MISSISSIPPI STATE UNIVERSITY EXTENSION

Composting Mortality in an Avian Influenza Outbreak

The 2014–2015 outbreak of highly pathogenic avian influenza (HPAI), which claimed approximately 50.5 million birds in 21 states, was classified as the largest animal health emergency in the history of the United States. Since then, we have continued to experience more severe HPAI outbreaks. The 2022–2023 HPAI outbreak affected more than 60 million birds.

Currently, the U.S. is still seeing sporadic outbreaks in poultry flocks, and large-scale occurrences in wild bird populations, as well as an ongoing multistate outbreak in dairy cattle and occasional detections in other mammals, and a handful of human cases affecting dairy and poultry workers.

Since the 2014–2015 outbreak, it has become clear that the disease can reappear in conjunction with the movement of migratory waterfowl, which are the main reservoir for the virus. At this point, a sound biosecurity program is the best defense against the virus affecting commercial or backyard flocks in Mississippi, as well as other poultry and dairy cattle across the U.S.

There is no cure for HPAI, and the death rate is extremely high—95 to 100 percent of infected birds will die. During an outbreak, infected birds either die or are humanely euthanized to control the spread of the disease. In a situation where there are millions of birds to dispose of, proper carcass management is vital for managing nutrients, preserving and protecting the environment, and preventing disease spread.

If the carcasses are not handled correctly, improper disposal may lead to odor nuisances, disease spread, and environmental issues if the resulting leachate (fluids from carcass decomposition) finds its way into groundwater or surface waters. In addition, HPAI virus in the carcasses could be spread by rodents, predators, insects, and direct contact with other birds. Therefore, it is critical that **correct** mortality management practices be implemented **immediately** following an HPAI event.

The most commonly implemented mortality option in the recent HPAI outbreak was **mass mortality composting**.

Composting is a biological heating process that results in the natural degradation of organic material (in this case, poultry carcasses) by microorganisms. Composting has been used on commercial poultry farms to manage everyday mortality for more than 25 years. It has also been successfully used throughout the U.S. for nearly two decades to control outbreaks of low pathogenic avian influenza (LPAI) and HPAI.

The composting process can be modified to be effective with most bird types and poultry house designs if the proper people, equipment, and materials are in place. Within a windrow of well-constructed compost material, microbial activity will generate and maintain temperatures sufficient to inactivate the avian influenza (AI) virus.

It is possible to monitor the effectiveness of the virus inactivation process by evaluating compost temperatures and the shape of the time and temperature curves, and by observing carcass decomposition within the windrow and the homogeneity of the compost mixture.

However, certain components are required for successful mortality composting to take place. If any of these components is lacking, the process will likely fail to produce the desired results. The USDA has determined that successful mortality composting requires the following:

1. A qualified subject matter expert (SME) to guide and assist with windrow construction.
2. Trained equipment operators to properly construct the windrow(s).
3. Sufficient carbon source, water, and space.

Composting is characterized by microbial breakdown of a large nitrogen source surrounded by an adequately sized carbon source, known as the bulking agent. The bulking agent (sawdust, shavings, wood chips, broiler litter, etc.) supplies the carbon needed for a microbial energy source, while poultry carcass tissues and fluids supply the nitrogen necessary for microbial protein synthesis. Composting is, by definition, a controlled biological decomposition process that converts organic matter into a stable, humus-like product.

Successful composting is part art and part science. The chemical and physical properties of the raw materials affect the rate of decomposition. Particle size and surface area of the waste material influence the type of microorganisms involved and the degree of biological activity in the composting process. Therefore, smaller carcasses, or those that have been cut or ground, usually compost more easily than large, whole carcasses.

Moisture content is also critical to the composting process. Ideal moisture content seems to be approximately 50–60 percent. At 70 percent moisture content, the composting process begins to go anaerobic, which slows down the decomposition process and increases odor and fly issues. Moisture levels of less than 50 percent also slow the composting process. High moisture levels can be controlled by increasing the amount of bulking material used. Low moisture problems can be overcome by sprinkling the windrow with a measured amount of water.

Composting is a fairly forgiving process. If you mess it up, you can fix it. However, fixing it takes time, and time will not be on your side if you are dealing with an AI outbreak. Therefore, it's best to **get it right the first time**. This is why you need a qualified SME to assist in windrow construction, qualified equipment operators, and sufficient carbon source(s), water, and space.

Optimal conditions for carcass composting include a carbon to nitrogen ratio (C:N) around 30:1 and a moisture content of approximately 50 to 60 percent. If the C:N ratio is less than 25:1, organisms cannot utilize all of the nitrogen available, and excess nitrogen is then lost as NH_3. This will likely result in an unpleasant odor, possible air pollution issues, and reduced fertilizer value. C:N ratios of greater than 30:1 slow the composting process.

The composting process begins with an initial breakdown of soft tissue from the carcasses by naturally present microorganisms that produce heat, NH_3, CO_2, and volatile organic compounds as by-products. Following a period of soft tissue decomposition, thorough mixing of the bulking agent and carcasses promotes an ideal blend of carbon and nitrogen for optimum composting. The bulking agent helps trap leachate and odors produced during the process and lessens the threat to the environment.

Heat (>130°F) produced through proper composting will destroy most pathogens, including the AI virus. When the composting process is complete, microorganisms will have degraded the carcasses to the point that only a few larger bones remain.

Estimating Carbon (Bulking Agent) Needs

It is critical to determine how much carbon will be needed to provide an adequate energy source for the microorganisms. Without adequate carbon, the composting process will not proceed in a timely manner. In the event of an AI outbreak situation, time will be a critical factor.

The large number of carcasses that could be involved will make rapid mass disposal critical to the success of managing the outbreak. With this in mind, the USDA has developed the following guidelines for estimating carbon (bulking agent) needs.

Methodology

Described below is one approach to estimating the amount of additional carbonaceous materials needed to compost poultry carcasses. There are three methods described in the USDA publication Mortality Composting Protocol for Avian Influenza Infected Flocks. However, this method may most closely apply to the situation in Mississippi. All three require estimating the volume of litter in a building. To do this:

1. Obtain the length and width of the building.
2. Estimate the average depth of existing litter.
3. Calculate cubic feet of existing litter = length (in feet) × width (in feet) × [depth (in inches) / 12].
4. Convert to cubic yards: volume of litter in cubic feet / 27 = cubic yards of litter.
5. Modify the estimate based on the condition of litter (volume should be reduced if there is a large volume of "cake" or of very wet litter).

Once an estimate of the existing litter has been made, an estimate of the total amount of carbonaceous material is needed. Below is a weight-based approach for estimating the total.

Method 1. Weight-Based Estimate of Carbon Needed

1. Effective in-house composting must have a **minimum of 1.5 pounds of carbon material** (based on bulk density of 30 pounds/cubic foot material) **per pound of bird** (1

pound of carbon per pound of bird for the base and cover and the remaining carbon for the mix).

2. **Determine total pounds of birds.**
   a. Pounds of birds = number of birds × average weight in pounds
3. **Determine total pounds carbon needed.**
   a. Total carbon = pounds of birds (from above) × 1.5
4. **Determine pounds of litter in house.**
   a. Cubic feet of litter in house (see above)
   b. Pounds of litter = cubic feet of litter × weight of a cubic foot of litter (average bulk density = 30 pounds; Range = 25 to 35 pounds)
5. **Determine amount of additional carbon needed.**
   a. Cubic yards of additional carbon needed = [(total pounds of carbon needed-pounds of litter in house)/ (weight per cubic feet of carbon material)] / (27)
      i. wood chips, litter, or wet sawdust = 30 pounds/cubic foot
      ii. dry sawdust = 15 pounds/cubic foot

In-house composting of AI-infected flocks will likely be the best option should an AI outbreak occur in Mississippi. However, outside composting may be another option (especially in a cage layer situation where in-house composting is not an option) if adequate precautions are taken. There are **three critical elements of windrow construction** that must be considered. You will need 1) a porous layer, 2) a uniformly mixed windrow core, and 3) an adequate cap surrounding the core. USDA recommends the following windrow construction steps:

Windrow Base Construction

- Before in-house composting, clear carcasses and litter from the windrow location(s) of the poultry house to create a 12- to 15-foot-wide work area for construction of the windrow base(s). Distribute the material on either side of the pathway.
- Before outside composting, an adequate site must be identified. Site modifications and approval from state and local agencies may be required.
- Using the largest loader possible, begin building the windrow base.
- The windrow base should be 12–15 feet wide with a depth of 10–15 inches.
  - Carbon material for the base should be porous and bulky enough to allow adequate air flow into and through the windrow. Ideal materials for the base include bark mulch or coarse wood chips. Other acceptable materials include straw, wood shavings, active compost, small grain hulls, and corn stover. However, coarse, woody material in excess of 2 inches in size should be avoided to ensure that the resulting compost can be land-applied as a soil amendment at a later date.

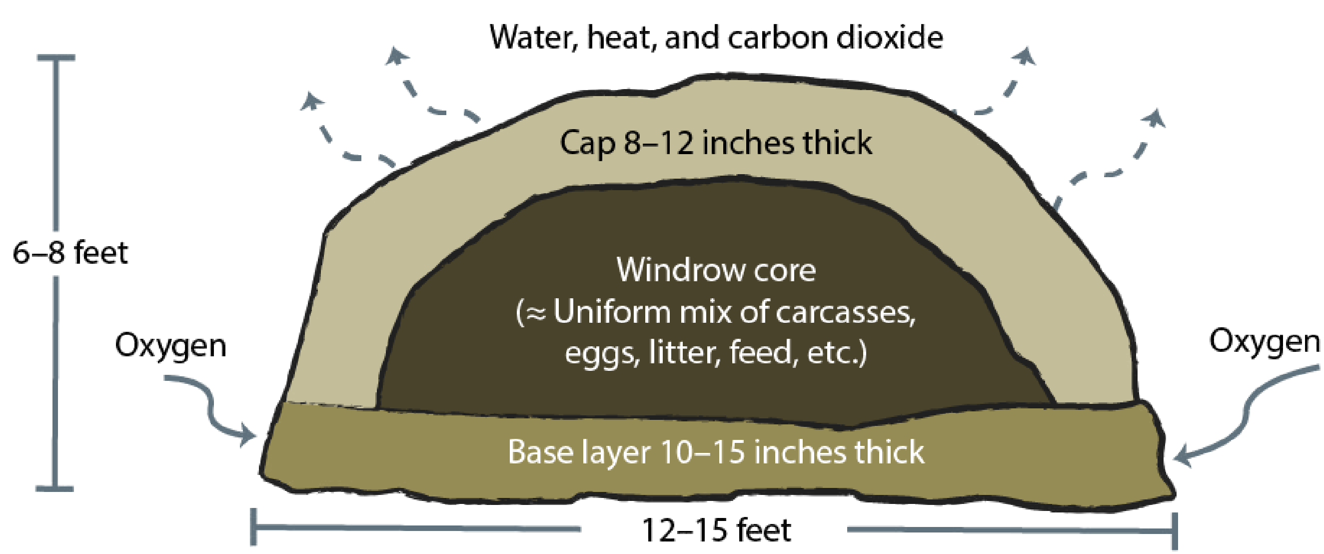

Figure 1. Cross-section of compost windrow.

- If these materials are not available, poultry litter may be used for the windrow base if it is sufficiently dry, porous, and bulky and contains enough carbon.
- To maintain the base's porosity and avoid compaction, do not drive equipment on the base.

Construction of the Core

- The windrow core should consist of a uniform mix of carcasses and litter. The easiest way to get a uniform mix throughout the windrow is to scoop litter and birds together in each bucket load and add it to the windrow in a manner that thoroughly mixes the contents of the bucket. If additional carbon material is needed, the material should support heat generation (i.e., composting). Suitable materials include fresh wood shavings, active compost, poultry litter, straw, corn stover, and small grain hulls. In many instances, this material may need to be blended with the existing litter and carcasses to be suitable.
  - Any suspect feed should be blended and mixed with the carcasses and litter before windrow construction. Move infected material as little as possible.
  - The mix of carcasses and litter should be added from both sides of the windrow. This allows the operators to reach the center of the windrow and avoid compacting the base with the tires or tracks of the loader.
  - The windrow core should be constructed such that 1 foot of base material is exposed on both sides of the windrow.
  - Add water as needed.
  - The core should be dome-shaped and of sufficient height to include the litter and carcass mix from the area adjacent to the windrow. At this stage, the windrow height should not exceed 6 feet.
- Continue building the core until all litter and carcasses have been placed on the base.

Capping the Windrow

- Before capping the windrow, remove any carcasses that are near the edge of the windrow base and include them in the core of the windrow.
- Cap the windrow with 8–12 inches of a suitable carbon material. Carbon material for the cap should prevent flies from contacting carcasses, serve as an insulating blanket, and allow air to flow out of the piles. This material may be finer in texture than the base. Suitable material includes small grain hulls, sawdust, new bedding, and wood chips. Straw, corn fodder, or similar material may also be suitable; however, experience has shown that these products can blow off the windrow and may need to be thicker to serve this purpose than other materials.
- Ensure that the entire core is uniformly covered with cap material with no carcasses exposed.
- Avoid compacting the windrow. Do not operate the loader's tires or tracks onto the sides of the windrow while capping.
- The completed windrow should be approximately 6–8 feet high.

Temperature monitoring is an important part of the composting process. Windrow temperatures should reach at least 130°F, which will kill most pathogens and the AI virus. The health and safety of the individual conducting the temperature monitoring within a confined space (chicken house) should be monitored. Ammonia is produced naturally from decomposition of organic matter, including plants, animals, and animal wastes and can become concentrated in enclosed structures.

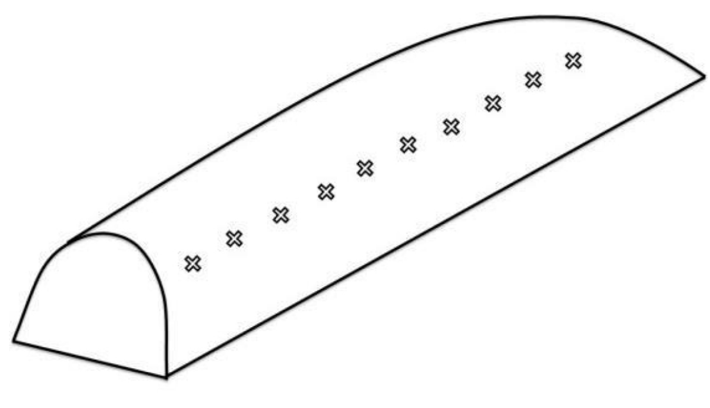

Figure 2. Example of temperature monitoring locations.

Signs of Exposure to Ammonia

Strong odor provides adequate early warning of ammonia's presence, but prolonged exposure can be hard to detect due to olfactory fatigue and adaptation. High concentrations can cause airway destruction, resulting in respiratory distress or failure. Signs of exposure include the following:

- burning of the nose, throat, and respiratory tract;
- coughing; and
- skin and eye irritation.

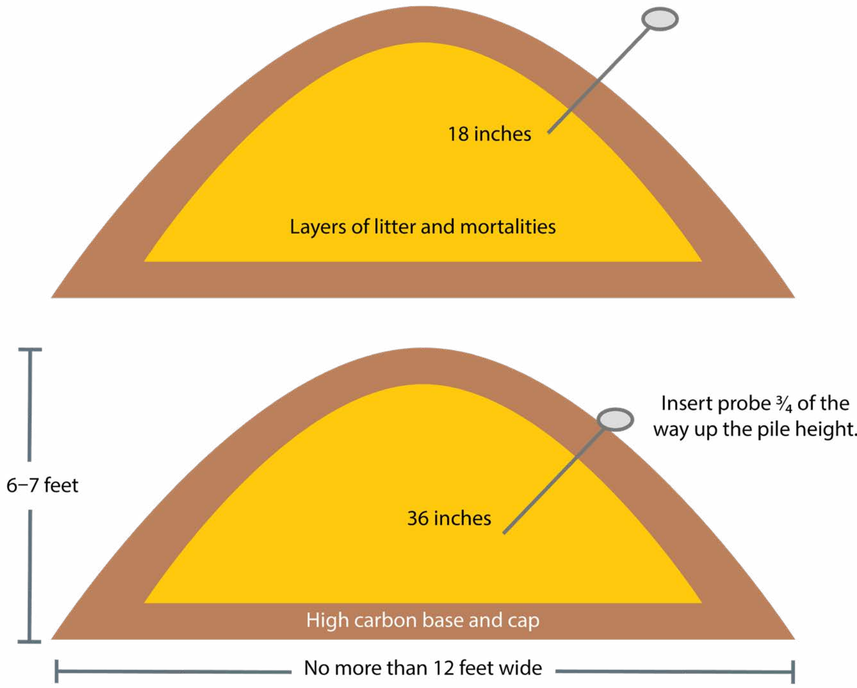

Figure 3. Insert probe thermometer at a 45-degree angle three-fourths of the way up the windrow at 18 and 36 inches.

How to Reduce Ammonia Exposure

- Increase ventilation when possible.
- Reduce the amount of time spent in areas where levels of ammonia are high.
- Wear proper PPE (personal protective equipment):
  - gloves,
  - half face with goggles or a full face respirator with at least a particulate/ammonia cartridge (green) or a multi-gas cartridge, and
  - cloth coveralls or disposable coveralls (Tyvek).
- If possible, measure ammonia levels in the work area with an air gas meter before entering, or know recommended exposure times based on the ammonia levels in the work area.

Exposure Guidelines (National Institute of Occupational Safety and Health, or NIOSH)

- Long-term exposure (8 hours): 25 ppm
- Short-term exposure (15 minutes): 35 ppm
- Short-term exposure (5 minutes): 50 ppm

If exposed:

- Seek fresh air.
- Flush irritated skin or eyes with water.
- If needed, seek immediate medical attention.
- Contact your supervisor if irritation of skin, nose, throat, or respiratory tract is persistent.

Temperature Monitoring Procedure

Monitor temperatures of the windrow daily at 10–12 flagged locations. The temperature monitoring locations should be spaced equidistantly the length of each windrow. Take two temperature readings at each flagged location; one reading at a depth of 18 inches and another reading at a depth of 36 inches.

To ensure consistent temperature monitoring to the same depth, mark the thermometer probe at 18 inches and 36 inches. Place the temperature probe three-fourths of the way up the windrow at a 45-degree angle. Ideally, temperatures should be monitored by a single individual for consistency. Temperature probes should be calibrated before use.

Instructions

- Turn on fans or open the doors and curtains (if present) to all the houses containing compost piles to allow them to air out and to maximize ventilation.
- **Use the Buddy System**. Entering a house with active compost or dead birds requires a two-person team.

- Place the stem of the thermometer approximately 18 inches and then 36 inches into the compost pile halfway up the pile at a 45-degree angle.
- Leave the thermometer at each depth and point for at least 60 seconds.
- Log the reading from the thermometer from each flag and at both depths (18 and 36 inches).
- Compare readings to the previous day's readings.
- After completing the house readings, close the doors and curtains.
- Calculate the average temperature for each pile and note it in a logbook.
- Windrows should reach an average temperature of 131°F for a minimum of 72 hours or be assessed by an SME for possible corrective measures.
- Disinfect the thermometer and return it to its protective case.
- Keep each thermometer at the location being monitored.
- Do not take a thermometer from one location to another.
- If, 3 days after initial windrow construction, compost temperature averages are consistently (more than 3 days) below 100°F or greater than 160°F, an SME should be consulted immediately.
- During the second 14-day composting phase, an SME should be consulted immediately if any monitoring location is consistently (more than 3 days) below 100°F or greater than 160°F.

Siting an Outside AI Compost Location

Selection and siting of environmentally suitable and appropriate locations for composting poultry carcasses infected with AI is an important consideration in the disease-management process. Because of the virulent nature of this disease, it is important to locate such sites within or in close proximity to the infected premises.

The site access should be able to handle heavy vehicle traffic and allow for biosecurity around the site's perimeter, securing access to and from the site. Additionally, it is critical to choose sites that will not be adversely impacted by potential releases of nutrient-laden leachate and that will not result in nuisance complaints in the event that odors, flies, or scavengers begin to appear on-site.

In general, emergency poultry mortality compost sites should be large enough to accommodate all of the generated carcasses, litter, waste feed, and other contaminated materials, as well as have the ability to store any additional amendment materials that may be needed for successful composting. Along with the criteria noted above, ideal HPAI compost sites should—

- be located such that the prevailing wind directions do not travel to nearby residences (whenever possible),
- be located at the top of the slope of the field, on moderately well to well-drained soils (usually land that is used for crop production),
- have a gentle 2- to 4-degree slope to encourage on-site drainage,
- contain on-site soil depths in excess of 24 inches to seasonal high water tables,
- contain on-site soil depths in excess of 36 inches to bedrock,
- not be located on a flood plain,
- be constructed or designated for the current emergency, and
- have diversion ditches, terraces, or berms to direct surface water flows and stormwater away from active compost piles. (Note: if windrows are located between production houses, then roof and surface drainage should be directed away from the compost area).

The edges of the identified site should have the following minimum setbacks:

- 200 feet from a water supply well used for drinking,
- 200 feet from water bodies, including ponds, lakes, streams, and rivers,
- 200 feet from a nearby residence (not owned by the premises),
- 50 feet from a drainage swale that leads to a water body, and
- 25 feet from a drainage swale that does not lead to a water body.

Summary

Avian influenza outbreaks pose a serious threat to commercial and backyard poultry flocks in Mississippi and across the country. Proper and timely disposal of mortality losses associated with such an event are critical to managing an outbreak. Mass mortality composting (preferably in-house but possibly outside) will likely be the best option to deal with flock losses, should they occur. The purpose of composting mortality during an HPAI outbreak is to use biological heat treatment methods to degrade the carcasses, inactivate the AI virus, control odors, and reduce fly exposure in a safe, biologically secure, and environmentally sustainable manner. The final composted material is a valuable and useful by-product that can then be land-applied as a fertilizer source and soil amendment that can recycle nutrients and organic matter back to the soil.

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