Using Active, Sludge Compost to Address Catastrophic and Routine Poultry Mortality Disposal Needs

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Introduction

Each year, Maine poultry farmers lose approximately 50,000-520,000 birds due to routine and catastrophic mortality issues. By far, egg-laying hens comprise the majority of Maine's poultry numbers with approximately 4,000,000 birds housed among three major central Maine facilities: Decoster Egg Farms (Turner) and Dorothy Egg Farms (Winthrop and Leeds). Each week, these facilities experience mortalities ranging from 0.1 to 0.5 percent.

Traditional disposal methods include rendering and burial. In the event of a catastrophic epizootic disease outbreak such as Avian Influenza, mortalities could easily exceed several hundred thousand birds, exhausting local response capabilities, including available equipment and manpower. Rendering costs have steadily risen, whilst rendering facilities capable of handling mass mortalities have declined markedly. Additionally, Maine soils are plagued with shallow water tables, making burial a risky proposition at best. Composting offers a practical, cost-effective, and environmentally sound alternative to the previously mentioned disposal options. During composting, soluble nutrients are consumed by microbes and converted into complex compounds that are resistant to breakdown and reduce potential leaching issues. Additionally, the hot temperatures achieved during the "active" compost phase help to destroy pathogenic organisms that may persist in the carcass.

During February of 2002, a small Central Maine duck-rearing farm experienced an outbreak of a low pathogenic strain of Avian Influenza (H7N2). To address this outbreak, the Maine Department of Agriculture employed a disposal method consisting of placing the bird carcasses in active sludge-derived compost. Following three weeks of composting, swabs were taken from the interior of the pile and tested for Avian Influenza; results were negative. Only some of the feathers and leg bones were noted when exploratory excavations were done following a month of composting. The current study evaluates the efficacy of using this methodology on a much larger scale, with birds averaging 3-4 lbs. in size.

Research Design

Materials and Methods: During the late summer and fall of 2006, the Maine Compost Team, a collaborative interagency team including staff from the Maine Department of Environmental Protection, Maine Department of Agriculture, University of Maine

Cooperative Extension, and Maine State Planning Office, began a series of poultry composting trials (using active, immature municipal sludge-derived compost) at Highmoor Farm, a University of Maine Research Farm located in Monmouth, Maine. All sludge compost used in the study was obtained from the Hawk Ridge Compost Facility located in Unity Plantation, Maine. For our purposes, we chose compost that had met EPA approved Pathogen Reduction and Vector Attraction Reduction standards, but had not yet completed the full, active compost or curing phase. Incoming loads of compost averaged temperatures in excess of 140 ^{o}F. Initial compost windrows were formed using a front-end loader to establish the base layer and to complete carcass covering. A total of three replicate windrows (Pile #1-#3); measuring 10 feet wide by 5.5 feet high by 16 feet long (approximately 24 cubic yards of compost) were formed and observed over a five-week compost period. For each trial, an initial base layer of sludge compost, measuring 18 inches in depth, was placed on the ground surface prior to off-loading the poultry mortalities. Windrows were comprised of two (2) separate layers of birds, measuring one and a half (1.5) feet in depth; separated by a six (6) inch layer of compost. The addition of the compost between the bird layers afforded an opportunity to absorb leachate generated from the breakdown of the birds, while also providing additional texture and “bulkiness” to enhance even air-flow through the windrow. A final cover of amendment measuring 24 to 36 inches in depth was placed over each completed windrow. The mortality count per completed windrow was as follows: Pile #1-480 birds, Pile #2-517 birds and Pile #3-680 birds.

Windrows were monitored using a series of three (3) dial type thermometers (ReoTemp ©) placed in four (4) evenly distributed sampling locations. At each sampling location, a four-foot thermometer was inserted into the “core” of each windrow to allow continual mortality temperature monitoring throughout the six-week compost period. Two (2) additional thermometers were placed at each of the four sampling locations within each windrow (at one-foot and three-foot depths) to track the temperature profile of each windrow (Figure 1). In most instances, both the tip of the three-foot and four-foot thermometers was initially located within the mortality layer due to the configuration of the piles. In addition to trial temperatures, observations were made regarding pile volume losses over the compost period, extent of carcass deterioration on day 14, 21, 28, and 35, and environmental concerns including: odor, leachate, and vector attraction issues).

Figure 1. Photograph depicting temperature sampling array of thermometers placed (from left to right) at one-foot, three-foot, and four-foot depths.

To better understand the effects of precipitation events and potential subsequent leachate losses, one of the three (3) trials (Pile #3) was built over a PVC leachate collection system (Figure 2). The system consisted of three (3) ten-foot long sections of three-inch schedule 40 PVC pipe, with a series of four holes drilled around the top and sides, at one-foot intervals, along the length of the pipe. These pipes were laid upon an eight by ten-foot plastic tarp to direct all leachate into the collection system. The three pipes were then connected to a central collection area with a five-gallon bucket serving as a leachate collection/sampling point. To maximize the potential for leachate collection, Pile #3 was constructed to intercept surface water (run-on) from an upslope drainage area (measuring >2,000 $ft.^2$ in size).

Figure 2. Photograph depicting “Leachate Collection System”, prior to construction of Pile #3.

Composite samples were collected from each windrow following the active compost period. These samples were sent to the University of Maine Analytical Lab for testing. A standard compost test plus stability testing were performed on each sample.

Results

Results suggest that using immature, active municipal sludge-derived compost may be ideally suited to poultry carcass disposal needs.

Temperature Response: In each of the three trials, temperatures at the one-foot, three-foot and four-foot levels remained in excess of 110 ^{o}F for greater than two consecutive weeks (Figure 3); easily exceeding the published standard, necessary to inactivate the Avian influenza Virus, of 99 ^{o}F for 24-36 hours (Lu et al., 2003). Initially, and throughout the study period, one-foot temperatures for each of the trials consistently exceeded 120 ^{o}F. This suggests that poultry growers could use this composting methodology for disposal of carcasses infected with highly pathogenic Avian Influenza (H5N1) without concern for transmission of the virus, as the high temperatures contained in this outermost layer would serve as a “barrier” to prevent virus escape. All three trials showed consistent temperature responses at the one foot level, however, both Pile #1 and #2 showed consistently higher temperature performances, at both the three-foot and four-foot depths, than Pile #3. This is best explained by looking at the initial pile set-up. Pile #3 was formed shortly after the sludge compost had been delivered to our site. During construction of this pile, we noted that the compost appeared to be very dry. In addition, poultry mortalities had been dumped on the ground with no effort to pre-mix with amendment. Finally, Pile #3 contained the most mortalities (610 birds). For both Pile #1 and Pile #2, birds were received on a bed of compost that had been exposed to precipitation. This pre-mix with moist amendment helped to better distribute moisture within the pile “core” as well as ensure adequate contact with compost media, thus helping to ‘jump-start’ inner core temperatures. On Day 16, Pile #3 experienced a significant (10 degree) drop in temperature at both the one-foot and three-foot levels. This is a significant finding, in that the one-foot reading shows the “cooling” effects of a significant precipitation event (3.5 inches) as it penetrates the pile surface, whereas the three-foot reading shows a similar temperature drop resulting from the absorption of surface water as it traveled underneath the pile (Figure 3).

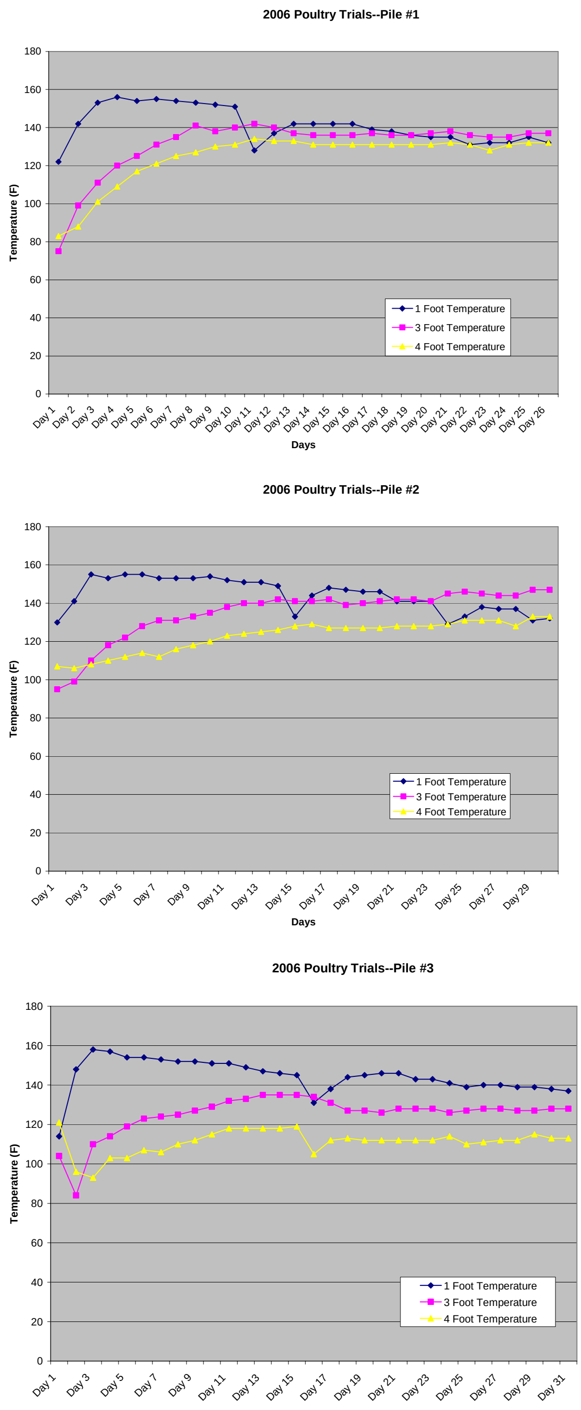

Figure 3. Summary of one-foot, three-foot and four-foot temperatures recorded in Pile #1-#3 during the 2006 poultry trials. Note consistent temperature performance among the individual trials.

Pile Excavations: Pile excavations for all of the trials demonstrated that after approximately two-weeks of composting, 50-70 % of the soft tissue and feathers had been digested (Figure 4). Most of the bones had a gelatinous appearance and the only raw, soft tissue noted was a small amount of breast meat which constituted the bulk of the bird's initial body mass. Most of the other remaining tissue appeared to have been "par-boiled" and was the consistency of cooked chicken (Figure 4). In the early stages of pile activity, it was noted that the extent of decomposition was dependent on two (2) factors: moisture content near the pile core and percentage of bird contact with compost. Soft tissue and feathers showed more advanced breakdown and decomposition in areas where birds were initially surrounded by compost and where the surrounding compost layer was high in moisture. In many instances, tissue digestion was noted to be more advanced in areas that appeared to be slightly anaerobic, as evidenced by strong odors released during subsequent excavation attempts.

Figure 4. Photographs depicting soft tissue remains after approximately two-weeks of composting. Photograph on left shows "slimy" bones and remains of breast meat; photograph on right shows "par-boiled" tissue appearance of slightly cooked chicken.

By day 21, 90% of the soft tissue was gone, and remaining bones, now clean of soft tissue, were soft and gelatinous (Figure 5). Most of these bones could be teased apart easily using the blade of a shovel. Additionally, all of the feathers examined had been digested to the quills, with some small clumps of gooey "feather balls" being noted near very moist sections of the pile.

Figure 5. Photograph depicting remains of poultry carcass following 21 days of composting.

By day 35, the compost piles had decreased noticeably in both size and volume as compared to their original dimensions. The multiple bird layers formed during initial windrow construction were reduced to a single bird layer. The compost surrounding this layer was noticeably dry. Pile excavations in this layer revealed clean, brittle bone fragments and some matted feathers that appeared to have been charred and “tanned”; yielding a “leather-like” texture and consistency (Figure 6).

Figure 6. Photographs depicting sludge-based compost pile at day 35. Photograph on left shows pile cross-section (note: blue-tipped pen has been placed adjacent to single bird layer); photograph on right shows clean, brittle bones and dry, charred feathers.

Leachate Study: A total of five (5) leachate discharges were recorded for Pile #3 during the 35-day study period. During the first two-weeks of the trial period, the study site experienced several minor precipitation events (<1.0 inches each) which were readily absorbed by the compost piles. On the 15th day, however, the first leachate discharge was noted from Pile #3 following a 3.5 inch precipitation event. Excavations of the pile revealed that the precipitation had penetrated only 12 inches into the pile surface, while the base was saturated (Figure 7). This would prove to be the case for each subsequent leachate event, leading us to believe that the leachate was not generated by moisture passing through the carcasses, but actually from the effects of surface water saturating the pile base (upslope side) and then underneath the pile, into the leachate collection system. Additionally, on October 28, 2006, during a very heavy precipitation event, a steady stream of leachate was observed flowing from the collection system. Surface water was observed flowing into the upslope side of the pile and standing water was observed along the upper edge of the pile. It was also noted that throughout the study period, the slope and profile of Pile #3 changed noticeably, going from a steep slope at a height of 5.5 feet to a somewhat flatter slope at 3 feet in height. This profile change (flatter, wider top) obviously allowed the pile to absorb more water during precipitation events, but it appears that the major force leading to leachate events was due to influence of run-on, surface water impacts on Pile #3.

Figure 7. Photograph of Pile #3 following 3.5 inch rain event. Excavation on left depicts penetration of precipitation approximately 12 inches into pile, whereas excavation on right shows saturation of pile base from surface water impacts.

Odors and Vector Activity: During the course of the study, neither odors nor vector activity played a prominent role. Once each pile was formed, the sludge compost characteristically emitted a unique odor which was neither strong nor offensive in nature (except when piles were disturbed during excavations; and only for a brief duration). Sludge-derived compost odors were never observed outside of the study area, and did not noticeably change throughout the course of the study. We also found that none of the project piles were attractive to vectors and that no scavenging activity was observed. In fact, a resident flock of turkeys that routinely rooted feedstock piles (farm's vegetable dump) located onsite were never observed climbing-on or approaching any of the poultry compost piles (Pile #1-Pile #3). In previous Team projects (Large Animal Compost Studies, 2001 and 2004) sludge-derived compost piles were routinely avoided by all scavenging animals.

Summary

In each of the trials (Pile #1-Pile #3), sludge-derived compost performed extremely well; suggesting that this material would be an ideal choice for mass mortality disposal. In all cases, piles maintained high temperatures necessary to destroy potential pathogens (e.g., Highly Pathogenic Avian Influenza, H5N1), while also effectively breaking down poultry mortalities. By day 28, all of the original poultry carcass tissue and 60-70% of feathers had been completely digested. Bones were clean of tissue and were so brittle in nature that they could be easily teased apart using the blade of a shovel. By day 35, bones were visibly crumbling on the ends, and any remaining feathers had a “burned” appearance and a leathery texture, suggesting that they had be through a chemical tanning process.

Leachate observations from Pile #3 were recorded on days following heavy precipitation events (> 3 inches) or were observed following several consecutive days of less significant rainfall. In all cases, surface water flow underneath of the pile was the single most significant contributing factor leading to leachate events. Changes in pile slope and profile may contribute to overall precipitation retention, but our observations showed that each of the compost piles generally had a strong affinity for moisture, and frequent, non significant precipitation events were readily absorbed and utilized by each of the piles.

Both odors and vector issues played a subordinate role in this study. None of the compost piles were disturbed by scavenging animals, although vectors (such as turkeys) were routinely observed onsite. It is possible that the odors emitted by the sludge compost act as a repellent to scavenging animals or, quite possibly, there were other more attractive areas (e.g., vegetable dump site) on site.

Literature Cited

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