Professional Agricultural Workers Journal

Volume 6 | Number 2 Article 9

11-15-2019

Goat Mortality Composting

Roger Merkel
Langston University, merkel@langston.edu

GOAT MORTALITY COMPOSTING

***Roger Merkel[1]**
[1]Langston University, Langston, OK
***Email of author: merkel@langston.edu**

Abstract

One lawful method to dispose of animal carcasses is composting. Mortality composting is a "green" method that provides the producer with valuable soil amendments. Composting sites should be away from water sources and public areas. Some states require a facility and/or permit for carcass composting so producers should contact their State Veterinarian. Animal composting generates little to no odor and generates temperatures high enough to kill pathogens. Mortality composting is an aerobic process and requires a proper C:N ratio achieved by using a high carbon source to envelop the carcass, moisture content of roughly 50%, and available oxygen. Common composting materials are sawdust, ground hay or straw, rice hulls, and stable waste. It can be done using permanent structures or low-cost alternatives. About half of the resulting compost can be used to establish a new pile. Compost from mortality composting can be used on pastures, in landscaping, and elsewhere.

Keywords: Mortality, Composting, Goat

Why Compost Goat Mortality?

All livestock producers need a plan to dispose of livestock mortality. Dead animals must be disposed of promptly because carcasses left on the ground have the potential to spread disease, contaminate surface and groundwater, feed coyotes and other predators, and cause complaints by neighbors and passersby. Further, improper disposal is illegal. Criminal statutes prohibit leaving a carcass to decompose in the open. As an example, in Oklahoma carcasses may not be deposited within ¼ mile of surface water, dwellings or public highways, or be buried along streams or other waterways. Livestock owners must lawfully dispose of their animal mortality.

There are five lawful options for animal carcass disposal: rendering, incineration, landfills, burial, and composting. Finding a rendering service for goats is difficult. Due to regulations concerning the handling of ruminant carcasses and offal and the risk of transmissible spongiform encephalopathies (i.e., BSE and scrapie), many rendering facilities either do not accept goat carcasses or offal or disposal fees may be prohibitively high. Open-air incineration of goats is prohibited and producers wishing to use this option must purchase a closed incinerator. Not all landfills accept carcasses and producers must pay disposal fees as well as trucking costs. Trucks hauling dead animals should be cleaned and disinfected after use.

Burial is a viable option for many producers who own the needed equipment; but if machinery must be leased the cost may be high. During winter, frozen soil can prevent the prompt burial of mortality forcing producers to seek other disposal options. Further, there are state regulations on burial that must be followed and producers should contact their local extension service or state department of agriculture for information.

Composting is an inexpensive, environmentally friendly method of disposing of animal mortality that is commonly used in the poultry and swine industries. Mortality composting allows producers to legally dispose of carcasses, preventing contamination of ground or surface water and the

feeding of predators that can occur with indiscriminate carcass disposal. Mortality composting can become part of a farm biosecurity plan to deal with the disposal of dead animals and prevent disease spread.

When done properly, animal composting generates little to no odor and the high temperatures generated kill most pathogens. Animals suspected to have died from zoonotic diseases (diseases that can be passed to humans) should not be composted. Sheep and goats that die from scrapie should never be composted because the prion agent responsible may not be killed at common compost pile temperatures. However, for most cases of mortality, composting is a safe, low-cost alternative to other carcass disposal options.

As with burial, producers are advised to seek out information on their state's rules and regulations regarding mortality composting. Although some states only require concentrated animal feeding operations to obtain permits to compost mortality, other states may require permits for any amount of mortality composting. Often states will base acceptable mortality composting practices using the standards set forth by the Natural Resources Conservation Service (NRCS) found in Conservation Standard Practice, Animal Mortality Facility Code 316, and Composting Facility Code 317. The Cornell Waste Management Institute has a website on U.S. Mortality and Butcher Waste Disposal Laws providing information on state requirements at http://compost.css.cornell.edu/mapsdisposal.html. Another website with state information is the Veterinary Compliance Assistance website, under Carcass Disposal (http://www.vetca.org/lacd/).

Mortality Composting Basics

In the same way, microorganisms degrade vegetative waste and turn it into a rich soil amendment, animal carcasses can be turned into an organic matter-rich material that can be spread on pastures and other agricultural lands. To successfully compost animal mortality requires attention to the basics of any good compost pile: proper carbon to nitrogen ratio (C:N), moisture content, available oxygen, and temperature.

Carbon: Nitrogen Ratio

Microorganisms doing the work of composting require nutrients in the form of carbon and nitrogen in a C:N ratio of roughly 30:1, or 30 parts carbon for each part nitrogen. Animal carcasses are high in nitrogen (having a low C:N ratio, Table 1) and the surrounding compost material should be high in carbon to create an acceptable C:N ratio. There are many suitable carbon sources for mortality composting. When selecting a carbon source, consider year-round availability, amounts needed, and cost. Seek out easily obtained materials for composting to make the process as easy and economical as possible. Materials such as wood chips from utility companies or municipalities or forage unsuitable for feeding can be used. Used bedding after a livestock show at a local fairgrounds or horse arena can be an easily obtained, inexpensive carbon source. Other carbon sources used in mortality composting include old or moldy hay, crop residues such as straw, corn stover, silage, rice hulls, and ground corncobs (Table 1). One commonly used material is sawdust. Sawdust has a high C:N ratio, good particle size, and the ability to absorb and retain moisture.

Table 1. Carbon:Nitrogen ratio of some common composting materials

Material	C:N ratio (weight basis)
Sawdust	200 – 750:1
Straw	48 – 150:1
Wood chips	40 – 100:1
Corn stalks	60 - 73:1
Finished compost	30 – 50:1
Horse manure	22 – 50:1
Cattle manure	19:1
Goat manure	16 – 21:1
Turkey litter	16:1
Poultry litter	14:1
Animal carcasses	5:1

Sources: On-Farm Composting Handbook. 1992. NRAES-54, Natural Resource, Agriculture, and Engineering Service, Ithaca, NY. ISBN:0-935817-19-0. EBAE172-93. 1996. North Carolina Cooperative Extension Service, Raleigh, NC.

The particle size of the carbon source affects aeration of the pile with subsequent effects on pile temperature and decomposition rate. A general guideline for particle size is roughly 1/8 to ½ inch (up to 1 cm) in diameter. Materials such as hay, straw, and corn stover will work better if coarsely ground prior to use. Alternatively, these materials can be mixed or layered with other materials, such as manure or finished compost, in a 50:50 mixture and used.

Moisture Content

Microorganisms require proper moisture conditions to work. The optimal moisture content for a compost pile is approximately 50%. If the compost pile material is too dry, bacteria have insufficient moisture and composting will be very slow. If the material is too wet, water fills the pore spaces in the compost pile, causing desirable aerobic bacteria to be replaced by anaerobic bacteria. Decomposition by anaerobic bacteria is very slow, generates odors, and does not produce sufficient heat to inactivate pathogenic organisms in the compost pile. Too much water also increases the chance for liquid (leachate) to run out of the pile, potentially contaminating soil and water. Add water to the carbon material to obtain an adequate moisture level.

To test for moisture content, squeeze a handful of the compost material. If water drips out, it is too wet. If none sticks to your hand, it is too dry. The material should feel like a damp sponge. For a more accurate moisture level reading, use a portable moisture probe.

Available Oxygen

In addition to proper carbon and moisture content, aerobic microorganisms require oxygen. The amount of oxygen available to microorganisms in a compost pile is largely dependent on the particle size of the carbon material used. If the particle size is too small, there will be inadequate pore space for oxygen movement. If the material is too large, there can be too much air transfer allowing heat, odors, and moisture to escape the pile. Sawdust, mixtures of shavings and manure,

or bedding and manure all have good-sized particles providing adequate pore space and oxygen circulation.

Temperature

Microorganisms working in a compost pile include bacteria, fungi, and actinomycetes; bacteria by far outnumber other organisms. In initial stages of composting, mesophilic bacteria that work best at temperatures of up to about 105°F dominate. As temperature increases, thermophilic bacteria that grow at temperatures up to 160°F take over. Mortality compost piles work best in a temperature range of 130 to 150°F. To reduce pathogens, the NRCS standard practice recommends a compost pile reach a temperature of at least 130°F for a minimum of 5 days. Temperatures above 145°F kills most weed seeds. A pile temperature that is too high, greater than 160°F, can affect bacterial survival, hampering the composting process.

It is best to monitor temperature using a 36" or 48" compost thermometer (Photograph 1) thrust into the pile's core. If a thermometer won't be used, insert a long piece of metal rod, such as a piece of rebar, into the pile's core withdrawing it occasionally to feel if the pile is heating. At temperatures above 130°F, the tip of the rod can be held in one's hand for only 1 or 2 seconds.

Photograph 1. Compost Thermometers are 3 to 4 feet Long

Site Selection

Producers should check with their state department of agriculture to determine if specific guidelines exist for mortality composting site placement. If there are no specific requirements, use guidelines for animal burial to properly situate mortality compost facilities. In general, the site should be 300 feet away from water sources, public areas, roads, and property lines. A firm surface near the pile is needed for equipment and vehicle access and storage of the carbon source. Some states may require an impermeable base to any mortality compost pile. Water should be available for use in building piles. Mortality compost piles can be made with no surrounding structure; however, curious animals may dig into the pile so some type of surrounding wall or fence is beneficial.

Mortality Composting Bins

Different types of bins can be constructed, taking into consideration your state's mortality composting regulations, the level of mortality expected, funds available, and the permanence desired. These may be permanent structures or bins made from stock panels, wire, or old pallets. The number of bins needed depends on expected mortality. For most goat farms a simple three-bin system will be sufficient.

Permanent Bins

Permanent bins may be new structures specific to composting or they may be unused sheds, cribs, or other buildings. Permanent composting structures should have a concrete or packed surface floor and sufficiently high ceilings to allow the use of a tractor or skid steer. A concrete pad prevents runoff and liquid seepage into the ground and provides a good working surface. A graveled area around the pad helps when working in wet weather. A permanent mortality composting structure should have at least three bins: two working bins and a third bin to cure compost, store carbon source, or use as an additional working bin if needed (Photograph 2). A roof will shelter the pile from weather, allowing better control of composting conditions. If a roof is not built, covering bins with a tarp in areas with abundant rainfall helps protect the pile from becoming too wet, creating anaerobic conditions leading to poor decomposition and odor generation.

In general, bin width should be 6 to 8 feet or 1.5 times the width of tractor or skid steer buckets used in constructing and turning piles. Bin depth should be at least 6 feet and is often equal to or greater than the width, up to 10 feet, depending upon expected mortality. Bin wall height should be 5 to 6 feet to accommodate piles of layered carcasses. The front of the bin could be closed with wood or a hinged gate or left open if bin depth is sufficient and animals cannot enter the area. Bin walls are commonly built from pressure-treated wood, although cement or cement blocks can be used. Spaces can be left between boards to encourage air exchange.

Photograph 2. A Permanent Three-Bin Wooden Mortality Composting Structure.

Low-Cost Alternatives

There are many low-cost alternatives to constructing permanent structures for small herds having minimal mortality. These low-cost bins can be placed on a concrete pad if state regulations mandate, or on a soil base. Two stock panels wired to form a circle, eight wooden pallets on edge held in place by T-posts or wired together, or woven wire and T-posts can be used to make easy, low-cost bins (Figure 1). Three large round bales can be placed to form a three-sided bin in which mortalities can be placed. A surrounding fence can prevent disturbance from wildlife and dogs.

Mortality composting bins should be 6 to 8 feet in diameter. This size can hold one to two adult goats and one to three kids, depending upon size, composted in two layers. Too small a compost pile will have insufficient insulating qualities and poor heat retention. The pile will not heat properly and composting will be slow.

Figure 1. Low-Cost Alternative Compost Bins

When building small compost piles in the open, the final covering layer of carbon source should be piled into a cone shape to shed rainwater, preventing the pile from becoming too wet. A tarp tied to cover the pile is beneficial in areas with high rainfall. Preventing a pile from becoming too wet is easier than drying a pile that has become too moist and is not composting properly.

Mortality Composting Process

Ensure you have plenty of carbon source material before beginning mortality composting. The amount needed for wooden bin composting can be estimated from the volume of the bin. For alternative bins made from wire, pallets, round bales, or other material, the amount will depend upon the diameter of the bin and the height of the final pile. However, a rule of thumb is approximately 100 ft^3 (3.5 yd^3) or 4 to 5 tractor buckets of the carbon source mixture for every 100 pounds of mortality. If two or three carcasses are layered in a bin, the total will be somewhat less on a per animal basis as the base layer will be used for more than one carcass. However, too thin a base or covering layer of carbon source will lead to poor decomposition, excessive leachate, or odors.

Building the Pile

1. Cover the base of the bin with a minimum of 18 inches of carbon source material as an absorbent layer to trap liquid leached from the carcass during composting. The base layer can be laid down several days prior to adding carcasses so it begins to heat. This will speed up the initial stage of carcass decomposition.
2. Add a carcass in the middle of the base a minimum of 12 inches from bin walls or sides. Limbs may be tied or removed and laid next to the body if needed to keep away from bin sides.

3. If the bin is of sufficient size and two or more carcasses need to be composted, add a second carcass to the layer. Place adult carcasses back to back 8 to 10 inches apart and lamb or kid carcasses 6 inches apart with feet pointing to the pile's edge.
4. Use a knife to lance the rumen. This provides access by microbes to the inside of the carcass and prevents the rumen from bursting due to gas build-up from ruminal microbes. Additional cuts can be made on the limbs or torso allowing bacteria to enter, speeding up the decomposition process.
5. Add enough water to the surrounding carbon source to create a moisture content of roughly 50%. One to two 5-gallon buckets of water may need to be added per 100 pounds mortality. Adjust the amount depending on the dryness of the carbon source. Do not get the layer too wet. The carcass contains significant water and this must be considered when adding additional water.
6. Cover the carcass layer with 6 to 12 inches of carbon source material if the second layer of carcasses is to be added. If not, proceed with the covering layer.
7. The second layer of carcasses can be added as mortality happens. Scoop out a portion of the layer covering the first carcasses and lay fresh carcasses on top. Maintain at least 6 inches between layers. Lance the rumen and add additional water as needed. If composting in deep wooden bins, complete layers in the back before beginning to compost in the front area of the bin.
8. After all carcasses have been added, top off the pile with a minimum of 18 inches of carbon source material creating a cone shape to shed rainwater if no roof or tarp covering will be used.
9. After a couple of weeks, the pile will have shrunk and additional carbon source may be added to the covering layer. Check the pile occasionally to ensure animals have not disturbed it and that no portions of the carcass are visible. Also, check for noticeable odors and pile temperature. (Note: Figure 2, Photograph 3, and Figure 3 show different phases of the composting process and temperature movement).

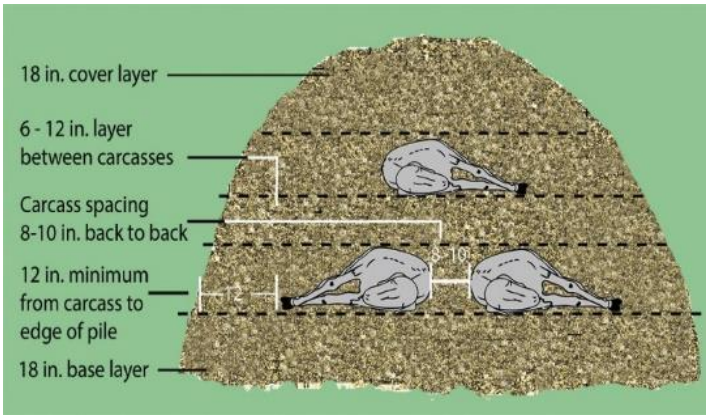

Figure 2. Carcass and Layer Spacing in a Small ruminant

Heat Cycles and Aeration

Mortality compost piles should undergo two heat cycles, the first cycle after building the pile, and a second cycle after turning the pile. After building the pile, bacteria will be working and generating heat. After 3 or 4 days, pile temperature should reach over 130°F and may remain at that temperature for up to 2 weeks or longer before beginning a gradual decline. This heat is important to speed up decomposition and to reduce pathogens. Pathogens are destroyed due to the combination of pile heat and length of exposure. For this reason, it is important to monitor pile temperature. This need not be done daily but at a minimum temperature should be checked every 2 to 3 days.

The first heat phase continues until pile temperature begins to drop. By this time, all flesh and soft tissues will have decomposed and mainly large bones are left. In a well-working pile containing carcasses of adult animals, this occurs in roughly 10 weeks at which time the pile can be turned. Use a tractor bucket to pick up material and either dump it back on the pile or into a second bin. Allow the material to fall from the bucket. This aerates the pile and mixes the contents. Use additional carbon source material to ensure enough covering layer is put on the turned pile. Moisture can be added if the pile is too dry or the pile can be allowed to dry if it is too wet, from trapped rainfall, for example. During the first heat cycle, most small bones will be degraded. When turning the pile, collect larger bones and place them in the pile center.

After turning, the pile will heat again and reach temperatures over 130°F. This is particularly important in reducing pathogens because not all parts of the original pile may have reached high temperatures for a sufficient length of time. Redistributing pile contents via turning increases the

Photograph 3. Goat Rib Bone after 10 Weeks of Composting

probability all portions of the compost will heat up sufficiently to kill disease-causing pathogens. Monitor the temperature of the pile as it heats. After a second 10-week period, the compost pile can be left to cure for several weeks before use. Any large bones left at this time should be added to a future compost pile for further break down.

Although turning compost piles speeds up the process, the decision to turn piles will depend upon the producer's reasons for composting and available equipment. If a producer wishes to create

compost for use on pastures, turning piles to initiate a second heat cycle and speed up decomposition is best. If a producer's main interest is lawfully disposing of mortality, turning is optional. This would also be true of producers who may not have the machinery to easily turn mortality compost piles. Piles left unturned, referred to as static piles, will continue to decompose, only at a slower rate.

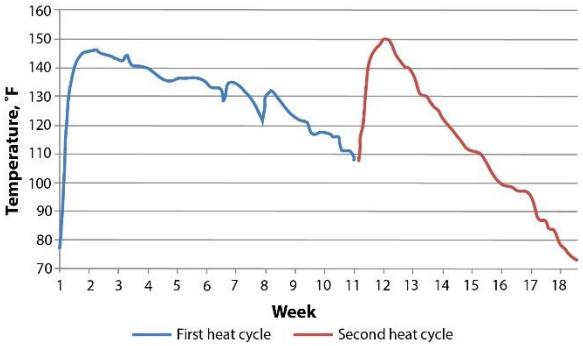

Figure 3. Temperature of a Goat Mortality Compost Pile Turned at 11 weeks

Cold Weather Composting

Composting can be done at any time of the year, even in winter. It can be difficult to establish a new compost pile in very cold weather, but active piles with sufficient covering layer insulation will continue to heat and decompose carcass material even if covered with snow and ice. Winter mortality composts best when added to an active pile or if hot, active compost from an existing pile is used as the main portion of the carbon source for a new pile. If possible, do not let carcasses freeze before adding to a working compost pile. Add an additional cover layer to insulate the pile and retain heat when very cold. The composting process may take longer in winter, but the carcasses will degrade.

Troubleshooting Mortality Compost Piles

Common problems that occur with mortality compost piles are low temperature, odors, and failure to decompose. The causes of these problems are often too little or too much moisture, improper C:N ratio from too many carcasses in the pile, or too much air movement. Too much pile moisture will reduce oxygen in the pile, creating anaerobic conditions that cause low temperature, slow decomposition, and odor. Open the pile and allow it to dry a little. You can also turn the pile and mix an additional carbon source to create better conditions for composting. If a pile is too dry, add additional water.

Adding too many carcasses to a mortality compost pile results in an improper C:N ratio. Odors may be generated and flies noticed around the pile. Add more carbon source, check moisture, and ensure a thick covering layer. Flies will not be seen around a well-built pile.

If there is too much air movement in the pile, heat will escape and decomposition will be poor and odors noticed. This may happen if using corn stover or unchopped straw or hay. Ensure a proper particle size of the carbon source. If using long-stem hay or straw, mix or layer manure or another suitable carbon source in the pile. Make sure carcasses are a minimum of 12 inches from the side of the pile or bin and that the covering layer is at least 18 inches thick. The covering layer not only

acts to shed rainwater, it also serves as a biofilter trapping gasses and odors generated by the composting process.

Fluids seen running out of the pile indicate too thin a base layer, compost that is very wet, or a pile containing too many carcasses. In these cases, the pile may have to be rebuilt or split into two piles.

Scavengers may disturb pile contents if the surrounding structure cannot prevent entry. For example, the openings between slats in a pallet may not stop wild animals from entering the pile, particularly if odors are present. If entry becomes a problem, additional wire surrounding the pile may be needed.

Compost Use

About one-half of the material from a mortality compost pile can be reused in a new pile and mixed with additional carbon source material. This reduces the amount of carbon source that needs to be on hand and also provides a source of bacteria for the new pile. The remaining composted material is a nutrient-rich medium that can be applied to pasture and other agricultural lands. Mortality compost should be included in a total farm nutrient management plan and spread accordingly. It is not recommended to use small ruminant mortality compost on vegetables or areas where food is produced for direct human consumption.

Conclusion

Mortality composting is an easy, lawful, low-cost alternative for producers to dispose of livestock losses. Select sites away from water sources and the public. Producers can construct permanent wooden bins on a concrete pad or use simple wire or pallet enclosures. A carbon source such as sawdust, wood shavings mixed with manure, stable bedding, or other carbon-rich material is needed to combine with the carcass. The proper moisture content of approximately 50% is essential to ensure a working pile. The temperature in a properly made pile is high enough to kill most pathogens. A portion of the resulting compost can be reused and the remainder spread on pastureland. Producers should check with state and local officials for any laws, rules, or guidelines that must be followed concerning mortality composting and the use of resulting compost.

References

American Institute for Goat Research. (2014). “What Farmer Educators Need to Know about Mortality Composting - Beyond the Basics.” Langston University http://www.luresext.edu/?q=Mortality Composting [Retrieved October 14, 2016].

Auvermann, B., S. Mukhtar, and K. Heflin. (2006). “Composting Large Animal Carcasses.” Publication E-422, Texas Cooperative Extension, Texas A&M University. https://tammi.tamu.edu/2017/07/20/composting-large-animal-carcasses/ [Retrieved May 18, 2018].

Bonhotal, J., L. Telega, and J. Petzen. (2002). “Natural Rendering: Composting Livestock Mortality and Butcher Waste.” Cornell Waste Management Institute. Cornell Cooperative Extension.
http://compost.css.cornell.edu/naturalrenderingFS.pdf [Retrieved October 14, 2016].

Colorado State University. (2016). "Livestock Mortality Composting." Cooperative Extension http://extension.colostate.edu/topic-areas/agriculture/livestock-mortality-composting/ [Retrieved October 14, 2016].

Cornell Waste Management Institute. (2016). "Mortality Composting." http://cwmi.css.cornell.edu/mortality.htm [Retrieved October 14, 2016].

Estienne, M.J. (2008). "Disposing of Dead Goats." Maryland Cooperative Extension. http://www.sheepandgoat.com/dispostinggoats [Retrieved October 14, 2016].

Higgins, S.F., S.J. Wightman, and A.A. Gumbert. (2013). "On-Farm Composting of Animal Mortalities." Publication ID-166, Cooperative Extension Service, College of Agriculture, University of Kentucky http://www2.ca.uky.edu/agcomm/pubs/id/id166/id166.pdf [Retrieved October 14, 2016].

Higgins, S., S. Guinn, and A.A. Gumbert. (2013). "On-Farm Disposal of Animal Mortalities." Publication ID-167. Cooperative Extension Service, College of Agriculture, University of Kentucky http://www2.ca.uky.edu/agcomm/pubs/id/id167/id167.pdf [Retrieved October 14, 2016].

Flynn, R.P., and R.G. Hagevoort. (2013). "Whole Animal Composting of Dairy Cattle." Guide D-108. Cooperative Extension Service, New Mexico State University. http://aces.nmsu.edu/pubs/_d/D108.pdf [Retrieved October 14, 2016].

Morse, D.E. (2009). "Composting Animal Mortalities." Agricultural Resources Management and Development Division, Minnesota Department of Agriculture St. Paul, MN. http://www.mda.state.mn.us/news/publications/animals/compostguide.pdf [Retrieved October 14, 2016].

Mukhtar, S., A. Kalbasi, and A. Ahmed. (2004). "Chapter 3 Composting." In *Carcass Disposal: A Comprehensive Review* (pp 85). National Agricultural Biosecurity Center, Kansas State University, Manhattan, KS. http://krex.k-state.edu/dspace/handle/2097/662 [Retrieved October 14, 2016].

Natural Resources Conservation Service. (2015). "Conservation Standard Practice, Animal Mortality Facility Code 316." http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd340263&ext=pdf [Retrieved October 14, 2016].

Natural Resources Conservation Service. (2010). "Conservation Standard Practice, Composting Facility Code 317." http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs143_026122.pdf [Retrieved October 14, 2016].

Payne, J. (2009). "Proper Disposal of Routine and Catastrophic Livestock and Poultry Mortality." BAE – 1748, Cooperative Extension Service, Oklahoma State University. http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-6301/BAE1748web.pdf [Retrieved October 14, 2016].

Veterinary Compliance Assistance Website. (2016). "Carcass Disposal." http://www.vetca.org/lacd/ [Retrieved October 14, 2016].