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Natural Rendering: Composting Poultry Mortality

The Emergency Response to Disease Control

Ultimate Disposal of Avian Mortality - Current Situation

The Need: Consider Composting

Although New York State (NYS) has a relatively small poultry industry, farms produce approximately $86 million worth of processed poultry products that are sold in NYS and around the world. There are over 300 farms that raise chickens, turkeys, ducks and other birds for meat or egg production, as well as countless small backyard flocks.

The poultry producers find themselves, in many cases, with limited disposal options. Producers need to manage routine mortality and depopulation, natural disasters, and disease outbreaks. The poultry industry needs a convenient, socially and environmentally acceptable, biosecure way of disposing of carcasses.

Small poultry farms employ a variety of methods in raising meat birds or laying hens, from housed and cage-raised to free-ranged or free-ranged but caged. Where free-range strategies are used there can be more potential for disease spread, as it will be harder to contain and disinfect in cases where birds are not contained in one location.

Poultry carcasses left to decay naturally above ground or buried in shallow pits pose risks to surface and groundwater and endanger the health of domestic livestock, wildlife and pets. Improper disposal may also have implications for biosecurity of the flock. Landfills generally will not accept carcasses and are hesitant about accepting diseased mortality. Poultry carcasses can be incinerated, but that method has air quality ramifications. Healthy spent birds can be marketed for use in soups, stews and other processed meat products when there is a large volume and they can be shipped to market.

When there is an outbreak of avian influenza or other diseases that can be easily spread, the options become more limited. It is important to move the mortality as little as possible to prevent disease spread and ensure biosecurity of other poultry houses and neighboring farms. In NYS, a farmer can bury up to 100 birds from a disease outbreak, but with burial there is no pathogen kill and animals are placed closer to the water table. Outbreaks with more than 100 mortalities must be composted. Static pile composting has proven to be environmentally safe and effective, and better ensures biosecurity. It can be implemented for a small number of birds as well as with farms experiencing catastrophic losses.

Many people do not realize that composting mortality is a legal and acceptable way of disposing of carcasses and poultry litter. They fear that if regulators find out, they may be cited and fined. Regulators, on the other hand, fear that with the current disposal situation, farmers may cause problems with improper disposal. Composting can be accomplished in compliance with environmental regulations in many states, but check regulations in states outside of New York before you start.

A "Composting Poultry Mortality" video clip complements this fact sheet and is available at: http://cwmi.css.cornell.edu/ai.htm

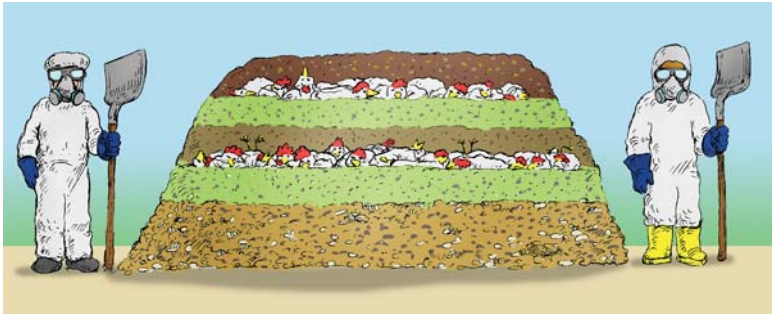
Natural Rendering Fact Sheets:

- **Composting Livestock Mortality and Butcher Waste** *(2002) – Jean Bonhotal (CWMI), Lee Telega (PRO-DAIRY), Joan Petzen (CCE Allegany/ Cattaraugus)*
- **Composting Road Kill** *(2007) – Jean Bonhotal, Ellen Harrison, Mary Schwarz (CWMI)*
- **Composting Poultry Mortality** *(2008) – Jean Bonhotal, Mary Schwarz (CWMI), Nellie Brown (Cornell ILR)*

Potential Environmental and Biosecurity Risk of Dead Animal Disposal:

Lowest risk

- Rendered or properly composted on the farm.

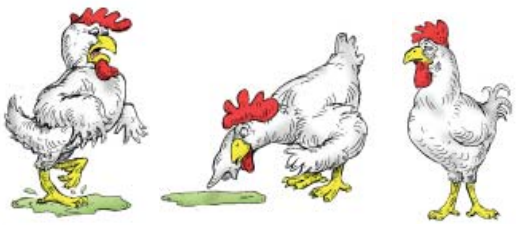


- Buried 6 feet deep in appropriate soils and buried more than 200 feet from a water body, watercourse, well or spring.

- Partially buried less than 6 feet deep or buried closer than 200 feet from a water body, watercourse, well or spring.

- Carcass is left outside for scavengers or to decay. This is very risky from an environmental standpoint and for disease transmission on farm.

Highest Risk



Composting

Composting provides an inexpensive alternative for disposal of all dead animals, including poultry. The temperatures achieved during properly managed composting will kill or greatly reduce most pathogens, reducing the chance to spread disease. Properly composted material is environmentally safe and a valuable soil amendment for growing certain crops. In-house composting provides a controlled environment that reduces the need to move contaminated manure, litter and birds from poultry houses and provides better control of disease spread.

Benefits of Composting

♦ Can kill pathogens and help control disease outbreaks.

♦ Can be done any time of the year, even when the ground is frozen.

♦ Can be done with equipment available on most farms.

♦ Relatively odor-free.

♦ All sizes and volumes of animals can be composted.

♦ Egg waste and hatching waste can be composted.

♦ Relatively low requirements for labor and management.

♦ Economical.

Choosing a Site & Considering a Pad

Pads are level areas constructed of compacted soil, asphalt, or concrete. They have several purposes, including water quality protection, providing a good working surface and allowing access through wet weather conditions. In dry conditions, most soil types provide a good working surface, but many will be problematic after a storm event or during spring thaw. Pads need to provide a solid working surface so that machinery can function throughout the year. If composting is not a routine part of farm operations, it is unlikely that a pad is needed. However, emergency composting does require space on your land to construct the compost piles and takes 2 to 8 weeks for the primary compost process and longer for the curing period that follows.

With Avian Influenza (AI), the birds should be moved as little as possible to ensure disease containment; litter and other organic material should be composted with the birds. Poultry houses will be out of production for at least 10 to 14 days so that the first active stage of composting can be completed. After the compost is removed from the building and placed in curing piles, the building can be totally disinfected. If it is not feasible to compost in-house, composting should occur as close as possible to the infected site to minimize movement of infected materials.

Disease Concern - If composting is implemented in a situation where there is potential for the disease to spread, it is best to compost on the affected farm and preferably in the buildings where diseased birds were living.

After depopulation: Birds may be moved within the poultry house or to a nearby area outside, most probably by small payloader, forklift, or other machinery. It is assumed that birds will be kept whole and added to the pile as is. To minimize handling and thus prevent creating airborne dusts or aerosols, birds will not be crushed, tilled, or shredded before adding to the pile. Poultry litter, contaminated feed, and other such items will be added to the pile during the layering process.

Routine Mortality: If there is not a disease concern, select a site that is well-drained and away from watercourses, sinkholes, seasonal seeps or other landscape features that indicate the area is hydrologically sensitive. Make sure the piles are set up in a way that minimizes risk to healthy animals. Select the same type of site for the outside stage of composting after a disease outbreak.

Moderate to well-drained, hard-packed soils with gentle slopes are well suited as composting sites. A slope of about two percent is desirable to prevent ponding of water. Steep slopes are not satisfactory because of potential problems with erosion, vehicular access, and equipment operation.

Compost windrows should run up and down the slope, rather than across, to allow runoff water to move between the piles rather than through them (see figure 1). The initial site preparation will usually require grading and may require an improved surface such as cloth and gravel, asphalt or concrete (see Compost Pads fact

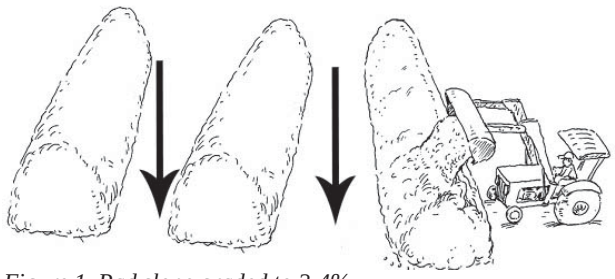


Figure 1. Pad slope graded to 2-4%.

sheet #6: http://cwmi.css.cornell.edu/compostfs6.pdf). Siting is very important to help avoid neighbor issues. Determine the dominant wind direction, and if most air-flow is directed toward populated areas, look for another site. In NYS, permitted compost facilities need to be at least 200 yards away from the closest dwelling. They cannot be sited in a floodplain or wetland, or where the seasonal high groundwater is less than 24 inches from the ground surface, or where bedrock lies less than 24 inches below the ground surface, unless provisions have been made to protect water. Natural Resources Conservation Services (NRCS) also provides guidance for compost facilities (http://www.nrcs.usda.gov/technical/standards/nhcp.html).

Building and Maintaining Compost Windrows

♦ When implementing in-house composting, the poultry house will be vented naturally, but mechanical ventilation should be turned off. If indoor space is unavailable or limited, you will need to compost outdoors as close to the infected area as possible but following the same procedure.

♦ Push litter and feed off to the side of the barn. Lay an 18 inch deep bed of coarse wood chips, 8-12 feet wide (depending upon structure and equipment constraints) and as long as space permits.

♦ Add a 12-15 inch layer of litter and birds, then cover with a 12-15 inch layer of wood chips or other carbon source.

♦ Add another layer of litter and birds until the windrow is two or three layers high and as long as needed.

OR

♦ If your birds and litter are not separate, put a carbon base down, as described above, and add birds mixed with litter and bedding to a height of 4-5 feet.

Mixed bird composting in Virginia.

♦ Cover the windrow with a 2-foot layer of wood chips or other carbon sources. The finished pile should be 5-7 feet high.

♦ Make sure all mortalities are well-covered to keep odors down, insulate pile and keep vermin or other unwanted animals out of the windrow.

♦ The primary process in-house, where it reaches thermophilic temperatures, will take 10-14 days. During this time, no turning, agitating or active aeration should occur. Take temperatures at three levels in the windrow (outer 18", middle layers and core) to ensure the thermophilic range is reached throughout the windrow.

♦ Monitoring is the only activity that will occur. Temperature probes will be used to record temperatures and should range from 131°-150°F or 55°-65°C during most of this time period.

♦ After the required time/temperature duration, windrows can be moved outside the buildings for the curing process. If temperatures are not reached, then testing for the presence of the disease will be required.

♦ Site cleanliness is the most important aspect of composting; it deters scavengers, helps control odors and keeps good neighbor relations.

♦ Let sit for 4-6 months.

During the Process: The dead birds and litter, such as woodchips or sawdust, are layered in the barns, most of which have steel walls and concrete floors. The layered pile is dampened and aerated naturally. Air and moisture feed microbes that in turn give off enough heat to kill the virus.

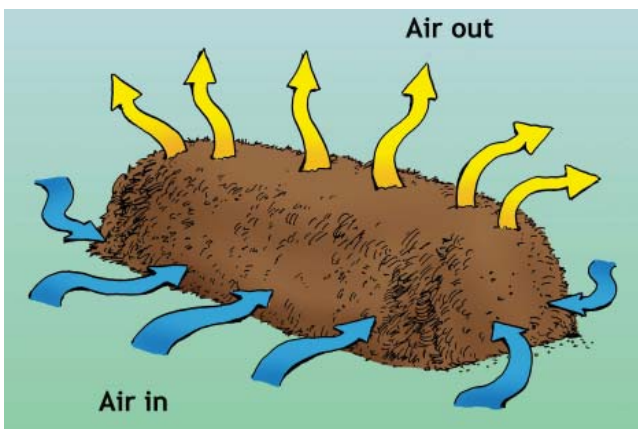
Moisture Note: *If litter is very dry, add moisture to the layers as you are building them. The compost feedstock should be at 30-40% moisture.*

Turning Note: This is a process that requires little to no turning or pile movement. It is not like typical turned composting but a passively aerated system. These windrows consist of feedstock that is not well mixed and C:N ratios that are hard to access but the process works. If temperatures do not reach the thermophilic range, turning may be required to reach temperatures thus killing pathogens. If windrows are close to the range, let the windrow work and turn after 10-14 days. If windrow stays at ambient temperatures for more than 3 days, it is not working. Consider rebuilding windrows with additional carbon but ask for guidance if there is a disease concern.

Monitoring Compost Piles or Windrows

A log of temperature, odor, vectors (any unwanted animals), leachate (liquid that comes out of the pile), spills and other unexpected events should be kept as a record of the process. This will allow the composter to see if sufficiently-high temperatures were reached and to adjust the process if there are any problems. Also, odor can be an issue and compost piles are an easy target for complaints. When there is an odor problem, a compost pile may be blamed and may not be the cause.

Monitoring of the pile is done mostly by checking temperatures. Internal compost pile temperatures affect the rate of decomposition as well as the destruction of pathogenic bacteria, fungi and weed seeds. The most



Natural air flow: pile heats, heat rises and fresh air is pulled in from the base.

efficient temperature range for composting is between 104°F - 140°F (40°C - 60°C). Compost pile temperatures depend on how much of the heat produced by the microorganisms is lost through aeration or surface cooling. During periods of extremely cold weather, piles may need to be larger than usual to minimize surface cooling. As decomposition slows, temperatures will gradually drop and remain within a few degrees of ambient

Finished compost.

air temperature. Temperature monitoring is crucial for managing the compost process especially when there is disease concern. Thermometers with a 3-4 foot probe are available (see Thermometer Sources, page 11).

Controlling Pathogens

Pathogens are organisms that have the potential to cause disease. There is a wide array of pathogens found in our environment, and they may be elevated in livestock operations. In addition, there is the possibility of viruses spreading diseases such as AI. While there are currently no temperature regulations for mortality and butcher residual composting, following New York State Department of Environmental Conservation (NYS DEC) regulations currently applicable for biosolids are highly recommended to ensure adequate pathogen control in this type of composting.

Thermometer showing elevated temperatures.

When using an aerated static pile, the pile must be insulated (covered with a layer of bulking material or finished compost) and a temperature of not less than 131°F (55°C) must be maintained throughout the pile for at least 3 consecutive days.

Heat destroys the AI virus, but it remains viable at moderate temperatures for long periods, and indefinitely in frozen material. The virus is killed by heat (56°C for 3 hours, or 60°C for 30 minutes) and with common disinfectants such as formalin and iodine compounds (Dawra, 2006). Research has shown that composting poultry carcasses can inactivate the AI virus. Lu et al. (2003) showed a loss of infectivity of the AI virus in

15 to 20 minutes at 133°F (56°C). As an extra safety measure, the farms are required to keep the material at that temperature for 3 days. Research performed by Senne (2007) in which chickens inoculated with HPAI virus were composted in bins showed no virus isolated after 10 days of composting.

Using Finished Product and Bones

If there is concern of disease spread, compost should be tested for that specific disease before moving or land applying the material. The finished material can be field applied on animal feed crops, preferably where soils will be tilled. Applying this compost to "table-top" crops directly consumed by people is not recommended. In the future, testing and quality assurance standards may enable expanded uses of the finished compost product.

Nutrients in carcass and butcher residue composts are higher in N, P and K than compost containing only plant material, giving it more fertilizer value both on and off farms.

About Avian Influenza (AI) and Composting

Avian influenza (bird flu) is caused by influenza viruses that are carried by wild waterfowl and shed in saliva, nasal discharges and feces. Domestic poultry get the disease when they come in contact with the viruses either directly from waterfowl (drinking from contaminated water, foraging in places where waterfowl have been), or from contact with other infected domestic birds, cages, feed, feces or workers that may be carrying the virus on their clothes or vehicles.

The compost temperatures destroy the AI virus in a short period of time. Composting has a high level of biosecurity as no untreated material leaves the farm. It can be used to treat carcasses as well as infected litter using equipment normally available on the farm.

AI can be classified into two forms based on the severity of illness it causes in birds. Low pathogenic avian influenza (LPAI) causes only mild symptoms such as ruffled feathers and a drop in egg production, or it may not cause any illness at all and thus go undetected. It is

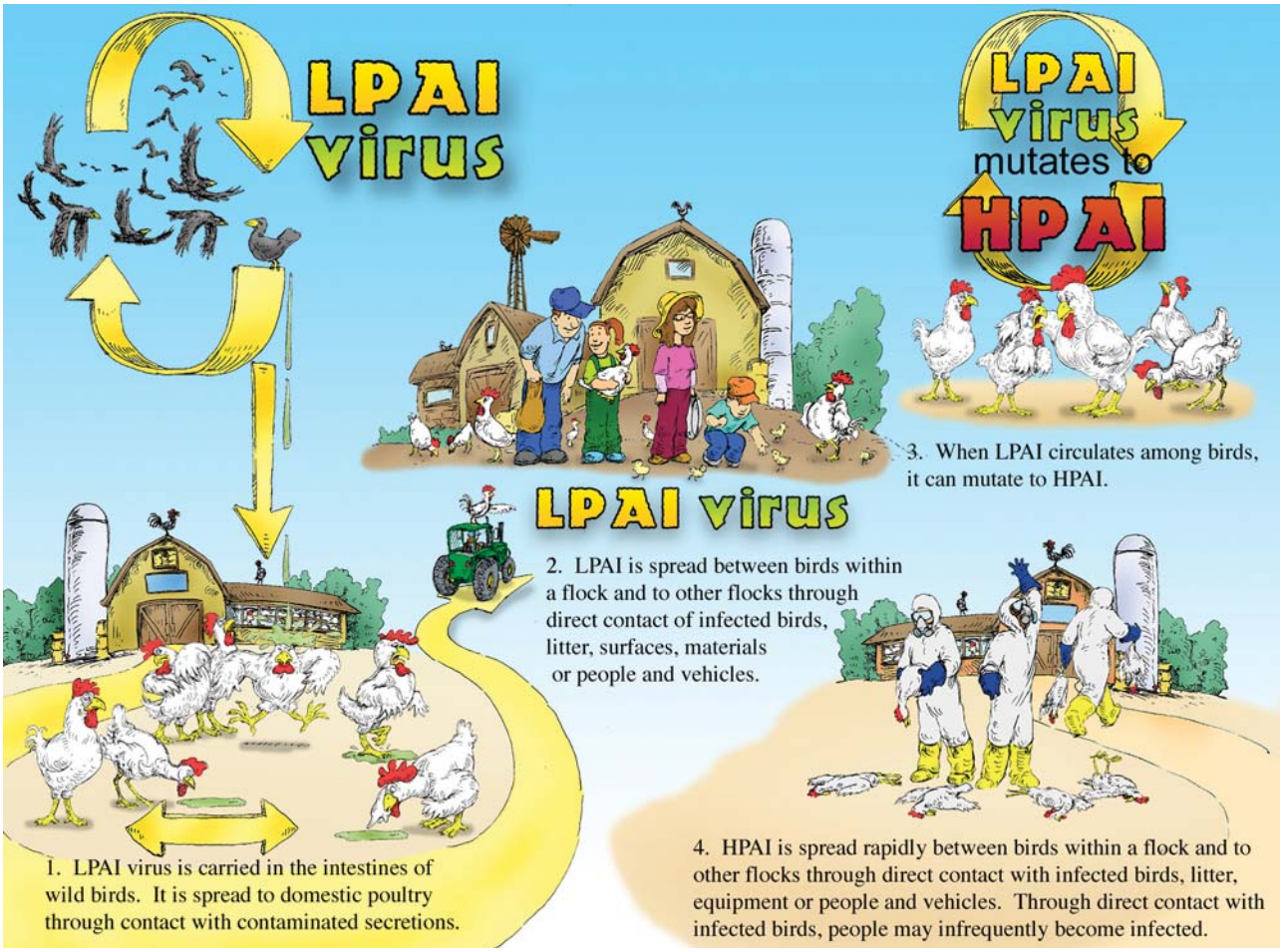


Figure 2. Avian Influenza evolution and transmission.

rarely transmitted to humans and is not life-threatening. Highly pathogenic avian influenza (HPAI) causes serious illness and death in infected birds, often within 48 hours of onset. As with LPAI, it is easily spread through a flock by contact among birds and through litter, cages, equipment and air (particularly within poultry houses). Transmission to humans occurs rarely and is usually associated with high levels of exposure to infected birds. It is a serious, often deadly, disease if contracted by people. It is not known to be transmitted from person to person.

AI and Human Health

The concern for human health is that HPAI may create conditions leading to a pandemic. Pandemics can start when three conditions have been met:

- A new influenza virus subtype emerges.
- It infects humans causing serious illness.
- It spreads easily and sustainably among humans.

The HPAI virus currently circulating in Asia and elsewhere has met the first two conditions. It can meet the third if it mixes with a human virus (this would result in rapid spread), or if it gradually adapts to bind to human cells (there would be small clusters of cases at first). According to the World Health Organization (2005), "Each additional human case gives the virus an opportunity to improve its transmissibility in humans, and thus develop into a pandemic strain. The recent spread of the virus to poultry and wild birds in new areas further broadens opportunities for human cases to occur."

The AI Cycle

The AI cycle (figure 2) starts with transmission of LPAI from wild birds to domestic flocks that can then circulate in the flock and be transported to other flocks. LPAI may mutate into HPAI that can circulate in the flock and be transported to other flocks. Control of LPAI can thus help to prevent creation of HPAI. Once a flock has contracted LP or HPAI, preventing off-site movement of birds, litter and contaminated equipment can help control the viruses. Composting of dead birds and litter can also control the viruses.

Effectiveness of Composting

According to the U.S. Environmental Protection Agency (USEPA, 2006), "On-site composting has been proven effective in deactivating avian influenza virus. On-site composting limits the risk of groundwater and air pollution contamination, the potential for farm to farm disease transmission, and transportation costs and tipping fees associated with off-site disposal. Also, there is the benefit of producing a usable product." See Avian Influenza Research Summary: http://cwmi.css.cornell.edu/aisummary.pdf.

In a disease outbreak, potentially-exposed people would include:

- Farm owners/operators.
- Farm employees: permanent and part-time.
- Migrant workers and illegal aliens: if a quarantine is imposed, it may be difficult to enforce due to these workers' fear of exposure to government entities. This may create a danger of spreading the disease if they leave the farm.
- Experts in carcass composting procedures, quality control, safety and health, etc. who would be assisting the farm with the composting process. This does not include government officials from public health, veterinary, medical, agricultural, or other specialties who were assumed to already be conversant with proper procedures and equipment for protecting themselves from exposure during field investigations for disease outbreaks (USDA APHIS, 2008).
- Paramedics: in the event of worker injury or illness, paramedics may enter a contaminated area but must be protected appropriately.

In Virginia, in 2002, an AI outbreak on the Delmarva Peninsula was successfully confined to only 3 farms despite the high density of poultry farms in that area by the use of in-house composting of the 5 pound broilers. However, it was unclear if it would work with larger birds. Therefore, in the fall of 2004, several Virginia state agencies conducted a research and demonstration project to evaluate the effectiveness of in-house composting of turkeys (17-40 lb birds) as a means of disease containment and disposal of catastrophic losses. Windrows were set up with several types of carbon materials and birds were placed as either whole, crushed or shredded. All were effective in composting the turkey mortalities, but those with whole birds took more time to compost than those with crushed or shredded carcasses. Temperatures of 60°C (140°F) were achieved within 5 days for crushed carcasses, and 16 days for whole ones (Bendfeldt et al., 2006).

• Children: Children should not do any work that requires the wearing of a respirator. As the tasks covered by this report require the use of respiratory protection, children should be excluded from performing any of these tasks and should not be involved in outbreak-containment.

• Susceptible groups at greater risk of infection (from viral infection and from compost pile fungi) typically are people who are immunodeficient. Persons with compromised host defenses should be excluded: diabetes, cancer (especially leukemia), cystic fibrosis, alcoholism, inherited immune deficiency, acquired immune deficiency (AIDS), burns, skin cuts, abrasions, or other trauma, invasive medical procedures, certain medications (some antibiotics and immunosuppressive drugs).

Personal Protective Equipment (PPE)

In order to protect potentially-exposed people from AI, PPE is needed when working on an infected site.

Appropriate PPE for AI workers includes:

• Hand protection: wear impermeable gloves (light-weight nitrile or vinyl disposable gloves, or heavy-duty 18-mil rubber gloves that can be disinfected; use the glove appropriate for the activity). Avoid touching the face and mucus membranes, including the eyes, with gloved hands that have been contaminated. Change or discard gloves if torn, punctured, or otherwise damaged.

• Body protection: wear disposable outer clothing or coveralls with an impermeable apron over them, or wear a surgical gown with long, cuffed sleeves plus an impermeable apron. Choose light-weight clothing to prevent heat stress. Take precautions (see box on page 12) to avoid the effects of heat stress.

• Head protection: wear disposable head cover or hair cover to keep hair clean.

Sources of personal protection equipment can be found by an internet search.

• Foot protection: wear disposable shoe covers or rubber or polyethylene boots that can be reused after disinfection.

• Eye protection: wear safety goggles; these should be non-vented or, at a minimum, indirectly vented (or wear a respirator with a full face-piece, hood, helmet, or loose-fitting face-piece). For employees who wear prescription lenses, make sure goggles can be fitted over regular glasses without compromising eye or respiratory protection; or alternatively use lens inserts in the goggles or use goggles with the correction built-in.

• Respiratory protection: wear National Institute for Occupational Safety and Health (NIOSH)-approved disposable respirator (N-95, N-99, or N-100) or NIOSH-approved reusable particulate respirator. Wear whenever working in the poultry barns or when exposure to infected poultry or virus-contaminated materials or environments may occur. Make sure that eye protection does not interfere with the face-piece seal of the respirator. The wearer should conduct a seal check each time he/she dons a respirator. For farms using oils as dust-suppressants, use minimum R-95 or P-95 disposable respirators.

Static pile composting in process.

• To be effective, tight-fitting respirators must have a proper sealing surface on the wearer's face. Items that interfere with the proper seal of a respirator include: facial hair, skull cap, facial features such as wrinkles, absence of one or both dentures, weight gain or loss since a previous fit-testing (may necessitate a new fit-testing), glasses, (see "eye protection" above), skin conditions (such as pseudofolliculitus barbae) which render shaving difficult, or allergies (such as to rubber, silicone respirators are available as an alternative).

• For employees who are unable to wear a disposable particulate respirator because of facial hair or other fit limitations, they can wear a loose-fitting helmeted or hooded powered air-purifying respirator (PAPR) with high-efficiency particulate air (HEPA) filters. The face-piece provides eye and mucous membrane protection as well as respiratory protection. Occupational Safety and Health Administration (OSHA) requires that respirators must be used in the context of a complete respiratory protection program as per 29 CFR 1910.134; this includes training, fit-testing, and user seal checks to ensure appropriate respirator selection and use.

Safety in Managing Avian Carcasses

Exposure to AI could occur when farm owners/operators and their employees are engaged in the on-farm activities of depopulating flocks of birds and composting the carcasses that are either infected or have been exposed to AI, especially to highly-pathogenic AI. While this disease at present occurs almost exclusively in birds, in a limited number of cases, the H5N1 strain of the virus has been shown to cause infections or flu in humans with a case fatality rate of 61%. Most cases have been linked to close contact with infected poultry. OSHA has issued guidance for protecting workers against avian flu, but has not issued a standard or regulation for this disease nor for any diseases other than those spread by the blood borne route. It is important to note that a disease outbreak could be a natural occurrence or an act of bioterrorism. This section of the fact sheet deals with the tasks, anticipated routes of exposure, and protection for farm owners/operators, their employees, and compost process experts/consultants who would be expected to be exposed should an outbreak of HPAI occur in NYS.

Worker Protection

• Workers should receive the current season's influenza vaccine to reduce the possibility of a dual infection with avian and human influenza viruses.

• Workers should receive an influenza antiviral drug daily for the time period when in contact with infected poultry or contaminated surfaces and for a period of time afterwards. First choice is oseltamavir (a neuraminidase inhibitor); 2nd choices would be amantadine or rimantadine.

• Workers should be instructed to be vigilant for any fever, respiratory symptoms, or conjunctivitis for 10 days after their last exposure to infected or exposed birds or contaminated surfaces. If so, seek immediate medical care and notify your health care provider (in advance) that you have been exposed to avian influenza. Also, notify your health and safety representative.

In 2007, routine pre-slaughter testing of a turkey flock in West Virginia showed a positive test for LPAI H5N2. Since USDA policy is to eradicate LPAI with subtypes H5 and H7 to ensure that they don't mutate into HPAI, the turkeys were depopulated. 1,022,400 lbs of turkey carcasses, as well as 20 tons of feed and 350 tons of litter needed to be disposed of. Composting was selected as the disposal method. The birds were euthanized with fire fighting foam which added a significant amount of water to the mix and created a challenge to the composting. Some piles were constructed primarily in-house, then removed and turned 3 weeks later to compost to a finished product. After 3 weeks, carcass decomposition was about 95%, and there was no ammonia or rancid smell. Internal windrow temperatures in the 1st 3 weeks ranged between 43-57°C (110-135°F). All samples of the compost material taken for virus isolation tested negative. Land application of the finished material as a soil amendment occurred after 3 months of composting. In July of 2007 a similar size flock of market age turkeys (40 lb. average weight) in Virginia tested positive for LPAI H5N1. These birds were also euthanized with foam, and composted primarily in-house. Lessons learned from the West Virginia incident resulted in reducing the time that the compost was kept in the houses from 3 to 2 weeks, and having a finished compost ready for land application in 45 days. Some of these lessons learned included premixing of the carcasses and litter prior to constructing the windrow, and paying greater attention to keeping equipment from compacting the windrow base (Flory et al., 2007).

Do and Don'ts

• Do not eat, drink, smoke, or use bathroom facilities while engaged in activities where contact with contaminated animals or surfaces is possible.

• PPE should be properly removed and discarded or disinfected; then hands should be washed thoroughly before eating, drinking, smoking, or bathroom use.

• Maintain or update tetanus vaccination for cuts or puncture wounds.

• Plan for heat stress, especially that caused by the insulating effect of wearing PPE.

• Keep influenza vaccine up-to-date.

Upon Recognition of Infection

Upon recognition that an infection, known or suspected, of low-pathogenic or highly-pathogenic avian influenza appears to be occurring, farm owners/operators and staff should have a basic protocol in place regarding work practices and personal protective equipment which is to be implemented immediately. The facility should have an avian influenza response plan (can be developed using the guidance from the NIOSH ALERT at http://www.cdc.gov/niosh/docs/2008-128/) that complements the regional, state, and industry plans and should select a response plan manager. The plan should be coordinated with appropriate state animal and public health agencies. The employer should make sure that workers are aware of the plan and of their specific responsibilities. Employees should don personal protective equipment.

Doffing PPE:

• While wearing the respirator, goggles, and gloves: remove all personal protective clothing.

* Place disposable clothing in approved, secure containers for disposal; approved secure containers (according to 29 CFR 1910.1030(d)(4)(iii)(B)) are closable, constructed to contain all contents and prevent leakage during handling or transport, labeled or color-coded, and closed before removal.

* Place reusable clothing in approved, secure containers for cleaning and disinfection.

• Remove gloves carefully, remembering that the outside of the gloves are contaminated.

* Begin by pinching the palm of one glove and pulling it off.

* For the second glove, slide your bare finger under the cuff of the glove, and turn the end of the glove over. Now remove your finger and pinch the inside of the glove, which is clean, and pull it off.

* Discard in an approved, secure container for biohazardous wastes.

* Thoroughly wash hands with soap and water for 15-20 seconds.

* If no hand-washing facilities are available, use waterless soaps or alcohol-based sanitizers (note: these may be harsh to the skin if used too often).

• Remove goggles and then the respirator.

* When removing eye protection, do so carefully to prevent it from contacting eyes, nose, or mouth.

* Discard disposable respirator in designated receptacle.

* Thoroughly wash hands again with soap and water or sanitizer (as before).

* Shower at the worksite or a nearby decontamination station.

* Leave all contaminated clothing and equipment at work, never wear it outside the work area.

Proper second glove removal.

Proper hand washing with soap and water or sanitizer.

Troubleshooting Table

Symptoms	Problems	Recommendations
Pile fails to reach temperature.	Material is dense. Not enough air circulation.	Rebuild pile with more chunky carbon. *If it is in an odor sensitive area and the pile cannot be moved, let process run its course and turn in 4-6 months.
	Pile too small.	To heat, pile needs to be greater than 4'x4'x4'.
	Frozen carcasses placed in pile.	May need to wait until warmer weather to reach temperature.
Insects and other animals attracted to pile.	Carcasses not covered well.	Cover carcass or residual well with carbon.
	Leachate puddling on pad surface.	Pad should have 1-2% slope and holes should be filled to avoid standing water.
Carcass uncovered.	May have insufficient cover.	Use plenty of wood chip cover material.
Standing water/surface ponding.	Inadequate slope.	Establish 1-2% slope with proper grading.
	Improper windrow/pile alignment.	Cover standing water with wood chips.
		Improve drainage, add an absorbent such as wood chips. Run windrows/ piles down slope, not across.
	Depressions in high traffic areas.	Fill and grade.
Odors	Ponded water.	Regrade the site to make sure there is no standing water.
	Insufficient cover.	Make sure piles are covered with at least 2 feet of wood chips.
		Add a cover blanket of fresh chips or finished compost.
	Anaerobic conditions.	Build piles that are not too wide or too dense so that air flow can keep the piles aerobic. DO NOT turn or disturb piles for 4 months (depending on the size of the animals). Turning can release odors, especially early in the process.

Suppliers - Temperature Probes

- Meriden Cooper Corporation — Meriden, CT — 800-466-8448
- Morgan Scientific — Haverill, MA — 800-525-5002
- Omega Engineering — Stanford, CT — 800-826-6342
- Reotemp Instruments — San Diego, CA — 800-648-7737
- Spectrum Technologies — Plainfield, IL — 800-248-8873

Lessons learned from the Canadian experience with H7N3 in British Columbia (Tweed et al., 2004) indicate the importance of planning for worker protection challenges. In this case, a large number of birds required disposal crews to work in barns where culled chickens had been dead for a week. Workers were subsequently covered in feces and chicken parts, working in barns where manure pits had not been cleaned for 7 years.

• **Heat and humidity** made N-95 respirators and plastic overalls very uncomfortable; switched to cotton coveralls and half-face respirators; and later to full-face respirators because a drinking tube could allow responders to re-hydrate without risking contamination while doffing PPE.

• **PPE compliance needs monitoring**, as compliance could be poor; veterinarians, especially, did not wear protective gear or take the antiviral drugs offered.

• **Extra PPE** needed to replace any that are shredded or torn while working around cages and coops.

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