PRACTICAL SOLUTIONS FOR ON-FARM MORTALITY DISPOSAL[1]

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Introduction

Within any livestock enterprise some animals die before being processed or marketed. This is a fact of life for any species on large and small operations, including those that are well managed and those that are poorly managed (although death losses are typically greater on poorly managed farms). These death losses or "mortalities" may be broadly classified as catastrophic or routine. Catastrophic mortality events involve death losses of substantial magnitude as might result from a barn fire, hurricane or flood or entry of an epidemic disease. An extreme example is the Foot and Mouth Disease (FMD) epidemic that occurred in the United Kingdom in 2001. On 2,030 premises within in small geographic area this event resulted in the death or destruction of 3,297,385 sheep, 595,884 cattle, 144,931 pigs and 2,368 goats along with the necessity of associated carcass disposal (Scudamore and co-workers, 2002). Mortality disposal in catastrophic situations requires oversight and approval of agencies such as the state veterinarian office and health, environmental or regulatory agencies. The topic of this brief paper is disposal of routine mortality. These losses can be expected to occur and fluctuate throughout the course of production and may include stillborn lambs and afterbirth, nursing and weaned lamb mortalities and occasional breeding sheep losses.

Importance of Proper Mortality Disposal

Within the past 10 to 15 years, disposal of routine livestock mortality has received greater attention for improvement. This period coincides with development of larger more intensive swine, dairy and poultry farms which may have made the problem more visible. In addition mortality management and disposal is not considered a profit center and does not create return on time and investment as do improvements in breeding efficiency, lambing rate, growth rate and carcass value. Regardless of farm size and despite the fact that mortality disposal is not a specific profit center, there are a number of reasons why mortality disposal is important and should be done well:

1. Farm bio-security and disease control.
2. Preventing attraction of predators and varmints.
3. Esthetics and public perception of the farm.
4. Morale of farm family members, employees and visitors.
5. Environmental protection.
6. Nuisance avoidance and regulatory compliance.

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Methods of Disposal

There are strengths and limitations associated with the various methods of mortality disposal currently in use. The methods chosen for any given farm will depend on farm circumstances, regulatory requirements, operational costs and producer preferences. Some traditional methods such as burial are being discouraged or eliminated from a regulatory standpoint. Recently the Virginia Department of Environmental Quality (DEQ) has released a preference hierarchy for methods of animal mortality management indicating the agency's most preferred to least preferred methods (Table 1).

Table 1. Virginia Department of Environmental Quality animal mortality disposal method preference hierarchy (DEQ, 2009)*.

Preference level	Mortality Disposal Method:
1st	Rendering to recycle animal mortality to useful products of commerce
2nd	On-site composting to convert animal mortality back to stable soil nutrients
3rd	Concentrated animal composting at DEQ permitted composting facilities
4th	Incineration using a DEQ permitted incinerator to sanitarily dispose of mortality
5th	Landfill burial in a permitted sanitary landfill (if permitted by local landfill)
6th	On-site burial on the premise the animal mortality is generated

*Available at: http://townhall.virginia.gov/L/ViewGDoc.cfm?gdid=3969

Rendering. There are good reasons why DEQ would indicate rendering as the most preferred method of mortality disposal. Livestock mortality, a product that is essentially a valueless liability can be rendered into useful products that have commercial value such as rendered fat and meat and bone meals. Historically the process involved renderer pickup in specially designed trucks or producer delivery to a commercial rendering plant for processing of dead stock. This option was attractive to producers because renderer pick-up was typically at no cost and producer delivered material would actually result in small payments based on weight of dead stock.

However, developments over recent decades have made commercial rendering essentially nonexistent as a mortality disposal option for sheep producers and many other small livestock producers. In 1989 U.S. rendering plants began excluding sheep carcasses because of the potential for use of rendered sheep products infected with scrapie as feed ingredients to contribute to bovine spongiform encephalopathy (BSE or mad cow disease). In 1997 the US Food and Drug Administration (FDA) banned the feeding of most mammalian derived rendered proteins as feed supplements to ruminants, a ruling that still exists with some modifications. The net result has been a reduction in value of meat and bone meal and reduction or elimination of demand for dead stock by independent renderers.

Incineration. Incineration refers to the burning of material to the point that the resulting end products are heat, gaseous emissions, and residual ash. Burning mortality in open-air pyres is objectionable from an esthetic and environmental standpoint. In addition most state regulations, including Virginia's, prohibit open-air burning for mortality disposal. However,

fuel-assisted (diesel or LP gas) fixed-facility incinerators specifically designed for livestock and poultry mortality disposal are available and used effectively in the industry.

Commercial incineration units come in various models and capacities to accommodate different animal sizes and loading rates. Costs excluding delivery and hookup may range from $5,000 to $7,000 for a 700 lb. load capacity unit with larger models costing more and smaller models less. Addition of a secondary burn chamber or "afterburner" on any unit increases costs, but is required by Virginia law. A published estimate of fuel use is 1.35 gallons per 78 lbs. of mortality burned in units equipped with an afterburner (Henry and co-workers, 2001).

Use of a commercially installed incinerator has the advantage of bio-secure on-site disposal, but installation and operational costs associated with fuel use are potential drawbacks. In Virginia the greatest potential limitation, especially for small operations, is that operation of a solid waste incinerator requires obtaining and maintaining a specific permit from the Virginia DEQ air division.

Burial (on-farm and public landfill). Historically burial has been a commonly used method for the disposal of livestock mortality. But as viewed currently by DEQ and other environmental agencies, on-farm or public landfill burial are the least preferred methods of dead livestock disposal. This is mainly related to the potential for soil and groundwater contamination, a concern that has increased as some livestock and poultry operations have become concentrated on fewer but larger farms. Research is limited but there is evidence that burial of livestock mortality does pollute soil and groundwater at and near the site, and actual decomposition of the animal tissues within burial pits is slow (Glanville, 2000; Engel and co-workers, 2004).

On commercial farms burial typically involves using a backhoe to dig a narrow trench in which dead stock is placed and covered with compacted soil. Practical problems encountered may be water draining and pooling in the trench, particularly if it is built larger to accommodate future mortalities. There is also the difficulty of digging in frozen soil during winter months. Although Virginia DEQ discourages burial as a disposal method, the agency has issued a guidance document for burial (http://townhall.virginia.gov/L/ViewGDoc.cfm?gdid=3969). This is in response to the fact that some producers have limited options for mortality disposal. Table 2 provides a summary of DEQ burial criteria from the guidance document.

In some cases local landfills may accept livestock mortalities on a fee basis. Fees and acceptance and delivery conditions will vary across localities, so producers should contact local authorities to determine if transport to a landfill is a viable option for their situation.

On-farm composting. Mortality composting was originally developed as a means of disposing of dead birds on poultry farms. Subsequently the practice was adapted as a method of disposing of livestock mortality including hogs, sheep and cattle. When performed properly, composting converts dead animals into components of an organic residue that can be used as a soil amendment and fertilizer. If properly set-up and managed, composting units present minimal risk for air, soil or water contamination. The operative words here are *properly set-up*

and managed. A poor or inattentive approach to mortality composting will give the expected poor results and associated odor, leaching and fly problems.

Table 2. Virginia DEQ animal burial guidance document summary (DEQ, 2009)

Burial shall occur on the property which is used for the raising or husbandry of the livestock.
The carcass shall be buried within 48 hours of death and prior to creation of an open dump, hazard, or nuisance situation.
Each carcass shall be buried in a separate pit (i.e., one carcass per pit).
There must be at least two acres that are able to meet the site criteria for burial pits as follows. Burial pits shall not be within: • 50 ft. of the property boundary; • 100 ft. of any surface waters; • 200 ft. from any well used as a drinking water source; • 50 ft. from caves or sinkholes; • 50 ft. of rock outcrops; • a 25-year floodplain as defined by FEMA or local planning officials; • 2 ft. from the seasonal high water table (refers to the bottom of the burial pit); • areas where bedrock occurs at a depth of less than 5 ft.; • 200 ft. from any off-property residence, health care facility, school, recreation park, daycare or similar public institution; and • 25 ft. from all other buildings and structures.
The carcass shall be buried deep enough to cover the top of the carcass with at least two (2) ft. of compacted soil to keep other animals from unearthing the carcass.
Carcasses shall not be buried deeper than 6 ft. below grade.
On-site burial is limited to 2,000 lbs. of dead animals on any given acre per year.

Composting is a natural biological process of decomposition of organic materials in a predominantly aerobic environment. During the process, bacteria, fungi, and other microorganisms break down organic materials into a stable mixture called compost while consuming oxygen and releasing heat, water, carbon dioxide and other gases. Four variables are considered critical to successful composting: (1) moisture content (40 to 60%), (2) temperature (113 to 140° F), (3) oxygen concentration (10% desirable level), and (4) carbon: nitrogen ratio (20:1 to 30:1 desirable range). Temperatures of at least 131° F for a least 3 consecutive days are generally needed to kill pathogens; destruction of weed seeds that can make finished compost undesirable for agronomic purposes requires temperatures of at least 140° F.

When composting sheep or other livestock mortality, the carcasses, which are nitrogen-rich, are fully covered with and allowed to react with carbon-rich bulking materials such as coarse sawdust, wood chips, cotton gin trash, chopped straw, chopped hay, chopped corn stalks or similar material. Naturally occurring bacteria in the mixture then cause the conversion of these components into humic acids, bacterial biomass and compost.

In mortality composting, it is essential that each carcass be fully surrounded and covered with bulking material to allow for complete interaction of carbon- and nitrogen-rich materials and to absorb moisture and odors released by the carcasses. The bulking material also serves as

an insulator to retain the heat and moisture that is generated during the composting process. If mechanically chopped to reduce particle size, straw, corn stover and waste hay make suitable carbon-rich bulking (cover) material. However, in long form these materials tend to form mats that impede the composting process. Poultry litter has been used successfully as bulking material for mortality composting, but due to its high nitrogen content, it is best when blended with other more carbon-rich materials. When bulking materials are too dry when placing dead stock into a compost pile, it may be necessary to add water to promote the composting process. On the other extreme an excessively wet or water logged compost pile excludes air from within the pile restricting the composting process.

If properly located it is feasible to safely perform mortality composting in exposed piles on compacted earth. Round hay bales (Figure 1), tubular steel gate panels and old round bale feeders have been used to form pile enclosures for this method of mortality composting. However, the best managed compost units are those that have a dedicated structure with constructed bins that hold static piles of mortality compost in various stages of maturity. These permanent multi-bin structures are typically constructed on concrete surfaces to facilitate scooping, moving and turning of the material (Figure 2). Plumbing a water source to the compost unit is helpful to allow efficient application of water to the compost piles when necessary.

The static-pile passively ventilated composting process has been described as using primary, secondary, and storage or curing phases. Early definitions of these phases were based on the observation that initial carcass decomposition was accompanied by moistening, weakening, and compaction of the cover materials, leading to decreased diffusion of oxygen into the pile and declining temperatures and decomposition rates. At this stage, it became necessary to turn the pile to break up wet zones and to introduce more oxygen and moisture, if needed, in order to reactivate aerobic microbial activity and stimulate a "secondary" cycle of heat production. After completion of the secondary heating cycle, soft tissue decomposition generally was complete and the compost was sufficiently stable to be stockpiled before land application. In practice, most livestock mortality compost is turned only one or two times. Turning speeds carcass decay, but research has shown that turning is not essential if the carbon material used to cover the carcasses is sufficiently permeable for oxygen diffusion into the pile (Harper and co-workers, 2008).

As static pile and windrow pile composting has caught on some livestock farms, commercial companies have developed mechanical systems to facilitate and speed up the mortality composting process. These include forced air systems in which fan-driven air is forced through compost piles using a system of PVC pipes below the piles, and elongated rotating drum systems in which mortalities and carbon material are placed in one end of the drum and composted material is removed from the opposite end after the process is complete. These commercial systems are being installed on some large livestock farms, but high initial costs make them less feasible on small operations.

It is feasible to recycle some secondary phase or cured mortality compost back into new mortality compost piles. Experience indicates that recycled mortality compost should make up no more than half of the cover material when new piles or bins are being loaded with fresh mortalities. At some point cured or stockpiled mature mortality compost must be land applied. Although quite variable from batch to batch, livestock mortality has a nutrient and soil

amendment properties similar to poultry litter. The material can be applied using standard dry manure application equipment and is an effective source of plant nutrients when applied to forage and crop land at agronomic rates. A compost nutrient analysis coupled with soil testing enhance the ability to utilize the material effectively.

Regulatory personnel at DEQ have indicated that, when it is performed properly, composting to dispose of routine livestock mortality is exempt from permit requirements under an agricultural exemption. As for burial, the agency has published guidelines for mortality composting which can be viewed at http://townhall.virginia.gov/L/ViewGDoc.cfm?gdid=3968.

Summary

Even on well managed livestock farms some animals will die before being processed or marketed. This is true for operations running small sheep flocks as well as for very large hog or dairy operations. Regardless of operation size or type, it is critical that routine livestock mortalities be disposed of properly for many reasons including human and animal health, prevention of predators, esthetics and public perception, morale of personnel, environmental protection, nuisance avoidance and regulatory compliance. Delivery to rendering plants, once a viable option, is essentially nonexistent as a mortality disposal option for sheep producers today. Incineration using fuel-fired commercial units can be quite effective but has the requirement for a DEQ air division permit and significant fixed and operational costs. On-farm burial is another traditionally used mortality disposal method. But, due to soil and groundwater protection concerns, DEQ and other agencies discourage this method. The DEQ does recognize that small farm operators have limited disposal options and has issued a set of guidelines for burial when other methods are not feasible. Public landfill burial may be available in some localities but producers must check with local agencies to determine the feasibility of this option. Composting, when performed properly, can be an effective option for mortality disposal on sheep and other livestock farms. Like any management practice, certain procedures and guidelines must be followed for good results with mortality composting. Although directed at swine mortality disposal, a source for mortality composting procedures and guidelines is Virginia Cooperative Extension publication 414-020, *Composting for Mortality Disposal on Hog Farms* (http://pubs.ext.vt.edu/414/414-020/414-020.html).

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Figure 1. Old round hay bales being used to form an enclosure for mortality composting.

Figure 2. A pole-type multi-bin mortality composting shed.