Department of Animal Science

COMPOSTING DAILY POULTRY MORTALITY

April 2023
Tom Tabler, Department of Animal Science, University of Tennessee
Shawn Hawkins, Department of Biosystems Engineering and Soil Science, University of Tennessee
Pramir Maharjan, Department of Agricultural and Environmental Sciences, Tennessee State University
Victoria Ayres, School of Agriculture, Tennessee Tech University
Jonathan Moon, Department of Poultry Science, Mississippi State University
Jorge Urrutia, Department of Poultry Science, Mississippi State University

Composting, the biological decomposition of organic matter under purposefully controlled conditions, is the most widespread method used to manage normal daily mortalities on commercial poultry farms. Composting is a safe and efficient disposal method if the proper procedure and timeline are followed. To use composting successfully for daily mortality management, it helps to understand that composting is a natural, aerobic process (meaning oxygen is required) that is carried out by microorganisms that metabolize organic wastes as an energy source for growth, in this case transforming poultry mortality into a stable final product that has added value as a fertilizer and soil amendment. Although this process can be highly effective, attention to management detail is essential for success. Failure to properly manage poultry carcass composting will create odors and flies, attract unwanted scavengers and other vermin to your farm/compost site, and leave you with a material that is not stable in final storage and not suitable to land apply without creating nuisances. Proper mortality compost management is critical in order to avoid nuisance complaints. Successful composting requires following a recipe and the orderly mixing of ingredients for the microorganisms to do their job and completely break down carcasses in a timely and efficient manner.

A few pertinent facts

Composting daily poultry mortality on the farm has several advantages, including:

1. **Averts the potential for groundwater pollution that, in the past, was associated with burial or the continuous use of open disposal pits;**
2. **Avoids the high fuel cost and potential air pollution concerns associated with incineration; and**
3. **Prevents potential disease transfer caused by moving poultry carcasses off the farm**.

In recent decades, across the country, the number of farms has significantly decreased. This is true in the poultry sector as well as other agricultural enterprises. The farms that remain have

significantly increased in size. Many integrated commercial broiler farms today have six to eight or perhaps even more production houses on a single farm, whereas a generation ago two to four houses were common. In addition, the size of individual production houses has increased substantially versus a generation ago. The increase in the production capacity of commercial poultry farms means more normal daily mortality must be managed, often in a smaller geographic area.

While normal daily mortality losses are small, they are continuous throughout the flock grow-out cycle. Therefore, **dead bird disposal is an essential daily management chore**. Composting these daily mortalities is cost-effective, environmentally sound and a biosecure management technique that also produces a valuable and useful soil amendment. However, there are requirements and specific procedures to consider for the composting process to be successful.

Compost recipe

Creating good compost of any kind is like baking a cake; a specific recipe must be followed, otherwise the end product will not have the desired characteristics, including notably a lack of offensive odors. In mortality composting, this recipe is designed to accommodate and allow the microorganisms that break down carcasses to flourish. These microorganisms require carbon, nitrogen, oxygen and moisture in the proper proportion to efficiently degrade carcasses. Any ingredient lacking or in excess will slow down decomposition and microbial growth, resulting in inadequate heat production and a generally poor composting environment. Generally speaking, **the recipe is to add twice the volume of a bulking material to carcasses**; this bulking material can be recently de-caked litter and/or a largely carbonaceous bedding material such as wood shavings/chips. This recipe/mixture provides the ideal carbon to nitrogen (C:N) ratio that compost microorganism need to grow rapidly. Critically, the added bulking/carbon materials provide voids through which air can flow to the microorganism degrading the carcasses. Because the degradation process produces heat, continuous airflow occurs through the compost material as hot air rises and induces a draft that draws in replacement air through the compost materials.

This recipe is fixed regardless of the method used to compost poultry mortalities. In the past, bin composters (Figure 1) that included primary and secondary bins were a popular mortality management methodology. More recently, alleyway composters (Figure 2) have become a popular choice because they ease material handling. In-vessel rotary drum composters (Figure 3) are the newest method to compost poultry mortalities and can significantly increase efficiency and decrease the time required to produce a high-quality compost end product.

Figure 1. Static-bin composter.

Figure 2. Alleyway composter.

Figure 3. In-vessel rotary drum composter.

Factors affecting mortality composting

Although the recipe is relatively simply, it is important to consider that the composting process is directly affected by several critical factors, including:

- **Moisture:** 50-60 percent, when squeezed into a ball compost holds shape; very little free water.
- **C:N ratio:** 25-30:1, about a 2:1 volumetric ratio of bulking/carbon material to mortality
- **Temperature:** Should peak between 130-150 F.
- **Oxygen:** Voids are required to promote airflow, refreshed with mixing/turning.
- **Amendment particle size:** Avoid old, finely divided litter which will inhibit air flow.
- **Pile surface area:** Large piles have a low surface area promoting poor airflow.
- **Microbial population and activity level:** Heating (temperature) is the key indicator.
- **Mortality size:** Large birds require more carbon and decomposition time.

If the recipe is followed correctly, the correct carbon-to-nitrogen ratio (C:N) is achieved, but the moisture content and oxygen level in particular must still be managed carefully, otherwise the composting process will work inefficiently as indicated by lower than expected temperatures (<110-120 F). Improper compost management is an environmental concern because the end product that is land applied is capable of spreading disease and causing nuisances as a result of soft carcass tissue decomposition. On the other hand, high temperatures, which are achieved with the right compost recipe and good management, will kill disease organisms and fully decompose 100 percent of soft carcass tissues. Temperature of 122 F maintained for 24 hours, or equivalently a temperature of 142 F for 1 hour (both achieved throughout a compost pile), is required to kill pathogenic bacteria, viruses, and insect and worm larva. The right recipe and proper compost management, which result in these high temperatures, will not attract scavengers, flies, or vermin that dig into the compost material and drag potentially diseased partially degraded carcasses onto neighboring property. Without proper heating, flies and malodors are sure to be issue that results in neighbor complaints.

While all the factors are ultimately critical to produce a high-quality end product, the moisture content is likely the most important factor. The moisture level primarily controls whether the compost process occurs under aerobic or anaerobic (without oxygen) conditions. A moisture

content in the 50-60 percent range work wells. Composting slows significantly at a moisture content less than 40 percent (when squeezed into a ball, the material readily falls back apart). Anaerobic conditions, which are indicated by noxious odors, generally occurs at a moisture content greater than 70 percent (when squeezed into a ball, free water is readily released).

The C:N ratio is also critical to the composting process because it affects biological activity of the microorganisms. A C:N ratio of 25-30:1 works best. Nitrogen will be lost as volatilized ammonia if the C:N ratio drops well below 25:1, a process that reduces the compost fertilizer value and results in noxious odors and neighbor complaints and even lawsuits if not resolved. Table 1 lists common bulking agents and their C:N ratios. Note that the wood products tend to work best as carbon sources because of their high C:N ratios. However, de-caked litter is often used successfully as a bulking agent, particularly in combination (50:50 volumetric ratio) with carbon materials. In any case, older and drier litter should not be used in mortality composters. For reference in examining Table 1, a broiler carcass has a C:N ratio of approximately 5:1.

Table 1. Common composting bulking agents and their C:N ratios.

Source	**C:N ratio**
Softwood shavings	641:1
Hardwood chips	560:1
Sawdust	442:1
Wheat straw	127:1
Rice hulls	121:1
Straw (general)	80:1
Corn stalks	67:1
Finished compost	40:1
Horse manure	35:1
Hay (general)	24:1
Cattle manure	19:1
Broiler litter	12:1

Generally speaking, it is better to add more bulking material or carbon material than you think you need — **do not skimp on the bulking/carbon material**. This seems like a simple enough process to manage, that is, adding enough bulking/carbon material, but is more difficult than one might think. Birds are constantly increasing in size each day and therefore, adjustments to the amount of bulking material must continually be made to balance for this size increase. While a low 1:1 ratio of bulking material to mortality may work for one-week-old chicks, it can take a 5:1 ratio (or more) for large market-age birds. Extra bulking/carbon material is needed for large birds to absorb the moisture in the daily mortality losses. While week-old baby chicks will release very little water per bird as they degrade, each eight-pound market-age broiler can release ¾ of a gallon of water. Therefore, growers must constantly adjust bulking material amendment rates not only to fluctuations in daily mortality losses (5 birds vs. 25 birds per day), but also for individual bird size (baby chicks vs. market-age birds). With practice, composting is a process that anyone can learn to manage so long as you carefully observe and react to temperature, odors and the presence of noxious leachate, for example

One thing to keep in mind is that composting is a somewhat forgiving process. If you mess it up, given a little time, you can fix it. For example, if your mortality compost gets too wet, say, due to wind-blown rain, you can mix in some additional dryer bulking material to absorb the excess moisture and the process will go back to working again. If the material gets too dry in summer, adding the right amount of water to bring the moisture content back into the 50-60 percent range will result in improved composting you can easily measure as a temperature increase. Note that while it is possible for the compost to become too dry, **most growers that fail with composting poultry mortality fail because the material gets too wet**. Excessively wet compost is usually caused by not using enough carbon material to soak up the fluids released from decomposing carcasses or because proper layering for mortality in compost bins (see below) is not followed. One common mistake that leads to excessively wet compost is to place mortalities into compost bins in a layer that is too thick. This effort to try to improve the space efficiency of composting results in a very low C:N ratio and poor air flow, which in turn adversely affects the activity of the microbial population degrading the carcasses.

Composter management

Bin and alleyway composters require similar management practices. Each consists of one or more bins of various size constructed of treated lumber set on a concrete slab with a roof overhead. The slab prevents the compost material and any draining fluids (known as leachate) from seeping into soil or groundwater. The walls keep the compost contained. The roof protects the material from precipitation. For each of these types of composters, ingredients should be layered as illustrated in Figures 4 and 5 below. Failure to do so will result in only partial composting and yield a product that is not suitable for land application. The steps to successful composting in bins and alleyway composters include:

- First, begin a new mortality compost cycle by placing an initial 12-inch layer of de-cake or fresh cleanout liter or carbon material on the concrete slab floor. Litter will supply bacteria to start the composting process, will help absorb carcass fluids or excess water that may be added to the composter by wind-blown rainfall, provides voids through which air can flow to the carcasses as they are being degraded, and insulates the compost material from excessive heat loss through the concrete floor.
- **Do not dump mortalities into a compost bin in a heap!** Rather, add a single bird thick layer of carcasses arranged side by side, touching each other. Place carcasses no closer than six inches to the walls of the compost bin because heat loss from the composting material is high where it touches the walls. Carcasses placed too near the walls will not compost as rapidly because of the lower temperatures near the walls; this can cause noxious fluids (leachate) to seep from the compost bin.
- **Do not skimp on the carbon material, which can be litter, carbon bedding material or a mixture of litter and carbon material.** This layer should be twice as thick as the layer of carcasses underneath. If only a partial layer of birds is placed for that day's mortality, **all the birds must be adequately covered when they are placed, otherwise you will create a prolific breeding ground for flies.** The rest of the layer can be used for mortality in the coming days. To emphasize these points again, **you cannot dump a front-end loader bucket of dead birds into the composter and cover them with just enough bulking material so that they are out of sight. This will not work, it is not composting, and it will not produce a suitable product for land application**.

- Continue to add subsequent single bird layers of carcasses and litter/carbon source until reaching a height of 5 to 6 feet. A stacking height of 5 to 6 feet, with adequate porosity and moisture is not a fire hazard. However, excessive height can induce compost temperatures that exceed 170 F and increase the chance of spontaneous combustion and a shed fire.
- Cap the final layer of birds with a layer of 12 inches of litter/carbon source. This final cap is critical to retain heat and moisture and avoid attracting flies.
- It is important to measure compost temperature regularly because it is an excellent method to gauge performance and detect recipe and management problems early on, when they can be fixed. It takes just a few minutes, and you only need two things: a 3-foot-long compost thermometer and a clipboard to record data. Record the temperature of your compost bins frequently, ideally twice a week. For alley way composters, record temperatures along the length of the alleyway as it is filled with compost.
- **When you observe a temperature decline below 120 F in your newly formed compost pile (generally after 2-4 weeks), you must then rotate the material to a new bin.** This newly mixed material should be covered immediately with 8-12 inches of fresh litter or carbon-based bulking material to avoid excessive heat and moisture loss and to avoid attracting vermin and flies. **This process of mixing the compost materials adds oxygen to reinvigorate aerobic decomposition of all the carcass soft tissue. Turing the compost at least once is critical to make sure pathogen destruction occurs throughout all the compost materials.** Approximately 4-6 weeks after turning, the compost should be inspected to verify soft tissue has been consumed (ideally any remaining bones will be soft). If necessary, the compost can be returned to provide an improved end product.

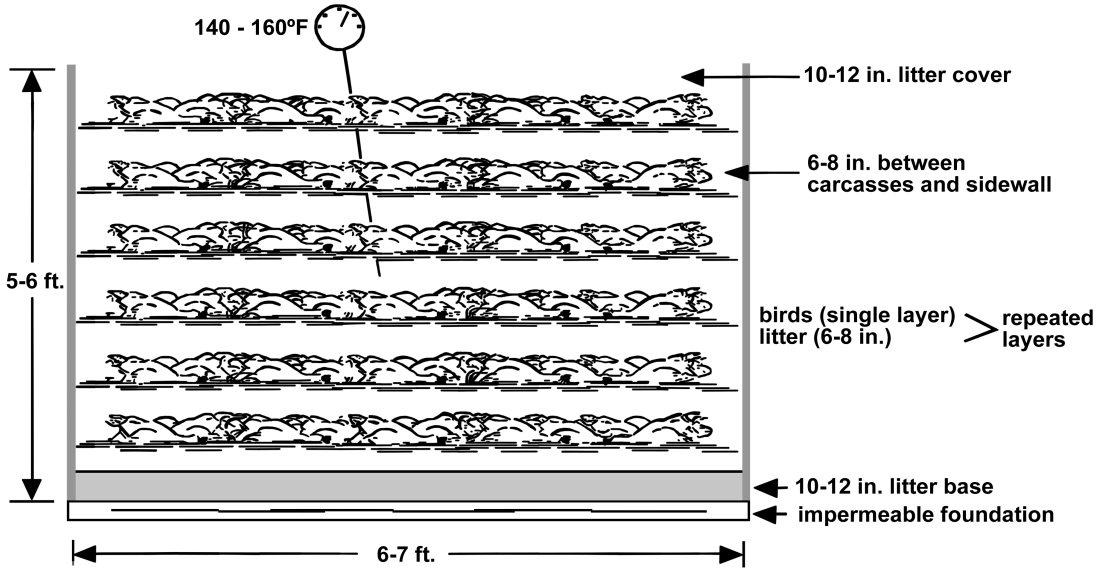

Figure 4. Bin composting diagram. Side view of mortality and bulking/carbon material layers in a compost bin. The bin is 6-7 feet wide and 5-6 feet high. The bin sets on a concrete slab which eliminates vermin burrowing. A 12-inch layer of litter/carbon source is placed on top of the slab to begin composting. Single bird thick layers are then alternated with 6-8 inches of litter and/or

carbon material. Finally, a 12-inch cap of litter is placed on the final layer of birds. Note that there is 6-8 inches of space between the bird carcasses and the bin sidewalls on all four sides.

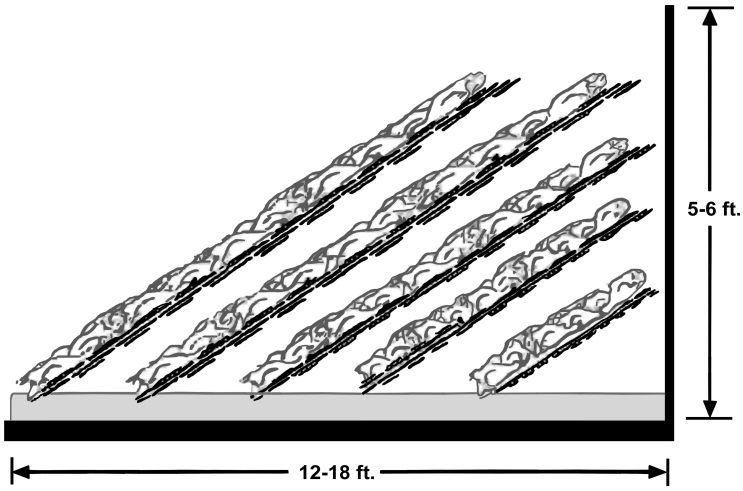

Figure 5. Alleyway composting diagram. Side view diagram of an alleyway composter. Width is usually 12-18 feet with a wall height that should not exceed 5-6 feet. The bin sits on a concrete slab to prevent burrowing vermin. Leave 6-8 inches of space between bird carcasses and the alleyway back and sidewalls.

In-vessel rotary drum composters

The process of turning mortality compost is automated with rotary drum composters, but these devices still require a similar ingredient recipe as traditional bin and alleyway composters. Because the turning process occurs daily or perhaps multiple times daily, and the drums use controlled forced aeration from blowers, oxygen easily infuses throughout the compost materials near continuously which greatly speeds up the composting process. A nice feature of these devices is that they have built-in thermometers used to control the mixing and aeration process and which allow you to constantly monitor the temperature of the material inside the drum. The drums also greatly reduce the ill effects of weather on the composting process because the product is contained inside the drum. This protects the compost from blowing rainfall and cold winds which can increase heat loss. The drums are also more aesthetically pleasing than a bin or alleyway composter, enhancing public perception of the task of composting dead birds. Public acceptance of agricultural practices is increasingly important today. Every commercial poultry farming operation needs to recognize this and take public perception of on-farm mortality management seriously.

Diagnosing morality compost problems

Even with good management, you can expect problems and difficulties to arise. These problems will be most evident in the temperature data you collect, which will show poor or very slow heating performance. Use Table 2 below to categorize and correct these problems and get your mortality compost system back to working efficiently.

Table 2. Troubleshooting guide for carcass composting.

Problem/symptom	**Potential cause**	**Correction**
Improper temperature	Too dry	Add water
	Too wet	Add bulking material and turn pile

	Low C:N ratio	Increase bulking/carbon material amendment rate
	Improper layering of ingredients	Layer birds in single bird thick layers covered with adequate bulking material (see Figure 3 and 4).
	High heat loss	Ensure adequate bulking material is used for cover and base
Failure to decompose	Low C:N ratio	Increase bulking/carbon material amendment rate
	Carcasses layered too thickly	Carcasses must be placed in a single bird thick layer
	Carcasses at outside edges	Maintain 6-10” between carcasses and edges
Bad odors	Too wet	Add bulking material and turn
	Low C:N ratio	Increase bulking/carbon material amendment rate
	Inadequate cover over carcasses	Cover every layer of carcasses promptly with 12 inches of bulking material
Flies	Inadequate cover over carcasses	Cover every layer of carcasses promptly with 12 inches of bulking material
	Too wet	Add bulking material, turn pile, cover pile with 12 inches of carbon material; avoid leaching from pile, cover leachate with carbon bulking agent promptly if this occurs
	Failure to reach proper temperature	Assess C:N ratio and layer management
Scavenging animals	Inadequate cover over carcasses, inadequate final cover	Place 12 inches of bulking material cover promptly over fresh mortalities layers. Avoid initial entry with a fence, barrier or cover where vultures are a problem.

Summary

Composting is the most common method of managing daily poultry mortality losses on commercial farms, and the process works well when it is managed properly. Commercial poultry producers should view mortality composting as a value-added process that produces a beneficial product. This realization justifies the daily attention and invested management time the process requires. Composting is a recipe, a properly proportioned mixture of poultry mortality and a bulking agent or carbon source to achieve the correct C:N ratio, which then requires oxygen and right amount of moisture to turn large quantities of instable organic matter, in this case dead

birds, into an inoffensive and useful soil amendment in a short period of time. Mortality compost must be properly managed, otherwise bad odors, flies, scavenging and vermin will plague you as well as your neighbors. These problems can be easily avoided by monitoring compost temperatures and using the troubleshooting guide in Table 2. Following the composting recipe and attention to detail on a daily basis will ensure that your finished compost product is safe, free of disease pathogens and suitable for land application as a valuable soil amendment.

UTIA.TENNESSEE.EDU