own borders. An important component of the US safeguards now in place is a restriction on the use of ruminant-based animal protein feed ingredients in ruminant feed (21 CFR 589.2000), along with enhanced government inspections and stringent border controls measure concerning livestock and animal-based feed ingredients. By all accounts, these measures have succeeded in preventing the introduction of BSE to the North American continent, where no indigenous case has ever been detected. A recent computer-based simulation analysis conducted by Harvard University's Center for Risk Analysis finds that the United States is highly resistant to BSE outbreaks. In short, the study concluded:

> *"In summary, measures taken by the U.S. government and industry make the U.S. robust against the spread of BSE to animals or humans should it be introduced into this country. Preventing sick animals or contaminated feed from entering the country, ensuring compliance with the FDA feedban, and reducing the potential for infectious tissues to enter the animal or human food supply will ensure that these risks remain low. If BSE has been introduced into the U.S., as has been suggested by some observers, the course of the*

> *disease has been arrested and it is destined for eradication by the measures currently in place."*
>
> Source: Evaluation of the Potential for Bovine Spongiform Encephalopathy in the United States (Executive Summary), Harvard University, November 30, 2001.

Despite the exceedingly low risk that BSE poses to the US livestock sector, the USDA and FDA remain committed to examining ways in which the current safeguards can be enhanced even further. It is now incumbent on these agencies to examine the full environmental and economic costs and consequences of any further BSE regulations in relation to the degree to which the risks of BSE in the US can be further reduced. One proposal under consideration concerns the disposal of dead and downer livestock through rendering facilities, which is currently allowed under existing regulations. This report is intended to provide USDA/APHIS and other interested parties additional information about the quantity of livestock mortalities produced in the US, and the current methods used to dispose of this material. Sector-wide cost estimates of alternative disposal methods are also included.

The remaining sections of this report are organized as follows:

- **Livestock Mortalities in the United States.** This section uses data from several sources, including the USDA, discussions with industry participants, and earlier reports prepared by Sparks Companies to estimate the number and volume of various species of livestock that die prior to slaughter. Estimates of the volume of meat and bone meal (MBM) produced from these carcass is also presented, along with estimates of the use of alternative disposal methods by the livestock sector.

- **Costs of Alternative Disposal Methods Compared.** In this section, sector-wide annual costs are estimated for all major disposal methods, and compared across methods. The potential costs to the livestock sector if all mortalities were rendered, but the resulting proteins were disposed of in a landfill rather than being sold in the feed markets, are also presented.

- **Implications/Conclusions.** The implications of this research, including direct costs to the sector and potential environmental impacts if dead animals were no longer rendered, are discussed.

II. Livestock Mortalities in the United States

The United States boasts one of the largest and most highly developed livestock production sectors in the world. It annually produces in excess of 26 billion pounds of beef, 19 billion pounds of pork, and 35 billion pounds of poultry, along with hundreds of millions of pounds of meat from various other animal species, including lamb, sheep and goats. The production of such vast amounts of edible meat products requires the annual slaughter of more than 36.2 million cattle, 1.1 million calves, and 100 million hogs, along with other minor species.

The vast majority of livestock raised are eventually slaughtered for human consumption, but a small proportion either die of natural or accidental causes prior to slaughter, or are condemned at the time of slaughter and therefore must be disposed of by alternative means. Although the proportion dying prematurely is very modest, the sheer size of the US livestock sector results in the generation of several *billion* pounds of livestock mortalities annually, creating a disposal challenge for farmers, ranchers, and meatpackers. The disposal of these mortalities is complicated because of the need to ensure that adverse environmental consequences do not arise, including the spread of human and animal disease or the pollution of ground or surface water. Rendering firms have traditionally been important disposal outlets; able to transform this otherwise valueless and potentially harmful material into various useful compounds, while reducing environmental risks posed by improper burial or other unapproved disposal techniques.

While BSE has never been detected in livestock produced in North America, and all indications are that the preventive safeguards erected after the outbreak in Europe have been fully successful, USDA/APHIS is nevertheless considering placing restrictions on the practice of rendering dead and downer animals to remove this material from the feeding chain. Such restrictions would require that these mortalities be disposed of by alternative means, but given the potential environmental impact from the improper disposal of such large amounts of material, the USDA/APHIS must act with caution to ensure that a larger public health or environmental crisis is not created in the process of attempting to further reduce the already near zero risk of a BSE outbreak.

The first step in evaluating the potential effects of restrictions on rendering dead livestock is to determine the amount of material at stake, and the characteristics of the animals that die prematurely. It appears that most interest focuses on dead cattle, particularly older cattle, which are thought to be at a greater risk of harboring the BSE prion. Thus, it is important to determine the annual number of premature cattle deaths, and—to the extent possible—the age distribution of these livestock at the time of death. We also examine the number of dairy cattle deaths versus beef cattle. Estimates of the number and weight of swine, other mammalian, and poultry mortalities follow later in this section.

Cattle

As noted above, over 36 million cattle are slaughtered annually to supply current demand for US beef products. In addition, a continuous inventory of approximately 9.2 million dairy cattle is needed to supply the 166 billion pounds of milk annually consumed in the US. But the livestock

growth and reproduction cycle[1] implies a much larger population of cattle and calves at any point in time than is annually slaughtered for human consumption. As of January 1, 2001, USDA estimates just over 81 million head of cattle in the US in excess of 500 lbs, along with about 16.2 million calves weighing less than 500 lbs (Table 1). Maintaining this population requires an annual surviving calf crop of about 38 million or more head.

Table 1. U.S. Population of Cattle and Calves, January 1.

Classification	Approximate Age	1998	1999	2000	2001
		1,000 head			
Cows and Heifers That Have Calved	24 months +	**43,084**	**42,878**	**42,759**	**42,603**
Beef Cows		33,885	33,745	33,569	33,400
Milk Cows		9,199	9,133	9,190	9,203
Heifers (that have not calved), 500 lbs +	7 to 24 months	**19,800**	**19,774**	**19,649**	**19,775**
For Beef Cow Replacement		5,764	5,535	5,503	5,588
For Milk Cow Replacement		3,986	4,069	4,000	4,047
Other Heifers (for slaughter)		10,051	10,170	10,147	10,140
Steers 500 lbs +	7 to 24 months	**17,189**	**16,891**	**16,682**	**16,438**
Bulls 500 lbs +	7 months +	**2,270**	**2,281**	**2,293**	**2,272**
Total Cattle, 500 Lbs +	7 months +	82,343	81,824	81,383	81,008
Average Annual Calf Crop		38,812	37,796	38,621	38,400
Calves under 500 lbs, Jan. 1	0 to 6 months	17,401	17,290	16,815	16,221
Cattle on Feed, Jan. 1		13,964	13,219	14,003	14,199

The age distribution of cattle is governed by the rate and age at which cattle are removed from the herd for slaughter, and the average death rate from other causes over the life of the animal. Identification of the age distribution of the cattle population is important for several reasons. First, since all livestock gain weight as they age, knowledge of the average death rate (e.g. mortality loss per month) coupled with the age distribution of the existing population, will identify the total volume (i.e., weight) of mortalities produced annually. Second, some researchers suggest that cattle that die at later stages in their life, typically in excess of 24 months, would have a relatively higher likelihood of harboring the BSE prion if it were present in North America. Knowledge of the age distribution of living cattle can be useful in estimating the age distribution of cattle that die prematurely.

Table 2. Cattle Mortalities, 1998-2000

	1998	1999	2000
		1,000 head	
Cattle	1,673.0	1,659.0	1,721.8
Calves (under 500 lbs)	2,546.5	2,454.8	2,410.0
Total	4,219.5	4,113.8	4,131.8

USDA/National Agricultural Statistics Service (NASS) estimates that in the year 2000, approximately 4.1 million cattle died before they could be sent to slaughter (Table 2). Of these, 2.4 million were calves (under 500 lbs), with the balance of 1.7 million over 6 months of age (or, as reported, in excess of 500 lbs).

[1] The useful reproductive life of most cattle is approximately 5-6 years after maturity (reached at approximately 24 months), and the vast majority of livestock slaughtered for meat are sent to the packer at or before two years of age.

Based on the age and species distribution identified in Table 1, and typical mortality rates, slaughter rates, weight gain, and cull rates[2], it is apparent that the majority of cattle mortalities (58.33%) are 6 months of age or younger, and over 77% are less than 24 months old at the time of death (Table 3). This is not surprising, since the typical death rate for cattle within the first two months of birth averages about 5% per month, compared with much less than 1% per month over most of the rest of their lives. Cattle (like many species of livestock) are most vulnerable at birth, and severe health complications later in their useful life are relatively rare, especially with continued improvements in veterinary care. Beef cattle, owing to their large population, account of the greatest proportion of cattle mortalities (80.54%) as well as the highest number within each age category.

The useful life of most cattle is relatively short, reducing the opportunity for death to occur from natural causes. Most steers and heifers raised for beef—which accounts for the largest proportion of living cattle—are slaughtered between the ages of 13 and 24 months. Cattle that live beyond 24 months tend to be primarily breeding stock (cows and bulls) used to repopulate the herd, or diary cows impregnated primarily for their milk production. In most North American commercial beef and dairy operations, the useful life of a breeding cow tends to be about 5 cycles or less, after which the cow is sent to slaughter (culled), usually producing low-value cuts of meat. Since cows typically reach reproductive maturity at about 24 month, 5 breeding cycles would result in a cow that is approximately seven years of age. The continuing process of culling the breeding herd as it ages to make way for more productive replacement heifers skews the distribution of both live cattle and mortalities towards younger animals. Therefore, the number of cattle that live beyond seven years (and hence are subject to dying older than seven years) is quite modest.

Table 3. Estimated Age Distribution of Cattle Mortalities, 2000

	Dairy		Beef		Total	
Age	**Number**	**Percent[1]**	**Number**	**Percent[1]**	**Number**	**Percent**
Months	*1,000*	*%*	*1,000*	*%*	*1,000*	*%*
0 to 6	513.3	12.42	1896.7	45.90	2410.0	58.33
7 to 12	30.7	0.74	337.3	8.16	368.0	8.91
13 to 24	60.8	1.47	352.7	8.54	413.5	10.01
25 to 48	123.2	2.98	338.2	8.19	461.4	11.17
49 to 72	61.0	1.48	283.6	6.86	344.6	8.34
73 and up	15.0	0.36	119.3	2.89	134.3	3.25
Total	804.0	19.46	3327.8	80.54	4131.8	100.00

1. Percent of total, i.e. Dairy + Beef

Cattle gain weight rapidly as they mature, so older cattle account for a much higher proportion of the total volume of dead stock produced annually (Table 4). Similarly, dairy cows tend to be heavier than beef cattle so their proportion of the total volume of dead stock exceeds their proportion of total cattle deaths[3]. Despite the fact that cattle over the age of 24 months account

[2] These assumptions are based on those described in the Harvard Risk Analysis Study, Appendix 1 pages 18-19.
[3] Beef cattle raised commercially tend to average about 1,150 lbs at slaughter (between 13 and 24 months). Mature dairy cows can weigh in excess of 1,450 lbs by the time they culled (4 years of age or older).

for less than 23% of cattle deaths, these large animals account for more than 51% (996.1 million pounds) of the greater than 1.9 billion pounds of dead cattle that occur annually.

This distribution has important environmental implications. Large animals, such as mature cattle, tend to decompose slowly and generate substantial amounts of biological run-off, and their thick hides often remain even after the rest of the cadaver has been reduced to compost, soil, or ash. To accelerate decomposition, the carcass often must be cut into smaller pieces, resulting in higher labor costs and increased occupational risks to the livestock producer. For these reasons, on-farm incineration and composting (discussed in more detail in the following section) tend to be impractical disposal options without the aid of large, expensive, and specialized facilities. Therefore, rendering has traditionally been the preferred method of disposal for these mature species. Without this option the likelihood increases that producers could turn to unapproved methods that threaten the environment and worker safety. Furthermore, rendering is currently the only option that allows regulators to trace mortalities through the production chain, since other options tend to be unregulated and generate no data regarding the volume of mortalities generated and the way that material is disposed of or handled.

Table 4. Estimated Age Distribution Cattle Mortalities, by Weight, 2000

	Dairy		Beef		Total	
Age	**Volume**	**Percent[1]**	**Volume**	**Percent[1]**	**Volume**	**Percent**
Months	*1,000 lbs*	*%*	*1,000 lbs*	*%*	*1,000 lbs*	*%*
0 to 6	100,918.5	5.22	286,136.5	14.81	387,054.9	20.03
7 to 12	19,821.8	1.03	195,174.4	10.10	214,996.2	11.13
13 to 24	61,559.3	3.19	272,452.9	14.10	334,012.2	17.29
25 to 48	156,493.2	8.10	313,378.7	16.22	469,872.0	24.32
49 to 72	88,004.7	4.55	292,668.1	15.15	380,672.8	19.70
73 and up	22,429.8	1.16	123,142.0	6.37	145,571.8	7.53
Total	449,227.3	23.25	1,482,952.5	76.75	1,932,179.8	100.00

1. Percent of total, i.e. Dairy + Beef

Other Livestock Species

Like cattle, a small proportion of the population of all species of commercial livestock dies on the farm or before being slaughtered for meat production. Disposal of dead hog, sheep, goat, and poultry carcasses creates challenges similar to those faced by beef and dairy producers, but also different issues that reflect the structure of these livestock sectors and the characteristics of the species. For example, mortalities from other livestock sectors will tend to have a younger age distribution than cattle, and the smaller and lighter species could be easier to dispose of individually; but the large hog and poultry populations also imply more deaths per annum than in the cattle sector.

Also, consolidation trends in both the hog and poultry production sectors have been rapid in recent decades (much more so than in the beef and dairy sectors), resulting in fewer, but much larger and more intensive operations. For instance, hog farms that produce tens of thousands of hogs each year are not uncommon, and account for an increasingly large share of the total production of pork in the US. Consolidation in the poultry sector has been even more

pronounced. Such large operations will naturally produce large volumes of dead stock, even if they face death rates similar to smaller producers. Highly intensive livestock firms like these are unlikely to have adequate land resources for on-farm burial, and the large volume of mortalities continuously generated over time implies the need for frequent, reliable disposal options that will prevent the unhealthy accumulation of large amounts of decomposing carcasses. While some of the largest operations are turning to on-farm incinerators or composting facilities, renderers remain an important outlet for these mortalities, as well.

Similar to cattle, the most vulnerable period for hogs occurs within the first several weeks of birth. A death loss of near 10% for pre-weaned hogs is not uncommon, so the roughly 12 million sow farrowings each year (with an average litter of nearly 9 pigs) leads to an annual loss of more than 11 million pre-weaned hogs (Table 5). However, at an average weight of only about 6 pounds, the volume of pre-weaned hogs requiring disposal is fairly modest. Market hogs tend to weigh up to 200 pounds or more, and breeding hogs often exceed 350 pounds so the more than 6.8 million hogs that died on-farm in 2000 (Based on USDA/NASS estimates) resulted in more than 915 million pounds of material requiring disposal (assuming the weight distribution of hog mortalities reflects the weight distribution of live hogs). While this is substantially less than the more than 1.9 billion pounds of cattle mortalities produced each year, it nevertheless represents an enormous amount of material that, if disposed of improperly, could create a significant threat to human health and the environment.

Table 5. Number and Weight of Hog Mortalities, 1998-2000

	1998		1999		2000	
	Number	**Weight**	**Number**	**Weight**	**Number**	**Weight**
	1,000	*1,000 lbs*	*1,000*	*1,000 lbs*	*1,000*	*1,000 lbs*
Market Hogs	5,299.3	563,787.8	5,584.3	635,986.3	6,132.7	660,691.6
Breeding Hogs	625.5	218,916.7	690.7	241,751.1	727.3	254,557.4
Weaned Total	5,924.8	782,704.5	6,275.0	877,737.4	6,860.0	915,249.0
Pre-Weaned Hogs[1]	11,700.1	70,200.8	11,291.8	67,750.6	11,067.7	66,406.2
Total Death Loss	17,624.9	852,905.3	17,566.8	945,488.0	17,927.7	981,655.2

1. Assuming approximately a 9.7% annual death loss for all hog farrowings

On-farm deaths of chickens and turkeys result in roughly 350 million pounds of material requiring disposal each year (Table 6), the next largest category behind hog producers. A large proportion of these mortalities are rendered, but rarely by the same companies that render mammalian species.

Table 6. Number and Weight of Poultry Mortalities, 1998-2000

	1998		1999		2000	
	Number	**Weight**	**Number**	**Weight**	**Number**	**Weight**
	1,000	*1,000 lbs*	*1,000*	*1,000 lbs*	*1,000*	*1,000 lbs*
Chickens	53,428.0	154,614.1	54,951.0	162,218.6	50,507.0	154,950.7
Turkeys	32,860.0	197,159.8	32,186.3	193,117.7	31,946.5	191,679.0
Total Poultry	86,288.0	351,773.9	87,137.3	355,336.3	82,453.5	346,629.7

Other species of livestock also produce some volume of dead stock requiring disposal, but the amounts tend to be small in comparison to the beef, pork and poultry sectors. In 2000, there was an estimated 832,000 on-farm deaths of sheep, lamb and goats, producing over 64 million pounds of material requiring disposal (Table 7). Despite the comparatively small size of these industries, the volume of dead stock produced each year could still pose significant health risk if disposed of improperly.

Table 7. Number and Weight of Sheep, Lamb and Goat Mortalities, 1998-2000

	1998		1999		2000	
	Number	Weight	Number	Weight	Number	Weight
	1,000	*1,000 lbs*	*1,000*	*1,000 lbs*	*1,000*	*1,000 lbs*
Sheep	290.8	22,682.4	260.8	20,342.4	281.5	21,957.0
Lambs	500.8	39,062.4	481.9	37,588.2	486.2	37,923.6
Goats	70.0	4,550.0	67.5	4,387.5	65.0	4,225.0
Total	861.6	66,294.8	810.2	62,318.1	832.7	64,105.6

Combining the volumes of on-farm mortalities across all major livestock species reveals nearly 3 billion pounds of mammalian livestock mortalities was generated in 2000, and 3.3 billion pounds if poultry mortalities are included (Table 8). Beef cattle are the largest contributors to this total, accounting for nearly 50% of all mammalian livestock mortalities generated (just below 45% including poultry). Ruminants (cattle, sheep, lamb, and goats) combine to account for only 21.7% of on-farm mammalian livestock deaths per year (the balance being swine), but account for 67% of the volume (weight) of dead stock material requiring disposal.

Table 8. Livestock Mortalities in the US, 2000

	Farm Mortalities		Percent of Farm Mortalities			
			Total		Mammalian	
Species	Number	Weight	Number	Weight	Number	Weight
	1,000	*1,000 lbs*	*Percent*			
Dairy Cattle	804.0	449,227.3	0.8	13.5	3.5	15.1
Beef Cattle	3,327.8	1,482,952.5	3.2	44.6	14.5	49.8
Hogs	17,927.7	981,655.2	17.0	29.5	78.3	33.0
Sheep	281.5	21,957.0	0.3	0.7	1.2	0.7
Lambs	486.2	37,923.6	0.5	1.1	2.1	1.3
Goats	65.0	4,225.0	0.1	0.1	0.3	0.1
Total Mammalian	22,892.2	2,977,940.6	21.7	89.6	100.0	100.0
Chicken	50,507.0	154,950.7	47.9	4.7		
Turkey	31,946.5	191,679.0	30.3	5.8		
Grand Total	105,345.7	3,324,570.4	100.0	100.0	100.0	100.0

Volume of Mortalities Currently Rendered

Renderers process roughly 50% of all livestock mortalities, providing a valuable service to farmers that are faced with finding ways to dispose of these dead or condemned animals. Renderers that provide this service tend to be the independent firms, unaffiliated with a packing facility. Ongoing consolidation trends, especially in this segment of the industry, have likely

reduced the availability of rendering services for some producers, especially in geographically isolated regions.

Incentives to send dead animals to rendering facilities are greater when the markets for animal protein feed ingredients are strong. Profitable markets for rendered protein raise the value of dead animals as a raw material, but as the protein markets decline, the value of this raw material declines as well. Animal protein markets have been under severe pressure for the last several years in response to excess supplies of vegetable-based protein sources (especially soybean meal) and regulations that have restricted the animal protein feed markets. Hence, most renderers today charge for the service of collecting dead animals from farms and ranches, while as recently as 1995 collection fees were extremely rare—if they existed at all. This reduction in the value of dead livestock as a raw material has almost certainly decreased the extent to which some producers use renderers as a method of disposal. Especially for small producers that generate modest amounts of dead stock, on-farm burial has likely increased in response to rendering fees particularly if such fees are levied on a per-visit basis or otherwise inversely related to the volume generated.

Besides sending dead animals to rendering facilities, other on-farm disposal practices include burial, incineration, composting, or abandonment of animal carcasses in remote areas of the farm or ranch. Data on the volume of livestock mortalities rendered, and the relative contribution of each species and type of supplier, are quite limited. The most recent large-scale survey of the rendering industry was conducted by Sparks in 1995, when it was estimated that renderers process 1.68 billion pounds of dead stock annually. Current estimates based on recent discussions with rendering firms and survey data collected by USDA/APHIS suggest the volume processed today decreased only slightly, to about 1.56 billion pounds (Table 9).

However, these numbers mask the probable effects of some important trends in the livestock industry. The steady increase in the number of large, high volume livestock operations, especially in the pork sector, has led to an increase over time in the volume of swine mortalities rendered, since these large operations tend to be much more limited in their on-farm disposal options given the large and concentrated volumes of mortalities they produce. Plus, since large animal enterprises supply dead stock to renderers in greater quantities and more consistently, the renderer is likely to levy a smaller unit fee for collection than they might for small livestock operations—or even offer a premium to these producers if the market for the animal proteins is favorable.

Consolidation trends have been much less pronounced in the beef cattle industry, and to some extent the dairy industry. The majority of operations in these industries are still rather small, each generating a modest volume of dead livestock annually. Infrequent collection of modest numbers of mortalities from a large number of geographically dispersed beef and dairy operations is relatively less economical for most renderers, likely resulting in higher per-unit collection fees levied on these producers. Hence, renderers estimate that the volume of cattle mortalities rendered today—the largest contributor to the overall volume—has likely decreased by at least 10% since 1995.

Table 9. Estimated Amount of Dead Stock Rendered in the US, 1995 and 2000

1995[1]			2000			
Species	Dead Stock	Percent of Deaths	Species	Dead Stock	Percent of Deaths[3]	MBM Production[4]
	1,000 lbs	*%*		*1,000 lbs*	*%*	*1,000 lbs*
Cattle	1,064,149.3	55.7	Cattle	869,480.91	45.0	241,715.69
Swine	425,007.2	57.1	Pre-weaned Hogs	35,261.69	53.1	9,802.75
Other[2]	190,015.1	55.0	Weaned Hogs	622,369.30	68.0	173,018.70
			Sheep, lamb, goats	32,052.80	45.0	8,910.68
Total	1,679,171.6		Total	1,559,164.72	52.4	433,447.79

1. From Sparks 1995 Industry Survey
2. Includes sheep, lamb, pre-weaned hogs, and other species
3. Estimates for pre-weaned and weaned hogs based on USDA/APHIS, other estimates based on discussions with renderers and Sparks 1995 report.
4. Assumes MBM yield of 27.8%, estimated in Sparks June 2001 Report

The total production of animal protein feed ingredients (primarily meat and bone meal; MBM) attributable to processing of livestock mortalities is estimated at more than 433 million pounds, approximately 6.5% of the estimated 6.65 billion pounds of mammalian-based MBM produced annually in the US.[4]

Further restrictions on the use of animal-based feed ingredients, including restrictions on the use of rendered material from livestock mortalities in livestock feed, will lead to further increases in the fees renderers must levy for collection of dead livestock. Fees today vary considerably based on several factors, including the type of species and the volume of dead livestock produced at each farming operation. Industry experts suggest that a typical charge for collection of dead, mature cattle averages about $10/head, but in certain cases it could be significantly more than this, even in excess of $100/head for the pick up of an individual mortality in remote areas not easily served by a local rendering facility. By restricting markets for animal protein produced from dead stock, this rendered material would have to be disposed of by other means, perhaps at a landfill, with these additional costs plus the loss in market value passed back to producers in the form of higher collection fees. Such fee increases could make other disposal methods—including unapproved methods—much more economically competitive for many producers. These potential costs are examined in more detail in the following section.

Alternative Methods of Mortality Disposal

The methods generally approved for disposal of livestock mortalities include burying the carcass at least 4 feet below the surface of the ground (i.e. covered with at least 4 feet of earth) often with a layer of lime; burning the carcass in a permitted incinerator; removing it by a licensed rendering company; or composting. Mortalities could also be delivered to a public or private landfill, but the practically of this is questionable based on the transportation costs that would likely be required, the "tipping fees" producers would face, and the fact that not all landfills are likely to accept this type of waste given public perceptions and landfill space constraints faced by most jurisdictions. Burial, incineration, composting, and removal by a rendering company

[4] Based on estimates presented in the Sparks June 2001 report.

are thus the most practical methods, and typically must be done within a short, state-mandated time frame to avoid the potential to spread disease.

Accurate data on alternative (non-rendering) disposal methods employed is difficult to obtain, especially since the public is sensitive toward the potential for environmental damage associated with some methods, and producers are hence reluctant to divulge accurate or detailed information regarding their own actions vis-à-vis mortality disposal. Especially for smaller operations that generate modest amounts of dead stock, and which might be less sophisticated than their larger counterparts, the temptation to avoid renderer charges by employing unapproved disposal methods, including improper burial techniques or abandonment of carcasses in remote fields, is likely great.

Burial of livestock is, along with rendering, one of the most widely used methods of carcass disposal. However, it is also the method that creates the largest risks to human health and the environment because of the potential for ground and surface water pollution if proper techniques are not followed. Livestock carcasses must be buried at least 4 feet below the ground within 36 hours. There are many challenges and risks associated with this disposal method. A common practice is to dig a trench and then, starting at one end, fill the trench in over time with carcasses and soil. However, maintaining an open trench poses a serious occupational hazard. Given this risk to human life, this burial method is discouraged for routine disposal of livestock, except for occasional or catastrophic losses.

Earth-moving equipment must be used to excavate a hole or trench for the carcasses, and during winter months it is difficult, if not impossible, to bury the carcasses in frozen soil. The liquid from decomposing carcasses can pose a risk to groundwater. The burial site should consist of deep, fine textured soils (such as clay and silt) with an underlying geology that poses little risk to groundwater contamination. The burial pit should be at least 100 feet away from production facilities to lessen risk of disease transmission by rodents.

Regulations concerning on-farm burial vary considerably by state, sometimes requiring detailed knowledge of the local geology to determine the maximum number of burials on a given area of land, or to ensure that the mortality is buried some specified distance above the water table.

Incineration is recognized as one of the most biologically safe methods of disposal. If done properly, it curtails the spread of disease and minimizes water pollution concerns, and produces only a small amount waste by-product (ash) that does not attract insects or scavengers. A mortality incinerator is essentially a convection oven (starved air combustor) that burns a carcass under a controlled environment at a very high temperature, reducing the carcass to ashes. Incinerators usually operate on diesel, natural gas, or propane. A diesel-fueled incinerator will require from 1 to 3 gallons of fuel per 100 pounds of carcass. However, large carcasses are more difficult to burn in most farm-operated incinerators; most tend to work best for carcasses smaller than 500 pounds. Therefore, carcass from mature cattle would likely need to be cut into smaller pieces prior to incineration, increasing the labor requirement and the potential for worker injury.

To own and operate an incinerator, most states require an operating permit, and sometimes require the incinerator owner to report the weight of carcasses burned annually in a yearly

emission inventory report. Oftentimes there are also county and city ordinances in place concerning incinerators. This can add to the management burden associated with this method. Burning carcasses in open pits typically does not comply with Department of Environmental Quality (DEQ) air quality standards and is not recognized as an approved method.

Composting is an approved method of disposal in most states, although strict regulations are often in place regarding construction of the composting structure and the type, size, and amount of livestock that can be composted at a single location. These regulations can add to the management burden and expense of this method, often requiring the advice of extension agents or other professionals to ensure compliance.

The concept can be described as burying the animal above ground in a mound of sawdust or other carbon source and allowed to decay. In the composting process, bacteria, fungi, actinomycetes, and protozoa break down the tissues of carcasses aerobically to produce water vapor, carbon dioxide, heat, and a stabilized organic residue. High temperatures indicate good microbial activity and will reach 120 to 160 degrees F, which is high enough to kill most pathogens, but far lower than the temperatures achieved through rendering. An internal pile temperature of at least 131 degrees is needed for three days to destroy disease-causing organisms, though the resulting material is still not guaranteed to be pathogen free and the process would be incapable of destroying the BSE prion if it were present. Furthermore, maintaining the proper heat, moisture content, and C:N ratio is critical to minimize odors and diseases, but can be difficult under all but ideal conditions. Even under the best of circumstances, odors can be a problem. Thus, the process requires intensive management oversight.

Facility site selection is also important to successful composting and to avoid environmental dangers. A site must be selected so that surface water and groundwater sources will not be polluted, and it is beneficial to locate the facility away from neighbors and human dwellings. The facility should be at least 100 feet away from production facilities to lessen the risk of disease transmission by rodents. The drainage of the site should be considered when deciding what type of compost facility to build. There should be no surface water contacting the compost area. Clean water diversions should be built to control runoff water.

Given the potential for adverse environmental consequences, composting often requires additional time and equipment compared to the other disposal methods. To successfully operate a compost facility, a bucket loader or skid steer is needed to transport carcasses from buildings or lots to the compost facility, cover the carcasses, and move piles from the primary to the secondary stages. Equipment to haul and unload incoming carbon source is also needed. Finished compost can be spread on crop ground as a fertilizer source using a solid manure spreader, but if the BSE prion were present, this material would have to be disposed of by other means to ensure that the prion does not re-enter the food chain through plants grown where the compost was spread.

Large animals such as mature cattle will often need to be cut into smaller pieces prior to being placed in the composting facility to ensure complete decomposition. And, the thick hides on mature cattle tend to be difficult to compost, requiring additional cycles to achieve complete composting.

Digesting/liquification is an increasingly popular method of disposal of livestock manure in many areas, and while it is a theoretically feasible option for disposing of animal carcasses, to date there are no livestock operations currently employing this technology and few companies or individuals have expressed interest in advancing this option. A digester is essentially a sealed facility that allows anaerobic bacteria to convert organic matter to methane and carbon dioxide, along with fiber and liquid nutrients that can be further composted and used as fertilizer. Its increasing popularity is due in part to its ability to produce methane gas, which can be used or sold as a valuable energy source. However, it only nominally reduces the amount of material that requires disposal after the digesting process, most of which is spread on fields as a fertilizer source. Although research is being conducted to use this process for disposal of carcasses, the ability to effectively digest large amounts mortalities does not currently exist. Plus, this method is only a "first step" in a process that would still require that aid of a composting facility to break down the remaining fibrous material. Since this method presently is not employed for dead stock disposal, its cost estimates are not examined directly in the following section.

Use of Alternative Disposal Methods

The Animal and Plant Health and Inspection Service (APHIS) of the USDA periodically conducts surveys of producers to collect various types of information concerning practices employed in particular livestock sectors. Recent industry studies that report on farm-level carcass disposal methods have been published for the swine, egg (layer), and beef feedlot industries (Tables 10 through 12). Unfortunately, APHIS has not published estimates of the use of alternative mortality disposal methods by dairy or cow-calf operations.

Several factors determine the degree to which individual producers rely on renderers for mortality disposal, including the species, concentration of death loss, and the proximity of a rendering firm. As noted above, large animals, such as mature cattle, tend to be difficult to dispose of by burial, composting, or incineration, so dairy farms and beef feedlots are likely to be highly dependent on renderers' services. According to USDA/APHIS, over 94% of cattle that die on feedlots are collected by renderers, with the bulk of the remainder (only 5.3%) buried by the feedlot operator (Table 10). By comparison, only about 41% of dead hens are rendered (Table 12). This difference reflects the difficulty in disposing of larger animals by alternative means, especially for intensive operations with large volumes of heavy livestock on a fairly limited land base, such as feedlots.

Table 10. Mortality Disposal Methods at Beef Feedlots[1]

Method of Carcass Disposal	Feedlots[1]	Deaths
	Percent	
Burial on Operation	11.8	5.3
Landfill	1.2	0.5
Renderer Pick up	94.3	94.1
Other	16.1	0.1
Total		100.0

1. Cattle at feedlots account for only about 16% of all cattle greater than 500lbs, with the remainder from dairy or cow-calf operations.
2. Some sites employ more than one method, so total percent of farm sites exceeds 100

Source: USDA/APHIS, National Animal Health Monitoring System (NAHMS) Feedlot '99

Mortality disposal data is not available for dairy or cow-calf operations. The 94% of cattle feedlot mortalities collected by renderers account for just over 16% of all mature cattle mortalities. In Table 9 it was estimated that renderers collect about 45% (by weight) of all cattle mortalities, so the remaining 29% of cattle mortalities collected by renderers come from either dairy or cow-calf operations. Industry experts suggest that dairy operations also rely heavily on renderers for mortality disposal, which is not surprising owing to the difficulty in disposing of these large animals by alternative means, and the increasingly concentrated and intensive production that characterizes most dairy operations today. If it is assumed that renderers collect 80% of all dairy cattle mortalities, the combined proportion of beef feedlot and dairy cattle mortalities rendered would equal about 32% of all cattle mortalities. The remaining cattle mortalities rendered (to reach 45%) must be comprised of dairy calves and mortalities from beef cow-calf operations. No information is available concerning the disposal methods used for the estimated 55% of all cattle mortalities that are not collected by renderers (which are overwhelmingly from cow-calf operations), but discussions with livestock experts suggest that a large proportion are either buried on the farm, or (especially for beef calves and small cattle) abandoned on remote parts of the farm or ranch.

USDA/APHIS reports detailed statistics regarding mortality disposal methods for hogs and laying-hens. This data suggests that renderers collect 53% and 61% of all pre-weaned and weaned hog mortalities, respectively, and 41% of dead laying hens (Tables 11 and 12). Owing to these species' smaller size, burial, composting, and incineration are frequently used disposal methods, but even for these species, renderers remain the primary disposal method.

Table 11. Disposal Methods for Hog Mortalities

Method of Carcass Disposal	Pre-weaned Deaths		Weaned Deaths	
	Farm Sites[1]	Deaths	Farm Sites	Deaths
	Percent		*Percent*	
Burial on operation	45.3	15.0	37.8	11.5
Incineration	15.4	14.5	11.6	6.0
Renderer Pick up	22.2	53.1	45.5	68.0
Composting	23.2	15.4	18.0	12.7
Other	4.4	2.0	2.5	1.8
Total		100.0		100.0

1. Some farm sites employ more than one method, so total percent of farm sites exceeds 100
Source: USDA/APHIS, National Animal Health Monitoring System (NAHMS) Swine 2000

Table 12. Disposal Methods for Dead Laying Hens

Method of Carcass Disposal	Farm Sites[1]	Dead Hens
	Percent	
Burial on operation	32.0	17.9
Incineration	9.0	10.4
Renderer Pick up	32.0	41.4
Composting	15.0	11.7
Other	16.1	18.6
Total		100.0

1. Some farm sites employ more than one method, so total percent of farm sites exceeds 100
Source: USDA/APHIS, National Animal Health Monitoring System (NAHMS) Layers '99

III. Costs of Alternative Disposal Methods Compared

It is useful to estimate the total costs to the livestock sector of alternative methods of disposal of livestock mortalities. For each method, costs can be broken into *variable costs of operation* and *fixed costs of investment*. For some methods, such as burial or collection by a renderer, fixed investment costs are likely to be negligible since no specialized equipment is required, but variable costs, primarily labor and/or renderer collection fees, can be quite high. For other methods including composting and incineration, large fixed investment costs would be necessary to construct the required specialized facilities.

Sector-wide aggregate estimates of operating costs under each disposal method are presented below[5], followed by the fixed investment costs that would likely be incurred if ample on-farm incineration or composting capacity were constructed. The cost estimates only include disposal of mammalian livestock, poultry is excluded since this is a unique industry segment typically served by specialized rendering firms that appear unlikely to be subject to new BSE regulations. All costs are based on dead stock quantities in 2000. The costs do not include labor or loader use for removing dead animals from the production facility since it is assumed that this would be the same for all alternatives. Labor costs are included when the method requires moving dead animals more than a few yards from the production facility. Labor costs are estimated at $10.00/hour, and equipment costs (rental or depreciation of a backhoe) are $35.00/hour.

Annual Operating Costs for Alternative Disposal Methods

Rendering

As noted in the previous section, depressed markets for animal proteins have reduced the value of dead livestock as a raw material for renderers, causing most firms to levy collection fees. Furthermore, consolidation trends among renderers have resulted in fewer rendering plants nationwide, likely restricting the extent to which rendering services are available to farms and ranches in geographically remote areas. Despite these structural changes, renderers still process roughly half of all on-farm livestock mortalities.

Accurate information on the magnitude of fees charged by renderers is difficult to obtain, and is not reported by any public agency. Industry participants report that fees vary greatly based on a number of factors, including the frequency of collection intervals and the animal species, and could be levied on either a weight basis ($/ton) or a per head basis. In the calculations below, the following fees are used to provide a "benchmark" estimate of the current value of renderers services: $10/head for cattle over 500 lbs, $7.00/head for calves, hogs, and other mature livestock, and $0.50/head for pre-weaned hogs. Estimates are provided based both on the

[5] To provide consistent cost comparisons across alternative disposal methods, cost calculations assume *all* dead livestock are disposed of by each method. In reality, many different methods are likely to be employed across the sector depending upon the economics of each local operation.

quantity of dead livestock currently sent to renderers, and (to provide consistent comparisons with estimated costs of alternative disposal methods) for a hypothetical scenario where all mortalities were collected by renderers and subject to equivalent collection fees.

Using the above assumptions, the value of renderer services (i.e. payments by livestock producers and packers for this service) based on current quantities of dead stock rendered is about $53.8 million per year, but if all livestock were sent to renderers and subject to the same fees, the annual charges to the sector would approach $93.5 million per year (Table 13). Since not all livestock are sent to renderers, the difference between these two estimates ($39.7 million) suggests the upper bound on the amount producers are currently willing to pay to dispose of the remaining dead livestock (i.e., methods currently employed for the remaining livestock are costing producers less than this amount). However, it is illustrated below that approved methods could be substantially more expensive, suggesting either that producers have been extremely effective at containing disposal costs on their own operations, or that the use of unapproved methods at lower costs is artificially deflating the actual value of renderer services.

Table 13. Current and Potential Renderer Collection Fees for Livestock Mortalities

Species	Fees	Deaths	Current Scenario Rendered	Current Scenario Charges[1]	Potential Charges[2]
	$/head	*1,000*	*%*	*$1,000*	*$1,000*
Cattle	10.0	1721.8	45.0	7,748.10	17,218.00
Calves	7.0	2410.0	45.0	7,591.50	16,870.00
Weaned Hogs	7.0	6860.0	53.1	32,653.60	48,020.00
Pre-weaned Hogs	0.5	11,067.7	68.0	2,938.47	5,533.85
Other	7.0	832.7	50.0	2,914.45	5,828.90
Total				$53,846.12	$93,470.75

1. Based on estimates of dead stock currently rendered

2. Assuming all livestock mortalities were rendered and subject to current collection fees.

Rendering Costs With Prohibitions on Feed Use

Renderers' incentive to collect livestock mortalities is not only based on fees charged for this service, but also (and more importantly) from the products produced from this material including, rendered protein, greases, fats and tallow. The primary market for the rendered protein is non-ruminant livestock feed. If renderers were prohibited from selling protein from dead or condemned livestock in the feed markets, rendering fees would necessarily increase to cover the lost value of the product plus the disposal costs of this segregated, rendered protein. Under such a scenario, the approximately 433 billion pounds of MBM produced annually from rendered (mammalian) dead stock (see Table 9) would no longer have a market and would therefore need to be disposed of by alternative means. Furthermore, renderer revenues would decrease by an amount corresponding to this 433 billion pound reduction in product sales. Hence, fees charged by renderers to collect dead stock would necessarily increase to cover the

reduction in revenues plus the additional costs of disposing of the rendered product[6]. To estimate the costs to the livestock sector under this scenario, the current market value of rendered protein attributable to dead livestock is calculated (based on Table 9 estimates), along with disposal costs for the rendered protein estimated at $75/ton, inclusive of transportation costs to the landfill[7]. Like the analysis above, costs are estimated according to both the actual amount of material currently processed by renderers, and the hypothetical case where all livestock mortalities were processed by renderers. Assuming current quantities of dead livestock processed by renderers is maintained, the costs to the sector if this material can no longer be sold in feed markets would exceed $106.7 million annually (Table 14), and if all livestock mortalities were processed through renderers, the costs of this scenario would approach $195 million per year (Table 15; comparisons on a "dollar per head" basis are presented in Table 19).

Table 14. Cost of Rendering Dead Stock if MBM is not Sold in Existing Markets: Current Quantity

		Current MBM Production		Potential Costs		
Species	**Deaths**	**Production**	**Value**	**Current Fees[1]**	**Disposal**	**Total[2]**
	1,000	*1000 lbs*	*$1,000*		*$1,000*	
Cattle & calves	1859.31	241,715.69	20,424.98	15,339.60	9,064.34	44,828.91
Weaned Hogs	4664.80	9,802.75	828.33	32,653.60	6,488.20	53,761.88
Pre-weaned Hogs	5876.95	173,018.70	14,620.08	2,938.47	367.60	4,134.41
Other	416.35	8,910.68	752.95	2,914.45	334.15	4,001.55
Total						$106,726.76

1. Based on Table 13
2. The current value of MBM produced from dead stock, plus current rendering fees, plus disposal costs

Table 15. Cost of Rendering Dead Stock if MBM is not Sold in Existing Markets: All Dead Stock

		Potential MBM Production		Potential Costs		
Species	**Deaths**	**Production**	**Value**	**Potential Fees[1]**	**Disposal**	**Total**
	1,000	*1000 lbs*	*$1,000*		*$1,000*	
Cattle & calves	4,131.8	537,146.04	45,388.84	34,088.00	20,142.98	99,619.82
Weaned Hogs	6,860.0	254,439.22	21,500.11	48,020.00	9,541.47	79,061.59
Pre-weaned Hogs	11,067.7	18,460.87	1,559.94	5,533.85	692.28	7,786.08
Other	832.7	17,821.19	1,505.89	5,828.90	668.29	8,003.09
Total						$194,470.56

1. Current collection fees applied to all dead stock, from Table 13
2. Potential value of MBM produced from all dead stock, plus current collection fees applied to all dead stock, plus disposal

[6] It is assumed that renderers would continue to process dead animals into MBM, which would in turn be disposed of in landfills. The incentive to continue processing this raw material comes from the reduction in the volume of material needing to be landfilled, the continued value of lipids from this raw material, and environmental safety concerns. See Sparks June 2001 report for a discussion of disposal cost economics. However, since here the fees would be borne most directly by livestock producers (often of modest means), in reality many would likely switch to alternative on-farm disposal methods if faced with substantial increases in rendering fees.

[7] These costs are based on estimates provided in Sparks' June 2001 report.

On-Farm Burial

The costs to the livestock sector if burial were used as the primary method of dead animal disposal are not well defined and are difficult to estimate. The viability—and costs—of this option depend on numerous local factors, and on whether the method is employed in an environmentally sound manner. Soil type, topography, distance to wells, depth of groundwater, available equipment, weather, and climate are a few of the variables that influence whether this option can or should even be considered for individual producers.

Many states have strict guidelines regarding the volume of dead animals that can be buried in a single trench or within an acre of land (maximum loading rates). For instance, Missouri has a maximum loading rate of 7 cattle, 44 swine, or 47 sheep on any given acre of land per year where groundwater pollution is *not* a concern. Where there is the potential for groundwater pollution, maximum loading rates fall to 1 bovine, six swine, or 7 sheep. As a result, producers with large numbers of mortalities on a limited acreage base (such as large, confinement operations) might not have adequate land resources to bury all of their mortalities.

Calculations of the costs of burial are also challenged because of the likelihood that some producers are likely to employ this method without having full knowledge of (or choosing to ignore) the appropriate standards and procedures necessary to minimize environmental impact. In this case, while the economic costs of digging a trench and burying dead livestock might be relatively low for producers equipped for this task, additional environmental costs are likely to be borne by others at a later date in terms of reduced water quality, the spreading of disease, or other adverse effects.

However, in these calculations we assume that all environmental safeguards are followed, that all livestock operations could employ this method regardless of geographic region or climate, and that the only direct costs associated with burial are labor and machinery. We also assume that each mortality is buried individually, and that labor and equipment time to dig the trench, deposit the dead livestock, and backfill are: 20 minutes for cattle over 500 lbs, 10 minutes for calves, weaned hogs, and other mature livestock, and 10 minutes for each group of 10 pre-weaned hogs. Labor costs are estimated at $10.00/hour, and equipment costs (rental or depreciation of a backhoe) are $35.00/hour. These assumptions suggest the total annual cost to the livestock sector if burial were employed for all livestock mortalities is $109.9 million (Table 16).

Table 16. Variable Costs of Proper Burial of all Livestock Mortalities

Species	Deaths	Hours	Estimated Costs		
			Labor	Equipment	Total
	1,000			*$1,000*	
Cattle	1,721.8	573.93	5,739.30	20,087.67	25,827.00
Calves	2,410.0	401.66	4,016.60	14,058.33	18,075.00
Weaned Hogs	6,860.0	1143.33	11,433.33	40,016.67	51,450.00
Pre-weaned Hogs	11,067.7	184.46	1,844.61	64,56.19	8,300.78
Other	832.7	138.78	1,387.83	48,57.42	6,245.25
Total					$109,898.03

Incineration

Use of on-farm incinerators to dispose of animal mortalities is increasingly common, although its use is still not widespread. One of primary barriers to adoption of this method of disposal is the significant fixed cost associated with construction of an incineration facility for on-farm use. However, once a facility is constructed, the costs of operating it are relatively modest, limited primarily to fuel costs.

Incineration is often the chosen method in poorly drained areas where burial is not acceptable or where rocky soil or persistent cold temperatures for several months a year make digging expensive or impractical. It is also recognized as one of the most biologically safe methods of disposal, since it completely eliminates all living tissue and microbes, produces very little waste, and does not create water pollution concerns. The primary environmental concern is the emission of particulates generated during the burning process.

Costs of operating an incinerator will vary based on several factors, including the capacity of the unit constructed, efficiency of fuel use, whether an afterburner or other equipment is required by local ordinance to reduce emissions, and the amount of record-keeping required by state or local laws. Also, it is likely that large animals would first need to be cut into smaller pieces to assure complete and rapid incineration. Estimation of operating costs to the livestock sector if all mortalities were disposed of by this method are based on the following assumptions: a "typical" on-farm incinerator can process 90 lbs of material per hour, burning one gallon of fuel (at a cost of $1.10/gallon for diesel);[8] labor costs (exclusive of transporting the animal to the facility) are assumed to be minor for most species (estimated at 25 hours/year at $10/hour) but mature cattle would first need to be cut into smaller pieces, which is estimated to take an additional 10 minutes per mortality. Under these assumptions, total operating costs incurred by the livestock sector if all animals were disposed of in on-farm incinerators are estimated at nearly $58 million per year (Table 17)

Table 17. Variable Costs of Incinerating All Mortalities On-Farm

Species	Deaths		Operating Costs		
	Number	Pounds	Fuel	Labor	Total
	1,000			*$1,000*	
Cattle & calves	4,131.8	1,932,180	23,615.53	14,945.79	38,561.33
Weaned Hogs	6,860.0	915,249	11,186.38	5,720.31	16,906.68
Pre-weaned Hogs	11,067.7	66,406	811.63	415.04	1,226.67
Other	832.7	64,105	783.51	400.66	1,184.16
Total					$57,878.84

Composting

Composting is a naturally occurring process in which bacteria, fungi, and other micronutrients convert organic material into a stabilized product. The use of composting is becoming more

[8] This is based on an incinerator sized to handle 40,000 lbs of death loss per year (110 lb/day), approximately the amount generated by a typical 300-sow farrow to finish hog operation.

popular as renderer fees increase and environmental concerns regarding burial are becoming more pronounced, but its adoption is still not widespread. Effective composting can also be difficult to manage, requiring substantial management attention and in depth knowledge of the process and the methods needed to speed decomposition, reduce odors, and ensure complete decomposition. Like incineration, the fixed cost of constructing a composting facility can be prohibitive, especially for smaller producers, and operating costs will vary based on the size and sophistication of the structure. The primary operating costs for a composter are labor and machinery costs associated with managing the process and performing necessary mixing operations on the pile, and purchase of "bulking material" such as sawdust, to ensure the appropriate carbon content for proper decomposition[9].

Estimation of the costs to the livestock sector if all mortalities were disposed of through on-farm composting facilities are based on the following assumptions: a bulking agent (sawdust) must be applied at the rate of 0.0067yd^3 per pound of dead material (at a cost of $20/ton); for a typical-size on-farm facility, 95 hours of farm labor per year plus 35 hours of machinery use would be needed to manage the process, turn the pile, move material between primary and secondary bins, and remove composted material[10]. Plus, mature cattle would first need to be cut into smaller pieces, which is estimated to take an additional 10 minutes per mortality. Labor costs are assumed to be $10/hour, and machinery costs (rental or depreciation of a skid-steer loader) are $35/hour. Under these assumptions, the total annual operating incurred by the livestock sector if are estimated at nearly $192 million (Table 18)

Table 18. Variable Costs of Composting All Mortalities On-Farm

	Deaths		Sawdust		Operating Costs		
Species	**Number**	**Pounds**	**Volume**	**Cost**	**Labor**	**Machinery**	**Total**
	1,000		*yd^3*	*$1,000*		*$1,000*	
Cattle & calves	4,131.8	1,932,180	12,945.61	15,728.91	48,758.94	60,863.67	125,351.52
Weaned Hogs	6,860.0	915,249	6,132.17	7,450.58	21,737.16	28,830.34	58,018.09
Pre-weaned Hogs	11,067.7	66,406	444.92	540.58	1,577.14	2,091.79	4,209.51
Other	832.7	64,105	429.50	521.85	1,522.49	2,019.31	4,063.65
Total							$191,642.77

Operating Costs Compared

The calculations estimated above show significant variation in operating costs across alternative methods of livestock mortality disposal. Total costs to the sector if all mortalities were disposed of using by each method range from $58 million for incineration to $194.4 million if livestock were collected by renderers who in turn had to dispose of the resulting MBM in a landfill (Table

[9] In practice, there are many options available for use as bulking materials, such as straw, dried cornstalks, or used bedding material. Some of these options might be readily available to some livestock producers, so purchase of sawdust might not always be necessary. Hence, the bulking material costs estimated here represent the "worst case" scenario for the livestock sector.

[10] The labor costs are based on those that would be required for a composting facility designed to handle 40,000 lbs of death loss per year (110 lb/day), approximately the amount generated by a typical 300 sow farrow to finish hog operation.

19). Variable costs per mortality are greatest for cattle and calves (owing to their larger mass), and could be as high as $30 per head if cattle and calves are composted, compared to current renderer fees that are estimated at $8.25 per head (average for both cattle and calves). Prohibiting the sale of MBM produced from livestock mortalities could increase renderers' collection fees to an average of over $24.00 per bovine, an increase of 192% (Table 19).

Table 19. Operating Cost Estimates for Each Major Method of Mortality Disposal

	Rendering[1]				
Species	MBM Sold For Feed	No MBM For Feed	Burial	Incineration	Composting
	Total Costs ($1,000)				
Cattle & calves	34,088.00	99,619.82	43,902.00	38,561.33	125,351.52
Weaned Hogs	48,020.00	79,061.59	51,450.00	16,906.68	58,018.09
Pre-weaned Hogs	5,533.85	7,786.08	8,300.78	1,226.67	4,209.51
Other	5,828.90	8,003.09	6,245.25	1,184.16	4,063.65
Total	$93,470.75	$194,470.56	$109,898.03	$57,878.84	$191,642.77
	Dollars per mortality ($/head)				
Cattle & calves[2]	8.25	24.11	10.63	9.33	30.34
Weaned Hogs	7.00	11.53	12.45	4.09	14.04
Pre-weaned Hogs	0.50	0.70	2.01	0.30	1.02
Other	7.00	9.61	1.51	0.29	0.98

1. Assuming all dead stock were rendered
2. Under existing scenario, renderers are assumed to charge $10 per mature cattle, and $7 per calf

The cost variation across alternative methods is driven directly by the assumptions used in the calculations. The primary components of the variable costs estimated here are labor, machinery, and rendering fees. In practice, these expenses will vary greatly across individual operations based especially on scale economies. Operations that generate significant volumes of mortalities are likely to experience relatively lower variable costs of disposal for each method, since, for instance, renderers are likely to charge less per head if each collection generates a large volume of raw material. Similarly, labor and machinery costs are likely to be economized for the other methods if several mortalities are handled (buried, incinerated, or composted) simultaneously. Hence, in all cases larger operations are likely to experience lower unit costs of disposal than would their smaller counterparts. Equipment and labor costs are also likely to vary across operations based on availability and size of necessary equipment, machinery operating costs and assumptions used in depreciation, opportunity costs of time, and the extent to which family labor is employed and not counted as an expense.

Importantly, as noted above, these operating costs also do not account for fixed investment costs necessary to employ specialized methods such as composting and incineration. While the investment costs are only directly incurred infrequently (based on the useful life of the necessary facility), their size can make particular methods prohibitive especially to smaller operations that do not generate significant volumes of mortalities. Any method that requires a substantial initial investment is likely to be relatively less burdensome to larger producers since the costs can be spread over a larger volume of mortalities. Estimates of investment costs for the construction of composting and incineration facilities are presented below.

Fixed Investment Costs for Alternative Disposal Methods

For individual livestock producers, decisions regarding the preferred method of mortality disposal will depend not only on the recurring expenses associated with each method, but also on the initial investment in specialized equipment that can be required. This initial investment will vary greatly across alternative methods. For instance, sending dead livestock to a rendering plant requires minimal investment by the livestock producer, and especially for small operations that do not generate significant quantities of dead animals, incurring modest fees to have these mortalities collected by a renderer is likely to be preferred to the large investment in equipment or facilities that might be required for composting or incineration.

Unfortunately, estimating representative costs of constructing composting or incineration facilities for on-farm use is extremely difficult and subject to substantial variation based on the type of structure constructed, its capacity, quality of materials used, and local building codes and regulations. Each livestock operation is different, and the resources available, especially for large initial investments, vary. For this analysis, construction costs are estimated based on published sources from land grant Universities[11].

It is unlikely that all existing livestock operations would necessarily incur the investment costs described below even if existing disposal option were eliminated or regulations mandated the use of particular disposal methods. Most livestock production operations are quite small by industry standards, consisting of, for instance, fewer than 50 beef cattle, less than 30 dairy cows, or under 100 hogs. For operations of this size, which incur relatively little mortality loss on an annual basis and receive modest revenues from their operation, investment in a specialized method of disposal is unlikely to ever be economically feasible. If necessary, it is more likely that operations of this size would use the facilities of one of their larger neighbors (perhaps paying a disposal for use of the facility), cease operation entirely, or revert to using non-approved methods or on-farm burial.

In calculating the total investment required by the livestock sector if on-farm composting or incineration facilities were constructed to handle the annual death loss, it is assumed that these facilities would only be constructed on operations above a particular minimum size. The size cut-off below which facility construction would be assumed impractical is somewhat arbitrary, and for this analysis is assumed to correspond to operations *larger* than the smallest size category reported in the relevant USDA/NASS report describing each livestock sector (Table 20). Hence, these costs are based on an assumption that only about 28% of livestock operations would be considered large enough to invest in one of these structures.

[11] It is assumed that all producers have ready access to the necessary excavation equipment, such as a backhoe or skid-steer loader, through either rental or direct ownership. These costs (either depreciation or rental) are included in the estimates of operating costs, especially since this type of equipment is likely to find other valuable on-farm uses to justify its expense, while the costs of constructing composting facilities or incinerators are only associated with mortality disposal.

Table 20. Number of Livestock Operations Assumed Large Enough to Install Composting or Incineration Facilities

Species	Total Number of US Operations	"Large" Operations[1] Criteria	Number
Beef Cattle	830,880	> 50 Head	177,330
Dairy Cattle	105,250	> 30 Head	74,140
Hogs	81,130	> 500 Head	35,118
Other	71,340[2]	--	20,000
Total	1,088,600		306,588

1. Based on most recent USDA/NASS cattle, hogs and pigs, and sheep and goat reports
2. Estimated number of sheep, lamb and goat operations

Estimated Costs of Constructing Composting Facilities

The following assumptions are used in estimating construction costs:

- The structure must contain a minimum of three bins for the different stages of composting, with one being filled with the daily mortalities. The actual number of bins and bin size will depend on the volume of carcasses being composted and the amount of bulking agent required.

- The structure must be built on an impervious weight-bearing pad that is large enough to allow equipment to maneuver.

- The structure must be covered with a roof or other water-repelling materials (e.g. a tarpaulin) to prevent excessive moisture on the compost.

- The structure must be solidly built of rot resistant material that is strong enough to withstand the force exerted by the equipment (e.g. pressure-treated lumber or concrete)

Economists at the University of Nebraska at Lincoln estimated investment costs for two types of facilities sized to handle about 40,000 pounds of mortalities per year, approximately the amount of death loss generated from a 300 sow farrow to finish hog operation. Construction of a "high investment" version, which includes seven concrete bins, was estimated at $15,200, while a "low investment" version, which includes six smaller bins and no roof was estimated at $7,850. In each case, this assumes that the concrete work was hired and the wooden portion was constructed with farm labor. Economists at Auburn University estimated construction costs for smaller facilities at between $2,016 and $7,500. Since the majority of livestock operations are relatively small (although large operation account for the majority of livestock produced), investment costs to the livestock sector to construct adequate on-farm composting volume are based on a $7,000 investment per operation identified in Table 20. These assumptions lead to a total estimated investment of $2.1 billion for construction of on-farm composting facilities (Table 21). Composting facilities are assumed to have a useful life of about 15 years.

Table 21. Fixed Investment Costs of Constructing On-Farm Composting Facilities

Species	Number of Facilities	Total Investment
	Number	*$1,000*
Beef Cattle	177,330	1,241,310
Dairy Cattle	74,140	518,980
Hogs	35,118	245,826
Other	20,000	140,000
Total	306,588	$2,146,116

Estimated Costs of Constructing Incineration Facilities

The following assumptions are used in estimating construction costs:

- The incinerator is lined and thermostatically controlled, with a minimum capacity of 500 pounds.
- Capital expenditures are limited to the purchase of a ready-built incinerator, fuel tank, and fuel lines.

The cost of an incinerator varies considerably according to the size and capacity of the unit. In addition, local air quality regulations could increase the cost if additional pollution-control devices are required, such as an afterburner or catalytic converter. Economists at the University of Nebraska at Lincoln estimate the cost of a 500-pound capacity on-farm incinerator at $3,642 if no afterburner is required, and $4,642 with an afterburner. Auburn University economists estimate the cost of a smaller incinerator (for use on poultry operations) at $2,000. However, even a 500-pound capacity incinerator is unlikely to be adequate for disposal of larger livestock, such as mature beef or dairy cattle. Hence, it is assumed that for practical purposes, the average investment required for an on-farm incinerator is $4,500. While this might be considered high for a smaller-sized livestock operation, it is also likely to far underestimate the expense required for a large cattle operation generating several mortalities per day. These assumptions lead to a total estimated investment cost of $1.4 billion for construction of on-farm incineration facilities (Table 22). The useful life of an on-farm incinerator is estimated to be 10 years.

Table 22. Fixed Investment Costs of Constructing On-Farm Incineration Facilities

Species	Number of Facilities	Total Investment
	Number	*$1,000*
Beef Cattle	177,330	797,985
Dairy Cattle	74,140	333,630
Hogs	35,118	158,031
Other	20,000	90,000
Total	306,588	$1,379,646

Implications

Selecting a mortality disposal system is an important decision, as it impacts animal and human health. The viability of alternative mortality disposal methods for individual livestock producers depends can be on several factors, including logistic factors, and the quantity of mortality, location of production facilities, soil type, topography, amount of labor available, and access to equipment. The estimated cost of alternative disposal methods for each operation will be driven largely by the producers' attitude toward environmental issues, as well as management preferences and government regulations.

For many producers, paying a modest fee to have a renderer remove dead carcass is likely preferred to finding alternative on-farm disposal methods, which is fortuitous given the potential for environmental damage if this material is disposed of improperly. However, if fees should increase (perhaps in response to new regulations), producers will respond by re-evaluating their costs and deciding which other method is most cost effective. Importantly, producers will examine both the fixed costs and operating costs associated with each method, so even a method that is relatively inexpensive to operate on a daily basis could be out of reach for some producers when substantial fixed investment costs are involved. Small operations will likely be at a disadvantage to adopting capital-intensive methods, forced instead to employ methods that are more expensive on a per unit basis, putting them at a competitive disadvantage to large animal enterprises. Additional discussion of the implications of these disposal cost estimates is presented in the following section.

VI. Implications of Disposal Cost Estimates

The calculations in the preceding sections are based on the best information available, but are nonetheless subject to significant variation based on the assumptions employed. The large number of livestock mortalities produced each year and the unpleasant fact that improper disposal can result in direct harm to human health and the environment is likely to drive some producers to under-report the actual number of livestock deaths on their own operation, and perhaps not be entirely truthful in reporting the methods they use for disposal. Since by in large these animals generate no revenue to the livestock sector, volume estimates cannot be estimated based on traditional measures such as sales or production. And, costs of disposal, even fees charged by renderers, are not publicly reported, necessitating the use of rigid assumptions that will clearly not apply to all operations. Hence, the entire system of producing and disposing of livestock mortalities operates "behind the scenes", and is not subject to the reporting techniques or market oversight that can typically shed light on other activities and production sectors.

The size of the livestock sector (with its population of over 139 million head of cattle, calves, hogs, and other livestock species) implies that the volume of mortalities generated annually, even barring catastrophic events such as disease outbreaks or weather disasters, is enormous. Based on USDA estimates, nearly 23 million head of livestock (3 billion pounds excluding poultry) died prior to slaughter and required disposal either on the farm or through a rendering facility. Renderers currently process about 50% of these mortalities, but slightly more than 50% on a weight basis (because of the volume of mature, heavy cattle included in the total). The remaining 50% are not sold in any market; rather they are buried, composted, incinerated, or simply abandoned in a remote part of the farm or ranch. It is this uncertainty and lack of direct market or regulatory oversight that makes it impossible to gauge with any accuracy the methods used on each of the hundreds of thousands of livestock operations in the US, and the total disposal costs incurred, including costs to the environment shared by society.

The volume of MBM produced from dead livestock is estimated at just over 433 million pounds, which accounts for about 6.5% of the total annual production. While MBM from livestock mortalities accounts for only a modest proportion of total industry sales, many individual renderers rely heavily on mortality disposal in their current operations, especially the smaller, independent operators. Thus, prohibitions on this practice will impact different renderers disproportionately, and would likely lead some firms to cease operation. And, as an industry segment, livestock producers would be on the front lines of any such regulation since it is they who would be forced to find alternative methods to dispose of this waste. Given the temptation to minimize costs, the likelihood that many livestock producers would turn to improper and potentially dangerous methods of disposal is high.

Importantly, the type of dead livestock that would likely be the primary focus of future restrictions—cattle, especially those above 24 months old—tend to be the ones which are most difficult to dispose of by alternative means. While cattle older than 24 months account for less than 23% of all on-farm cattle deaths, these large animals account for more than 51% (996.1 million pounds) of the more than 1.9 billion pounds of dead cattle produced annually. The absence of practical and cost-effective alternative disposal methods could cause this material to accumulate in areas where ground or surface water is put at risk, or force producers to incur

substantial costs to construct incineration or composting facilities capable of handling this waste. Over 80% of all beef livestock operations have fewer than 50 head of cattle, and 50% of all dairies have fewer than 50 cows, and would therefore unlikely have the resources available to use any of the more sophisticated methods of disposal. For these producers, on-farm burial would likely be deemed most economical, despite the inherent environmental risks. Over 94% of feedlots currently send their mortalities to renderers, reflecting the absence of other cost effective methods of disposal. It is therefore important that regulators balance the potential increased environmental costs of alternative disposal methods against the potential to further reduce the risk of BSE by placing restrictions on rendering this material.

Viability of Alternative Disposal Methods

Livestock producers will respond to cost and market forces when deciding which disposal method to employ. For many producers, paying a modest fee to have a renderer remove dead carcasses is still preferred to finding alternative on-farm disposal methods, which is fortuitous given the potential for environmental damage if this material is disposed of improperly. However, if fees should increase (perhaps in response to new regulations) or new restrictions were placed on available methods, producers will respond by re-evaluating their costs and deciding which other method is most cost effective, the economics of each viable method will then be used to make the final selection.

Estimates in the previous section reveal significant variation in both the operating costs and investment costs for each alternative methods of disposal. The actual costs of adopting each method will be determined by both the operating costs, which are incurred regularly, and the costs of constructing necessary facilities where applicable (Table 23). While most of these costs are modest relative to the total value of livestock sales (estimated at over $53 billion in 2000), most individual producers operate on tight profit margins and are often reluctant—or unable—to incur costs such as these that contribute no additional value to their operation.

Table 23. Total Estimated Costs of Adopting Each Major Method of Mortality Disposal

	Rendering[1]				
Species	MBM Sold For Feed	No MBM For Feed	Burial	Incineration	Composting
	Annual Operating Costs ($1,000)				
Cattle & calves	34,088	99,619	43,902	38,561	125,352
Weaned Hogs	48,020	79,061	51,450	16,907	58,018
Pre-weaned Hogs	5,533	7,786	8,300	1,227	4,209
Other	5,828	8,003	6,245	1,184	4,063
Total Operating	$93,470	$194,470	$109,898	$57,879	$191,643
	Initial Fixed Investment Costs ($1,000)				
Beef Cattle	N.A.	N.A.	N.A.	797,985	1,241,310
Dairy Cattle	N.A.	N.A.	N.A.	333,630	518,980
Hogs	N.A.	N.A.	N.A.	158,031	245,826
Other	N.A.	N.A.	N.A.	90,000	140,000
Total Fixed	N.A.	N.A.	N.A.	$1,379,646	$2,146,116
Cost of Adoption	$93,470	$194,470	$109,898	$1,437,525	$2,337,759

1. Assuming all dead stock were rendered

For specialized methods, such as composting or incineration, costs of constructing the necessary facilities are substantial, and even though these costs are incurred only infrequently, they nevertheless would likely be prohibitive for many producers, especially smaller operations that lack easy access to capital. The result could be more widespread use of less expensive, but unapproved, methods that risk the safety of human and livestock health and the environment. Since fixed costs tend to be only indirectly related to the volume of material requiring disposal, smaller producers are at an immediate disadvantage to adopting specialized methods such as composting or incineration. While large enterprises could spread these costs over a larger quantity of material, small producers might be forced to use methods that are more costly on a per unit basis but do not require the large initial investment. This only decreases their competitive position in the already competitive livestock markets, and will likely speed the demise of some of these small operations.

Beyond these monetary costs, other factors will also determine whether a particular method is viable on a particular operation. These include:

Incineration:

- Smoke and odors could be a nuisance to neighbors.
- In most cases, carcasses should be smaller than 500 pounds, so large animals might need to be cut into pieces prior to incineration. This will increase both labor costs and risks to worker safety.
- Required permits must be obtained, and required records meticulously maintained (for instance, if annual reporting is required), increasing the potential management burden.

Burial:

- Operator must have access to a backhoe or other earth moving equipment.
- Labor must be available for daily trenching and covering.
- Land must be available year round for burial.
- Sufficient land must be available to burying the volume of mortalities generated without exceeding approved maximum loading rates.
- Burial pit should be at least 100 feet away from production facilities.
- Burial site should consist of deep, fine textured soils.
- Underlying geology must pose little risk for groundwater contamination, so water-table measurements must be performed.
- Trench bracing equipment might be necessary for safety concerns.
- Local or state regulations might require the maintenance of accurate records regarding death loss and volume buried on particular plots of land.

Composting:

- Ample carbon source must be readily available.
- If not using sawdust, a bale processor or other means to chop wheat straw, hay, etc. might be required.
- Labor must be available to process carcasses and turn compost.
- Suitable location must be available for the composter, which should be at least 100 feet away from production facilities.

- The composter must not pose risk to surface water.
- Manure spreader must be available to apply the compost to available land.
- If compost cannot be applied to the land (perhaps because of BSE concern), alternative compost disposal options must be explored at substantial additional cost.
- Bucket loader must be available for loading and turning the compost.
- Odors could be a concern if the process is improperly managed.
- Local or state regulations might require the maintenance of accurate records regarding death loss and volume of mortalities composted.

Many of these issues can be ignored only at risk to the environment or worker safety; in other cases substantial capital expenses—beyond those illustrated in the previous section—could be involved. And, the risk that producers will attempt to minimize costs by not fully complying with all necessary procedures increases with the costs of alternative methods, and these are costs that could be shared by the rest of society or future generations.

Importantly, rendering is currently the only form of mortality disposal that is regulated and that maintains complete records concerning the number and types of mortalities collected. Thus, the disposition of mortalities throughout the sector is more easily "traceable" and can be monitored much more closely than if producers dispose of mortalities on the farm. And, the rendering industry is well equipped to safely and efficiently handle livestock mortalities using its existing infrastructure. Rendering is both environmentally benign, and cost effective. Of course, if renderers should continue to collect dead stock but were forced to segregate the resulting proteins from existing market channels, additional costs of labeling, installing separate processing and handling lines to ensure segregation, and record-keeping could cause collection fees to increase even above the levels necessary to cover the costs reported in Table 23.

Other Considerations

Of all potential methods employed, only incineration is thought to hold the capability to destroy the prion believed responsible for the spread of BSE. One of the issues cited as a key reason that digesters have not been heavily promoted or researched as an alternative method of carcass disposal is that the BSE prion is not destroyed in the process. Given the operational challenges of developing a digester capable of handling large, dead cattle, the potential to reduce the risk of spreading BSE has not been deemed sufficient to justify adopting the process on a widespread basis. Since the sludge from the digesting process is in turn primarily used for fertilizer, if that prion were present it could conceivably re-enter the feeding chain through pasture grass or vegetable-based feed produced where the sludge was applied. Importantly, the same result holds for the byproduct of composting facilities, since composters are also incapable of destroying the BSE prion. Hence, the potential to reduce BSE risk by encouraging disposal methods alternative to rendering is somewhat reduced.

The estimates of livestock mortalities used throughout this report are believed to not include most "downer livestock", many of which are currently processed into human food at specialized slaughter facilities. The number of downer livestock in the US is unknown, but estimates put the number as high as 1.5% of all cattle, or nearly 1.8 million cows per year (National Market Cow and Bull Audit). Legislation has been proposed to restrict the use of downer livestock by meat

packers, requiring instead that they be humanly euthanized. Regardless of the merits of such legislation, if passed it would certainly increase the volume of dead livestock requiring disposal, which would place additional strain on the sector to dispose of these animals in an environmentally sound manner, especially if existing disposal techniques are restricted

Conclusions

It is clear that despite the fact that livestock mortalities represent a relatively small proportion of the total output of the sector, costs of disposal are substantial and can create economic challenges to individual producers. Since most disposal practices operate behind the scenes, out of sight from market forces or regulatory enforcement, the temptation to improperly dispose of this material is substantial. It is clear that rendering currently offers a safe, and environmentally-sound method of mortality disposal. Plus, it is the only method for which there is an existing method of regulatory oversight.

Further increases in the costs of disposal, such as would occur if current rendering practices were restricted, would increase the likelihood that this material is disposed of improperly, at risk to the environment and human and livestock health. It is therefore important that regulators examine all costs that could result from further regulation of disposal methods, including the potential for unintended consequences, and balance these costs against the potential for further reducing the risk of BSE.