Symposium on Composting Mortalities and Slaughterhouse Residuals

May 24-25, 2005
Portland, Maine
Sheraton South Portland Hotel

SYMPOSIUM COSPONSORS:

Maine Department of Agriculture
Maine Department of Environmental Protection
University of Maine Cooperative Extension
Maine State Planning Office
Maine Department of Transportation
Maine Compost School
Maine Inland Fisheries & Wildlife
BioCycle, Journal of Composting & Organics Recycling
Cornell Waste Management Institute
U.S. Environmental Protection Agency

Conference proceedings prepared by:

University of Maine Cooperative Extension
Knox-Lincoln County office
377 Manktown Road
Waldoboro, Maine 04572-5815
Mark Hutchinson, Extension Educator
markh@umext.maine.edu
Jeanne S. Pipicello, Administrative Assistant
jeannep@umext.maine.edu

TABLE OF CONTENTS

PAGE

Plenary Session: Introductions and Keynote Address

Are We There Yet? Status of Mortality and Slaughterhouse Residuals Composting

Submitted by:
Nora Goldstein, Executive Editor, BioCycle, Journal of Composting and Organics Recycling (presenter)
419 State Ave., Emmaus, PA 18049
ph. 610.967.4135, ext. 26; fax 610.967.1345
email: noragold@jgpress.com
http://www.biocycle.net

Robert Rynk, Environmental & Agricultural Engineering Consultant

Composting livestock mortalities has been practiced on farms for a number of years. Recently, however, the practice has received more attention as other management options for animal mortalities — rendering in particular — have become more costly and subject to end product market difficulties due to concern over "Mad Cow" disease. This situation has made composting a leading option for management of livestock mortalities and slaughterhouse residuals. Concurrent with the increased use of composting on farms is application of the practice to wildlife road kill. Composting methods developed for mortalities and slaughterhouse residuals, and used for wildlife, appear to be effective, both in terms of processing capabilities and cost-efficiencies. This talk will review the evolution of composting methods utilized, provide highlights of research findings, and discuss constraints, caveats and questions that remain to be answered.

Biosecurity/Diseases – Session Chair: Mark Hutchinson

Discoveries of Prion Degradation and a Safe Prion Surrogate Protein

Jason C.H. Shih
Department of Poultry Science
North Carolina State University
Raleigh, NC 27695-7608
Telephone: 919-515-5521; Email: Jason_shih@ncsu.edu

A bio-process called thermophilic anaerobic digestion (TAnD) was developed at NC State University for the treatment of poultry waste and production of biogas energy. During the operation, feathers mixed in the waste were completely degraded. This observation prompted a series of studies of feather degradation. A feather-degrading bacterium, the enzyme keratinase that hydrolyzes feather keratin and the gene that encodes keratinase were isolated. Genetic modification enabled the bacterium to over express keratinase and scale-up fermentation made the production of the enzyme in large quantities possible. Transmissible spongiform encephalopathies (TSE), including bovine spongiform encephalopathy (BSE), sheep scrapie, deer chronic waste disease (CWD) and human Cruesfeldt-Jakob disease (CJD) are caused by prions, made of very stable protein resistant to standard sterilizing processes and common proteases. Because of the structural similarity between prion protein and feather keratin, the keratinase was tested for its activity on prion degradation. Resulted from the collaboration with CIDC-Lelystad in the Netherlands, it was found that BSE and scrapie prions were indeed degradable by the enzyme to the undetectable level. This discovery indicated that the keratinase and other similar enzymes may be developed into a new enzymatic process that degrades prions and prevents TSE. To test and optimize the enzymatic process, a prion surrogate protein (PSP) as a safe bio-marker has been developed. PSP, genetically modified from yeast Sup35NM, has been cloned and over expressed in *E. coli*. Physical-chemically it behaves like prion protein, yet it is non-pathogenic and safe for laboratory and field tests. The combination of keratinase and PSP are believed to be a useful toolbox for prion degradation and TSE prevention. Keratinase-enhanced composting, monitored with PSP, could be an answer to the handling of prion-contaminated animal mortalities. (Grants supported from FDA and JIFSAN)

Lessons Learned from Avian Influenza Outbreaks in Virginia 1984 – 2005

Eric S. Bendfeldt[1], Robert W. Peer[2], and Gary A. Flory[3]

Early developments in commercial hatchery technology, artificial incubation and brooding, marketing, diagnostic testing, and key infrastructure improvements from 1900 to 1950 contributed to the growth and present prominence of the poultry industry in the Shenandoah Valley and its importance in the agricultural economy of Virginia. In 2003, Virginia ranked 5th, 9th, and 31st in the nation for commercial turkey, broiler, and egg production. The value of Virginia's turkey, broiler, and egg production was $692 million. The expansion and density of poultry production in the Shenandoah Valley has posed challenges to the industry and regulatory officials in the control of contagious diseases like avian influenza (AI). Poultry diseases were noticed, tested, and reported as early as 1928. The avian influenza outbreaks of 1984 and 2002 were particularly challenging and problematic due to the magnitude and urgency of the epidemic and carcass disposal issues. Many lessons were learned as a result of these outbreaks and the experience of trying to dispose of poultry carcasses through on-site burial, burial in sanitary landfills, incineration, rendering, and Ag-Bag composting. Each outbreak was certainly unique and offered many environmental and economic challenges. Virginia regulatory officials, as a result of these experiences, have encouraged the poultry industry to consider sanitary landfills and in-house or on-farm composting as rapid response tools of disposal and disease containment, particularly with low pathogenic avian diseases.

In 1984, an avian influenza outbreak cost Virginia poultry farmers and industry $40 million and resulted in the disposal of 5,700 tons of poultry carcass material. Approximately 88% of the material was disposed of on-site in burial trenches and the remaining 655 tons of carcass were disposed of in a local sanitary landfill (McClaskey, 2004). The cost of on-site burial and landfill was $25 per ton or $142,000. Neighbor concerns about contaminated groundwater from these sites and the discovery, during the excavation of a school building site in the late 1990s, of relatively intact carcasses affected future decisions of disposal actions.

Eighteen years later, the poultry industry in the central Shenandoah Valley was affected by an even larger avian influenza outbreak. At the time of the outbreak in 2002, more than 56 million commercial turkey and chickens were being grown on over 1,000 poultry farms. On March 12, low pathogenic avian influenza was confirmed in a turkey breeder flock near Penn Laird, Virginia. One month later, more than 60 flocks tested positive. A total of 197 farms were

---

[1] Extension Agent, Environmental Sciences, Virginia Cooperative Extension, 965 Pleasant Valley Road, Harrisonburg, Virginia 22801-0963 Phone: (540) 564-3080 Fax: (540) 564-3093 Email: ebendfel@vt.edu

[2] Agricultural Program Coordinator, Virginia Department of Environmental Quality, Valley Regional Office, P.O. Box 3000, Harrisonburg, Virginia 22801 Phone: (540) 574-7866 Fax: (540) 574-7844 Email: rwpeer@deq.virginia.gov

[3] Agricultural and Water Quality Assessment Manager, Virginia Department of Environmental Quality, Valley Regional Office, P.O. Box 3000, Harrisonburg, Virginia 22801 Phone: (540) 574-7866 Fax: (540) 574-7844 Email: gaflory@deq.virginia.gov

infected with the virus and 4.7 million birds were destroyed to eradicate the virus. Turkeys accounted for 78% of the positive farms and bird losses (DEQ, 2002).

On-site burial was used for the first flock and assumed to be an acceptable method of disposal. However, several complaints about on-site burial and possible well contamination were raised by adjoining landowners. State authorities developed stricter criteria for on-site burial such as public disclosure of sites on deed records, a compacted clay layer, the burial of less birds and use of more cover, and the installation of monitoring wells in response to these concerns. As the disease progressed, many alternative disposal methods were researched, but five options were actually implemented: burial in sanitary landfills, controlled slaughter, incineration and air curtain destructors, in-house and Ag-Bag composting. Rendering was not used as a disposal method because of biosecurity risks associated with central collection sites and possible disease transmission.

Approximately 13,100 tons of infected poultry were landfilled. Two large landfills located over 160 miles from Harrisonburg accepted 7,900 tons, but transportation was expensive and problematic because of distance and a lack of enough trucks (Senne, Holt, and Akey, 2004). Tipping fees for landfilling the carcasses ranged from $45 to 89 per ton. With euthanasia, truck loading, and tipping fees, the actual disposal cost was $145 per ton. In 2004, a long-term contract was negotiated with two mega-landfills to accept carcasses at a cost of $75 per ton.

Table 1 Disposal Methods for Avian Influenza Infected Poultry and Quantity Disposed of by Method in 2002.

Method of Disposal	Number of Birds	Percent of Total
Composting (Ag-Bag & In-house)	43,000	0.9
Incineration	641,000	13.4
Landfilling	3,103,000	65.5
Controlled slaughter	943,000	19.9
On-site burial	15,000	0.3
Total	**4,732,000**	**100.0**

Composting was implemented as a disposal technology for two flocks during the outbreak with limited supervision and success. In-house composting has not been considered a viable option by the industry because of this experience, the potential loss of production space and the perception that composting would not work on larger birds. Successful in-house composting of 5-pound broilers on the Delmarva Peninsula in 2004 proved the effectiveness of composting as a method of disposal and containment for an AI outbreak (Malone, 2004a; Malone et al., 2004b). Avian influenza was confined to 3 farms despite the high density of poultry farms in the area. In-house composting appears to be the most acceptable method of disposal because it limits the risks of groundwater and air pollution, high fuel costs, potential for farm-to-farm disease transmission, transportation costs, and tipping fees (Tablante et al., 2002).

State environmental officials and poultry industry personnel learned a number of important lessons from their experiences with the AI outbreaks in the Shenandoah Valley. The most significant was the value of a current prevention and rapid response plan. In the 18-years between the 1984 and 2002 AI outbreaks, there was a significant shift in accepted environmental practices which made the preferred disposal method from the 1984 outbreak unacceptable in 2002. Since the 2002 outbreak, the poultry industry has worked to develop a thorough plan for prevention and rapid response for future challenges and meets regularly to ensure that the plan is current. In the fall of 2004, Virginia Cooperative Extension, Virginia Department of Agriculture and Consumer Services, Virginia Department of Environmental Quality, Virginia Poultry Federation, Virginia Poultry Disease Task Force and the poultry industry initiated a research and demonstration project to evaluate the effectiveness of in-house composting of turkeys as another means of disposing of catastrophic losses and disease containment.

Other lessons learned by method:

- Landfilling
    - With proper biosecurity, transportation to and disposal at commercial sanitary landfills can be an effective disposal method.
    - Disposal at smaller county or regional landfills poses many logistical difficulties and would not be recommended in most cases.
    - Successful landfill disposal requires significant resources: track-hoe or similar heavy equipment, adequate lighting for operating after normal working hours, cleaning and disinfecting crews and equipment, double lining of transport vehicles to assist in the offloading of carcasses, stabilizing material for working in wet conditions, and an adequate communication system between the affected farm and the landfill.
    - Transport trucks need hydraulics "wet lines" to operate dump trailers.
    - Safety concerns need to be adequately addressed during the offloading of transport trailers.
    - Litter and feed still need to be disposed of after the carcasses are removed from the houses – in 2002 over 5000 tons needed a $10/ton USDA incentive paid to recipients of this material because of the "stigma" of coming from an AI infected farm.
- Controlled Slaughter
    - Impact on export and domestic markets needs to be addressed.
    - Communication, biosecurity and pre-planning are critical for large-scale controlled slaughter.
- Incineration
    - Contracting agencies need tight oversight of wood procurement, (quality and quantity), scheduling, and proper loading of the incinerator.
    - A 3-sided portable metal loading platform, such as used for unloading biosolids, could be used to prevent runoff from stockpiled carcasses.
    - Provisions need to be made for either recycling or disposing of large quantities of ash (6000 tons were generated in 2002 - approx.3 tons ash/ 1 ton carcass).
- On-Site Burial
    - Public is more aware and concerned about environmental issues than they were in the 1984 outbreak.
    - Groundwater contamination concerns need to be adequately addressed.
    - New solid waste permitting requirements need to be followed.

- Ag-Bag Composting
    - Specialized equipment requires permits for transportation and is difficult to move from site to site.
    - Coordination is required to provide the necessary equipment, supplies and personnel.
    - Many sites do not have the level ground required for the Ag-Bag's use.
    - Moisture content should be managed to prevent excessive moisture in the finished bags.
    - Uniform mixing of the carcasses and the carbon source before loading the Ag-Bag is critical (and difficult to achieve).
- In-House Composting
    - Compost piles need to be effectively constructed and managed to be effective.
    - In-house composting can be accomplished within 4-weeks at which time the compost can be moved out of the poultry house for land application or further composting.
    - In-house composting can be a cost effective and biosecure method disposal of carcasses.
    - All of the litter and feed is managed with the carcasses.
    - The volume of material is reduced in half.

The two major avian influenza outbreaks that affected the Virginia poultry industry in 1984 and 2002 presented unique environmental, economic, and policy challenges. The poultry industry has worked to develop a thorough prevention and rapid response plan for low pathogenic AI and meets regularly to ensure that the plan is current. The lessons learned will help industry, producers, and government agencies respond quickly and effectively to future diseases.

References

Malone, G. 2004. In-house composting of avian influenza infected flocks. Proceedings 2004 Virginia Poultry Health & Management Seminar. Roanoke, VA. pp. 23-24.

Malone, G., S. Cloud, R. Alphin, L. Carr and N. Tablante. 2004. Delmarva in-house carcass composting experiences. Proceedings 2004 National Meeting on Poultry Health and Processing. Ocean City, MD. pp. 27-29.

McClaskey, J. 2004. Economic and Cost Considerations. Ch. 9 *In*: Carcass Disposal: A comprehensive review. National Agricultural Biosecurity Center Consortium

Senne, D.A., T.J. Holt, and B.L. Akey.2004. An overview of the 2002 outbreak of low-pathogenic H7N2 avian influenza in Virginia, West Virginia, and North Carolina. (Available on-line at http://library.wur.nl/frontis/avian_influenza/06_senne.pdf) (Verified 27 April 2005).

Swayne, D.E., and B.L. Akey, 2004. Avian influenza control strategies in the United States of America. pp. 113-130. In: G. Koch (ed.) Proc. of the Wageningen Frontis International Workshop on Avian Influenza Prevention and Control. Wageningen. The Netherlands: Kluwer Academic Publishers. (Available on-line at http://library.wur.nl/frontis/avian_influenza/13_swayne.pdf.) (Verified 17 March 2005).

Tablante, N.L., L.E. Carr, G.W. Malone, P.H. Patterson, F.N. Hegngi, G. Felton, and N. Zimmerman. 2002. Guidelines for In-house Composting of Catastrophic Poultry Mortalities. Maryland Cooperative Extension Fact Sheet 801.

Virginia Department of Environmental Quality. 2002. Avian Influenza Outbreak Summary. VA. Dep. Env. of Qual. Harrisonburg, Virginia.

Foot and Mouth Disease, Equine Infectious Anemia: Biosecurity Considerations and Response Strategies

Submitted by: Don Hoenig, MDAFRR, 28 State House Station, Augusta, ME 04333, phone: (207) 287-7610, email: Donald.E.Hoenig@maine.gov

In this talk, I'll be focusing on disposal of large numbers of animal carcasses in an emergency disease outbreak, drawing on experience in the UK in 2001 and also on our own avian influenza experience here in Maine in 2002.

Wildlife and Road Kill Issues – Session Chair: Jean Bonhotal

Assessing Pathogens in Road Kill

Jean Bonhotal, Ellen Harrison
Cornell Waste Management Institute
Dept of Crop &Soil Science
101 Rice Hall
Ithaca, NY14853
Jb29@cornell.edu

Over 25,000 dead deer and numerous carcasses of other animals such as raccoons, coyote and fox are managed annually by NYSDOT. DOT maintains and operates a 15,656 mile highway system of interstates, expressways and collectors which comprises about 15 percent of NYS's total of 111,000 miles of highway. The 25,000 dead deer managed annually by NYSDOT do not account for deer killed on county and local roads that must be managed by local highway departments.

Disposal options for these carcasses are limited and appropriate disposal is expensive. Carcasses are often left by the road or dumped into low areas. These methods are becoming less acceptable as rural areas become more populated and there is increased concern for environmental quality. Water quality can become compromised when animals decompose on or below ground. Current NYSDOT practices include contracting with service providers to pick up and dispose of the animals. This is becoming costly and inefficient and service providers do not always have a legal and environmentally sound plan for disposal. Contractors are paid between $30 and $80 per deer for pick-up and disposal (Rick McKeon, personal communication, NYSDOT) and in FY's 2000-2002 this totaled just over $1.1 million. Landfills generally will not take carcasses and when they do it tends to be restricted, so the NYSDOT is left with limited and/or costly disposal options.

Over the past several years, the Cornell Waste Management Institute (CWMI) has worked with dairy farms to manage mortalities through on-site static pile composting. Workshops and demonstrations held at these sites have generated substantial interest in the process. The NYS Department of Environmental Conservation (NYSDEC), local and regional Departments of Health, Soil and Water committees and Natural Resources Conservation Service (NRCS) staff have attended workshops and become familiar with the process. Regional and local DOT personnel have attended workshops and indicated interest in trying composting to manage road-killed deer. In response, composting of road-killed deer is being piloted under CWMI guidance at several DOT facilities in NYS where it seems to be working well. These piles are easy to manage, do not generate odors, and the carcasses are transformed into compost. However, questions remain about the hygienic quality of the process and product as well as about worker health.

Passively aerated static pile composting is proving to be a good method of managing these wastes. It is simple, takes less time than dragging a carcass out back, uses equipment and materials used in daily operations and is cost effective. This method helps protect ground and surface water by keeping the carcasses out of contact with water and by reducing pathogens in properly managed piles and it reduces nuisance and odors.

The effectiveness of inactivating pathogens through composting is generally assessed by monitoring the reduction in indicator organisms. *Salmonella* and fecal coliform are the usual indicator organisms. These are the organisms that the USEPA requires for evaluation of the hygienic quality of sewage sludges. It is widely recognized that the sensitivity of different pathogenic organism to heat varies significantly and questions have been raised about the use of the current indicator organisms. Evaluation of the effectiveness of static pile composting to inactivate pathogens in road-killed carcasses requires identification of the pathogens that might be present and analysis of their sensitivity to inactivation by heating. That, combined with time/temperature data from the compost piles, will provide the information needed to assess the hygienic quality of the compost product.

Chronic Wasting Disease (CWD) is a prion disease that is of concern in wild populations. CWD has just been found in NYS, it was first found in a captive herd and with intensive sampling one wild animal (April 2005). There is no evidence to show whether CWD would be killed in the composting process. Compost temperatures are not high enough to inactivate prions, but it is possible that microbial and enzymatic activity could (Langeveld, et al; Kirill, et al.). Even if compost process does not inactivate prions, the end product (woodchips and bone) would be much more amenable to incineration than the untreated carcasses if incineration were required. Plans to manage the spread of CWD in wild deer populations are being developed up by NYS Dept of Environmental Conservation http://www.dec.state.ny.us/website/dfwr/wildlife/deer/currentcwd.html and NYS Dept of Ag and Markets (for captive herds)

Very little work has been done to assess the effectiveness of pathogen-kill in static pile mortality composting. The reduction of pathogens through composting due to elevated temperatures and microbial competition has been documented for intensively managed (frequently turned) compost piles handling other types of wastes. Even for turned piles, little information exists for carcass composts. Some research done in Ohio suggests regularly *turned* compost piles containing carcasses adequately kills common bacterial and viral pathogens (Keener et al).

Composting mortalities in turned piles requires more labor, machinery and management than static pile composting, thus increasing costs. It also provides the potential for release of odors if turned too early in the process. Static pile mortality composting is a more easily managed technique. By properly constructing the compost pile to allow for adequate natural aeration, mortality composting can be completed on intact animals with little or no turning. The process appears to be effective if the animals are enclosed in chunky carbonaceous material such as wood chips.

There is a need to evaluate the effectiveness of static pile composting of mortalities bulked with wood chips. Wood chips are an appropriate and easily available material for use in NYSDOT compost piles. Temperatures achieved in static pile composting suggest an adequate degree and duration of high temperatures to significantly reduce the survival of many pathogenic organisms, at least in the core of the piles. Preliminary investigations by CWMI at several piles in NYS indicate that temperatures of 140 degrees F are reached and that temperatures over 130 degrees are sustained for more than 6 weeks. However, temperature and pathogen kill in static compost piles have not been studied to the extent needed to provide confidence.

NYSDOT and local highway department staff who work with carcasses need health and safety information pertaining not only to carcass-borne pathogens, but also on tick-borne diseases such as Lyme disease, Rocky Mountain Spotted Fever, babesiosis and ehrlichisosis. Preliminary indications based on discussion with Cornell Vet College faculty indicate that ticks on deer have a relatively low infection rate at least for Lyme disease and that handling the carcasses would thus not be a major potential source of exposure. Ehrlichiosis is known primarily in the southern U.S. but has been reported in NYS and babesiosis is rare and is mainly coastal. However relevant data need to be gathered and assessed in order to develop appropriate guidance. Such guidance might address the life cycle, feeding behavior and data regarding infection coupled with advice on practices to minimize the risks of exposure and infection. This guidance would be relevant to all workers handling carcasses and not just to those engaged in composting.

An extensive study is underway to complete in depth literature searches, seed piles with indicator pathogens and provide more education on the composting process. Questions such as “What is the thermal stability/sensitivity of the pathogens that might be present in road-killed wildlife in NYS?”, “Are there worker health and safety issues?”, “When is the process finished?” and “Where can we use the finished product?” still need to be addressed.

Planning, Management of Chronic Wasting Disease Outbreaks in Wisconsin Science of a Transmissible Spongiform Encephalopathy (TSE) and Management Options for Disposal.

By Joseph W. Brusca
Wisconsin Department of Natural Resources
3911 Fish Hatchery Road
Madison, WI 53711
Phone (608) 275-3296
E-mail - Joseph.Brusca@dnr.state.wi.us

In February 2002 the Wisconsin Department of Natural Resources (WDNR) through routine sampling of wild white-tailed deer, learned that the herd in the southern portion of the state had contracted CWD. This was the first evidence of CWD infecting a free-ranging herd east of the Mississippi River. Colorado and several other western states have been involved with managing CWD infected elk and mule deer for years in both wild and captive herds. As of April 2005 CWD has been documented in free-ranging cervids in 10 states and 1 Canadian province and in captive reared cervids in 10 states and 2 Canadian provinces. TSE was well known in the devastating outbreak of Mad Cow Disease in Europe. TSE infected sheep in the form of scrapie has been common knowledge for decades. TSE also infects humans in the form of Creutzfeldt-Jakob Disease.

WDNR embarked on a very aggressive program to contain and eliminate CWD though several approaches. The first was to define the extent of CWD in the wild herd by sampling 40,000 animals of an estimated herd of 1.5 million in 2002. In addition, owners of captive herds were required to sample any animal that was killed or died on the farm. The results of that initial sampling indicated the geographic distribution of CWD was limited in the wild herd to an area of approximately 625 square miles in the southwest portion of the state. Several captive herds were also identified as having infected animals. The second strategy was to significantly reduce the concentration of wild deer in an area in what became known as the Disease Eradication Zone or DEZ to 5 deer per square mile. Deer density varies in this part of the state with the average of 40 deer per square mile.

Several teams were formed to cope with the strategy and operations of managing the disease. One of those teams was tasked with disposal of unwanted carcasses and CWD infected animals. The Initial strategy was to dispose of carcasses in an engineered landfill. Although this was the preferred alternative, it was quickly dropped from consideration in response to a flurry of media attention. Because of the persistence of prions in the natural environment, only two alternatives emerged as being acceptable to elected public officials. One was incineration and the other chemical digestion. Both of these alternatives had standing in the scientific community as acceptable treatments because the protein molecule chain was broken which has the effect of inactivating the prion. The problem faced in Wisconsin in 2002 was the throughput capacity of these alternatives would not be able to treat the large number of carcasses that were going to show up at our collection stations starting with the archery season in September. The Carcass Disposal Team developed bid proposals for handling carcasses and waste products from the fall hunt. We expected to generate waste from removal of heads for CWD sampling, butchered waste from hunters and meat processors, car killed deer and unwanted carcasses. What developed was a "frost and toast" option where carcasses were sampled and held in refer units (16 refrigerated semis) until test results allowed for sorting of positive and negative animals. This option was selected because the disease prevalence among all deer sampled in the DEZ was approximately 1.5-%. All negative animals could be landfilled. All CWD tested positive animals, butchered waste, heads and car-killed deer would be incinerated at a licensed pet crematorium. The 2002 season generated over 1.1 million pounds of waste (about 9,000 deer equivalents) at a disposal cost of $1 million.

In 2003 WDNR drafted legislation to allow for indemnification of publicly owned sewer plants and sanitary landfills that accepted DEZ harvested deer. The state legislature failed to act on the measure. The 2003 season was similar to the first with the "frost and toast" option selected as the preferred alternative with carcasses stored in refrigerated semis and sorting after test results were made available. The majority of the untested and positive tested waste went to Stericycle incinerators. A second option became available late in the fall season. The University of Wisconsin Veterinarian Diagnostic Lab (UWVDL) housed and operated a chemical digester purchased by USDA. The amount of waste handled through incineration and chemical digestion amounted to 633,000 pounds at a cost of $512,000 (including storage and sorting tested carcasses). Although the DEZ was expanded in response to the discovery of additional positive deer (1,153 square miles) the volume of waste was reduced by an increase in the number of deer retained by hunters during the 2003 deer season.

In 2004 the DEZ was expanded again to encompass additional positive deer along the Illinois border and portions of the Southeast Region of the State. A food pantry program was initiated so hunters could donate negative tested animals. The UWVDL digester took over the lion share of disposal needs with the crematorium used as backup. To date 382,000 pounds of waste were disposed of through chemical digestion and incineration. Over 200,000 pounds of venison were donated to food pantries. State contract costs for disposal and the pantry program amounted to $380,000 for the 2004 season.

CWD Waste Disposal Alternatives Analysis

Incineration is one of two scientifically accepted methods to inactivate prions. The incineration standard developed in Europe for Mad Cow Disease was complete combustion of the waste in the primary burn chamber at temperatures maintained at 1600 degree Fahrenheit with a secondary burn chamber and retention of 1 second of emissions at a similar temperature.

The second accepted method is chemical digestion. The standard for operating the digester at UWVDL is adding an equal amount of water (by weight) plus a 28% solution of potassium hydroxide to an adjusted pH of 10.5-11.5. The temperature is raised to 305 degrees F and maintained for 4 hours in the pressurized vessel. The capacity for each cycle of the digester is 4000 pounds of waste tissue. The effluent is trucked to the Madison Metropolitan Sewage District for disposal.

Composting is an effective method of volume reduction. However, the temperatures reached in compost operations are not effective in inactivating the prion resulting in a disposal problem of residual materials and remediation of the site once the facility is closed.

Rendering is another effective method of volume reduction. USDA promulgated rules that effectively removed rendering as a waste disposal alternative from a CWD designated area. The cost liability should a CWD positive animal go though the rendering process limited the industry to a dedicated plant. The cost of setting aside and operating a dedicated facility and the problem of wastewater disposal and end products eliminated this option from consideration because rendering is not consider effective in inactivating the prion. This approach was considered conservative by the industry since there has been no scientific evidence that CWD can cross over to cattle or humans.

Air Curtain Destructors were considered because of the initial low cost & throughput capacity. This option did not meet the incineration standards for maintaining temperature and there is no secondary burn chamber. The operation of ACD requires excellent control of start up and shut down procedures.

A dedicated landfill was given serious consideration. A request for proposal was sent out to design, construct and operate an engineered site with an artificial liner, leachate recirculation and lysimter monitoring system. The proposed site would have a capacity for 100,000 carcasses in a 4-phased configuration. The proposed site would be placed on state-owned property. The concept was abandoned because of time constraints and political fall out of exempting the siting process from local zoning.

Recommendations for Disposal of Waste from a CWD-Affected Area.

Considering cost, worker safety issues, logistics, capacity to handle waste volumes and environmental considerations the author recommends disposal of untested waste from a CWD-affected area in a sanitary landfill. Waste sources would include carcasses, heads, butchered waste and car killed deer. Our experience in handling waste is that workers are at risk from physical injuries and pathogens from carcasses that are poor condition. The WDNR prepared a risk analysis of the fate of prion in a landfill that can be found on the following web site:

http://www.dnr.state.wi.us/org/land/wildlife/Whealth/issues/Cwd/risk_analysis.pdf

The analysis concluded that the risk associated with landfilling prions in an engineered site would pose minimal risk to spreading the prion through waste waster treatment plant's solids spreading program. Placing the waste in the upper lifts of the fill allow for ample exchange capacity for the prion (prions are highly hydrophobic) to adhere to clay and waste particles before the prion encounters the leachate collection system. The sewer plants that treat leachate have little risk associated with prions entering the treatment system. Sewer plants that accepted landfill leachate and the concern by these plants that CWD waste would jeopardize their land spreading programs was the key issue in landfills refusing to accept CWD waste. The state of Wisconsin continues to work on indemnification legislation that would eliminate the financial risk for sewer plants and landfills that accept waste from CWD affected areas.

Relative Cost of CWD Waste Disposal Alternatives.

Costs do not reflect storage, handling and transportation fees which are considerably higher for the incineration and chemical digestion options when looking at large volumes of waste.

Costs are in dollars per ton.

LANDFILL	$35-70
CHEMICAL DIGESTION	$500
INCINERATION	$1300

Hunting season	**2002**	**2003**	**2004**
Square miles in DEZ	625	1153	1634
Harvest for the season	9509	13694	15,600
No. of deer retained by hunters	4009 (42%)	10694 (78%)	12,750 (82%)
No of deer disposed	5500	3000	650
No of deer donated to food pantry program	0	0	2200
Total amount of waste generated for disposal (in tons)	688	316	307
Total cost of disposal contracts	$1,032,669 ($1500/ton)	$512,000 ($1620/ton)	$237,000 ($771/ton)
Total cost of pantry program	0	0	$143,000

Carcass Composting – Session Chair: Bill Seekins

Evaluation of Composting for Emergency Disposal of Cattle Mortalities in Iowa-Thomas Glanville

Note:

To see complete abstract, go to ABSTRACT FOLDER, CARCASS COMPOSTING FOLDER, Maine Livestock Disposal - pdf

Large Animal Mortality Carcass Composting Field Trials: 2001-2004

Submitted by: Bill Seekins Maine Department of Agriculture State House Station 28 Augusta ME. Phone: 207-287-7531 email: bill.Seekins@me.gov

AUTHORS: B. Seekins, M.A. King, M.L. Hutchinson, N. Hallee

INTRODUCTION

The Maine Department of Agriculture became aware of the outbreak of Foot and Mouth Disease (FMD) in Great Britain during the winter of 2001. The two Maine State Veterinarians and the Federal Veterinarian in Maine all spent time in England assisting with managing the crisis. Upon their returns to Maine, they reported on the devastation caused by the disease and the problems that resulted from trying to dispose of the thousands of carcasses. Their experience heightened the concerns already felt by the Department and by the Maine livestock industry about what would be done here if an outbreak occurred. A task force was established by the Commissioner of Agriculture to develop a plan of action to deal with such an emergency. One of the efforts of the task force was to evaluate the disposal options available and to develop a plan for implementing those best suited to the conditions in Maine.

The methods of disposal that were considered were:

- burial
- burning
- rendering
- composting

When these options were evaluated, each was found to have a weakness, or concern.

As a result of these findings, the Maine State Soil Scientist, David Rocque suggested that the compost process should be tried using hot, active compost instead of sawdust or shavings as the compost media. The reasoning behind this suggestion was that hot compost would already have an active microbial population that was breaking down organic material. The heat and active microbes would create an environment that should be very hostile to pathogenic organisms such as the FMD virus.

The task force felt that this idea had merit and requested the assistance of the Maine Compost Team* (Compost Team) in evaluating this approach. The Compost Team was already planning to conduct animal carcass compost trials using farm based compost and so gladly accepted the charge. They determined that the most readily available source of active compost would be the large compost facilities that composted municipal waste water treatment sludges (biosolids).

* Note: The Maine Compost Team includes: Mark King, Maine Department of Environmental Protection; Bill Seekins, Maine Department of Agriculture and Mark Hutchinson, University of Maine Cooperative Extension. Neal Hallee, formerly of the University of Maine Cooperative Extension was also a member of the team at the time the trials began.

Literature on FMD virus survival suggested that the FMD virus did not survive beyond about 8 days in either liquid or solid manure if the manure was at or above 32°C (90°F). It also indicated that survival time was shortened significantly with every 2°C rise in temperature above this level. It was hypothesized that survival in a compost environment would be similar if it could be shown that the internal temperature in the carcass could be raised to this level and maintained for at least eight days.

DESCRIPTION OF PROJECTS

The Compost Team set up a demonstration/research project at Highmoor Farm, a research farm owned by the University of Maine. Several sets of trials were conducted at Highmoor and at other farm locations in the state. The first was done in the summer of 2001, trying different approaches for composting. A second trial was conducted in the winter of 2001-2002. This second trial focused on using the most successful of the approaches tried in the Summer Trials.

Summer Trials 2001

Four different approaches were tried during the Summer Trials. The initial trials began on June 5, 2001. Four dairy cows and two calves were used in the initial trials. These trials were set up to determine if there was any difference between just covering the carcass with active compost and completely surrounding it with compost and if placing the piles in a trench offered any benefits. The trials were set up as follows:

Two were done in trenches, one with compost under and over the carcass and the second on the soil with compost as a cover. Two others were done above ground. One used farm compost materials above and below the carcass, while the other used the municipal sludge compost above and below the carcass.

Monitoring consisted of daily visits to the site by a Compost Team member, who took and recorded temperature readings and made observations about odors, vector activity, moisture conditions and general pile appearance.

On September 6, 2001, the Compost Team dug into each of the trial piles to examine the condition of the carcasses. The amount and condition of the soft tissue was determined and the bones were examined for indications of decomposition.

<u>General Results of 2001 Trials</u>

Through out the project, the piles were watched for signs of leachate escaping from the piles. No moisture was observed leaving the piles at any time. Odors at the compost site were minimal throughout the project. The odor that was detectable on site most of the time, was the relatively mild odor associated with the compost materials themselves, not the carcasses. Vector activity at the site was minimal. None of the sludge compost piles were dug into at any time during the project.

Temperatures in 2001 Trials

The temperature response within the carcasses was an important indicator, both of the suitability of each method for achieving the pathogen reduction and of the relative performance of each of the trials.

Figure 1 shows a comparison between the internal carcass temperatures for all four trials. Note that Trial 4 (carcass on a sludge compost bed laid on the turf) had the most rapid and highest temperature response of any of the trials. It quickly reached temperatures of over 140°F(65°C) and sustained temperatures over 130°F (55°C) for several weeks. Trials 2 (carcass laid on a bed of sludge compost in a trench) and 3 (carcass laid on a bed of farm based compost on the turf) had similar temperature responses, with both exceeding 120°F (52°C) for several weeks. Trial 1 (carcass laid directly on the soil in a trench) had the lowest temperature response of all the trials. The temperatures rose slower, but eventually exceeded 110°F (47°C) and maintained that temperature for several weeks. All four trials exceeded 90°F (32°C) for at least 8 days.

Decomposition

On September 6, Piles 1 and 2 had been in place for 13 weeks; Pile 3 had been in place 12 weeks and Pile 4 had been in place 6 weeks. At that point in time, Pile 3 had achieved the greatest degree of decomposition. Most of the soft tissue was gone and the larger bones showed signs of advanced decay. The large bones were pitted on the surface and were easily broken or sliced with a knife. Pile 1, which was the carcass laid directly on the soil, also had a layer of gooey odorous material at the bottom of the pile next to the soil. Pile 4 had a similar level of decomposition to Pile 2, even though it had been in place for only 6 weeks. (Note: Pile 3, the farm based compost, was moister than the other piles and so had better conditions for composting, even though it did not have the uniform mix and higher temperature of the sludge compost.)

<u>Evaluation of 2001 Trials</u>

All of the trials were successful at achieving the goal of 32°c for 8 days. Given this, any of the methods tried should be suitable for containing and reducing the survival time of the FMD virus. The trials using the bed of compost (either type) placed on the turf rather than in a trench worked better than the trials in trenches from both the point of view of temperatures achieved and rate of decomposition. In addition, odors associated with the above ground piles was less than those in the trenches. This was probably due to the greater amount of air that could infiltrate the piles.

The farm based compost laid out as a bed on the soil surface and a cover of farm based compost over the carcass would be the preferred approach for managing normal mortality. The preferred approach for managing a large number of carcasses from a disease outbreak, however, would be the use of sludge based compost as in Trial 4, where the compost is laid out as a bed on the ground surface and is used as a cover over the carcass.

Other Trials – 2001 – 2003

Following the summer trials at Highmoor Farm, the Maine Compost Team conducted a winter trial using the approach that proved to be the most successful during the summer trials. One cow carcass was composted on a bed of hot municipal sludge compost with a hot compost cover. The trial ran from December 2001 to February 2002. After exactly 10 weeks the carcass was exhumed. Almost 100% of the soft tissue was eliminated and significant deterioration of the bones was observed.

Three additional trials were conducted on other farms in Maine between 2002 and 2003. The first of these occurred on a game bird farm that had an outbreak of avian influenza. Hot sludge compost was used to break down the birds and to create an environment that would kill the AI virus. A trial was conducted on a working dairy farm as a demonstration for Farm Days. This trial showed that it was possible by using dry calf bedding to achieve temperatures over 130° F for several weeks. A third trial was conducted the following winter at a small diversified farm. In this trial, the pile was started with a frozen carcass in February. It demonstrated that even under these adverse conditions, the soft tissues could be eliminated in as little as 13 weeks.

Media Comparison Trials – 2004 - 2005

The most recent trials in Maine were again at Highmoor Farm. This was a much more ambitious project that used 8 different compost media and two types of animal carcasses. This set of trials was established to serve as a basis for developing best management practices (BMPs) for Maine farmers to use in composting mortalities on their farms. Observations were made about the environmental and nuisance impacts associated with each media material as well as the performance in terms of temperatures and rate of decomposition.

The original design called for 22 individual trials. Seven different media were to be used for composting cow carcasses and four were to be used for horse carcasses. Each combination of media and carcass type was to be done twice. As the trials progressed, the design changed slightly in response to early findings and the availability of additional media materials. These changes resulted in dropping three of the original piles and adding four others. The table below indicates the combinations of media and types of carcass used.

Table 1. Combinations of Compost Media and Carcass Type Used in 2004 Trials

Media	Cow	Horse	Foal	Comment
Horse bedding	X (2)	X(2)		
Heifer manure/ bedding	X(1)			Only 1 trial due to lack of material
Sawdust/ shavings	X(2)	X(2)		
Woodchips	X(2)			Second trial included horse bedding around carcass
Municipal sludge compost	X(2)	X(4)		1st cow used fresh compost, 2nd used older compost
Leaf/ manure mix	X(2)			1st cow used fresh compost, 2nd used older compost
Silage/ bedding mix	X(2)			1st cow had 2/3 wet grass silage & 1/3 horse bedding; 2nd had 1/3 corn silage & 2/3 heifer bedding
Nviro Soil			X(2)	one used a woodchip base
Nviro Soil/ Sludge Compost mix	X(1)			

Each trial was set up using the same methodology that proved most successful in the earlier trials. Each carcass was laid on an 18" bed of material and covered with 2 ft of material. (See photos #1 through 4.) All carcasses were vented prior to covering and had a 4 ft thermometer inserted into the abdomen to track internal temperatures. Thermometers were also placed in the compost media to read temperatures at the one foot and three foot depths. Temperatures were taken approximately 5 days per week throughout the summer, fall and early winter. Observations were also made of odors, animal activity, insect activity, leachate, pile structure changes and management activities. (A separate report details the findings associated with these observations.)

Temperature Observations 2004 Trials

Temperature observations were made regarding peak temperatures achieved on all three thermometers in each pile, overall temperature profiles and number of days the internal carcass temperatures exceeded 130 °F. Compost media temperatures were also tracked for 1 and 3 ft depths in the piles.

Internal temperatures over 130° F.

The most critical observation was felt to be the internal temperatures achieved in the carcasses themselves. Only seven of the 24 trials failed to achieve at least 130° F inside the carcass. For four of the seven, insufficient porosity in the media, either due to moisture or fine texture, was most likely responsible for not achieving 130° F. The other 3 all lacked energy due to a high C: N ratio or the compost mixture being too old. All of the trials that had sufficient porosity and relatively fresh materials, heated up sufficiently to achieve pathogen reduction, even in the core of the carcass. See Figure 2 for a break down of peak temperatures by media type. Seven of the trials actually achieved peak internal temperatures of over 140°F.

The duration of the high internal temperatures was also noted. Twelve of the trials maintained temperatures over 130° F for 10 days or more and eight sustained those temperatures for more than 20 days. These eight 'top performers' were:

Cow in fresh municipal sludge compost – 42 days
Cow in fresh leaf/chicken manure compost – 25 days
Cow in horse bedding – 34 days
Horse in fresh municipal sludge compost – 20 days
Cow in horse bedding – 40 days
Horse in fresh municipal sludge compost – 25 days
Foal in Nviro soil w/ woodchip base – 32 days
Cow in 1/3 silage, 2/3 horse bedding mix – 53 days

Figure #3 displays the results for all the trials.

<u>Evaluation of 2004 Trials</u>

In general, it appeared that the conditions achieved in the compost media made a bigger difference than the actual media itself. Some examples:

Municipal sludge compost performed very well in terms of both peak temperatures and duration of temperatures when it was relatively fresh i.e. had only been composting/curing for about 3 to 4 weeks. Older municipal sludge compost (over four months old) from the same facility did not have as much energy and so did not result in internal temperatures as high or for as long.

A spoiled silage/ bedding mix proved to be the best overall performer in all the trials while another spoiled silage/ bedding mix turned out to be one of the most disappointing performers. The one with the poor performance was mostly grass silage which was very wet and dense with very poor structure. Consequently, the air space collapsed out of the pile within a day or two, causing the pile to cool down and resulting in a number of other nuisance problems.

Two 400 lb. foals were buried in two piles of Nviro soil. (Nviro soil is a soil amendment made from municipal sludge, wood ash and lime.) One of these was the worst performer in terms of peak temperature achieved, only reaching about 102° F. The other was among the top eight performers, achieving temperatures of over 140° F and maintaining temperatures over 130° F for over a month. The difference was that the second carcass had a bed of woodchips underneath for better aeration.

One leaf/ chicken manure compost mix was among the poorest performers while another was among the top eight. The difference was that the first was a relatively new mix with a low C:N ratio that still had a lot of energy, while the second was several months old with a higher C: N ratio and no longer able to sustain the higher temperatures.

Conclusion

Animal carcasses can be successfully composted in a variety of media. The ability to achieve temperatures proven to kill most pathogens will depend more on the conditions in the media than on the source of the media. Those conditions that appear to be most conducive to rapid and sustained heating are:

Porosity – Piles with very fine textures or very wet materials fail to heat due to lack of oxygen. Piles with a very high porosity, such as wood chips, heat rapidly but are unable to sustain the high temperatures a long as materials with a little less air space. Textures with particles between ¼ inch and ½ inch appear to give the optimum results.

C: N ratio – As with all composting, piles with C: N ratios too high (over 40:1) tend to heat slower, in general than those with a lower C: N. One exception to this is the woodchip piles in which there is very little available carbon due to the coarse texture.

Age – Piles with materials that have been mixed and composting for several months do not have the amount of energy or activity needed to sustain the temperatures within the carcasses when compared to relatively fresh active compost piles.

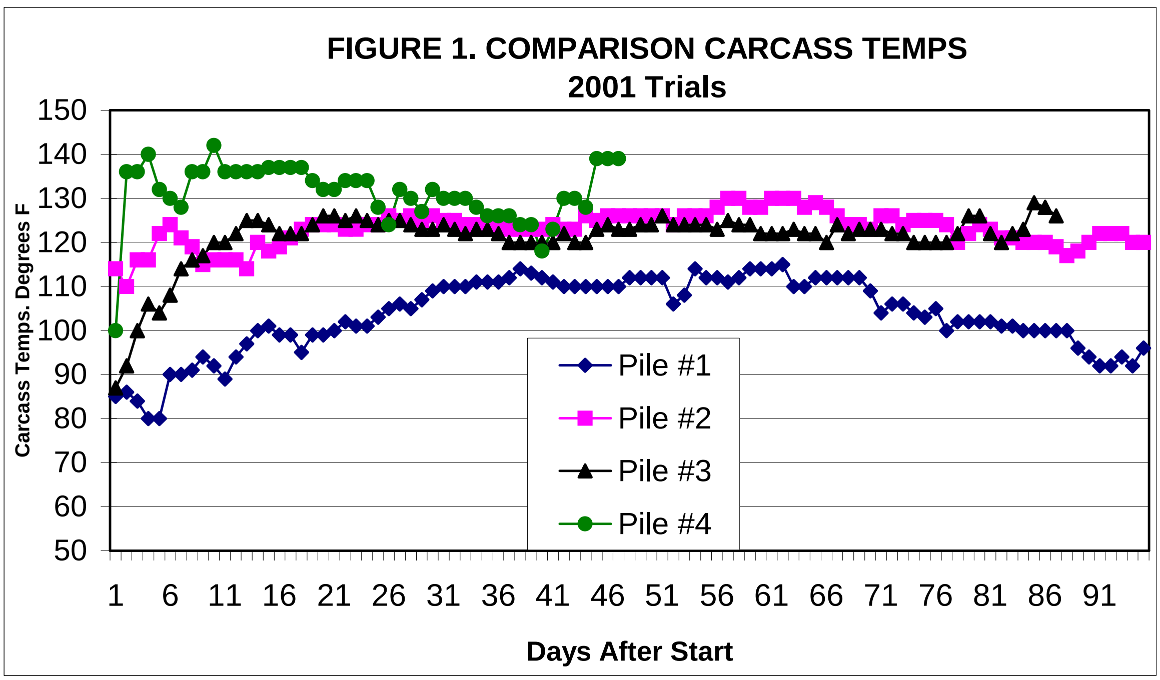
BIBLIOGRAPHY

Parker, J. 1971. The Veterinary Record. Presence and Inactivation or Foot and Mouth Disease Virus in Animal Feces. June. 659-662.

Photos: 2001 Carcass Compost Trials – Highmoor Farm

Photo #1. Placing Cow Carcass on Bed of Hot Municipal sludge Compost

Photo # 2 – Covering Cow Carcass in a Trench with Hot Municipal Sludge Compost



Pile #1- Carcass placed in trench on soil

Pile #2- Carcass placed in trench on bed of hot compost

Pile #3- Carcass placed on bed of farm compost (no trench)

Pile #4 – Carcass placed on bed of hot compost (no trench)

Figure 2. PEAK TEMPERATURES FOR COW & HORSE CARCASSES IN DIFFERENT MEDIA 2004 Trials

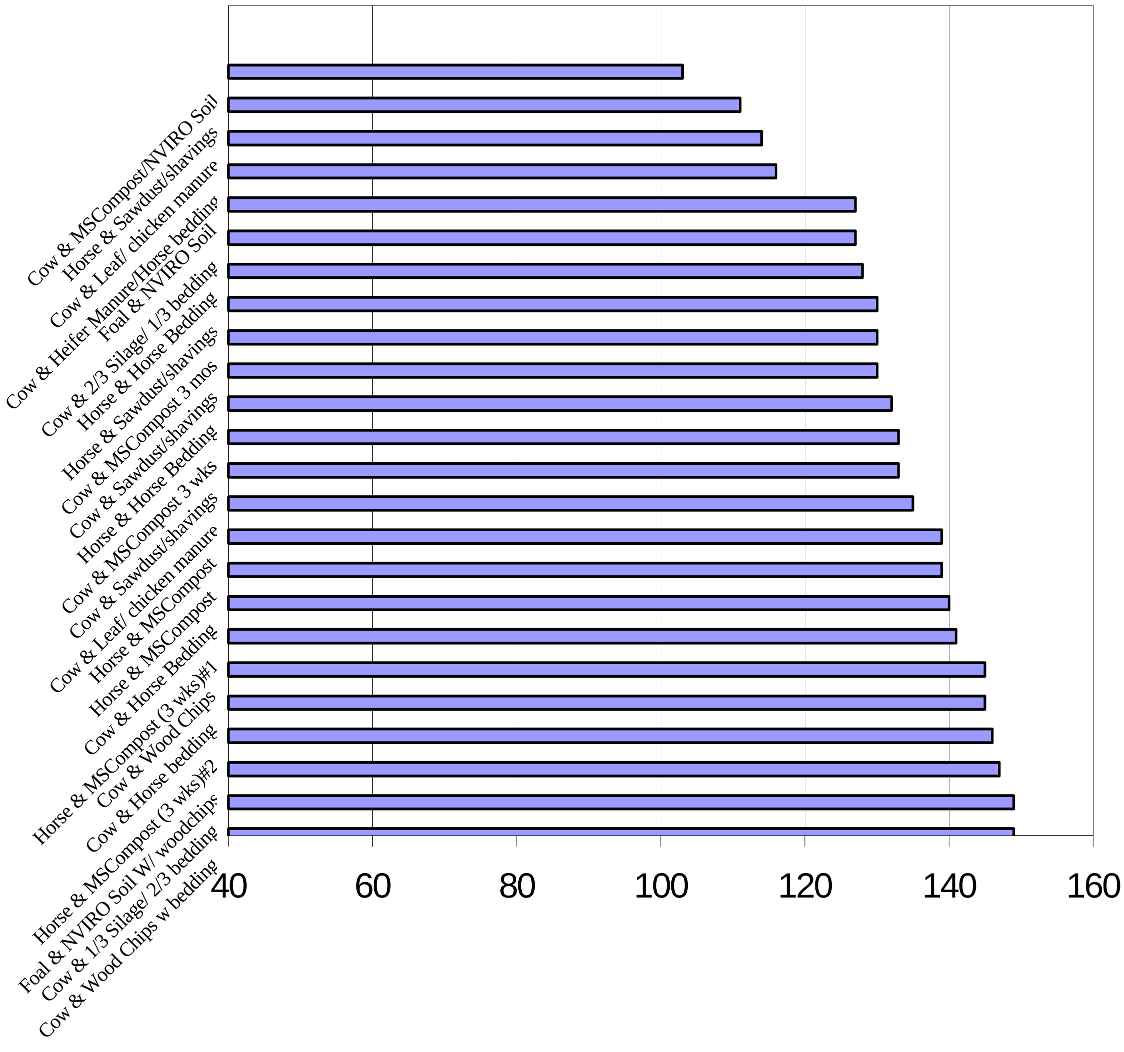
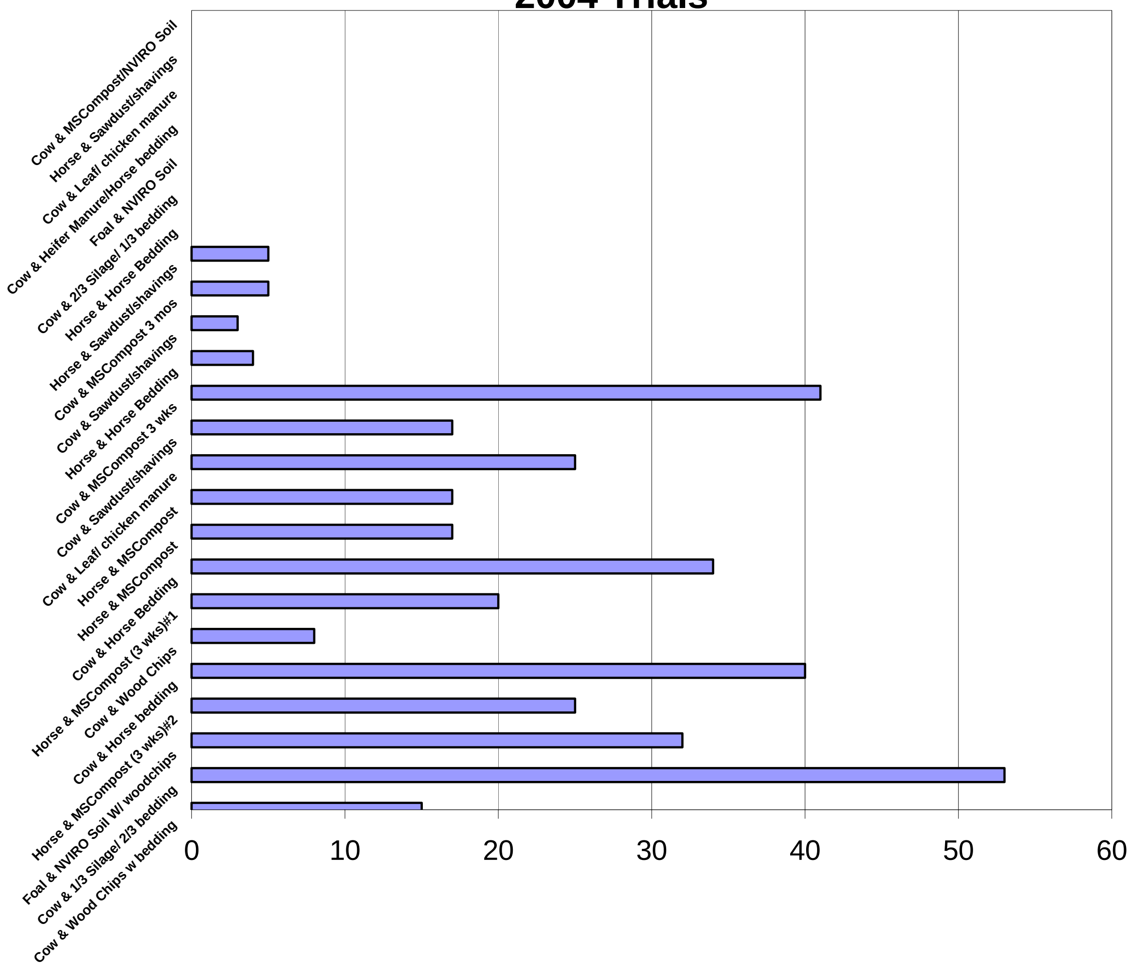


Figure 3. NUMBER OF DAYS OVER 130° F in COW & HORSE CARCASSES IN DIFFERENT MEDIA 2004 Trials



Photos: 2004 Carcass Compost Trials – Highmoor Farm

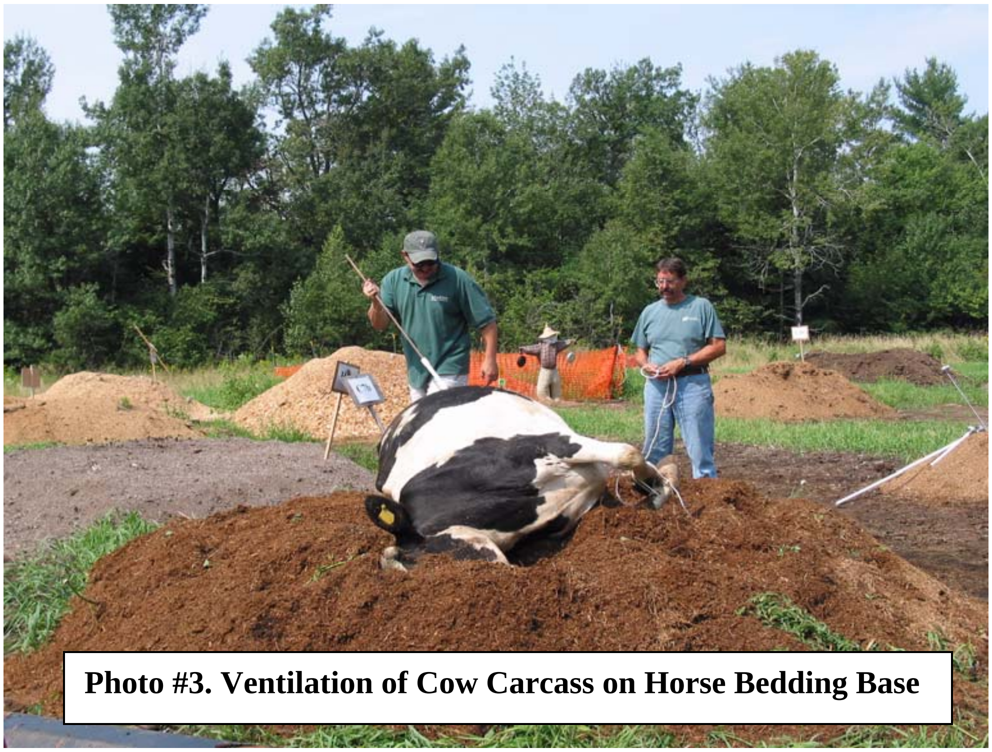


Photo #3. Ventilation of Cow Carcass on Horse Bedding Base

Photo # 4 – Covering Cow Carcass with Silage/bedding Mix.

New York State's Implementation of Mortality Composting

Jean Bonhotal
Cornell Waste Management Institute
Dept. of Crop and Soil Sciences
101b Rice Hall
Ithaca, NY 14853
607/255-8444 (w), jb29@cornell.edu

On-Farm Mortality - Current Situation

Until recently rendering plants have offered prompt, reasonably priced pickup of dead livestock at the farm. However, recent declines in prices of hides, tallow, meat and bone meal and the other useful commodities produced from animal carcasses have curtailed many rendering operations. In 2002, remaining plants are charging up to $70 for cows, $60 for pigs and $200 per horse to pickup animal carcasses from farms in their area. As a result, many livestock farms no longer have affordable access to rendering service.

Many livestock producers are unsure of what they should or could be doing to properly dispose of the occasional animal carcass. Brief anonymous surveys conducted in western New York and northern Pennsylvania reveal a widespread practice of improper mortality disposal. Animal 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. Likewise, land spreading of farm hospital pen wastes and fetal membranes may have implications for the biosecurity of the herd.

In the year 2001, there were 670,000 milk cows and 80,000 beef cows in New York State (Source: NYS Agriculture Statistic Service, www.nass.usda.gov/ny). With a typical death loss in dairy herds of two percent each year and beef herds of one-half percent per year, and a disposal cost of $30-70 per head, the state's livestock producers could save over half a million dollars with an easily managed, low cost mortality disposal alternative.

Response

Cornell Waste Management Institute has developed a 20 minute video, "Natural Rendering: Composting Livestock Mortality & Butcher Waste" and 10 page fact sheet and posters that are used to help teach farmers and butchers to implement these practices. Additional materials will be produced to address road kill.

Demand from farmers and butchers combined with CWMI expertise in the compost field made this program a natural fit. To date demonstration sites in 22 counties (serving 38 counties) have been set up with over 10,000 people in NY, VT and PA attending workshops 2001-05. Workshops generally consisted of presentation and pile openings in a 3-hour workshop. As workshops were set up hosts tried to ensure the local educators/ regulators were invited including NYS Dept of Environmental Conservation, Health Dept, NRCS, veterinarians, Cornell Cooperative Extension Agents and agriculture educators so they could enhance relationships and better understand the process.

Through workshops, tours and events CCE agents and others were trained to carry out local programs with technical support from CWMI. Display and demonstrations were utilized at trade shows like Empire Farm Days, fairs and conferences to raise the awareness of thousands of attendees. Newsletter, newspaper, and magazine articles will reach 16,500 producers throughout the Northeast Region. Cornell Waste Management Institute has posted the fact sheet and linked to other sites such as the Pro-Dairy web site. The “Natural Rendering”, program has received national awards from American Society of Agriculture Engineers, state and national agriculture associations and Outstanding New Extension Publication Award.

Impacts on Policy and Guidance

When composting mortality and butcher waste the process reduces odor, volume and pathogen. This is helping farms with their bio-security and has become part of CAFO plans. Research is currently on going for pathogen and use of the end product.

-NYSDEC promotes composting of mortality including road kill. They have a general mortality composting guidance in draft and they have released a report promoting road kill composting. New regulations will reflect these recent developments.

-NRCS has revised their national mortality standard. We also worked with NYS NRCS to revise (provide more detail) the compost and mortality standards to better suit NYS needs.

-NYS DOT Region 8 has written a guidance document to help their regions implement mortality composting.

Static Pile Composting Method for Mortality

Consider Composting

The livestock and custom butcher industries need a convenient, socially and environmentally acceptable, biosecure way of disposing carcasses and butchering residuals. Landfills generally will not accept residuals or carcasses. The livestock farmer and custom butcher find themselves, in many cases, without disposal services or facing high disposal fees. Most people don’t realize that composting is a legal and acceptable way of disposing these materials. 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 and butchers may cause serious problems with improper disposal. Composting can be accomplished in compliance with environmental regulations in many states, but check regulations before you start.

Composting provides an inexpensive alternative for disposal of all dead animals, butcher wastes and other biological residuals. The temperatures achieved during 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.

Composting animal carcasses is not new. Chickens, pigs, calves and occasional larger animals are composted. Ohio, Utah and Maryland have written resources and Maryland has a video on chicken carcass composting. Little information, however, is available to guide farmers that want to compost adult cattle or butcher residuals.

Composting

Static pile composting of dead, intact, fully-grown livestock and calves, aborted fetuses, placental membranes and butcher residuals is a practice that can fit into the management of livestock farms and butcher operations. The practice does require space on your land to construct the compost piles and takes from two to six months for the animal to decompose. Composting provides an inexpensive alternative for disposal of animal-based wastes.

Lowest Risk

- Picked up by rendering company within 48 hours after death or properly composted on the farm.
- Buried 6-ft deep in appropriate soils and buried more than 200 feet from a water body, watercourse, well or spring.
- Partially buried less than 6-ft deep or buried closer than 200 feet from a water body, watercourse, well or spring.

Highest Risk

- Carcass is left outside for scavengers or to decay. Because of the cost of disposal, it will be tempting to dispose of carcasses by leaving them exposed in a woodlot to be scavenged. This is very risky from an environmental standpoint and that of disease transmission on your farm.

Caution

Animals showing signs of a neurological disease must be reported to authorities and disposed of in the manner they recommend. It is not clear whether prions, the agent that causes Bovine Spongiform Encephalitis (Mad Cow Disease), would be destroyed in the composting process. Animals that show signs of a neurological disease should not be composted. Animals under quarantine that die and those with anthrax, should not be composted.

Key Points of Static Pile Carcass Composting

- Select site that is well drained, at least 200 feet from water courses, sinkholes, seasonal seeps or other landscape features that indicate the area is hydrologically sensitive.
- Lay 24-inch bed of bulky, absorbent organic material containing sizeable pieces 4-6 inches long. Utility and municipal wood chips work well. Ensure the base is large enough to allow for 2-foot clearance around the carcass.
- Lay animal in the center of the bed. Lance the rumen to avoid bloating and possible explosion. Explosive release of gases can result in odor problems and it will blow the cover material off the composting carcass.
- Cover carcass with dry, high-carbon material, old silage, sawdust or dry stall bedding (some semi-solid manure will expedite the process).
- For young animals, layer mortalities with a minimum of 2 feet of carbon material between layers.

- Let sit for 4-6 months, then check to see if carcass is fully degraded.
- Reuse the composted material for another carcass compost pile, or remove large bones and land apply (see Use of Finished Product and Bones section). Site cleanliness is the most important aspect of composting; it deters scavengers, and helps control odors and keeps good neighbor relations.

Turning Note

Carcass and butcher residual piles should not be turned early in the process unless there are no neighbors that would be affected. Odor is a big issue most of the time. After 3 months, turning is an option and will speed the curing process.

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 adjust the process if there is any problem. 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 some seeds. The most efficient temperature range for composting is between 104ºF and 140ºF (40ºC and 60ºC). 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 air temperature. Temperature monitoring is crucial for managing the compost process. Thermometers with a 3-4 foot probe are available (see Thermometer Sources).

Pathogen Control

Pathogens are organisms that have the potential to cause disease. There is a wide array of pathogens found in our environment and pathogens may be elevated in compost operations. While there are currently no temperature regulations for mortality and butcher residual composting, following NYS DEC regulations currently applicable for biosolids is highly recommended to ensure adequate pathogen control and minimization in this type of composting.

If 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 131ºF (55ºC) must be maintained throughout the pile for at least 3 consecutive days, monitored 6-8 inches from the top of the pile.

Very little work has been done on documenting pathogen kill in composting of dead animals and butcher residual. Research at Ohio State University suggests that common bacterial and viral pathogens are killed in regularly turned compost piles containing carcasses. Static-pile composting is being recommended as a more easily managed mortality composting technique. By properly constructing the compost pile to allow for adequate natural aeration, mortality composting can be completed on intact animals without physically turning and mechanically aerating the pile. Degree and duration of temperatures achieved in static-pile composting are adequate to significantly reduce pathogen survival. Compost amendment variables, temperature and pathogen kill in static compost piles are currently being investigated.

Use of Finished Product and Bones

It is recommended to reuse finished compost as the base for the next pile. The remaining bones add structure to the base material for improved aeration. The composted material can also be used on hay, corn, winter wheat, tree plantations and forestland. Applying this compost to "table-top" crops directly consumed by people is not recommended at this time. In the future, testing and quality assurance standards may enable expanded uses or sale 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 on and off farms.

When animal carcasses or butcher waste is composted, the large bones do not completely break down. Bones from immature animals degrade very quickly, but bones from mature animals take several seasons to breakdown. After the material is composted, bones can be reused as part of the base for the next compost pile. The bones that did not completely break down will add structure to the pile. Bones can be buried or disposed of in bone piles. Animal in the wild eat bones to meet calcium requirements.

When spreading the composted material, the bones can be removed and put in a hedgerow or forested land. Because they contain phosphorus and calcium, rodents will eat them; the smaller bones can be land spread and will disappear quickly. Smaller bones can be land spread, but large bones may splinter and can puncture tires. Also, avoid leaving skulls in the fields. Neighbors and the passing public may not fully understand the sight of a skull in the fields!

Economics of Mortality Disposal Options

Pick-up

Where available, the fee for pickup of dead animals ranges from $25-70/cow, $60/pig, and $200/horse. Some species are not accepted at all in rendering.

Burying

A Pennsylvania survey reports backhoe and loader rentals cost approximately $43.50 per hour. If we use one hour of labor at $10.00 per hour and about 0.6 gallons of fuel at $1.50 per gallon, the total cost for burial of a large carcass would be $54.40. Though carcass burial is permitted in New York, some states have outlawed the practice citing potential groundwater contamination. Burial at the recommended depth is also impractical in areas of shallow bedrock and when soils are deeply frozen.

Composting

The amount of carbon material (i.e., wood chips, sawdust, etc.) required to compost a full-grown cow is 12 cubic yards. Many of these materials can be used more than one time. Example: incorporating the residual bones and chips into the next season's base material.

Presently, wood mulch is selling at about $550 per tractor trailer load, or $5.50 per cubic yard. The cost per carcass for the five cubic yard base would be $33. If we assume reuse of the composted material from other piles and a 30% loss of material during composting, the cost for the base would be $9.90 per carcass. The remainder would be used as cover on a new base of wood chips and mulch. Kiln-dried sawdust is selling for $550 per load, or $4.50 per cubic yard. If we used six cubic yards the cost would be $27. With a 30% loss of material during the process, the cost per carcass would be $8.10. The total cost of material per carcass would be $18.

If we estimate 30 minutes for preparation and covering, the cost for labor would be $5; fuel for a 100 hp tractor at 0.4 gallons or $0.60. Tractor and loader rental in the northeast as reported by Doanes is $28 per hour. The total cost for the material, equipment, fuel and labor would be $37.60 per large carcass.

As you can see, the cost of death is expensive in more ways than one.

Source: Bonhotal, J.F., Telega, S.L., and Petzen, J.S. 2002. Natural Rendering: Composting Livestock Mortality & Butcher Waste, Cornell Waste Management Institute, 12 page fact sheet and 3 posters. For the complete fact sheet and further information visit http://cwmi.css.cornell.edu

Observations of Static Pile Composting of Large Animal Carcasses Using Different Media

Submitted by: Mark A. King, *Maine Department of Environmental Protection, 17 State House Station, Augusta, Maine, 04333, Mark.A.King@Maine.gov*

Authors: M. A. King, B. Seekins, M.L. Hutchinson

Introduction:

During the summer of 2004, the Maine Compost Team, a collaborative interagency team including members from the Maine Department of Environmental Protection, Maine Department of Agriculture, and University of Maine Cooperative Extension, began a study to determine if large animal carcasses (bovine and equine) could be properly composted using a host of residuals that are commonly found on-farm and at various solid waste processing facilities.

We chose to conduct our trials at Highmoor Farm, a University of Maine owned agricultural research center located in Monmouth, Maine. Highmoor Farm operates as a "working" farm, focusing on fruit and vegetable production.

The entire site consists of 250 acres of hay fields, interspersed with various garden trials and apple orchard plots. Our study site consisted of an eight (8) acre parcel of hay field underlain by moderately well-drained soils with 0-8% slopes. The entire study area was surrounded by a dense mixture of hardwood and coniferous trees (Figure 1). This combination, soils with the ability to properly treat leachate losses and excellent visual-screening afforded by the tree buffer, gave us an opportunity to conduct our trials in a real-life situation.

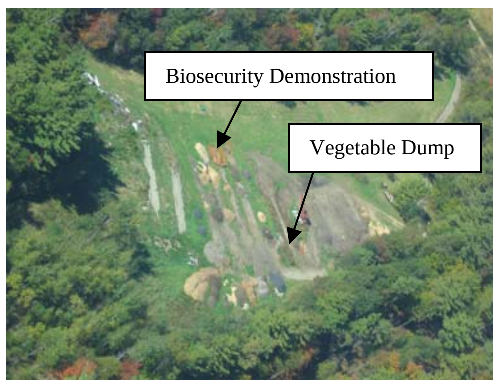


FIGURE 1. Aerial view of Highmoor Farm agricultural research center. Photograph on right shows research trials (center), feedstock storage area (bottom center), vegetable dump (located to the right of compost trials) and "biosecurity" demonstration area (orange snow fenced-in area upper left of center).

Study Design:

A total of eight (8) separate trials, with up to four (4) variants each (two (2) horse carcasses and two (2) cow carcasses) were set up and allowed to run for a two to three month "active compost" period, without turning or disturbance. Compost piles were formed using a farm tractor and combinations of the following residuals (exact trial recipes are listed in Table 1, below): horse manure, poultry manure, leaves, sawdust shavings, wood chips, animal bedding, N-Viro© Soil, and, hot, immature municipal sludge compost. Once the pile base was formed with 18-24 inches of compost media, the carcass was added and then covered with an additional 24 to 36 inches of mixture. Prior to final covering, the carcass abdomen was vented, in numerous areas, using a six-foot-long piece of re-bar. A four-foot thermometer was inserted into the abdomen to allow carcass temperature monitoring. Finally, the carcass was covered and two more thermometers were added to the pile at one foot and three foot depths.

TABLE 1

Compost Trial Mixture Recipes

Trial	Pile Composition	Density (lbs./yd^3)	C:N
C1A	Horse Bedding	450	62
C1B	Horse Bedding	450	62
C2B	Cow Manure (wet) + Horse Bedding	750	21
C3A	Wood Shavings	250	578
C3B	Wood Shavings	250	578
C4A	Wood Chips	250	677
C4B	Wood Chips + Horse Bedding (core)	____	___
C5A	Sludge Compost (3 weeks old)	550	28
C5B	Sludge Compost (3 months old)	____	___
C6A	Hen Manure +Leaves	550	16
C6B	Hen Manure/Leaves	300	52
C7A	2/3 Silage + 1/3 Horse Bedding	700	18
C7B	1/3 Silage + 2/3 Horse Bedding	550	17
C8A	Sludge Compost + N-Viro© Soil	800	30
H1A	Horse Bedding	450	62
H1B	Horse Bedding	450	62
H3A	Wood Shavings	250	578
H3B	Wood Shavings	250	578
H5A	Sludge Compost (3 weeks old)	550	28
H5B	Sludge Compost (3 months old)	____	___

Note: A "C" prefix in the trial column indicates a cow carcass trial and an "H" indicates a horse trial.

Each completed pile was sampled and tested for: bulk density (lbs. /yd^3), Carbon to Nitrogen Ratio (C: N), and pile nutrients (N, P, K and Total C). Additionally, overall mixture quality was observed, focusing on pile texture and relative porosity. During the "active" compost period, temperatures were taken, on a daily basis, from the three points within each pile: one foot deep, three feet deep and within the core of the carcass itself. Finally, pile observations were made regarding odor generation, animal (vector) scavenging activity/disturbance, and leachate generation. A field monitoring system (thermometer and rain gauge) was set up to provide data on ambient temperatures and precipitation volumes. This paper focuses on field observations noted during the course of the compost trials, including: pathogen reduction performance, odor generation, animal (vector) activity, and leachate generation.

Study Results:

Pathogen Reduction Performance

All but four (4) of the compost trials (N = 20) met or exceeded the EPA time and temperature standards for pathogen reduction (three consecutive days at 130^o F). The trials using horse bedding (C1A, C1B, and H1B), municipal sludge compost (C5A, C5B, H5A, and H5B), one mixture combining 1/3 silage and 2/3 horse bedding (C7B), and one mixture using hen manure mixed with municipal leaves (C6A), performed exceptionally well, sustaining temperatures in excess of 130^o F for greater than 17 consecutive days (range 17-53 days). Trial H1A (equine carcass in horse bedding) was the first study pile constructed, and consisted of a large draft horse. Although this pile never reached the pathogen reduction goal, it is important to note that it did manage to sustain 128^o F for most of the active compost period. The trials using wood shavings (C3A, C3B, and H3A) had moderate success (averaging greater than eight consecutive days above 130^o F). The remainder of the piles failed to reach target temperatures for a variety of reasons explained below.

Pile C2B (adult Holstein in 50% cow manure + 50% horse bedding) reached a maximum temperature of 116^o F. This mixture had a very high bulk density (750 lbs. /yd^3) which made it difficult to achieve a homogenous blend using the farm tractor bucket. As a result, this pile performed poorly due to inadequate porosity and texture, although it had a near optimal C: N ratio of 21.

Pile C6B (adult Holstein in 50% poultry manure + 50% municipal leaves) reached a high of 114^o F. This pile, like C2B, was difficult to mix thoroughly (bulk density 300 lbs. /yd^3), even though a manure spreader was used to enhance the mixing process. Additionally, C6B suffered due to the relative lack of “energy” afforded by the leaves and manure mixture. The municipal leaves had been stored on-site for several years, and were fairly decomposed when added to the manure, which was also about two months old. The combined mixture had a fairly high C: N of 52.

Pile H3B (adult horse in 100% wood shavings) reached a high of 111^o F. This pile was formed in early August and never seemed to take-off. The final mixture had a bulk density of 250 lbs. /yd^3 and a C: N ratio of 578. Although the texture and porosity allowed for ample aeration, the carcass did not provide enough nitrogen to “fuel” the compost process and overcome the high C: N ratio. Additionally, this pile was susceptible to cooling from heavy winds and drenching rain.

Pile C8A (50% N-Viro© Soil + 50% municipal sludge (three months old) achieved a peak temperature of 103^o F. This mixture had a “high” bulk density (800 lbs. /yd^3), a very fine texture, and poor porosity. This combination greatly inhibited self-aeration of the pile during active composting. Additionally, the relative high pH of the N-Viro© Soil (pH = 10-11) also served to inhibit microbial activity, resulting in a poor temperature response.

Odor Generation and Vector Attraction

Six of the compost trials (N = 20) experienced numerous odor releases (# >2) and animal disturbances (# > 2) during our study. This was especially true for the trials using recipes comprised entirely of wood chips or wood shavings. Additionally, the site was frequented by scavenging animals (vectors) due to a local farm dump, consisting of waste fruits and vegetables, located adjacent to our study area. The odorous piles proved to be very attractive to vectors, resulting in the need for diligent site management (Figure 2).

FIGURE 2. Example of animal disturbance noted during carcass study. Pile H3A, turkey foraging activity for maggots.

Pile C4A and C4B (adult Holsteins in wood chips) had the highest incidences of odor releases and animal disturbances (14 odor incidents and four (4) animal disturbances for C4A, and four (4) odor incidents and 5 animal disturbances for C4B). Both of these trials had a very low bulk densities (250 lbs. /yd^3) and very coarse texture that self-aerated easily. These mixtures also had the highest C: N ratios recorded during the study (677) and very little fine textured material available to capture soluble nutrients or to provide energy for microbial activity. As a result, as the carcasses decomposed, anaerobic (odorous) gases escaped the pile unabated and proved to be irresistible to vectors. Additionally, flies and maggots were observed on numerous occasions on the surface of these piles. Our belief is that the lack of aerobically driven microbial activity in the pile, coupled with the lack of fine carbon particles (to help absorb leachate) and resultant low temperatures in the media surrounding the carcass provided an optimal environment for the maggots, allowing them to travel back and forth between the carcass and the pile surface without consequence.

Pile H1A (adult horse in horse bedding) and H3A (adult horse in wood shavings) also had numerous odor releases and animal disturbances (three (3) odor releases and five (5) animal disturbances for H1A, and six (6) odor releases and four (4) animal disturbances for H3A). Like the wood chip trials, both of these piles had relatively low bulk densities (H1A = 450 lbs. /yd^3; H3A = 250 lbs. /yd^3) and excellent porosity. Trial H1A, as previously noted, was the first pile constructed as part of this study. Because of the large size of the horse (lengthwise), the pile was constructed in a long rectangular shape. Initially, we believe that we had applied sufficient cover, but later found that as the animal decomposed and shifted, there was not enough cover material to maintain pile structure. Another confounding factor was venting of the animal. This carcass was punctured once in the abdomen to release trapped gasses. This proved to be insufficient, as the carcass continued to expand and contract as it released trapped gasses; resulting in further compromise of pile structure. As a result of the odor releases and lack of proper cover material, this pile was continually disturbed during the first couple weeks necessitating numerous rakings and additions of horse bedding. We finally decided to add a thicker coating of horse bedding, place snow fencing over the pile surface, and erect a snow fence around the entire pile as a "biosecurity" measure. Additionally, a scarecrow (with visual and auditory distracters) was added to help discourage on-site animal activity (Figure 3). These collective acts resulted in elimination of the vector problem.

FIGURE 3. Photo depicting "Biosecurity" area around pile H1A, digital thermometer and rain gauge combo and Scarecrow.

Pile H3A experienced a somewhat different vector issue. This pile was formed in late August and almost immediately maggots were noted at the top of the pile surface. In fact, the maggots became so populous that the top of the pile literally appeared to be moving. Not long after the maggots appeared, the study site became populated with 10 to 20 wild turkeys. The turkeys, initially attracted by the adjacent dump site and an on-site hen manure stockpile, began feeding on the maggot-infested pile. Turkeys are notorious for tearing apart the ground as they forage. Pile H3A was no exception. Large portions of the pile face were torn away as the turkeys foraged for maggots (see Figure 2, above). Turkeys continued to disrupt the piles even after numerous re-coverings of the compost pile with horse bedding, and application of hot sludge compost to kill back the maggots. Therefore, we finally decided to obtain an "Animal Nuisance

Control" permit from the Maine Department of Inland Fisheries and Wildlife to help discourage turkey scavenging at the study site.

The remainder of the piles had infrequent odor releases and incidental animal disturbances (animal tracks on pile surface or slight exploratory digging events). For most of these piles, surface raking and additional amendment placed over the chimney area (upper top of pile) was sufficient to suppress additional odor events and to discourage animal disturbances.

Leachate Occurrences

The final area of observation involved incidents of leachate generation following precipitation events. As with other factors, leachate incidents were most prevalent for the piles constructed entirely of wood chips (C4A, six (6) occurrences and C4B, eight (8) occurrences). Both of these piles exhibited pools of leachate at the base following rain events in excess of one inch. The leachate was usually pink to dark red during the first part of the active compost phase and brown to dark brown near the very end of the compost phase. The low bulk density and coarse pile structure (very few fines) of these piles, allowed precipitation to percolate down through; flushing nutrients as it exited. This continual loss of nutrients is of concern as it affects the overall quality of the finished product, as well as raising the potential for dissolved nutrients to leach to groundwater and/or enter nearby surface waters. Based on these observations, along with the odor and vector issues noted previously, we decided not to conduct additional wood chip trials using horse carcasses. The remainder of the piles experienced fewer than two (2) leachate episodes during the course of the study, and only following precipitation events in excess of two (2) inches.

Recommendations:

The observations from this study indicate that on-site management is crucial throughout the composting event, especially during the first two weeks. Good site and carcass preparation facilitate carcass decomposition without causing nuisance odors, vector attraction issues, or generation of nutrient-rich leachate. Piles should be constructed using compost mixes with moderate bulk densities (300-550 lbs./yd.^{3}), optimal C: N ratios (25 to 40), good texture (appropriate mix of fine and coarse particles) and optimal porosity and pile structure. Horse bedding and municipal sludge compost performed very well during our trials and are ideal for most carcass disposal situations. Carcasses must be vented in numerous locations to release trapped gasses and allow abdominal contents an opportunity to mix with compost ingredients. In many cases, carcass legs may be tied together, depending on state of "rigor mortis", to help prevent extension out of pile as the carcass expands. Carcasses should be covered with 24 to 36 inches of cover material. This should be monitored during the first two weeks of composting, as carcasses slump, causing pile structure to collapse. Additional amendment may be needed, especially following pile collapse. Any occurrences of odors or maggots must be addressed before scavenging animals arrive. Covering with an appropriate amount of amendment will aid in reducing odor. Covering piles with hot, active compost will deter maggots. Likewise, leachate pools may also be amended and then re-incorporated into the compost piles.

IN-HOUSE COMPOSTING OF TURKEY MORTALITIES AS A RAPID RESPONSE TO CATASTROPHIC LOSSES

Eric S. Bendfeldt[4], Robert W. Peer[5], Gary A. Flory[6], Greg K. Evanylo[7], and George W. Malone[8]

An avian influenza (AI) outbreak in the central Shenandoah Valley of Virginia in the spring and summer of 2002 affected 197 poultry farms and had an estimated cost of $130 million to the poultry farmers and state economy. The total federal cost of avian influenza eradication in Virginia, including indemnity, was $81 million (Akey 2003; Swayne and Akey, 2004). Seventy-nine percent of the farms depopulated were turkey breeder and growout flocks. Five different methods were used to dispose of avian influenza infected poultry: on-farm burial, landfilling, incineration, slaughter, and composting (Ag-Bag and in-house). More than 3.1 of the 4.7 million birds infected or 13,000 tons were disposed of in landfills (DEQ 2002). Landfilling has been the preferred option for disposal because the infected flock can be removed from the poultry farm relatively quickly, which enables the farmer to begin cleaning and disinfecting the poultry houses. Drawbacks of landfilling include expense, transportation logistics, biosecurity risks, public perception issues, and environmental considerations. In 2002, turkey disposal costs exceeded $7.25 million with an average cost per farm of $30,175. The cost per ton with depopulation and disposal approached $145 not including the costs of additional litter handling at the farm.

Avian influenza depopulated poultry houses remained under quarantine on an average of 75 days each and for as long as 177 days (DEQ 2002). Composting was implemented as a disposal technology for two flocks during the outbreak with limited supervision and success. In-house composting has not been considered a viable option by the industry because of the potential loss of production space and the perception that composting would not work on larger birds. Successful in-house composting of 5-pound broilers on the Delmarva Peninsula in 2004 proved

[4] Extension Agent, Environmental Sciences, Virginia Cooperative Extension, 965 Pleasant Valley Road, Harrisonburg, Virginia 22801-0963 Phone: (540) 564-3080 Fax: (540) 564-3093 Email: ebendfel@vt.edu

[5] Agricultural Program Coordinator, Virginia Department of Environmental Quality, Valley Regional Office, P.O. Box 3000, Harrisonburg, Virginia 22801 Phone: (540) 574-7866 Fax: (540) 574-7844 Email: rwpeer@deq.virginia.gov

[6] Agricultural and Water Quality Assessment Manager, Virginia Department of Environmental Quality, Valley Regional Office, P.O. Box 3000, Harrisonburg, Virginia 22801 Phone: (540) 574-7866 Fax: (540) 574-7844 Email: gaflory@deq.virginia.gov

[7] Extension Specialist, Department of Crop and Soil Environmental Sciences, Virginia Tech, 426 Smyth Hall (0403), Blacksburg, Virginia 24061 Phone: (540) 231-9739 Fax: (540) 231-3075 Email: gevanylo@vt.edu

[8] Extension Poultry Specialist, University of Delaware, 16684 County Seat Hwy., Georgetown, Delaware 19947 Phone: (302) 856-2585 Fax: (302) 856-1845 Email: malone@udel.edu

the effectiveness of composting as a method of disposal and containment for an AI outbreak (Malone, 2004a; Malone et al., 2004b). Avian influenza was confined to 3 farms despite the high density of poultry farms in the area. In-house composting appears to be the most acceptable method of disposal because it limits the risks of groundwater and air pollution, high fuel costs, potential for farm-to-farm disease transmission, transportation costs, and tipping fees (Tablante et al., 2002).

The project objectives were:

- To test in-house composting as a method of disposal and disease containment for large birds (i.e., 17 to 40 pounds);
- To determine how quickly the in-house process could be completed;
- To test the effectiveness of carbon sources and rates;
- To compare the effectiveness of composting whole carcasses, shredded and tilled carcasses, and crushed carcasses;
- To demonstrate the composting process for farmers, industry and agency personnel.

The demonstration was initiated on December 2, 2004. Eight windrows (12' wide by 6' high), each representing a treatment, were formed. Each windrow contained 2500 to 3000 pounds of turkey carcasses weighing from 17 to 40 pounds each. An additional experiment was conducted to compare the effectiveness of crushing the carcasses versus whole birds and to determine the minimum amount of carbon material needed to prevent leakage and encourage composting at the highest possible density per square foot. The temperatures of all the windrows (i.e., at 10 and 30 inch depths) reached between 135 and 145 degrees F and maintained temperatures adequate for pathogen kill. The windrow with woodchips as the carbon source achieved the highest temperatures (Figure 1).

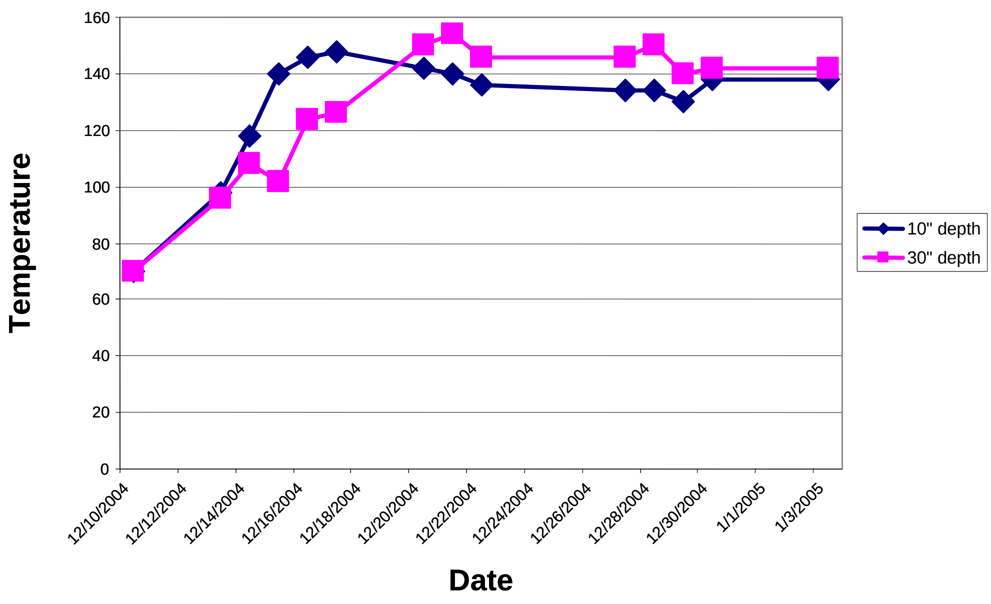


Figure 1. Daily temperatures of woodchips and whole carcass treatment.

Carbon materials compared for their effectiveness in composting turkey carcasses included:

- Hardwood Sawdust;
- Aged, weathered woodchips with relatively high moisture;
- Built-up Litter;
- Starter litter or wood shavings from brooder house;
- Blend of starter litter and built-up litter.

The turkey carcass treatments included:

- Whole carcasses mixed and piled;
- Shredded and tilled carcasses, mixed and piled;
- Crushed carcasses mixed and piled.

The results of the research and demonstration are summarized as follows:

- After two weeks, few carcasses remained in any of the windrow treatments.
- All four carbon materials (i.e., hardwood sawdust, woodchips, built-up litter, and starter litter) were effective in composting the turkey mortalities.
- Temperatures of all the windrows (at 10 and 30 inch depths) reached 140 degrees and maintained temperatures adequate for pathogen kill.
- Woodchips reached and maintained the highest temperatures due to good porosity, varying particle size, and relatively ideal moisture content.
- The starter litter required that some water be added during the mixing process, but only enough to make the litter and mixture glisten.
- Shredding and tilling the carcasses increased the effectiveness of composting approximately 2 to 3 days by increasing the surface area to volume ratio and exposing the bones and marrow to further decomposition and releasing more moisture into the compost mix.
- Whole carcasses composted as well without tilling.
- Tilling the litter floor after depopulation to break up excessive caked or crusted litter helped to increase the composting process and prevent any seepage.
- Maintaining the base and cap on the windrow is essential to composting and preventing any carcasses from being exposed to the air which can prevent decomposition.
- An alternative to tilling and shredding the birds would be to crush the birds by running them over with a skid loader or tractor.

To determine the minimum amount of carbon material needed, an additional experiment was setup to simulate the worst case scenario (i.e., where a farmer had very little litter or carbon material available following a clean-out and was attempting to compost heavy toms (~ 35 to 40 pounds)). The treatments compared were crushed carcasses versus whole carcasses. These were mixed with a blend of starter and built-up litter to achieve a density 12.5 pounds of carcass per square foot (Table 1) above a 5 inch base layer and below a 5 inch cap.

Table 2. Average characteristics of different turkey types and population densities.*

Bird Type	Age (weeks)	Weight (lbs.)	% Mortality	Population (after mortality)	Size of House (ft^2)	# of meat/ ft^2
Brooder hens	5	3.5	3	11,058	10,000	3.87
Brooder toms	5	4.0	4	8,640	10,000	3.46
Growout hens	14	17.5	2	10,837	20,000	9.48
Heavy hens	16	22	2	10,837	20,000	11.92
Light toms	15	24	8	7,949	20,000	9.54
Heavy toms	20	40	8	6,250	20,000	12.50

* The production goals and requirements for individual farms may vary from these averages.

The results from the experiment to determine the minimum carbon material needed for composting heavy toms are summarized as follows:

- Temperatures of 140+ degrees were achieved within 5 days for the crushed treatment and 16 days for the whole carcass treatment (Figure 2). Therefore, the poultry house could potentially become available 11 days sooner if the carcasses are initially crushed.
- With a 5 inch base layer and 5 inch cap (10” total), no seepage occurred at a density of 12.5 pounds per square foot and composting was promoted.
- Without crushing the carcasses, the whole birds tended to roll off the pile, require more labor, and take longer to begin composting.
- In the whole carcasses treatment, at least 0.8” of carbon material per pound of carcass was needed as a base and cap to adequately cover the carcass. More material, approximately 1” of carbon material per pound of carcass, was needed to promote composting.
- In the worst case scenario, where there is very little base litter (i.e., < 5”) and heavy toms in the poultry house, two tractor trailer loads of additional carbon material may be needed per house to promote composting. (In 2002, seven tractor trailer trucks were needed per house to haul carcasses off the farm to the landfill.)

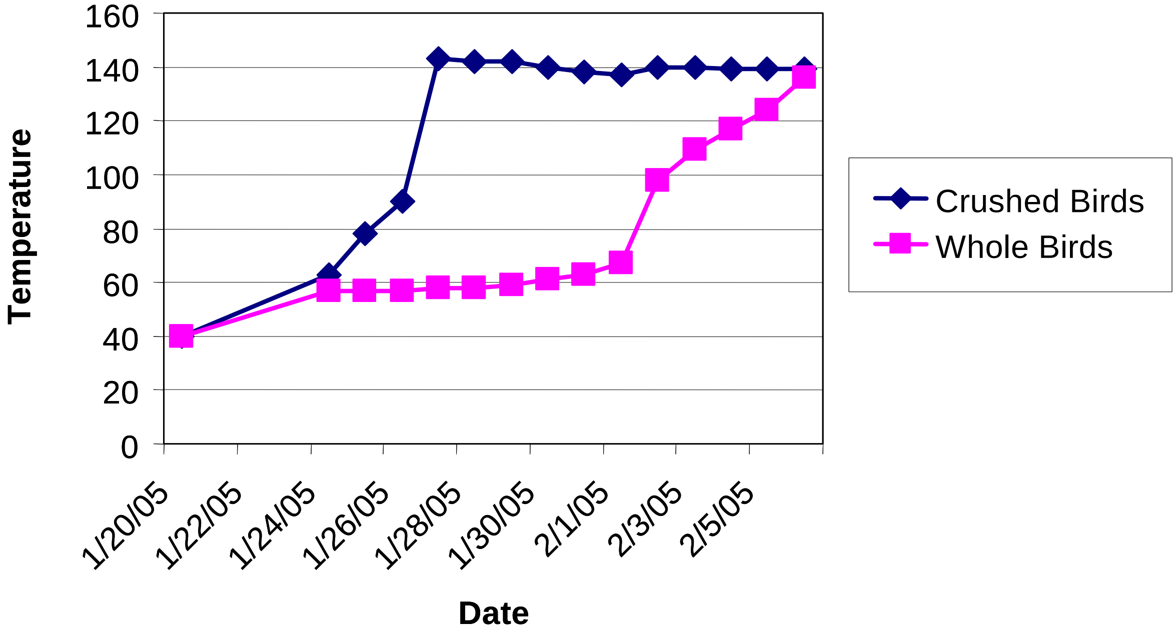


Figure 2. Temperatures of experiment to determine the minimum carbon material needed for composting at a density of 12.5 pounds of carcass per square foot.

A typical turkey farm affected with avian influenza in 2002 was as follows:

- 45,600 turkeys
    - 22,800 – 14 week old hens, Avg. body Wt. 16 lbs.
    - 22,800 – 4 week old hens, Avg. body Wt. 3 lbs.
- 352,000 pounds + 66,000 pounds = 418,000 pounds or 209 tons
- 14 Semi truck loads.

Cost estimates for in-house composting after euthanasia and depopulation:

- 2 skid loaders ~ $140 per house;
- 2 skid loader operators ~ $180 per house;
- 1 person knowledgeable of composting ~ $150 per house;
- 2 laborers ~ $120 per house for cleaning up litter and disinfecting skid loaders;
- 5 to 6 hours of operation per house including crushing the carcasses.
- 1 hour to clean and disinfect the skid loaders.

Cost estimates if no additional carbon is needed to compost the turkey carcasses:

- ~ $590 per house/ 104.5 tons of carcass per house = $5.65 per ton (if no additional carbon material is needed).
- ~ $700 for one 200’ roll of reusable compost fleece per house if a litter storage shed is not available.

Cost estimates if additional carbon is needed to compost the turkey carcasses:

- ~ $1000 per house for hardwood sawdust.
- ~ $590 per house for labor and equipment.

- 104.5 tons of carcasses per house.
- $15.22 per ton (if additional carbon material is needed).
- ~ $700 for one 200’ roll of reusable compost fleece per house.

Additional considerations for utilizing in-house composting as a disposal and disease containment method are summarized as follows:

- Farmers and industry have expressed concern about the quality of the finished product and the presence of bones. In the research with heavy toms, only the upper part of the leg bones was visible. Other bones broke down during the compost process.
- Application of the final compost to tillable row crops like corn, small grains, and soybeans would be the preferred method of utilization.
- Applications to pasture or hay land would require a simple method of screening the bones such as through a box spreader.
- In 2002, moving the untreated litter from AI infected farms was a problem and stigma. An incentive payment of $10.00 /ton of litter was needed and implemented to facilitate movement of 5000 tons of litter off farms.
- In-house composting could resolve some of these issues because composting reduces the volume of litter 40 to 60%, provides sufficient heat to deactivate most pathogens, and produces a quality final product that would not require an incentive payment to facilitate movement of the litter off farms.

Action items and potential research needed to make in-house composting the preferred option for disposal in a disease outbreak and catastrophic loss:

1) Identify suitable compost sites on individual farms for final composting and curing;
2) Identify and research which types of farms (i.e., broiler breeder, turkey breeder, double-deck houses) may need to compost outside of the house after euthanasia and depopulation;
3) Evaluate biosecurity and farm-to-farm transmission concerns prior to bird and litter movement;
4) Identify and secure several sources of carbon material (e.g., sawdust and woodchips) before an outbreak occurs. Sources might include county landfills, lumber mills, electrical power companies, tree trimming companies, and compost from wastewater treatment facilities.
5) Negotiate a long term contract for at least enough carbon material to compost five average size farms in an outbreak (i.e., about 10 tractor trailer loads@100 cy./load).
6) Encourage integrators to identify a site to stockpile carbon materials such as a county landfill or one of their facilities.
7) Request each integrator to designate a team or person to be trained for managing in-house composting in an outbreak and catastrophic loss.

In-house composting is an acceptable cost-effective method of disposal and disease containment. In-house composting has not been considered a viable option by the industry and farmers because of the potential loss of production space and the perception that composting would not work on turkeys. In-house composting of turkeys demonstrates that with a good base, cap, and proper disease monitoring, the compost could be turned and moved out of the poultry house within 3 to 4 weeks. This time would be comparable to the minimum down time experienced by farmers in the 2002 avian influenza outbreak. Each farm and type of flock would have to be evaluated, but with proper planning and training of farmers and industry personnel, in-house composting is an effective rapid response tool for managing catastrophic poultry losses.

References

Akey, B.L. 2003. Low-Pathogenecity H7N2 Avian Influenza Outbreak in Virginia during 2002. Avian Diseases 47:1099-1103.

Malone, G. 2004. In-house composting of avian influenza infected flocks. Proceedings 2004 Virginia Poultry Health & Management Seminar. Roanoke, VA. pp. 23-24.

Malone, G., S. Cloud, R. Alphin, L. Carr and N. Tablante. 2004. Delmarva in-house carcass composting experiences. Proceedings 2004 National Meeting on Poultry Health and Processing. Ocean City, MD. pp. 27-29.

Swayne, D.E., and B.L. Akey, 2004. Avian influenza control strategies in the United States of America. pp. 113-130. In: G. Koch (ed.) Proc. of the Wageningen Frontis International Workshop on Avian Influenza Prevention and Control. Wageningen. The Netherlands: Kluwer Academic Publishers. (Available on-line at http://library.wur.nl/frontis/avian_influenza/13_swayne.pdf.) (Verified 17 March 2005).

Tablante, N.L., L.E. Carr, G.W. Malone, P.H. Patterson, F.N. Hegngi, G. Felton, and N. Zimmerman. 2002. Guidelines for In-house Composting of Catastrophic Poultry Mortalities. Maryland Cooperative Extension Fact Sheet 801.

Virginia Department of Environmental Quality. 2002. Avian Influenza Outbreak Summary. VA. Dep. Env. of Qual. Harrisonburg, Virginia.

Funding for this research and demonstration project was generously provided by the Virginia Department of Agriculture and Consumer Services' Division of Animal and Food Industry Services in cooperation with the Virginia Poultry Federation.

Composting Hog Mortalities in Nova Scotia: Environmental Impacts

L. Rogers[1], R. Gordon[1], A. Madani[1] and G. Stratton[2]

1 Department of Engineering, Nova Scotia Agricultural College
2 Department of Environmental Sciences, Nova Scotia Agricultural College

A practical alternative to traditional methods of hog mortality management is practice that is best described as above ground burial with a biofilter (biopile) using composting techniques. This research is an attempt to determine the water quality impacts associated with managing hog mortalities using biopiles built on soil surfaces. A hog mortality management system was established at the Bio-Environmental Engineering Centre (BEEC) located in the AgriTECH Park (Nova Scotia Agricultural College) in Bible Hill, Nova Scotia, Canada.

Three different cover treatments (i. sawdust, ii. hog manure pack and iii. hog manure pack with tarp) over carcasses (700 through 900 kg dead-stock per surface area), replicated twice, were investigated over three trials (2001 through 2004). Leachate and surface runoff from biopiles were monitored with calibrated tipping buckets and water samples were collected during flow events and analyzed for various water quality parameters (*E. coli.,* NO_3^--N, NH_3-N, SRP, BOD_5, etc.). The sawdust cover provided for higher temperatures and better carcass decomposition in both the primary and secondary phase compared to the other treatments. The sawdust cover had the lowest leachate and surface runoff volumes and lowest leachate and surface annual loads for SRP (0.186 and 1.18 kg $ha^{-1}yr^{-1}$), $N0_3^-$-N (10.5 and 4.87 kg $ha^{-1}yr^{-1}$), NH_3-N (2.25 and 2.16 kg $ha^{-1}yr^{-1}$) and *E. coli* (8.17 x 10^7 and 4.19 x 10^8 CFU kg $ha^{-1}yr^{-1}$) compared to the other treatments. The sawdust cover end-product, however, had a lower nutrient content (3.04. to 3.42 g kg^{-1} N, 0.41 to 0.83 g kg^{-1} P and K 0.21 to 0.84 g kg^{-1} DM K) than the other treatments.

Final Disposition – Session Chair: Chuck Franks

BSE in Washington- Discovery, Response, and Disposal Issues

Primary Contact: Chuck Matthews (Washington State Department of Ecology, P.O. Box 47775, Olympia, WA, 98504-7775)
Kip Eagles (Washington State Department of Ecology, 15 West Yakima Avenue, Suite 200, Yakima, WA, 98902-3387)

Abstract

On December 23, 2003, the U.S. Department of Agriculture (USDA) announced the first confirmed case of Bovine Spongiform Encephalopathy (BSE) in the United States. The USDA was responsible for tracking down related animals that might carry or be affected by the disease. Potentially adulterated meat and animal byproducts already in circulation also had to be traced. The discovery resulted in the destruction of a significant number of animals, rejection of U.S. beef and beef by-products by many trading partners from around the Pacific Rim and other regions, and concerns about the safety of rendered materials that may have been produced from the processing potentially contaminated animals. Many domestic consumers have also turned away from mainstream beef in favor of paying higher prices for meat from producers that have carved out a niche market of providing grain raised beef produced without growth hormones and antibiotics. There is debate as to whether this beef truly offers any real added protection against BSE specifically, but perception that this is the case by consumers appears to have solidified a place in the market for these producers.

Some countries continue to impose a total ban of U.S. beef and byproducts until all animals are tested for BSE prior to export. These bans continue to have major economic impact to the beef industry in the Pacific Northwest. The USDA and U.S. Food and Drug Administration (FDA) have imposed restrictions on what can be included in animal feed and on feed production facilities. Canada and the United States continue to wrangle over import restrictions of Canadian-born cattle and beef products into the U.S. Some estimate the economic impact on the Canadian beef industry of up to seven billion dollars. While federal officials from both countries debate whether to re-open the border to Canadian products, three additional animals have tested positive in Canada for BSE in the past year. In addition to the economic and political fallout, the announcement of a positive BSE test in the U.S. spawned a media feeding frenzy that fueled consumer distrust of the government agencies involved, accusations of a cover-up, and skepticism about the ability to guarantee the safety of U.S. beef in general. While disposal issues were responded to relatively quickly, the political and economic repercussions from the incident continues a year and a half later.

By the time the investigation was complete, about 650 animals had been destroyed and approximately 2000 tons of meat and bone meal (MBM) were identified as potentially adulterated and were prohibited into the marketplace. Responsibility for detailing disposal options for the animal carcasses and MBM fell on state officials from the Washington State Departments of Agriculture, Ecology, and Health. These efforts were conducted in cooperation with local jurisdictional health departments and landfill operators managing Subtitle D compliant

landfills in both Eastern and Western Washington. Similar efforts were made in Oregon in case the event expanded to such a scale that depopulation efforts widened into a substantial part of the Oregon herds or the needs for disposal overwhelmed capacity in Washington. After reviewing disposal options, a decision was made to landfill the carcasses and MBM. Because of concerns about the durability of prions, composting was quickly ruled out. Inadequate regional infrastructure existed to manage the materials through incineration in a timely manner. Due to the large volume of material, alkaline digestion was not a practical option at the time either. Once the decision was made to landfill suspect carcasses and MBM, state officials identified suitable landfills and issued standards and precautions that should be applied during burial.

<u>Overview</u>

Once the USDA concluded its investigation and identified animals and byproducts that would require isolation and disposal, state agencies were looked to for guidance on what state law allowed regarding disposal of carcasses and recalled MBM. Because of the potential regional nature of incident, state officials from both Washington and Oregon became involved in identifying suitable landfills in both states where the waste could be taken. There was a sentiment among some state officials that federal investigators could have been better served at the local level if federal official had communicated more openly about the scope of their investigation and the potential volume of material requiring disposal. State officials assumed the worst case in their initial efforts to identify landfills and get local health departments and landfill operators on board and prepared in the event their services became necessary. A list of eleven Subtitle D landfills on both sides of the Cascade Range was provided and ultimately pared down to five facilities in Washington and one in Oregon. State officials worked with operators to determine what volumes of waste could be managed at their respective facilities in order to be prepared for the worst case. One of the Washington facilities was dropped after determining it could not meet all the published guidelines issued by the Department of Ecology (Ecology). Eventually, questions about volumes were answered and all the material was disposed of at the Roosevelt Regional Landfill overlooking the Columbia River on the Washington side. This 1800 acre facility is located in Eastern Washington in a remote arid region of the state. The landfill sits atop a layer of clay and basalt. Depth to groundwater is at least 450 feet. Leachate produced is recirculated back into the landfill to promote the generation of methane which is collected and used to produce energy.

The guidelines published by Ecology were essentially for use by local jurisdictional health departments (JHD) and operators to ensure worker safety, thorough entombment of the material, and adequate control of leachate. The location of the animal trenches and MBM within the landfill was logged in the event the need to exhume the materials arises in the future. It should be noted that Washington State is one of a handful of states in the country where authority for solid waste facility permitting and oversight is delegated by statute to JHDs. Ultimately, it was the JHD that decided whether or not to allow burial of potentially infected animals and byproduct at a facility within their jurisdiction. Ecology’s published guidelines promoted the following:

- Disposal should occur only at lined Subtitle D landfill facilities
- The landfill should collect leachate in a closed system for recirculation

- The placement cell should have at least 20 feet of waste in place.
- Delivery of whole animals, offal, or recalled meat must be by appointment only. This allows preparation by landfill staff to immediately deal with disposal of the delivered waste. In the case of whole animals, it is more desirable to have them delivered to the landfill live and euthanized on site.
- Whole animals must only be disposed one layer thick. They must be immediately covered with at least three feet of regular garbage.
- Offal shall be placed on a 12-inch layer of Department-approved absorbent material such as a dry pulp sludge or dry soil. In certain cases municipal solid waste may be able to be utilized as absorbent material. This absorbent material is in addition to the twenty feet of waste required to be in place. The offal shall be immediately covered with at least three feet of regular garbage.
- Large quantities of recalled meat (typically shipped from central locations) shall be placed on in-place garbage and immediately covered with at least three feet of regular garbage.
- The disposal area for any of these wastes shall be covered with a minimum of twelve inches of soil at the end of the operating day. Alternative Daily Cover (ADC) cannot be utilized to cover this material at the end of the operating day.

(Since the Washington event, a concern has emerged regarding the suitability of placement of animals suspected to be infected with a prion-related disease such as BSE, Scrapies, Chronic Wasting Disease, in landfills that discharge leachate to waste water treatment facilities or surface waters. At the request of the Environmental Protection Agency's (EPA) Office of Water, the Office of Solid Waste revised its guidance in November of 2004 for landfill disposal of animals potentially affected with CWD. The revision promoted limiting landfill disposal to facilities that recirculate leachate rather than discharge to a treatment plant or directly to surface water under a NPDES permit.)

Early in the week of January 6th, animals were trucked approximately 150 mile north of Mabton to a secluded closed processing plant in Wilbur Washington. Depopulation efforts occurred largely in secret and were performed by lethal injection. Carcasses were loaded into truck to be hauled south about 200 miles back south to the landfill. The operator, who was on call for this event, received a call at about 3:00 a.m. informing him that the carcasses were in route. The time of the call put the operator in the difficult position of securing a crew to bury the animals because the facility is about an hour's drive from any of the communities where most of the workers lived and the region had experienced a snow storm that evening. As soon as there was adequate light to work, burial commenced at under gray skies, a shroud of fog, and a blanket of snow. The facility was closed to other customers that day.

By the time investigation and disposal were complete…

A total of 449 animals were depopulated from the bull calf raising premises.

A total of 131 at-risk animals were depopulated from the index premises in Mabton, WA.

A total of 39 animals were depopulated from the facility in Mattawa, WA

A total of 15 animals were depopulated from the facility in Connell, WA.

- A total of 20 animals were depopulated from a facility in Boardman, OR.

In addition to disposal of animal carcasses, approximately 2000 tons of recalled meat and byproducts were disposed of. Before these materials were allowed to be transported to Roosevelt Regional Landfill, Baker Commodities and Darling International were each required to submit a disposal plan and obtain approval from the FDA's Center for Veterinary Medicine. These plans detailed the specific location of potentially adulterated products, quantities and types, transportation methods, contacts, and facility location.

<u>Observations</u>

- The discovery of BSE in Washington set in motion a sequence of events that exposed the need to plan for such incidents before they happen. Much of this planning is already taking place in states throughout the country under Homeland Security and other mandates. Officials need to understand risks associated with any animal disease that may require urgent response containment and perhaps mass depopulation ahead of the emergence of an incident warranting emergency response. Questions about necessary safeguards to protect human health and the environment, personnel protection, biosecurity, etc. in an emergency event should be answered and documented to help responders assemble necessary equipment and take appropriate precautions. Numerous animal diseases of concern have been identified and characteristics identified by national and international organizations. An understanding of disease characteristics such as how the disease spreads, it's potential to affect humans and nearby animal populations, whether quarantine is required, whether immediate destruction is necessary all are critical to good response planning should an outbreak occur. How should the risks be communicated to the public? Such planning will go a long way towards swift and efficient responses and may also prevent an overreaction to the incident.

- It's critical that agencies at all levels of government be prepared to work together in such a response. Planning noted above should clearly identify roles and responsibilities under specific circumstances. Communication between the federal investigators and state officials must be open, direct, and reliable. No less than seven state and federal agencies were directly involved with the response, in addition to numerous local agencies asked to assist in finding a solution to disposal issues. The need to communicate *within* agencies is as compelling as the need to communicate among agencies. Larger departments will frequently have many divisions within its agency that may have overlapping (and sometimes conflicting) responsibilities. Also, as with any emergency situation, elected officials at all levels of government will become involved out of concerns for constituents or simply to be seen as “on the job”.

- Poor communications and turf issues among involved agencies provide the media with fodder to fuel speculation about what is “really going on”. The speculation erodes public trust that officials are being truthful about the scope of the problem and efficacy of the solution. The behavior of officials towards media can be critical. Officials become discredited when the message is delivered with arrogance and when conflicting stories emerge from seemingly credible people. The public, when dealing with such conflicts, is far more likely to believe a story from a citizen asserting they had direct involvement who claims “cover up” over agency personnel who appear to deliver what is perceived a “company line” to protect the interests of the affected business over public safety.

- In retrospection, many state agency staff wonder if destroying the potentially infected cattle might have precluded an opportunity to study the development of the disease and advance the bank of knowledge about its transmission and symptoms in bovine animals among a typically bred population. Once isolated from commercial breeding and production, the animals posed very little risk to humans and to other animals. The focus of the response to the discovery of BSE was obviously on tracking down related animals and products as quickly as possible. However, once accomplished, there arguably was no real urgency to destroy them. Costs to maintain the herd and fears about possible impacts and future use of property hosting the herd would need to be considered, but the maintenance of the herd could provide deeper understanding of the disease.

- Finally, there was a sense that federal agencies should have relied more on the knowledge of state officials when seeking a disposal solution. Due to the nature of the business, solid waste staff in government and solid waste facility operators all understands the difficulty of the delivery of messages in the situation faced by the federal investigators. It is in no way uncommon that special situations arise that put the solid waste system in a situation of managing some of the less savory cast-offs of American society. It is unlikely that the disposal option eventually selected would have been different than what was ultimately selected, but the efficiencies of getting there would definitely have been improved. State solid waste professionals, both regulators and operators, routinely work closely together to ensure safe facility operations. Relationships exist that without question, could have been utilized and eased at least a portion of the anxiety and uncertainty of the situation experienced by all involved.

AGRONOMIC UTILIZATION of COMPOST - GROWING PLANTS and PROTECTING the ENVIRONMENT

Harold M. Keener
Dept. of Food, Agricultural, and Biological Engineering, The Ohio State University, Wooster, OH. 44691, <keener.3@osu.edu>;

Introduction

Many composts are marketed and priced based on their nutritive value, which is largely fixed (except for N) by the initial compost mix. This paper presents information on the chemical properties of composts generated from municipal and agricultural sources. In addition, it provides information on erosion control uses, plant responses to compost maturity, disease suppression from compost used in potting mixes, pathogen destruction and antibiotic breakdown during composting.

Chemical Properties of Composts During Utilization

During composting, the plant nutrients P, K, Ca, Mg, as well as heavy metals do not disappear appreciably from the system as the dry matter decomposes (unless leaching occurs). However, N is lost during composting via numerous pathways, with ammonia volatilization being the most common. Its loss is directly related to total N content of manure and by C/N ratio. Numerous studies have shown C/N ratios near 40 or above will minimize N loss (Michel et al., 2004). Also, if the compost mix starts with N < 1%, N is generally retained by the biomass as dry matter disappears from the mix such that N percentage in the compost increases. However, waste with high nitrogen content such as caged layer manure and biosolids generally have C: N ratios well below 40:1 for any reasonable level of amendment. To prevent N losses, unamended caged layer manure can be composted in an enclosed structure with high atmospheric NH_3 to reduced N losses (Keener et al., 2002). A second approach is acid scrubbing and reintroducing the NH_3 salt back into the finished compost. Still another approach has used alum (Eckinci, 2002) for controlling nitrogen loss, although it has been shown to reduce the solubility of P by >50 %.

Historically, mature compost has nutrient contents of approximately 2% N, 2% P and 1 % K (4.6% P_2O_5, 1.8% K_2O). However, these values are greatly influenced by the starting compost mix, additives to mixes, and stage of stabilization. Also, reported nutrient values for compost are meaningful only if reliable samples have been taken. Discrepancies between initial mixes and final compost composition often arise with heterogeneous composts as noted by Keener et al. (2000) for compost made from blended materials. Since compost nutrient values can vary within the size ranges of the cured compost (Elwell, et al., 1994), screening can also be used to modify NPK levels in products. Table 1 is a summary of properties of compost from yard waste, biosolids, municipal solid waste (MSW) and livestock manures that have been studied along with paper mill sludge. These results illustrate how compost properties are related to initial properties of the compost mixes and length of composting time. It should be also noted composting may increase plant availability of macro and micronutrients, although biomass N is not as readily available as the NH_3 form of N.

The US Composting Council (USCC, 2004) has developed detailed protocols for the composting industry to verify the physical, chemical, and biological condition of composting feedstocks, material in process and compost products at the point of sale. This protocol is called TMECC, Test Methods for the Examination of Composting and Compost.

Table 1. Chemical properties of compost made from yard waste, biosolids, MSW, animal manures, and paper mill sludge amended with yard waste, wood chips, sawdust or straw.

Description[1,2]	Initial C/N	Time day	N % db	C/N	P % db	K % db	NH_4-N (µg g-1)	NO_3-N (µg g-1)
Yard waste	Michel et al., 1996							
le/gr/br(4:1:1)	26.4	140	1.32+0.19	19.1	0.11+0.02	0.59+0.09	1.8+0.9	17+12
le/gr/br(4:2:1)	25.9	140	1.61+0.06	16.1	0.23+0.02	1.08+0.10	2.9+1.6	122+23
le/gr/br(4:3:1)	25.9	140	1.63+0.10	14.2	0.23+0.01	1.01+0.06	1.3+0.1	144+10
Biosolids	Elwell et al., (1994)							
bs/wc (< 0.375")	14	21	4.26+0.09		2.17+0.05	0.77+0.02	5400+850	288+17
Bs/wc/l20(< 0.375")	12.4	21	3.60+0.02		1.44+0.04	0.71+0.01	3650+71	253+32
MSW	Keener et al. (1992)							
kw/yw (4% inerts)	16.7	53	1.85+0.14	8.6+0.6				
msw (20% inerts)	46.8	61	1.25	17.1				
MSW	Iannotti et al., (1993)							
msw/cm (19% inerts, <0.375")	19.3	31	2.01+0.04	12.8				
MSW	Michel et al., (1995)							
so/le 1:1 (9% inerts)	32	54	2.3	12	0.35	0.91		
so/le 1:2 (6% inerts)	36	54	1.8	16	0.24	0.50		
Swine manure	Keener et al., 2001							
sm/sd	20.6+2.6	106	2.14	16.9	2.20	1.80	3818	117.0
Dairy manure	Wang et al., (2004), Michel et al. 2004							
dm/sd	33.0+1.22	112	3.39+0.06	12.7+0.3	0.54+0.01	2.3+0.04	89.0+7.8	90.6+14.6
dm/st	25.1+0.85	105	4.24+0.54	8.5+1.01	0.84+0.02	4.77+0.15	116+90	128+99
Poultry manure	Keener et al. (2002)							
cm (unamended)	5.8+0.6	56.00	5.58+0.57	5.80	1.80+0.25	2.51+0.23	4850+124 5	213+37.4
Chicken manure	Elwell et al., (1996)							
cm/yw	22	27	1.6+0.0	11.8+0.1				
cm/fw/yw	20.7+6.1	27	1.55+0.07	11.2+0.1				
Horse Manure	Keener et al. (2004)							
hm/cb	30,6+3.4	70	2.33+0.25	16.7+1.6	0.63	2.84	49+13	5.1+7.1
hm/cb	30,6+3.4	90	2.32	17.3	0.64	2.53	27	16.7
Paper mill	Brodie et al., 1996							
Ps/pl/wc (< 0.5 in.)	31.5	245	0.95	17.0	0.67		600	0.7

[1] br=brush, bs=biosolids, cb=cardboard, cm=caged layer chicken manure, dm=dairy manure, fw=food waste, gr=grass, hm=horse manure, kw=kitchen waste, le=leaves, msw=municipal solid waste, pl=poultry broiler liter, ps=paper mill sludge, sd=sawdust, sm=swine manure, so=store organics, st=straw, wc=woodchips, yw=yard waste.

[2] <0.375" indicates finished compost was screened to less than this size before analysis.

Compost Maturity

Composts prepared from wood industry wastes frequently have high C: N ratios and while technically "stable" may still immobilize N during utilization[9]. On the other hand composts from sewage sludges release significant levels of N early during crop production while a more mature compost from separated cow manure maintains a sustained level of N release over a longer time period (Chen et. al., 1996). Results (Wang et al., 2004) on dairy manure composted with sawdust or straw showed that a 100 day composting/curing time gave good growth responses. A growth trial (Wilkinson et al., 2004) conducted to identify the effect of cardboard/horse manure compost age on growth of cucumber seedlings (fig. 1) indicated that if fertilized at 200ppm N to overcome nitrogen immobilization, composting time should exceed 70 days. Results also showed the maturity or age of the compost in this study did not significantly affect the percent germination of cucumber seeds. In general total time for composting and curing will generally exceed 100 days to achieve well-stabilized, mature compost for use in potting mixes. For land application or other purposes, the time requirements could be less (See later discussion).

Fig. 1. Plants from the 100 ppm N fertilized group on day 22 versus age of compost used in potting mix.

Allelopathy, described as chemical warfare between plants, needs to be considered in composting. Tree barks in particular may be sources of such chemicals that inhibit plant growth. Fortunately, allelopathic chemicals responsible for this effect in both softwood as well as hardwood barks are destroyed within a few weeks of composting of barks from most tree species (Still et al., 1976).

Compost Toxicity.

Organic acids in compost, especially the low molecular weight fatty acids, negatively impact emergence of seeds. In practice, producing compost in properly aerated systems so that anaerobic pockets are prevented during composting/ curing/ storage avoid toxicity caused by organic acids. For the case where acids exist in the cured compost, removing and allowing the compost to cure for 1-2 weeks in smaller aerobic windrows can eliminate the problem. Ammonium from immature low C/N materials (e.g. composted manure, food waste, sewage sludge) and soluble salts can also cause

[9] Standards for compost stability generally have not yet been adopted but an oxygen uptake rate less than 0.1 and 1.0 mg hr^{-1} g_{vs}^{-1} of compost volatile solids (vs.) have been proposed. Compost maturity has many meanings and is usually assessed through the potential for plant growth (Keener et al, 2000).

toxicity. Using mixtures with high C: N ratio alleviates these two problems. Table 2 provides guidelines on allowable soil soluble salt levels to avoid salt toxicity and fig. 2 shows how ammonium toxicity limits use of compost for growing plants.

Table 2. Allowable soil soluble salts (mMhos/cm) to minimize salt toxicity.

Description	Saturated MediaExtract	2 : 1 Dilution
Satisfactory if soil is high in organic matter but too low if soil is low in organic matter	Below 2	0.15 to 0.50
Satisfactory range for established plants but upper range may be too high for some seedlings	3 to 4	0.50 to 1.80
Slightly higher than desirable	4 to 8	1.80 to 2.25

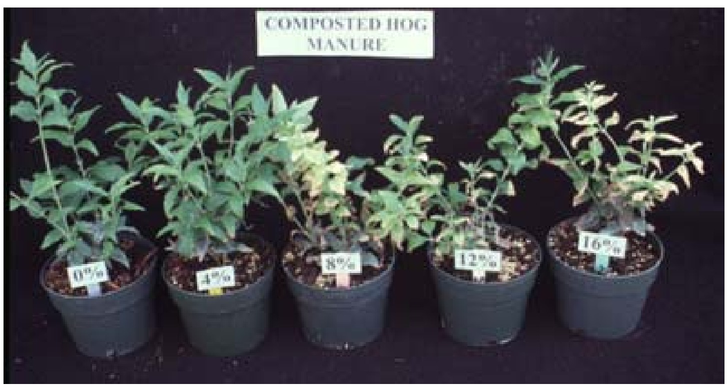


Figure 2. Growth studies using compost made from hog manure/sawdust for growing Deutizia "Gracillus". Compost is limited to 4% of mix due to ammonium toxicity (Keener et al., 2000).

Utilizing Compost

Land Application. Using composts for crop production requires attention to the source of compost and the timing, method and rate of application. Dalzell et al. (1987) recommended that mixtures of mineral fertilizers and composts should be such that at least 30% of the N is supplied by each source. However, composts made from biosolids often contain high concentrations of nitrate-N such that these composts require no mineral N additions (Chen et al., 1996). The timing of application versus when a crop is grown on the amended soil is important. Immature compost with a high C/N ratio should be applied several weeks ahead of planting to prevent immobilizing soil N and inhibiting crop growth. The method of application, i.e. surface applied or mixed into the soil, is controlled by whether N loss will be excessive from surface application and the tillage program for the crop production system. Lastly, rate of application is important. For crop production a minimum of about 2.5 Mg ha^{-1} (2.2 ton/acre) is required before benefits of compost application become evident. However, rates 10 times or more higher than the stated minimum rate can be equally effective if applications are not made annually but only every three or four years. If the compost contains heavy metals, application rates should not exceed the permissible levels based on the USEPA 503 regulations for biosolid compost (eg. Copper 67, Lead 13, Hg 0.76 lb/ac/yr)

Container Media. Utilizing compost in container media and soil blending is determined primarily by the compost effects on hydraulic conductivity, water retention and air capacity (Spencer and Benson, 1982). Compost addition should maintain air capacities above 25% as air capacity of a potting mix directly affects plant growth and has an impact on root rot severity. For example, observations in nurseries indicate that *Phytophthora* root rots do not occur in media that contain tree barks having air capacities > 25% and percolation rates > 2.5 cm/min. Since the ratio of compost to soil in land application is small, compost's physical properties usually have only marginal effects on soil physical properties for land application.

Mulches and Top Dressings. Organic mulches and top dressings effect the soil's ecology and plant health. They do this by controlling temperature swings, increasing water infiltration, reducing water evaporation, assisting in weed control, providing food for soil microbes, nutrients for the plants, etc. However, the effect they achieve depends on the materials particle size, available carbon, nitrogen and other nutrients.

Herms (2005) noted that ground wood pallets and composted yard waste mulches both increased soil organic matter and microbial biomass activity when used on rhododendron and river birch trees. However, the composted yard waste increased, while the ground wood decreased nutrient availability and plant growth. Only the yard waste compost suppressed root rot disease. Figure 3 shows organics in the landscape. Not all mulches have positive impacts and Hoitink (1998) noted dry composts and mulches cause problems for the user if nuisance fungi grow in them and produce spores that detach and stick to house siding.

Figure 3. (a) Wood mulch used as a surface covering. (b) 1" of finished compost being tilled into soil prior to sodding to help establish the sod faster. 1" compost = 134 yd^3/acre.

Erosion Control, Filtering. Compost is being actively market for erosion control for use along roadways, riprap channels, stream bank stabilization and gabions. In addition it is being used for filter cells to control runoff, bioretention ponds and bioremediation projects. Tyler (2005) noted: Bill Stewart pioneered filter berms and erosion control using compost in 1993; Maine Waste Mgt. Agency tests compost against others in Kennebec County - 1994; Clyde Walton, Maine DOT one of first to spec. berms in DOT projects - 1996; and EPA cites innovative uses for compost for erosion control- 1997. Novel approaches, such as Filtrexx™ socks[10] (Tyler, 2005), control soil loss, allow

[10] Use of product name or trademark does not mean endorsement by The Ohio State University.

rapid establishment of cover vegetation, and avoids non-organic structures in the environment such as plastic filter fence.

Disease Suppression

Disease suppression using compost occurs by three mechanisms, general suppression, specific suppression and induced suppression. It has been found that general (Natural) suppression will occur in about 90% of mature composts. The diseases most frequently controlled are Phytophthora and Pythium root rots (fig. 4). The second area, i.e. specific disease suppression, occurs in about 20% of mature compost and Rhizoctonia root roots are often the disease one is attempting to control. The third area is induced systemic resistance. It occurs in about 2% of the compost naturally and confers the ability to control foliar diseases (fig. 5).

Producing disease suppressive compost. It is recognized that control of root rots with composts can be as effective as that obtained with fungicides (Hoitink et al., 1997). The ornamental plant industry now relies heavily on compost products for control of diseases caused by soil borne plant pathogens. However, composts must be of consistent quality to be used successfully for biological control of diseases of horticultural crops, particularly if used in container media.

Effects of chemical properties of composts on soil borne disease severity are important but often overlooked. Highly saline composts such as those prepared from dairy manure or hog manure (Keener et al., 2001) enhance Pythium and Phytophthora diseases unless they are applied months ahead of planting to allow for leaching. Compost prepared from municipal sewage sludge has a low carbon to nitrogen ratio. They release considerable amounts of ammonium nitrogen and enhance Fusarium wilt diseases (Quarles and Grossman, 1995).

Figure 4. This Phytophthora root rot bioassay helped prove that natural suppression is effective in 90% of well prepared compost mixes. (Spring et al., 1980)

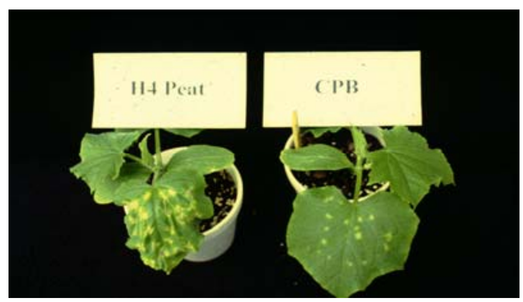


Figure 5. Compost and compost water-induced systemic acquired resistance in cucumber. CPB=composted pine bark. (Zhang et al., 1998)

Controlling recolonization of compost during curing with beneficial organisms. Most beneficial microorganisms, along with pathogens and weed seeds are killed during the high temperature phase of composting. During curing, mesophilic microorganisms that grow at temperatures <40 C recolonize the compost from the outer low temperature layer into the compost windrow or pile. Therefore, suppression of pathogens and/or disease is largely induced during curing. The reader is referred to Hoitink and Boehm (1999) for more detailed discussion on mechanisms. In order to induce the growth of suppressive organisms, water content must be maintained at 40-50% w/w during curing. Compost pH also affects the potential for beneficial bacteria to colonize composts. A pH <5.0 inhibits bacterial biocontrol agents.

To minimize variability in compost suppressiveness three approaches are suggested: 1) cure the composts for four months or more (Kuter er al., 1988); 2) incorporate composts into field soils for several months before planting (Lumsden et al., 1983); and 3) inoculate composts with specific biocontrol agents (Hoitink, 1990). Composition of the feedstock appears to have an impact on the microflora in composts active in biological control. This factor has to be considered when specific inoculants are introduced into composts on a commercial scale.

Selecting feedstock to sustain longevity of suppression in compost: In mature compost, where concentrations of nutrients are low, plant diseases such as sclerotia of *R. solani* are killed by the parasite *Trichoderma*, and biological control prevails (Hoitink et al., 1997). This reveals that composts must be adequately stabilized to reach that decomposition level where biological control is feasible. Note, however that excessively stabilized or pyrolyzed compost does not support adequate activity of biocontrol agents. Because practical guidelines defining this critical stage of decomposition in terms of biological control is not yet available, industry achieves this end condition by maintaining constant conditions during the entire process and adhering to a given time schedule (Hoitink et al., 1999). In practice, this occurs in composts that have been (1) stabilized far enough to avoid phytotoxicity and (2) colonized by the appropriate specific microflora.

Developing compost for foliar disease control. During the past, papers have been published on the control of plant diseases of above ground plant parts with water extracts, also known as steepages, prepared from composts (Yohalem et al., 1994, Conforti et al., 2002). Unfortunately, efficacy varies with the compost, batches of steepages produced, crops and the disease under question. Recently it has been shown that composts incorporated into soils can protect the foliage of plants from foliar plant pathogens (Hoitink et al., 1997; Zhang et al, 1998; Pharand et al., 2002; Krause et al., 2003). It seems likely, that composts may be used more widely in the future for control of foliar diseases.

Pathogen and Antibiotic Destruction

Many pathogens associated with animal and human disease are known to be killed at temperatures above 55^{o}C (131^{o}F). Recent studies of Michel et al. (2005) on manure pathogens documented that E. coli, Salmonella, and Listeria were killed by composting for 3 days at 55 C, but that *Mycobacterium avium subsp. paratuberculosis* still persisted even after 55 days. In liquid manure systems, the same pathogens persisted for more than 20 days. Recently Arikan (2005) reported on the disappearance of antibiotic oxytetracycline) OTC) during composting or anaerobic liquid storage. The composting experiment was done on beef manure containing OTC mixed with straw and woodchips. The half-life of OTC for composting was 3.2 days and the half-life of OTC for anaerobic digestion was 50.7 days. OTC removal was 99.8 % from composting compared to the 27.4% from anaerobic digestion process. These studies suggest that composting maybe more effective than anaerobic digestion in reducing OTC and pathogen contents of manures.

Acknowledgement:

Much of the material used in this paper on disease suppression is adapted from the writings of Dr. H.A.J. Hoitink and Dr. W.A. Dick in the reference by Keener et al., 2000. Author thanks Dr. F.C. Michel Jr. and T.F. Wilkinson for editing the manuscript.

Literature Cited

Arikan, O.A., L.J. Sikora , S.U. Khan and G.D. Foster. 2005. Compostıng and anaerobıc dıgestıon of manure from antıbıotıc (oxytetracycline)treated calves. OCAMM Seminar. Feb. 16. Wooster, OH.

Brodie, H.L., L.E. Carr, E.K. Biermann, G.A. Christiana and J.R. Udinskey. 1996. Composting coal ash with poultry litter for topsoil manufacture. Compost Science and Utilization 4(4): 6-13

Chen, L., W.A. Dick, J.G. Streeter, and H.A.J. Hoitink. 1996. Ryegrass utilization of nutrients released from composted biosolids and cow manure. Compost Science & Utilization 4:73-83.
Conforti, C., M. Blair, K. Hutchins, and J. Koch. 2002. The Effects of Compost Tea on Golf Course Greens: Presidio Golf Course, San Francisco CA. Proceedings 2002 International Symposium on Composting and Compost Utilization. May 6-8. Columbus, Ohio. Published on CD - Disease Suppression II. May 7.
Dalzell, H.W., A.J. Biddlestone, K.R.Gray and K. Thurairajan. 1987. Soil management: Compost production and use in tropical and subtropical environments. *FAO Soils Bulletin 56*, Food and Agriculture Organization of the United Nations (FAO), Rome.
Ekinci, K., H.M. Keener and D.L. Elwell. 2002. Composting short paper fiber with broiler litter and additives. II. Evaluation and optimization of decomposition rate versus mixing ratio. Compost Science & Utilization. 10(1):16-28
Elwell, D.L., H.M. Keener, H.A.J. Hoitink, R.C. Hansen and J. Hoff. 1994. Pilot- and full-scale evaluations of leaves as an amendment in sewage sludge composting. Compost Sci. & Utilization. 2(2):55-74.
Elwell, D.L., H.M. Keener, and R.C. Hansen. 1996. Controlled, high rate composting mixtures of food wastes, yard wastes and chicken manures. Compost Sci. & Utilization 4(1):6-15.
Herms, D. 2005. Using mulches in managed landscapes. Ohio Compost Operator Education Course. Feb.9. OARDC, Wooster, OH. [Herms et al. 2001. http://www.extension.iastate.edu edu/Publications/SUL12.pdf.]
Hoitink, H. A. J. 1990. Production of disease suppressive compost and container media, and microorganism culture for use therein. US Patent 4960348. Feb. 13, 1990.
Hoitink, H.A.J., A.G. Stone, and D.Y. Han. 1997. Suppression of plant diseases by composts. HortScience 32(2):184-187.
Hoitink, H.A.J. 1998. Control of Nuisance and Detrimental Molds (Fungi) in Mulches and Composts. http://ohioline.osu.edu/hyg-fact/3000/3304.html (accessed May 2, 2005).
Hoitink, H. A. J., and Boehm, M. J. 1999. Biocontrol within the context of soil microbial communities: A substrate-dependent phenomenon. Annu. Rev. Phytopathol. 37:427-446.
Iannotti, D.A., T. Pang, B.L. Toth, D.L. Elwell, H.M. Keener and H.A.J. Hoitink. 1993. A quantitative respirometric method for monitoring compost stability. Compost Sci. & Utilization 1(3): 52-65.
Keener, H.M., D.L. Elwell and T. Pang. 1992. Effects of temperature and weekly turning on composting rates--Phase I. Nov. 28. Report to Buhler, Inc., Minneapolis, MN. 28p
Keener, H.M., W.A. Dick and H.A.J. Hoitink. 2000. Composting and beneficial utilization of composted by-product materials. Chapter 10. pp. 315-341. *In:* J.F. Power et al. (eds.) Beneficial uses of agricultural, industrial and municipal by-products. Soil Science Society of America. Madison, Wisconsin.
Keener, H.M., D.L. Elwell, K. Ekinci and H.A.J. Hoitink. 2001. Composting & value-added utilization of manure from a High-RiseTM swine finishing facility. Compost Science & Utilization 9(4):312-321
Keener, H.M., D.L. Elwell and D. Grande. 2002. NH_3 emissions and N-balances for 1.6 million caged layer facility: manure belt/composting system vs. deep pit operation. Transactions of ASAE. 45(6):1977-1984
Keener, H.M., D.L. Elwell, K. Winbush, R. James. 2004. Evaluation of approaches for composting horse manure and commercial cardboard bedding. ASAE Paper 044068. Presented at 2004 ASAE/CSAE Annual International Meeting. 8/1-4. Fairmont Chateau

Laurier, The Westin, Government Centre, Ottawa, Ontario, Canada. Published on CD (search at asae.frymulti.com)

Krause, M.S., T.J.J. De Ceuster, S.M. Tiquia, F.C. Michel Jr., L.V. Madden, and H.A.J. Hoitink. 2003. Isolation and characterization of rhizocbacteria from composts that suppress the severity of bacterial leaf spot of radish. Phytopathology 93:1292-1300.

Kuter, G. A., H. A. J. Hoitink, and W. Chen. 1988. Effects of municipal sludge compost curing time on suppression of Pythium and Rhizoctonia diseases of ornamental plants. Plant Disease 72:751-756.

Lumsden, R. D., J. A. Lewis, and P. D. Millner. 1983. Effect of composted sewage sludge on several soilborne pathogens and diseases. Phytopathology 73:1543-1548.

Michel Jr., F.C., S. Drew, C.A. Reddy, L.J. Forney and E.Trondle. 1995. Characterizing supermarket organics. Biocycle 36(1):68-70.

Michel Jr., F.C., L.J. Forney, A.J.F. Huang, S. Drew, M. Czuprenski, J.D. Lindeberg and C.A. Reddy. 1996. Effects of turning frequency, leaves to grass mix ratio and windrow vs. pile configuration on the composting of yard trimmings. Compost Science and Utilization. 4(1):26:43.

Michel Jr., F.C., J.A. Pecchia, J. Rigot, H.M. Keener. 2004. Mass and nutrient losses during the composting of dairy manure amended with sawdust or straw. Compost Science and Utilization. 12(4):323-334.

Michel Jr., F.C., S.Grewal, S. Sreevatsan. 2005. Persistence of *Mycobacterium avium subsp. paratuberculosis* and other Pathogens during Composting, Manure Pack and Liquid Storage of Dairy Manure. Sym.on the State of Sci. of Animal Manure and Waste Management. 1/5-7. Marriott River Center, San Antonio, TX. Published on CD (search at: http://www.cals.ncsu.edu/waste_mgt/natlcenter/sanantonio/proceedings.htm)

Quarles, W. and J. Grossmam. 1995. Alternatives to methyl bromide in nurseries - Disease suppressive media. The IPM Practitioner 17(8):1-13.

Pharand, B., O. Carisse and N. Benhamou. 2002. Cytological aspects of compost-mediated induced resistance against Fusarium crown and root rot in tomato. Phytopathology 92:424-438

Spencer S. and Benson D.M. 1982 Pine bark, hardwood bark compost, and peat amendment effects on development *of phytophthora* spp. and lupine root rot. Phytopathology 72:346-351.

Spring, D.E., M.A. Ellis, R.A. Spotts, H.A.J. Hoitink, and A.F. Schmitthenner. 1980. Suppression of the apple collar rot pathogen in composted hardwood bark. Phytopathology 70:1209-1212.

Still, S.M., M.A. Dirr, and J.B. Gartner. 1976. Phytotoxic effects of several bark extracts on mung bean and cucumber growth. J. Am. Soc. Hortic. Sci. 101: 34-37

Tyler, R. 2005. Economics and marketing. Ohio Compost Operator Education Course. Feb.9. OARDC, Wooster, OH. (for more information see www.filtrexx.com)

USCC. 2004. USCC Projects. http://www.compostingcouncil.org/index.cfm (9/8/04)

Wang, P., C.M. Changa, M.E. Watson, W.A. Dick, Y. Chen, H.A.J. Hoitink. 2004. Maturity indices for composted dairy and pig manures. Soil Biology & Biochemistry 36:767-776

Wilkinson, T.F., H.A.J. Hoitink and H.M. Keener. 2004. Evaluation of approaches for composting Hunt Club bedding/horse manure - Phase II: Plant growth in compost mixes. Dec. FABE, OARDC, Wooster, OH.

Yohalem, D. S., R. F. Harris, and J. H. Andrews. 1994. Aqueous extracts of spent mushrooms substrate for foliar disease control. Compost Sci. Utilization 4:67-83.

Zhang, W., D.Y. Han, W.A. Dick, K.R. Davis and H.A.J. Hoitink. 1998. Compost and compost water-induced systemic acquired resistance in cucumber and arabidopsis. Phytopathology 88:450-455

Alternative Disposal Methods – Session Chair: Cliff Curtis

ANIMAL MORTALITY MANAGEMENT WITH BIOLOGICAL TREATMENT USING SERIES ANAEROBIC/AEROBIC DIGESTION

By
William J. Jewell, Professor
Department of Biological and Environmental Engineering
Riley-Robb Hall
Cornell University
Ithaca, New York 14853

ABSTRACT

A proposed series thermophilic anaerobic and aerobic biological treatment was hypothesized to be capable of achieving volume and mass reductions equivalent to incineration without generation of adverse by-products. Treatment of animal carcasses at these temperatures and retention times [55ºC and greater than ten days exposure] has the potential of achieving complete pathogen destruction and most organic matter conversion to energy. Methane generated by anaerobic digestion is sufficient to evaporate excess water and combust any remaining material if complete destruction is desired.

Synthetic wastes, including parts of full grown cows [tail sections], mice, goose and chicken feathers, baby chicks, paper, and plastics were processed in eight separate runs in a laboratory study of the proposed system. Greater than 85% of the dry weight of material added was reduced to methane, carbon dioxide, or refractory suspended solids that were easily separated from the liquid and the non-degraded material such as plastic films.

A stand-alone facility could be designed to process diseased animal and plant material. Such a facility could remain in an unoperated condition or at idle with minimal attention and return to full processing capacity in a matter of days. Existing digesters on a dairy could be retrofitted to process whole animals. Increase of the total manure digester volume by about three percent would enable processing of a full grown cull animal [~1500 pounds (~682 kg)] every 20 to 30 days. In cases of emergency, the entire digester could be used to process animal carcasses equal to six to ten tons of animals per day. The greatest design and operational change over manure processing would be the increase of digester operating temperature from mesophilic [35°C] to thermophilic conditions [55°C].

INTRODUCTION

Animal carcasses and other medical wastes are among the most difficult materials to safely eliminate without causing secondary problems. As we confront major pathogen issues such as the avian flu and chronic wasting disease, disposal of animal carcasses becomes a more pressing issue.

Solutions are needed for small processing capacities that use minimal resources and eliminate adverse effects of animal carcasses and medical waste treatment and disposal.
Today most options emphasize removing the pathogen hazard without concern about the secondary effects that final disposal may create. These options include landfills, heat treatment, steam sterilization, and dissolution with large quantities of alkali and heat. The resulting treated solids still require final treatment and disposal in a wastewater treatment facility or in a landfill.

GOALS AND OBJECTIVES

The goal of this study was to conduct "proof-of-concept" experiments to document whether biological processes can achieve volume reductions comparable to incineration for animal tissue and associated material in medical wastes. A synthetic medical waste was used to determine the potential of biodegrading a complex mixture. This mixture was then separated and the fate of various components was measured by determining the effluent wet and dry matter. Finally, a facility was designed to process one ton per day and costs were estimated.

BACKGROUND AND HYPOTHESIZED SYSTEM

Biological fermentation at high temperatures (60°+C) can enzymatically break down a wide range of materials such as animal carcasses, medical and veterinary wastes. Previous work by the author and others have shown that all pathogens can be eliminated during thermophilic fermentation at retention times much shorter than that required to convert biodegradable matter to final end products [Jewell et al.1980, Kabrick et al. 1980].

EXPERIMENTAL APPROACH

A synthetic medical waste [SMW] was developed for use in this treatability study in which animal tissue represented a third of the wet mass. Whole young animals [mice and chickens] and mature animals [slices of cow’s tails and goose feathers] as well as textiles [plastic diapers and cotton netting called “cheesecloth”] and various forms of plastics (biodegradable and conventional non-biodegradable) were included.

Laboratory reactors operated at 60°C with a 15 liter volume were first developed on animal wastes and operated continuously for several months prior to testing cycles of the SMW. Total wet masses of around 600 grams of the SMW were added once per week to anaerobic reactors inside plastic mesh envelopes that could be retrieved to measure larger materials that resisted decay and/or size reduction. These feed envelopes were transferred every seven days from the anaerobic reactor to the aerobic reactor and out of the system in the order in which they were fed. Eight batches were documented.

RESULTS

In general, the proposed system functioned as proposed. Between 37 and 44% of the feed was converted to gas by the first stage anaerobic treatment. Original estimates of biodegradability was 45 to 50%. Thus, most of the biodegradation occurred in anaerobic digestion in seven days. The maximum biodegradable fraction was around 54 to 59% of the dry feed.

An overview of the fate of material in biological treatment is illustrated for goose feathers [Figure 1] and results applied to whole animal carcasses [Figure 2]. With minimal drying a mass reduction of 64% is achieved. Effluents from this system would be pasteurized, free of viable pathogens and viruses and have an odor similar to typical mature compost.

Figure 1. Illustration of the fate of goose feathers in a thermophilic biological treatment system.

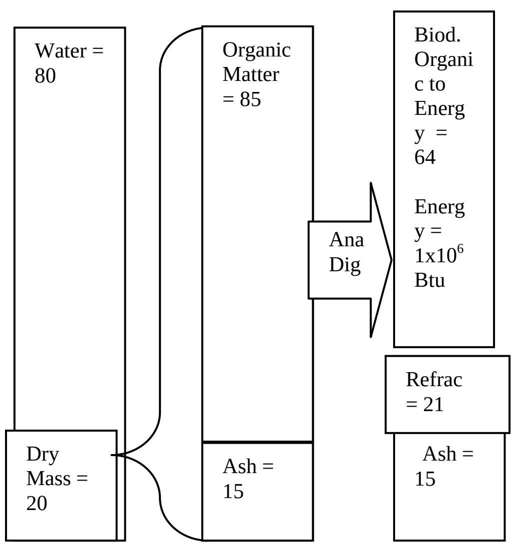


Figure 2. Overview of fate of typical animal matter consisting of 80% water and 20% dry matter. Values for wet mass values as % of total wet mass, dry mass as % of dry mass, and digested mass is % of dry mass. Digester effluent contains 8.3% dry matter as fraction of the wet mass, total mass reduction of live animal mass in digestion is 64% of dry matter or 13% of wet mass. Drying of digester effluent to a typical humus-like material results in wet effluent containing 15% of the original animal mass. Excess methane and organic energy is available to

evaporate water and combust refractory organics leaving a total ash of 3% to 5% of the wet animal mass, or a total reduction of 95+%.

Perhaps more important is that existing farm-scale digesters could be modified to incorporate whole animal carcasses. Increasing digester volume by about three percent on a 100 cow dairy would enable processing of at least one cull cow carcass every 20 to 30 days. Emergency stand-alone facilities could be constructed to process carcasses. Considering the costs of animal waste digesters, it would appear that retrofitting these bioreactors for carcass disposal could be technically and economically feasible.

REFERENCES

Jewell, W.J. and R.M. Kabrick. 1980. *Autoheated Aerobic Thermophilic Digestion with Air Aeration. J. Water Pollution Control Federation,* 52 (3): 512-523.

Kabrick, R.M., W.J. Jewell, B.V. Salotto, and D. Berman. 1980. *Inactivation of Viruses, Pathogenic Bacteria and Parasites in the Autoheated Aerobic Thermophilic Digestion of Sewage Sludges. Proceedings of the Thirty-fourth Annual Purdue University Industrial Waste Conference*. West Lafayette, IN: 771-789.

Composting the End Product of Alkaline Digested Animal Mortalities

Kathy Corwin Doesken, Research Associate, Soil and Crop Sciences Department
Jessica Davis, Professor, Soil and Crop Sciences Department
Barbara Powers, Professor, Department of Immunology, Pathology and Microbiology
Colorado State University

Colorado State University's (CSU) Diagnostic Laboratory (DL) located at the Veterinary Teaching Hospital (VTH) diagnoses the causes of animal mortality in many species of animals, which come from the VTH, the United States Department of Agriculture, and the Colorado Division of Wildlife. Some of the carcasses contain prions, the infectious agents of Transmissible Spongiform Encephalopathies (TSEs.). The DL initially disposes of its mortalities in an alkaline digester manufactured by Waste Reduction by Waste Reduction, Inc. of Indianapolis, Indiana (http://www.wr2.net/). The process destroys the infectivity of organisms, including prions after six hours. The effluent is an odiferous, alkaline (pH 10) solution that contains small peptides, amino acids, sugars and soaps. This effluent is also high in potassium from the alkaline agent potassium hydroxide used in the process. Over 130,000 gallons of effluent per year are produced. No satisfactory, economical method exists to dispose of the effluent. Research is underway to examine the feasibility of composting the effluent with a horse manure and wood shavings mixture, which is a waste product, produced by the Equine Teaching and Research Center (ETRC) at CSU. The final end product, compost, will be used on the CSU campus as a soil amendment. Composting research began in September 2004 in bins with a 350 cubic foot capacity at CSU's composting facility. Five composting mixes were replicated four times. The mixes included digester effluent, manure and wood waste, and other organic wastes from CSU. The mixes were sampled and analyzed in December 2004. Laboratory results showed that the compost had acceptable values for pH and soluble salts. The average ratio of total carbon to total nitrogen (C: N) was 36:1, which is higher than the acceptable range in compost that would be useful on campus. The high level of carbon in the finished compost was due to the high initial levels of carbon in the wood shavings and manure feedstock. Further composting research will examine how to lower the amount of carbon in the finished compost to an acceptable level by increasing the initial amounts of nitrogen by adding a higher proportion of digester effluent and food wastes. CSU will also conduct a study to look at other economically feasible bedding options for the ETRC that will result in a lower carbon feedstock that composts well with the digester effluent.

Managing Slaughterhouse Residuals – Session Chair: Bill Seekins

Precondition and Turn Approach to Composting Slaughterhouse Wastes

Presented by Bill Seekins, Maine Department of Agriculture

Authors: Bill Seekins; Mark King, Maine DEP; Mark Hutchinson, University of Maine Cooperative Extension

I. INTRODUCTION

In the winter of 2000-2001, the Maine slaughterhouse industry learned that the cost of their traditional disposal method for their by-products was increasing ten-fold. Due to a loss of markets for meat meal as a result of the ruminant to ruminant feed ban and to increasing costs of operation, the only renderer in New England, Baker Commodities was being forced to dramatically increase the cost of picking up offal from slaughterhouses, butcher shops and meat processors. There were also rumors that this service may not even be available in the future. This situation spurred industry leaders to approach the Maine Department of Agriculture for help.

In May 2001, the Department held an information gathering meeting with the industry and representatives of Baker Commodities. At that meeting, Baker Commodites explained the situation they faced and indicated that they intended to continue their service in the near future, but did not know what would happen if proposed further FDA bans on use of meat meal were to be implemented.

The Department offered industry representatives three possible options for managing their wastes. These were on-site burial, composting and pick up by another rendering company that was operating in New Brunswick. The first option pursued was the alternate rendering company. Negotiations throughout the summer of 2001, however, were unsuccessful in attracting another renderer into the Maine market. At that point, the Department decided to pursue composting to see if it could be done given the conditions and materials available in Maine. The Maine Compost Team was approached to conduct trials using slaughter wastes. The Maine Compost Team is an interagency collaborative, with members representing the Maine Department of Agriculture, Maine Department of Environmental Protection and the University of Maine Cooperative Extension.

One of the people in attendance at the May 2001 industry meeting was a farmer, Tom Campbell, who expressed interest in participating in any compost trials that might be undertaken. When it was clear, that compost trials would be needed, the Team approached Tom to do trials at his farm. A retired bunker silo behind the barn was selected at the site for the trials. The farm already had a tractor with a bucket loader and a skidsteer loader as well as a dump truck, so the basic equipment needed to conduct the trials was on-hand. The trials began in August/September, 2001.

II.TRIAL SETUP

SOFT TISSUE TRIALS

The Compost Team was aware that two distinctly different waste streams were produced by the slaughter facilities. The first was all the soft tissue, including the rumen, organs and other entrails. Along with this waste stream came a certain amount of paunch manure. The second waste stream consisted of the harder to compost materials, including the bones (with a certain amount of meat and connective tissue attached), heads, hides and hoofs. The first set of trials focused on finding the most appropriate method to manage the soft tissues.

The overall approach chosen for composting both waste streams was the ‘pre-condition and turn’ system. This is a hybrid between the passively aerated pile approach and a turned windrow system. It was felt that this approach offered the best opportunity for success due to the texture of the materials being composted, the difficulty of mixing this material with a bulking agent and the likelihood of significant odor, vector and nuisance issues if any were left exposed. In this system, the tissues would be buried in a pile of the dry bulking material and allowed to decompose to the point where it could be turned and mixed without problems. Part of the purpose of the trials was to determine how long the piles should be left undisturbed before the first turning.

Horse Bedding Trials

Horse bedding was chosen as the preferred compost media for these trials because it had some nutrients at the outset and a population of active bacteria, so that it would begin composting very quickly. Because most horse bedding in the area included sawdust and shavings as well as waste hay, it would provide excellent pile structure for aeration and moisture control. It was also a natural choice since it was in plentiful supply in the area.

Two approaches were tried in the initial trials. In both, a bed of horse bedding was formed about 18 inches deep, 8 ft wide and 15 ft long. The edges of this bed were mounded up to form a basin that would prevent fluids from escaping before the cover material had been added. Soft tissue was deposited in the basin by emptying the 55 gallon drums in which it was transported, directly into the pile. The soft tissue was then covered with approximately 18 inches of horse bedding. The difference between the trials was the provisions made for self aeration.

Each pile initially had roughly 6 cubic yards of horse bedding for each cubic yard of offal. The amount of offal added at the outset had to be limited due to the amount of liquid that accompanied the offal and the potential for additional moisture release as the material broke down. It was then sampled after the first turning to determine if sufficient nitrogen had been added to achieve the optimum C:N ratio in the mix. Additional offal was added based on the C:N ratio observed and the process started again. This was repeated until the C:N ratio of the mix was between 20:1 and 30:1. After all additions were made, the final mix was approximately 2 cubic yards of bedding for each cubic yard of offal composted.

With Aeration Pipes One pile was set up with three 4" diameter perforated PVC pipes laid parallel to each other on the pavement about 3 ft apart. A layer of hay was placed over the pipes to prevent the bedding from plugging up the holes, then the bottom layer of bedding was placed over the hay.

Without Aeration Pipes The second pile was made by laying the bedding directly on the pavement. Aeration in this pile would depend on the porosity of the horse bedding allowing air movement into the pile.

Hot Municipal Sludge Compost Trial

Later in the fall, the Team decided to try using hot municipal sludge compost as the medium for composting the offal. This material had been used successfully for composting whole carcasses in trials earlier that summer and so offered promise as an alternative to the horse bedding. The advantage of the municipal sludge compost was that it was already very active at the start and offered the potential for rapid pathogen kill in the event there was material suspected to have pathogen contamination.

BONE TRIALS

After the first successful trials using only soft tissues, the Team expanded the trials to include the composting of bones and other parts (collectively referred to as 'bones') that may be more difficult to compost.

No Grinding Trials

The first step in these trials was to simply bury the bones in a pile of horse bedding and allow them to 'cook' for 4 to 6 weeks undisturbed. The pile contents were watched to determine when most of the soft tissue (connective tissue, fat and meat) had been decomposed. At the end of this period, the Team dug into the piles to examine the condition of the bones.

Composting Material after Grinding

The first bone trials showed that the softer tissue connecting the bones would be eliminated during the first phase of the compost process, but that the larger bones survived with little change during that time period. This led to the bone grinder trials that were conducted at Highmoor Farm and reported elsewhere. It also led Mr. Campbell to obtain a large hammermill grinder on loan from a local company that was no longer using it to pulverize bark for mulch. Some of the pre-composted material was ground in the grinder and then repiled to continue the composting.

After grinding, one pile was left undisturbed while another was turned every 3 to 5 days. The resulting compost from each pile was then sampled and analyzed for the typical compost parameters. See Table 1 .

III. DATA COLLECTION

Because these trials were all conducted on a working farm, without staff dedicated to data collection, it was not possible to obtain detailed temperature data for the trials. Spot checks of temperature readings told the Team that the temperatures being generated were, in fact, consistently high enough to achieve pathogen reduction, especially after the initial turning in the soft tissue trials.

One of the purposes of the two initial trials was to determine how long the soft tissue should compost undisturbed before the first turning. Because of the nature of the material at the start and the potential for vector attraction and other nuisances, it was felt that the first turn should not happen until most of the soft tissue had decomposed and no longer had its original structure. Exploratory digs were made in each pile at 7, 14 and 20 days.

Sampling and Analyses The original piles were sampled after turning the first time and again after each addition of offal and turning. The process for collecting the samples was:

1. Seven samples were collected from different locations of each pile with a small spade and placed in a 5 gallon bucket.
2. Each sample was taken at a depth of about 12-15 inches from the surface of the pile.
3. The seven samples were mixed thoroughly for one minute.
4. A subsample was then taken from the bucket and placed in a one-gallon plastic zip-close bag.
5. The samples were then sent to the Plant and Soil Analytical Lab at the University of Maine.

The standard compost tests were performed on all the samples. These included:

Total Solids
Total Carbon
Total Nitrogen
Total Potassium
Total Phosphorus
Volatile Solids
pH
Bulk Density
C:N Ratio

The lab was also asked to test for:

Conductivity
Ammonium N (NH_4-N)

IV. RESULTS

SOFT TISSUE TRIALS

Both of the soft tissue trials showed that most of the material decomposed very rapidly. At 20 days, there was very little recognizable tissue left in either pile. The most striking remaining material was the paunch manure or partially digested feed. In some cases, when all the soft tissue around it had disappeared, there was a compacted lens shaped mass of grass that looked very much the same as the day it was eaten. As soon as this material was mixed with the surrounding bedding, it rapidly heated up creating a very active compost mixture.

The trials with and without aeration pipes performed very similarly. The pile without the pipes seemed to be slightly behind the one with the pipes in terms of initial heating and rate of breakdown. After the initial turning, there was virtually no difference between the two treatments. The aeration pipes, however, turned out to be a conduit for fluids to leave the pile and became breeding sites for flies. Based on this finding, the Team decided to proceed with additional trials without the use of the aeration pipes.

Hot Municipal Sludge Compost Trial

The municipal sludge compost trial results were similar to those observed for the horse bedding trials except that the material was drier initially and that it only required one batch of offal to reduce the C:N ratio to about 20:1. Looking at the changes to the analyses of the material before the offal was added and after it had been added and allowed to compost for 20 days showed that most of the parameters changed very little as a result of the addition of the soft tissue. See Table 3. The most significant change was in the moisture content as a result of the fluids and released water. But even with the added moisture, the moisture content of the material (56%) at this point was just enough to promote composting.

The municipal sludge compost material was hotter at the outset than the horse bedding, although the horse bedding eventually achieved similarly high temperatures (Both consistently were over 140°F within a few days of the first turn.) Paunch manure in the municipal sludge compost medium tended to dry out during the initial period prior to turning as did the rest of the compost medium itself. The process, when using the hot municipal sludge compost would have benefited greatly from addition of moisture during this stage.

BONE TRIALS

In the bone trials, the operator observed that the bones were free of soft tissue in 25 – 40 days. Some deterioration of bones was observed at this time as well, but the larger bones were still primarily intact. He also observed that the bone piles heated up more rapidly and to higher temperatures than soft tissue piles. There are several factors that probably contributed to this. The bone piles were generally larger than the soft tissue piles. The initial height of the bone piles was normally about 5 to 6 ft, while the soft tissue piles would usually be less than four feet high. The extra mass would allow more heating especially in colder weather. In addition to the size difference, the soft tissue piles routinely had more moisture associated with them, both from the fluid in the barrels and the release of moisture as the tissue broke down. There was also more nitrogen in the bone pile initial mixtures than in the soft tissue piles after the first batch of offal had been added. See Tables 1 and 2. Finally, the presence of rib cages and other larger bones resulted in a pile structure that did not collapse as much during the early preconditioning stage, allowing the piles to maintain better structure and aeration.

After the initial trials were concluded, the operator began incorporating some of the bone material into the soft tissue piles since this actually helped speed up the compost process for the soft tissue. The one drawback to adding the bones to this material is that it results in more material that needs to be run through the grinder.

Composting Materials after Grinding

There were some notable differences between the pile of ground bone compost that was turned regularly compared to the pile that was left undisturbed. See Table 1. The turned pile was much drier with 64.8% solids vs 42.3% solids for the unturned pile. The volatile solids content, total carbon and total nitrogen were all lower for the turned pile and the C:N ratio was lower. All these indicate a more advanced stage of the compost process in the turned pile than in the undisturbed pile.

V. CONCLUSIONS

The project organizers concluded that both the soft tissues and bone material from slaughterhouses can be successfully composted using either horse bedding or hot municipal sludge compost. They also concluded that the pre-condition and turn method is able to achieve the goals of minimizing the exposure of putresible material, generating temperatures sufficient to kill pathogens and optimizing the compost process. They concluded that even though the addition of aeration pipes may result in a slightly quicker breakdown for soft tissue, the resultant increase in loss of liquids and the creation of a breeding place for flies, make this option undesirable. Turning the piles after grinding the bone material appears to speed the compost process.

Table 1. Immature Bone Compost with and without Turning

Parameter	No Turning	With Turning	Comments
Total Solids (%)	42.3	64.8	
Total Carbon (%)*	39.7	32.0	
Total Nitrogen (%)*	1.51	1.41	
Total Potassium (%)*	0.38	0.47	
Total Phosphorus (%)*	1.45	1.67	
Volatile Solids (%)*	75.7	65.0	
pH	6.0	6.8	
Bulk Density (lbs/cu yd)	600	450	
C:N Ratio	26.2	22.6	
Conductivity (mmhos/cm)	4.4	4.5	
Total Calcium(%)*	3.87	4.90	
* Reported on a dry basis.			

Table 2. Soft Tissue Compost with and without Aeration Pipes.

Parameter	With Aeration Pipes	Without Aeration Pipes	After Second Batch of Offal
Total Solids (%)	41.1	43.8	34.2
Total Carbon (%)*	40.2	35.6	35.5
Total Nitrogen (%)*	0.84	0.75	1.19
Total Potassium (%)*	0.66	0.67	0.58
Total Phosphorus (%)*	0.28	0.21	0.27
Volatile Solids (%)*	78.2	82.4	75.1
pH	8.0	7.7	8.2
Bulk Density (lbs/cu yd)	500	450	650
C:N Ratio	47.7	47.3	29.8
Conductivity (mmhos/cm)	3.3	4.1	4.4
NH4-N (%)*	0.09	0.04	0.06
* Reported on a dry basis.			

Table 3. Municipal Sludge Compost before and after Addition of Offal

Parameter	Before Adding Offal	After Adding Offal	Comments
Total Solids (%)	61.1	44.2	Most notable change
Total Carbon (%)*	35.9	34.0	
Total Nitrogen (%)*	1.64	1.74	
Total Potassium (%)*	0.21	0.31	
Total Phosphorus (%)*	0.98	0.67	
Volatile Solids (%)*	72.1	67.8	
pH	7.6	8.1	
Bulk Density (lbs/cu yd)	550	650	
C:N Ratio	21.8	19.5	
Conductivity (mmhos/cm)	4.4	5.3	
NH_4-N(%)*	0.22	0.24	
* Reported on a dry basis.			

Cornell's Natural Rendering Method

Jean Bonhotal
Cornell Waste Management Institute
Dept. of Crop and Soil Sciences
101b Rice Hall
Ithaca, NY 14853
607/255-8444 (w), jb29@cornell.edu

Current Situation

In many rural communities, the custom butcher business is important to the survival of small farm operations that raise livestock. These businesses provide a critical service by processing farm-raised animals into a salable retail product — table-ready meat. Most small livestock farms sell their products directly to consumers. It would be very costly for them to operate their own slaughter and butchering facilities.

Butchers, in 2002, are paying $20 per barrel for disposal of residuals. Since slaughtered cattle generally yield 40% in retail cut, the processing of a 1,200 pound steer would produce approximately 720 pounds of non-retail residuals. This equals 1.5-2 barrels or $30-$40 in disposal fees after the brains, spinal cord and paunch manure are removed. With 400 butchers in New York State each processing an average of 600 beef cattle per year, the average cost to each operation is $18,000 to $24,000 a year in disposal fees. Total cost to the custom butcher industry for beef slaughter residuals alone would be approximately $10 million for disposal of 58,000 tons of butcher waste. Many butchers also process other species, including ostrich, deer, goats, sheep and hogs. These residuals must also be disposed of and are not accepted for rendering. Blood is not generally collected from smaller operations even if they have rendering services available. Much of it is poured on the ground or buried. This practice can cause biosecurity problems, attract animals and potentially pollute ground and surface water.

Key Points of Static Pile Butcher Residual Composting

- Select site that is well drained, at least 200 feet from water courses, sinkholes, seasonal seeps or other landscape features that indicate the area is hydrologically sensitive.
- Lay a 24-inch deep bed of coarse wood chips 10-12-feet wide and as long as space permits to allow for 1-2 months of butcher residual.
- Spread a 12-15-inch layer of residuals then cover with a 12-18 inch layer of wood chips and add another layer of butcher residuals and cover with 2 feet of wood chips. The finished section should be 5-6 feet high
- When incorporating large amounts of blood, make sure there is plenty of material to absorb the liquid. Make a depression so blood can be absorbed and then cover, if a blood spill occurs, scrape it up and put back in pile.
- Make sure all residuals are well covered to keep odors down, generate heat or keep vermin or other unwanted animals out of the windrow.
- Let sit for 4-6 months, then check to see if the offal is degraded.

- Remove large bones before land applying compost or use as part of the base for the next compost pile.
- Site cleanliness is the most important aspect of composting; it deters scavengers, helps control odors, and keeps good neighbor relations.

Pathogen Control

Pathogens are organisms that have the potential to cause disease. There is a wide array of pathogens found in our environment and pathogens may be elevated in compost operations. While there are currently no temperature regulations for mortality and butcher residual composting, following NYS DEC regulations currently applicable for biosolids is highly recommended to ensure adequate pathogen control and minimization in this type of composting.

If 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^{0}F (55^{0}C) must be maintained throughout the pile for at least 3 consecutive days, monitored 6-8 inches from the top of the pile.

Very little work has been done on documenting pathogen kill in composting of dead animals and butcher residual. Research at Ohio State University suggests that common bacterial and viral pathogens are killed in regularly turned compost piles containing carcasses. Static-pile composting is being recommended as a more easily managed mortality composting technique. By properly constructing the compost pile to allow for adequate natural aeration, mortality composting can be completed on intact animals without physically turning and mechanically aerating the pile. Degree and duration of temperatures achieved in static-pile composting are adequate to significantly reduce pathogen survival. Compost amendment variables, temperature and pathogen kill in static compost piles are currently being investigated.

Economics of Butcher Residual Disposal Options

The amount of carbon material (i.e., wood chips, sawdust, etc.) required to compost one ton of butcher waste is 15 cubic yards. Many of these materials can be used more than one time. Example: incorporating the residual bones and chips into the next season's base material.

Presently, wood chips selling for about $550 per tractor-trailer load, or $5.50 per cubic yard. The cost per ton for the eight cubic yard base would be $44. Seven yards of cover material if purchased will be $38.50. With a 30% loss of material during the process, the cost per ton would be $24.75.

If we calculate 30 minutes for preparation and covering, the cost for labor would be $5; fuel for a 100 hp tractor at 0.4 gallons or $0.60. Tractor and loader rental in the northeast as reported by Doanes is $28 per hour. The total cost for the material, equipment, fuel and labor would be $44.35 per ton.

Pathogen Control

Pathogens are organisms that have the potential to cause disease. There is a wide array of pathogens found in our environment and pathogens may be elevated in compost operations. While there are currently no temperature regulations for mortality and butcher residual

composting, following NYS DEC regulations currently applicable for biosolids is highly recommended to ensure adequate pathogen control and minimization in this type of composting.

If 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 131ºF (55ºC) must be maintained throughout the pile for at least 3 consecutive days, monitored 6-8 inches from the top of the pile.

Very little work has been done on documenting pathogen kill in composting of dead animals and butcher residual. Research at Ohio State University suggests that common bacterial and viral pathogens are killed in regularly turned compost piles containing carcasses. Static-pile composting is being recommended as a more easily managed mortality composting technique. By properly constructing the compost pile to allow for adequate natural aeration, mortality composting can be completed on intact animals without physically turning and mechanically aerating the pile. Degree and duration of temperatures achieved in static-pile composting are adequate to significantly reduce pathogen survival. Compost amendment variables, temperature and pathogen kill in static compost piles are currently being investigated.

Source: Bonhotal, J.F., Telega, S.L., and Petzen, J.S. 2002. Natural Rendering: Composting Livestock Mortality & Butcher Waste, Cornell Waste Management Institute, 12 page fact sheet and 3 posters. For the complete fact sheet and further information visit http://cwmi.css.cornell.edu

Management of Slaughterhouse Bone Residual for Composting

Submitted by: Mark Hutchinson, University of Maine Cooperative Extension, 377 Manktown Rd Waldoboro, ME 04572 phone: 207-832-0343 email: **markh@umext.maine.edu**

AUTHORS: M.L. Hutchinson, B.Seekins, N. Hallee, M.A.King

I. Introduction

Beginning in the winter of 2001, the Maine slaughterhouse industry faced a crisis associated with disposal of the waste products (offal) from their facilities. As a response to that crisis, the Maine Department of Agriculture, in cooperation with the University of Maine Cooperative Extension and Maine Department of Environmental Protection undertook a program to assess composting as a viable approach to managing these wastes.
One of the significant technical difficulties encountered in the offal composting trials was the management of bones. Trials were developed to assess the adequacy of different types of grinding equipment for managing the bones from slaughterhouses. Equipment was assessed for safety, grinding performance and composting performance of material after grinding.

II. Materials and Methods

A tub grinder, wood chipper, hammer mill, ALLU bucket, and vertical mixer wagon were identified for evaluation. The wood chipper was ruled out because of serious safety issues. Bone grinding trials conducted at Highmoor Farm Agricultural Experimental Station, evaluated a Farmhand tub grinder and an ALLU bucket. Other identified equipment not tested was either unavailable or not operational at the time of the trials.

For each piece of equipment, a trial was conducted with a mixture of bones and horse bedding that had been composting for approximately six weeks and a second trial with each piece of equipment using fresh 'bones' and horse bedding. In all cases, the 'bones' actually consisted of a mixture of bones, fat, hides, heads, feet and animal parts other than entrails from a slaughterhouse.

In all cases, the blended materials were ground using the piece of equipment and then formed into a windrow (pile). The windrows were identified by equipment and bone condition (See Table 1).

Table 1. ID Numbers for Trial Windrows

ID #	Equipment Used	Material Used
A1	ALLU Bucket	Precomposted bones & bedding
A2	ALLU Bucket	Fresh bones & bedding
B1	Tub Grinder	Precomposted bones & bedding
B2	Tub Grinder	Fresh bones & bedding

Approximately 50 cubic yards of material was ground in each piece of equipment, 20-25% offal and 75-80% horse bedding. Windrows were left undisturbed except for data collection and sampling activities. In a normal compost operation, the windrows would have been turned on a schedule dictated by the age of the materials and pile temperatures. In this trial, however, it was felt that turning would compromise the results. It would not have been possible to separate the changes in size distribution created by the composting process from the mechanical reduction that would happen as a result of turning with a windrow turner or front loader. The only management activities during the process were taking pile temperatures and making observations on pile odors, vector activity, leachate, etc.

IV. Data Collection Methodology

Data collected from each of the trials included: equipment performance and safety, temperatures early in the process, distribution of particle size within the windrow, total weight of large pieces that rolled to the outside during pile formation (tailings) and a laboratory analysis that included compost quality parameters.
The equipment characteristics evaluated included: necessary supporting equipment, time to grind bones and build windrows and safety concerns.
Temperatures were taken at approximately one week intervals during the first month of the trials. Readings were taken at depths of one foot and three feet on both the north and south sides of each windrow each time temperatures were taken. (See Figures 1 – 4)
The determination of the distribution of particle size within the windrows was done by screening out the fine material and then sorting the larger pieces by hand. Four size categories were established, particles that would pass through a ½ inch screen, pieces between ½ inch and 1 x 3 inches, pieces between 1 x 3 inches and 1x 6 inches and pieces larger than 1 x 6 inches.

To determine the size distribution, a five gallon bucket of material was randomly collected from each side of each windrow. The sample from each side of each windrow was screened and recorded separately. The screened portions were each weighed. (See Table 2)

Even though the same volume of material was collected from each windrow (10 gallons), the total weight of material for each windrow varied from 40 to 59 lbs. This is because of variations in the amount of bone and other heavy tissue, the moisture content and the overall texture of the mixtures. To adjust for these differences, the percentage of the total weight was also calculated for each fraction to allow for comparison between different samples. These are also displayed in Table 2.

The large pieces of bone, hide and soft tissue that rolled to the outside of the pile during pile formation (tailings) were quantified by collecting and weighing all the pieces that would not pass through the ½ inch screen from a five foot section in the center of windrow. Table 3 and Figure 6 show the total weights from each windrow.

At the conclusion of the project, random samples were taken from each pile for a complete compost analysis. The samples were collected by digging into the windrow approximately 12 to 15 inches and taking one shovel full at each location. The Plant and Soil Analytical Lab at the University of Maine completed the analysis using standard lab techniques. This included tests for

Nitrogen, Phosphorus, Potassium, Carbon, volatile solids, conductivity, moisture, bulk density, pH and C: N ratio.

V. Results

Equipment Performance

Normal safe operating considerations around front end loaders and agricultural implements are necessary. In addition, the following specific safety considerations were noted.

The ALLU bucket addition to the front end loader increased the weight on the front of the loader. The operator must take this weight increase into consideration during loader operation. The ALLU bucket appeared easier to use in bone grinding and windrow building and accomplished such in a minimum amount of time. There did appear to be more large bone particles mixed into the sample piles and more bone tailings accumulating at the base of the piles with the ALLU bucket. The ALLU bucket needs to process the same batch of material through the bucket more than once to achieve satisfactory bone particle size reduction.

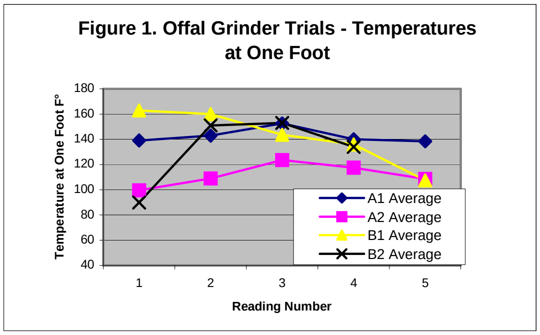
The tub grinder produced a finer ground mixture within the sample pile with very few bone tailings accumulating at the base of the pile. The tub grinder needed much more time to process that equivalent amount of material. There appeared to be bone fragments that were thrown out of the tub grinder during operation. The tub grinder experienced difficulty handling wet material. Brush was added to the tub grinder to move the bone/bedding mixture into the grinder, otherwise bridging occurred.

The ALLU bucket was able to grind the materials much faster than the tub grinder. However, the resulting size distribution of the bone fragments was much greater for the ALLU bucket than for the tub grinder (Table 2)

Table 2. OFFAL GRINDER TRIALS- Screening Results					
Size Category	<1/2 inch	1/2 TO 1x3 in.	1x3 TO 1x6 in.	> 1x6 in.	TOTAL
ID #	**Weight in Pounds**				
A1-Nov02	44.25	4.25	0.375	3.25	52.125
A2-Nov02	36.5	5.5	0.125	10.25	52.375
B1-Nov02	39	1.5	0.125	0.125	40.75
B2-Nov02	38.5	4	0.375	1.5	44.375
A1_May03	41.75	2.5	0.5	1	45.75
A2-May03	53.25	4	1	1.125	59.375
B1-May03	41.25	0.625	0.25	0	42.125
B2_May03	45	4	0.875	0.125	50
	Percentage				
A1-Nov02	84.89	8.15	0.72	6.24	100
A2-Nov02	69.69	10.50	0.24	19.57	100
B1-Nov02	95.71	3.68	0.31	0.31	100
B2-Nov02	86.76	9.01	0.85	3.38	100
A1_May03	91.26	5.46	1.09	2.19	100
A2-May03	89.68	6.74	1.68	1.89	100
B1-May03	97.92	1.48	0.59	0.00	100
B2_May03	90.00	8.00	1.75	0.25	100

Windrow Temperatures. Figure 1 shows the temperatures taken at the one foot depth. Note that the two trials using fresh materials (A2 and B2) both started out at a lower temperature than the two that had precomposted materials (A1 and B1). The temperature in the precomposted material ground with the tub grinder (B2) rose much quicker than that ground with the ALLU bucket and maintained a higher temperature through the sampling period. The precomposted material that was ground with the tub grinder (B1) started out at a much higher temperature than any of the other trials (over 160°F). The temperature in this windrow then slowly declined to about 110°F over the next five weeks. Windrow A1, on the other hand, started out at about 140°F, rose gradually to about 150°F and then returned to the 140 °F. The one foot temperature in windrow A2 demonstrated a very similar pattern to that for A1 but was generally 30 to 40°F lower. The lower temperatures in the two fresh piles (A2 and B2) may have been due to the less uniform mix and because the preconditioned piles had a well established biological population at the outset.
Figure 2 shows the temperature readings at three feet for all four trials. Here again, the two piles with preconditioned material (A1 and B1) had higher temperatures throughout the period than those using fresh materials (A2 and B2).

Overall, the two windrows with the precomposted materials (A1 and B1) maintained higher internal temperatures than the two with fresh materials (A2 and B2).



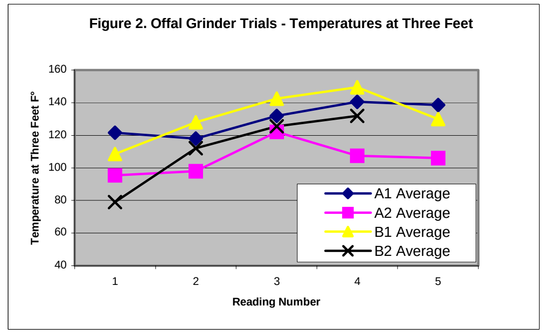
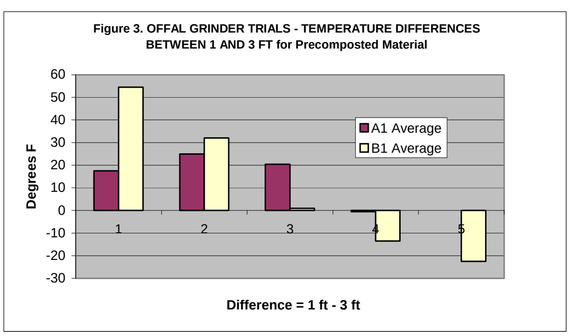
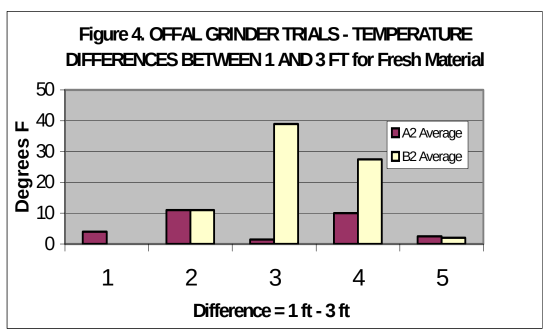


Figure 3 illustrates the differences in the one foot and three foot temperatures for the two piles using precomposted materials. Note that for both windrows, the one foot readings were consistently higher than the three foot readings for the first half of the sampling period. This difference indicates a high level of activity in the piles that results in reduced temperatures in the pile core as activity becomes limited by oxygen availability.

Figure 4 shows the differences between the one foot and three foot temperatures for the piles with fresh materials (A2 and B2). The temperature difference between the one foot and three foot readings rapidly increased and then declined over time. Because it contained fresh rather than precomposted material, the decline in activity occurred much later in the process. Windrow A2 (ALLU bucket) also had temperatures at one foot higher than at three feet throughout the sampling period, but these differences were relatively small throughout the period and did not display a consistent pattern. Again, this was probably because of the less uniform particle size and less adequate mixing in this windrow which slowed the activity in the pile.





The results of the screening trials done in November 2002 and May 2003 are displayed in Tables 2 and 3 and in Figures 5 through 10. Figures 5 and 6 show that most of the material in all four trials was small enough initially to pass through a ½ inch screen. Only windrow A2 (fresh material ground with the ALLU bucket) had more than 15 lbs (30%) of material that did not pass through the ½ inch screen. Figure 6 shows that for all four trials, the percentage of the material that passed a ½ inch screen was greater in May than in the previous November. This is consistent with what would be expected in a normal composting process. The largest increase in this fraction occurred in windrow A2 which originally had a very high percentage of the particles over ½ inch.

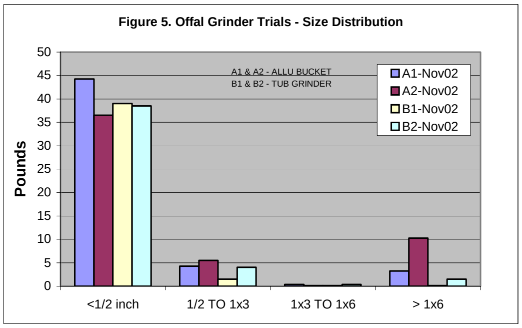


Figure 5. Offal Grinder Trials - Size Distribution

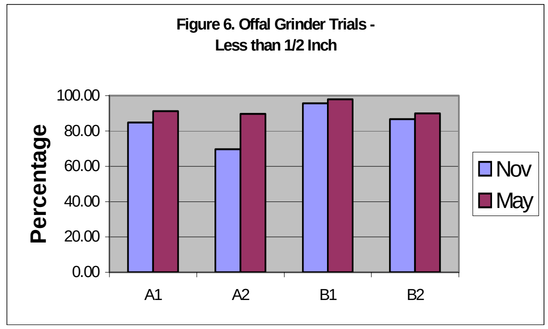


Figure 6. Offal Grinder Trials - Less than 1/2 Inch

Figures 7 through 9 look at the percentages of the materials that fell into different size categories over ½ inch. The most dramatic differences in the initial weights were in the ‘over 1x 6 inches’ size category. The two trials done with the ALLU bucket had a much larger percentage of the material in this size category than either of the tub grinder trials. Also, the trials with fresh material had noticeably larger percentages of large pieces than the trials with precomposted material. The large pieces in the fresh material included hides and other soft tissue in addition to the bones, while the precomposted material was primarily bones and bedding since the soft tissue had already decomposed prior to grinding.

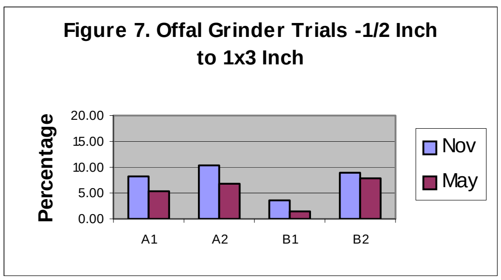


Figure 7. Offal Grinder Trials -1/2 Inch to 1x3 Inch

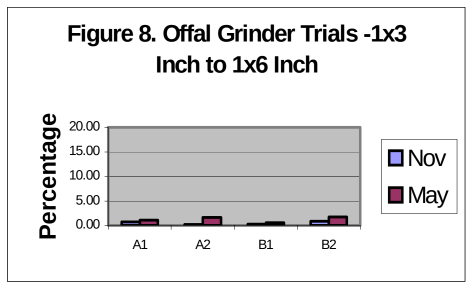


Figure 8. Offal Grinder Trials -1x3 Inch to 1x6 Inch

By the end of the trials in May 2003, however, the differences in the large category had reduced considerably. This was a result of a reduction of large pieces during the compost process. Trial A2, in particular, had a dramatic reduction of material in the large size category, dropping from about 20% of the total weight to about 2%. Trial A1 also had an impressive reduction from about 6% to about 2%. Trials B1 and B2 started out with a relatively small volume of large pieces and these had reduced to almost zero by the end of the trial.
The only size category over ½ inch that saw an increase was the next to largest category (1x3 to 1x6 inch). In this category, there were slight increases in each of the trials. This was probably because some of the material that was in the largest category at the start of the trials being reduced to this size, but not decomposing completely.

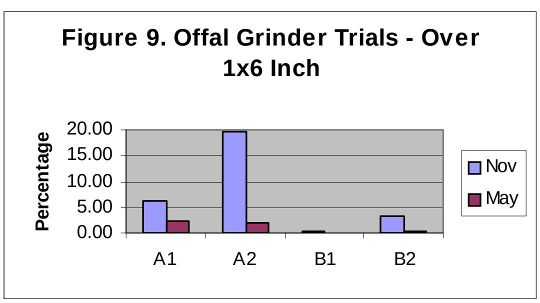


Figure 9. Offal Grinder Trials - Over 1x6 Inch

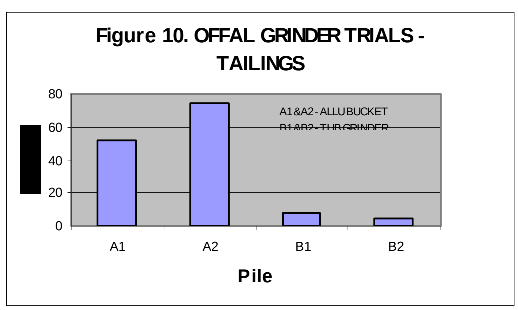


Figure 10. OFFAL GRINDER TRIALS - TAILINGS

Some of the greatest differences between the trials were the quantities of larger pieces that rolled out of the pile during the pile formation (tailings). Table 3 and Figure 10 display these differences. The windrows formed with the ALLU bucket had much more material along the outside than the two built with the tub grinder. The windrow of precomposted material had over 50 lbs from the ALLU bucket (A1) compared to only 8 lbs from the tub grinder for the same material (B1) while the windrow of fresh material ground with the ALLU bucket (A2) had over 70 lbs as compared to less than 5 lbs from the tub grinder (B2). However this did not significantly affect the compost analysis.

There were very few differences of any significance between the characteristics of the compost produced in the trials. The one difference uncovered was the soluble nitrogen content of the precomposted (preconditioned) material compared to the piles that started with fresh bone material. The soluble nitrogen (ammonium and nitrate) was considerably higher in Trials A1 and B1 than in A2 and B2. This means that the compost from the preconditioned piles would have more plant available nitrogen than the compost made from fresh bone material.

Table 3. OFFAL GRINDER TRIALS - Tailings from Each Pile

ID #	Pounds Along Ten Feet of Windrow
A1-Nov02	51.5
A2-Nov02	74
B1-Nov02	8
B2-Nov02	4.75

VI. Discussion and Conclusions

Precomposting works better. The first conclusion drawn from these trials is that precomposting the material before grinding is preferable to grinding it fresh. The temperature response in the windrows showed that the process was working more efficiently. There was also far less odor and potential for vector attraction with the precomposted material and so less likelihood of causing a nuisance or environmental problem. The more uniform particle size after grinding meant that it was possible to get a more uniform mix. In addition, precomposting the material would mean less management would be needed on the site. With the precomposted material, all the putrescent portions have decomposed before grinding so the only thing that might be exposed during or after the grinding would be clean bone pieces.

Side by side comparison of nutrient values and several other compost quality parameters suggests that most of these factors in the final compost product are not affected much by the choice of grinding equipment. Levels of ammonium and nitrate N were 4 to 5 times higher in the trials using precomposted materials compared to the trials using fresh bone material.

Tub grinder gave better composting performance. Both the fresh and precomposted materials ground with the tub grinder demonstrated better composting performance than their counterparts ground with the ALLU bucket. This was most likely related to the overall finer grind achieved and the smaller volume of large pieces in the mix. Because of the preferable texture, there was also a generally more uniform mixture that allowed the tub grinder piles to perform in the way that would indicate a well made compost pile. The tub grinder also resulted in far fewer tailings with both materials than the ALLU bucket, meaning that there would be less site clean up needed after each batch of material had been ground and formed into windrows.

ALLU bucket was quicker and easier to use. The use of the ALLU bucket was a two step process to build the windrow. The ease of the operation would allow the operator to come back to a windrow periodically and regrind as part of the turning process. If this piece of equipment was available on site as a regular part of the operation and could be used to regrind and mix piles, better results would be achieved.

The tub grinder, on the other hand, required some additional steps that slowed the process down. Wet heavy material slowed the tub and caused bridging inside so that the material did not get fed into the grinder uniformly. This was particularly a problem with the fresh material. Adding an occasional bucket load of brush (tree limbs and twigs) to the tub, kept the wet clumping material moving into the grinder blades and sped up the process. Having to add the brush, however, made another step for the operator.

Recipes and Hygiene for Animal Mortality Composting

***W. F. Brinton, Pamela H. Storms**
Woods End Research Laboratory, Mt Vernon Maine USA
*wfbrinton@woodsend.org

SUMMARY

The inclusion of mortalities of fish and mammals in composting has been on a steady increase since the 1980's, when pilot studies began many of which were conducted in Maine with involvement by the Woods End Research Laboratory. These pioneering efforts over the past 20 years evaluated issues concerning how to construct mix-ratios of disparate animal parts; bacterial and pathogen content of finished compost; odor and ammonia control; and process management and speed of disappearance of bodily parts. The experiences and findings led to improvements in understanding and enhancements in the success in several operations. Presently new hygiene issues are emerging as concerns of BSE presence in mortality waste present new challenges for recipe formulation and management. This presentation will present a historical overview with collected test data and selected images from many special particular studies.

Woods End's first significant effort focused on poultry mortalities arising from a catastrophic loss in a 1988 fire at the DeCoster egg facility, in Turner Maine. At that time, there was little or no evidence of published literature concerning large scale composting of dead birds. Recipes were developed empirically based on C:N and moisture balancing, and consisted of layering manure with added sawdust along with unearthed birds from previous burial followed by immediate windrow turning, and composted to the point of disappearance of all recognizable features.

Salmon mortalities at Maine aquaculture fisheries were a focus of another round of Woods End studies that focused on the scale and convenience of operations: small in-vessel drum composters were designed and placed near the unloading area of the docks. Monitoring of these vessels for C:N ratio, output of ammonia vapor and stabilization was accomplished, indicating a rapid disappearance of fish within 2-3 days followed by a long slow rise in ammonia, pH and heating. The high oil content (up to 20% wet weight) of certain fish wastes presented a new challenge as fatty acids temporarily accumulated during composting. These largely successful efforts lead other fisheries and firms in the Pacific Northwest, Scotland and the channel coast of England to employ Woods End's services to focus and guide mortality composting.

Together with the Merck Company, Woods End evaluated several medium scale options for composting of large cattle carcasses, by placement of pieces layers in 1-meter bins along with straw and manure, enabling turning with bobcat loaders. These tests conducted in the Midwest were then exported to cattle ranches operated by Merck in South America. Recipes were developed which anticipated the total content of nitrogen in the carcass as well as the water and the oil contribution. Fatty tissue in cattle can reach as high as 32%, and acts to "soak" the carbon materials, making them appear wetter than they actually are.

These efforts of composting cattle carcasses predated the period where bovine spongiform encephalopathy (BSE) emerged as a leading concern in the United Kingdom and elsewhere.

Significant shifts in focus in Europe, and the adoption of the EC Animal By Products Order, strictly regulating (and reducing) composting as an option for carcasses emerged after this time.

Composts made from mortality wastes are relatively new compared to manure based products, yet if constructed properly do not appreciably alter or change the apparent analysis of the end products. The nitrogen content of carcasses contributes favorably to the nutrient environment, and like other nitrogenous wastes must be aerobically managed to avoid generation of odorous compounds. Putrescent amines and ammonia plus fatty acids from intermediary decomposition products of fatty tissue, will be the principle concern to avoid nuisance.

Presently hygiene concerns for BSE presence in bovine waste must be carefully considered if composting is to expand for carcass disposal. There is a paucity of evidence that composting renders prions into safe, decomposed form. However, new evidence is emerging that provides some insight into degradation mechanisms that may be applicable to composting.

Prions are irregular proteins with complex layered pleated-sheet (folded) structures. To be digested (hydrolyzed) into their amino acid components whereby they would degrade rapidly in a compost, requires several steps including at least unpleating, disconnection from each other and then hydrolysis of the bonds between amino acids. The human digestive system is capable of hydrolyzing many prion types using enzymes (proteases) and normal proteins degrade by similar microbial mechanisms in nature. Prions that change their folding pattern slightly so that they are not digestible, are pathogenic because (a) they cause the normal prion replication to produce this digestion resistant form (“PrPres”) and (b) they form massive insoluble fibers (amyloids) that crowd and totally interfere with the normal functions of the organ in which they are formed. Eventually holes form where normal tissue is gone. Many human diseases result from accumulation of amyloid fibers. Transmissible Spongiform Encephalopathies, including BSE, CWD, CJD and vCJD, Scrapie, and others are among them.

Researchers have identified and tested bacteria that do secrete proteases capable of digesting these *PrPres* prions. Some are thermophiles from extreme environments but some are feather-digesters, i.e. involved in normal degradation of bird feather proteins. Evidence suggests they may require pretreatment before successful digestion, but these pretreatments may be within the range of conditions within some types of composts. These facts plus the general principal that there is a microorganism somewhere that will use any particular molecules as its carbon source direct us to seek those bacteria within the normal compost environment that includes feathers as feedstock.

A thorough search for the necessary enzymes (keratins) by assay of keratin-digesting capability followed by seeding of compost with newly available nonpathogenic prions could set the stage for actual composting of PrPres to extinction.

The diversity of experience of these many years indicates that various approaches and differing scales are feasible for processing animal parts via composting, but also that the field is evolving rapidly both under pressure of waste disposal and the sheer necessity of upgrading hygiene as significant new concerns emerge. It is likely that significant changes are in store for the future.

References:

M.Miller, et al. Environmental Sources of Prion Transmission in Mule Deer. *Emerging Infectious Diseases*. www.cdc.gov/eid, vol.10, No.6, June 2004

K. Tsiroulnikov et al. Hydrolysis of the Amyloid Prion Protein and Nonpathogenic Meat and Bone Meal by Anaerobic Thermophilic Prokaryotes and *Streptomyces* Subspecies. *Journal of Agricultural and Food Chemistry*. 2004, 52, 6353-6360.

J.P.M. Langeveld et al. Enzymatic Degredation of Prion Protein in Brain Stem from Infected Cattle and Sheep. *Journal of Infectious Diseases*. 2003;188:1782-1789.

Policies and Regulations – Session Chair: Tom Miragliuolo

On-Farm Mortality Management Initiatives for the Nova Scotia Agri-food Sector

R. Michitsch[1] and R. Gordon[2]

1 Soil and Crop Improvement Association of Nova Scotia
2 Department of Engineering, Nova Scotia Agricultural College

This presentation will focus on describing some of the current programs, farm-level options and pilot initiatives which exist for farmers within the province of Nova Scotia (Canada). Components of the current Deadstock Pick Up Program within portions of the province will be discussed in relation to operational costs, management and current annual volumes. The development of farm-level resource materials and producer training programs related to deadstock management will be described in the context of the Environmental Farm Plan Program. Additionally several industry-based composting pilot projects will be described including: (i) a municipal deadstock system, (ii) slaughterhouse waste demonstrations systems and (iii) a mink carcass composting systems.

Hurricane Floyd: Lessons Learned and Changes Made

Submitted by: Daniel J. Wilson, DVM, North Carolina Department of Agriculture, Emergency Programs, 1035 Mail Service Center, Raleigh, NC 27699-1035, phone: 919-807-4303, email: daniel.wilson@ncmail.net

North Carolina Department of Agriculture learned a lot about responding to disaster during Hurricane Floyd in 1999. This presentation will discuss six main points which were learned from this disaster and are being integrated into our current plan.

The first lesson was that all response agencies need to respond through the local or state emergency management (EM) office using the Incident Command System. During Hurricane Floyd the North Carolina Department of Agriculture (NCDA) needed resources for response, but since we didn't know how to request them from EM we either went without or wasted a lot of time trying to find the resource. Additionally EM spent a lot of extra money and time responding to animal issues with out the appropriate knowledge and background within that field.

The second lesson was to use local responders. During Floyd many out of state responders were brought in to assist. These responders had to be trained and informed about local resources. Then once the response was over, the responders all left the affected area and took the response money's with them, leaving little money in the affected areas for infrastructure reestablishment. If local responders were used the response time would have been shorter, the contacts between responders would have already been established, local resources would have been known and the recovery money's would have stayed local.

The third lesson is knowing where all the premises are located prior to the event. We were blessed with a good understanding of where the poultry and swine premises were located, but a lot of time was taken tracking other potentially affected species.

The fourth lesson is knowing your disposal methods. We lost over a week just discussing what the possible disposal methods could be. Once a method was considered we were not sure if it would work, what it would cost or how long it would take. Preplanning in this area can prevent a lot of headaches and departmental conflicts during an event.

The fifth lesson was not learned during Floyd, but has been learned since Floyd. The fifth lesson is the need for a unified effort or a "Clearing House" to gather and disseminate information about animal disposal. There are a lot of ideas, a lot of money and a lot of experience in the area of animal disposal. However Animal Disposal continues to be one of the leading areas of conflict and delay during an animal mortality event. This is largely because many states are working independently and without unified national direction. The establishment of an Animal Disposal Clearing House would compile information globally, combine previously disconnected practices, then present decision making tools in a concise and manageable format to all state agencies.

Finally the sixth lesson was about business continuity. This was not the case with Hurricane Floyd, since less than 1% of the industry was affected. However as bioterrorism has become a possibility, larger animal mortality disasters have been considered. The current policy for handling an emerging livestock disease focuses on “Stamping Out” the disease. If a disease were to expand beyond initial stamping out efforts, alternative eradication methods may be necessary to prevent destroying the vary industry we are trying to protect. The methods may include regionalization, vaccination and joint state agreements.

Although these are not all the lessons learned from Hurricane Floyd in North Carolina they are the spring board that started our emergency response capabilities.

OHIO's LIVESTOCK and POULTRY MORTALITY COMPOSTING PROGRAM - 10 YEARS of SUCCESS

H.M. Keener[1], S.S . Foster[2] and S.J. Moeller[3]
[1]Dept. of Food, Agricultural, and Biological Engineering, The Ohio State University, Wooster, OH. 44691, <keener.3@osu.edu>; [2]Extension Agent Darke County; [3]Extension Specialist, Animal Science, The Ohio State University, Columbus OH 43210.

Introduction

Dead animal composting as a disposal method on U.S. farms began with poultry in the 1980's (Murphy and Carr, 1991). Later it was adapted to swine (Fulhage and Ellis, 1994; Glanville and Trampel, 1997) and most recently it has been adopted for other livestock (cattle, sheep), exotic animals, and road kill. This need was brought on by the disappearance of rendering plants, concerns over burial and ground water pollution, and the economic cost and other issues related to incineration.

In Ohio, disposal of dead farm animals by composting became legal in 1994 with Ohio Senate Bill 73. However, this bill required farmers to be certified by Ohio State University Extension before they could put this method into practice and to dispose of compost from livestock mortalities. To develop the certification program, an Ohio composting team was constituted using personnel from The Ohio State University Extension, Ohio Agricultural Research and Development Center, Ohio Department of Agriculture (ODA), Ohio Department of Natural Resources (ODNR), USDA / Natural Resources Conservation Service, and the Ohio Livestock Coalition. This team consolidated information from many sources into the manual "*Composting Swine and Poultry Mortality in Ohio*". The manual was made up of eight chapters and provided information on composting principles, site selection, facility sizing, management of facility, biosecurity, rules and regulations, economics, and trouble shooting. It emphasized that either covered bin or outside windrow systems were satisfactory as long as the composter met four objectives:

1. protect ground and surface water from pollution;
2. reduce risk of the spread of disease;
3. prevent nuisances such as flies, vermin, and scavenging animals; and
4. maintain air quality.

The certification program itself consists of a 3 hour course with 15 to 30 minutes on each of the 8 chapters in the manual, using a 120 slides PowerPoint presentation with examples. Presentations are generally done by 2-3 presenters. Over 1200 farmers were trained using that first manual.

In 1999-2000, the team revised the manual to include all livestock species since rendering plants were continuing to close or increase charges to farmers. The revised manual, *Ohio's Livestock and Poultry Mortality Composting Manual* (OSUE, 2000), used a universal design procedure to size the primary and secondary composting volume requirements based upon the animal's body weight (Keener, *et al*., 2000; see Table 2). In the past specific recommendations had been adopted for composting each species and failed to recognize the similarities of the process for any mortality (species). Currently over 2900 Ohio farmers have been certified. Figure 1 shows the yearly certifications since the program began in 1995

Ohio's Experience with Program

Bender *et al*. (1998) surveyed swine producers in 1998 who had taken the OSUE course. For the 151 respondents, 51% found that composting saved them money, 46% found that it increased bio-security, 68 percent found it was easy to manage, and 44 % felt it exceeded their expectations. Only 0.6 percent found composting to be less successful than expected.

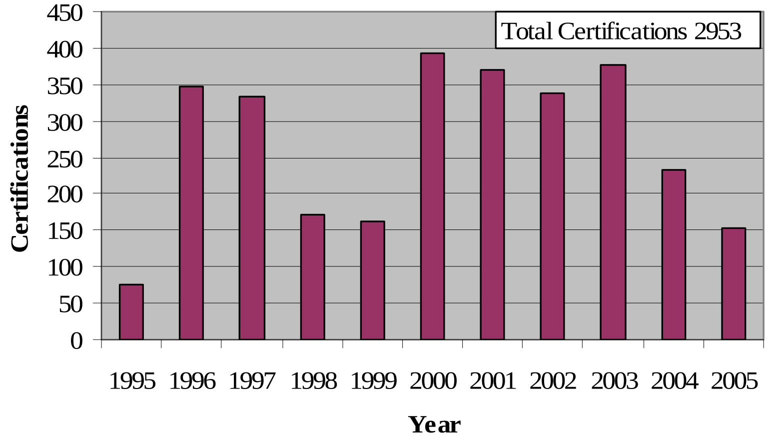


Figure 1. Number of certifications for mortality composting issued in Ohio by year.

In 2001, a general survey of mortality composting practices and procedures being followed by certified Ohio livestock producers was conducted by Foster, et al. (2001). Results showed that 43 percent of mortality composting occurred in outdoor windrow/static pile systems located on a compacted soil base, 13 percent composted in a windrow/static pile with a concrete base, and 25 percent used bin composting with concrete floors and a roof. When asked the greatest challenge associated with mortality composting, producers indicated degradation of long bones and skulls (27 percent), maintaining temperature of the pile (13 percent), lack of knowledge and skill about composting (11 percent), and scavenging animal control (10 percent). Overall, 90 percent of producers were please with the success of their composting program, and 91 percent rate the skills they learned from the program as valuable. These responses emphasized the importance of the certification program in providing producers with the proper information for managing the composting systems.

New Program Areas

Ohio highway departments (3 sites currently registered) and custom butchering businesses are adopting the concept of composting dead animals as a safe, economical way to handle road kill and meat processing by-product. This approach is being driven by landfills not wanting dead animals and renders charging more for their services. Under current Ohio rules and regulations, these composting sites are permitted by the OEPA and require a Class II site license.

Dead Animal Composting in Ohio

The following is a brief description of on farm dead animal composting as taught to Ohio's agricultural livestock producers.

Eligibility

On farm mortality composting is regulated by the ODNR Division of Soil and Water Conservation (Ohio Administrative Code-Rules 1501:15-5-01 through 1501:15-5-18 under Ohio

Revised Code Section 1511.022). For an operation to fall under ODNR rules, the operation must fit the description below. Otherwise, the Ohio EPA regulates the composting operations.

1) The composting is conducted by the person who raises the animals and the compost product is used in agricultural operations owned or operated by that person, regardless of whether the person owns the animals (*in essence, a farmer composts his livestock mortality on his own farm and reapplies it to his own fields)*; or

2) The composting is conducted by the person who owns the animals, but does not raise them and the compost product is used in agricultural operations either by a person who raises the animals or by a person who raises grain that is used to feed them and that is supplied by the owner of the animals *(the same general principal as above applied to contract/cooperative farming operations)*.

Compliance

To comply with ODNR's Composting of Livestock Mortalities Rule (1501:15-5-18), the person composting livestock mortality resulting from the operation shall be certified (see introduction). In addition they must use the appropriate method, technique, or practice of composting as established in the "USDA-NRCS Field Office Technical Guide" *(Standard 317 Composting Facility Standard)* or other such standard as approved by the Chief.

Restrictions

The ODA (Ohio Revised Code 941.06, ORC 941.14 and 941.15) regulates disposal of animal carcasses. If the ODA determines the animal died because of a dangerously infectious disease (reportable disease), the Director may require a specific method of disposal other than composting. A list of reportable diseases is maintained by the ODA. An example of mortality not permitted to be composted is cattle over two-years-of-age showing signs of neurological disease.

Process:

Dead animal composting can be described as *"above ground burial in a bio-filter with pathogen kill by high temperature*." The process is achieved in two stages, a primary and secondary stage using a static pile approach (Figure 2). In the primary stage the decomposition process is anaerobic (lacking oxygen) in and around the animal carcass, but aerobic in the surrounding material where odorous gases are ingested by microorganisms and degraded to CO_2 and H_2O (Figure 3). The amendment that surrounds the animal carcass or layers of carcasses provides carbon (energy) for the microorganisms and serves as the biofilter.

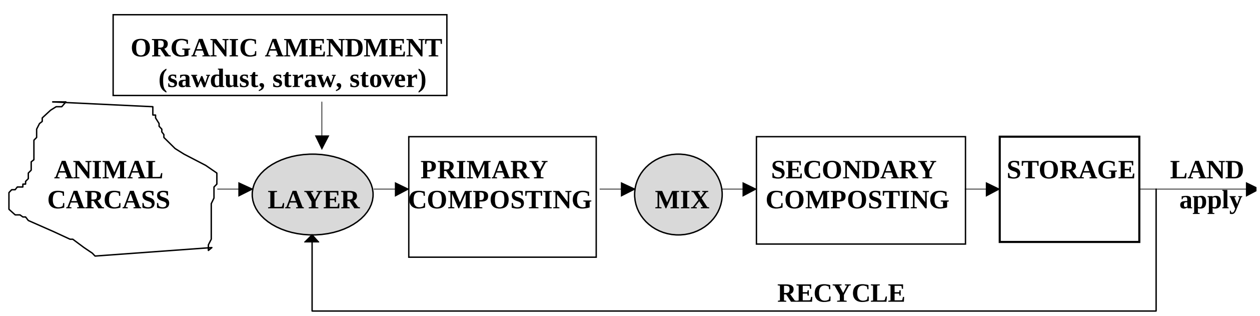


Figure 2. Material flow in dead animal composting. Forced aeration is not used. Materials are not mixed until flesh of the animal body is completely decomposed. Time can vary from 10 days (poultry) to over 100 days (> 400 lb animal).

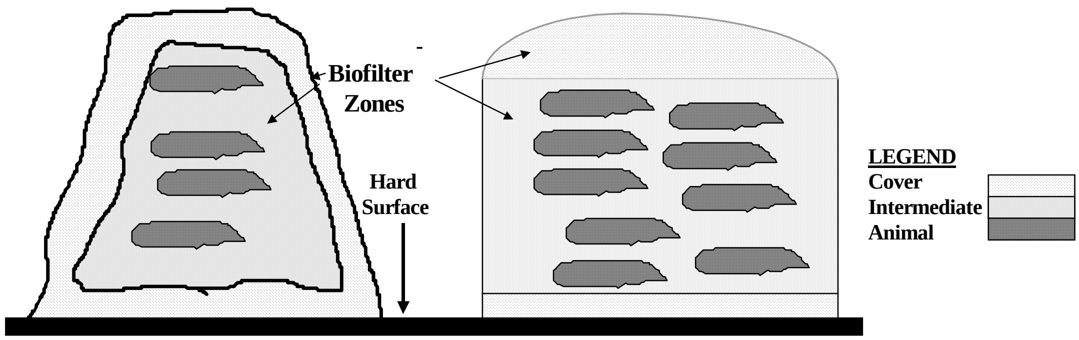


Figure 3. Cross Section Views of Composting in a Windrow or Bin for Animal Mortality. Layered animal carcasses are surrounded by material that not only provides carbon (energy) for the microorganisms, but also acts as a biofilter. Pile shape will depend on whether done in the open or in a bin.

The general procedure followed for composting carcasses in the primary stage is to first construct a base from sawdust or acceptable amendment at least 30 cm (1 ft) thick. (This may not be enough for very large animals.) Next, place a layer of carcasses on the sawdust base. Then cover the carcasses with 30 to 60 cm (1-2 ft) of damp amendment. The cover material prevents the pile attracting scavengers and flies, minimize water leachate in the case of high rainfalls for the uncovered pile, and insures adequate insulative value for the composting zone to reach 130^{o}F or higher (pathogen kill). In winter more secondary compost over the carcass is used to maintain pile temperature. If additional carcasses are to be added to the pile, hollow out the pile and place the new carcasses. Ten to 15 cm (4-6 in.) of amendment should be maintained between layers. For moderate size animals (poultry, pigs, sheep, etc.) the primary period is generally less than three months after the last carcass has been placed into the pile. Table 1 illustrates the relationship between the animal body weight and composting cycle times (Note: 10 days is a minimum cycle time).

After the primary stage, the compost is moved to a secondary area where it is allowed to compost for an additional time period of 10 days to several months before being placed in a pile for curing for 30 days or more (Table 1). Moving the pile for secondary composting and curing introduces air back into the pile and mixes the contents of the pile, leading to more uniformity in the finished compost.

Table 1. Cycle time for primary and secondary composting of animal mortality versus body size.

Mortality size (lbs.)	4	10	50	100	220	350	500	1000	1500
Primary stage (days)	10	16	35	50	75	95	115	160	195
Secondary stage (days)	10	10	12	15	25	30	40	55	65
Storage stage (Suggested minimum days)	30	30	30	30	30	30	30	30	30

Amendments

Dead animal composting requires addition of materials to provide acceptable C/N ratios and porosity for good biofiltration. To work well material moisture level should be around 50% w.b.

Sawdust is widely used as it enables high temperatures to be achieved and sustained during the primary phase. Also, because of its ability to shed rainwater, sawdust works well for outside piles where exposure to rain and snow could result in high moisture levels leading to leachate. When using sawdust, it is recommended 25-50% of the material be recycled compost from the curing pile as this reduces cost, improves the composting process, and leads to a higher quality finished compost. However, recycle rates should not exceed 50% as this may limit carbon availability, thus interfering with the composting process. The recycled material is placed next to the animal carcass and new material is placed on the outer surface of the pile. A general rule of thumb for amendments with no recycling is 0.0069 cu. yd sawdust per lb loss. (Example: 5000 lbs mortality, 34.5 cu yd sawdust).

Other materials besides sawdust can be used for composting, such as straw or corn stover (Elwell *et al*., 1998), but require additional management for water control. For poultry mortality, poultry litter and straw are recommended (Murphy and Carr, 1991). Peanut hulls have been utilized in North Carolina (cited in NPPC, 1997).

Facilities:

Mortality composting is commonly conducted in one of three primary facility types: a bin, static windrow (pile), or mini-composter. Each facility's has unique advantages and disadvantages.

Bin Composting **-** Composting in a bin usually involves construction of a facility with a concrete floor, wood or concrete sidewalls on at least 3 sides, and a roof over the facility to eliminate rainwater infiltration. In a bin system the front dimension is generally 2 ft. wider than the loading bucket width. Recommended depth for a bin system is 5 ft. With bin composting there will be a minimum of three active bins in operation at any given time, 1 primary being filled, 1 primary composting and 1 secondary. A static pile is sometimes substituted for the secondary bin in two bin systems. Figure 3 is a bin composting system designed for poultry mortality.

Static Windrow (Pile) Composting -The windrow composting system is established on a concrete base, geotextile fabric lined gravel base or low permeability soil to control water infiltration. In these systems, walls and roofs are not used, so access to the pile from all sides is possible to load, unload and mix the compost material. Producers using this design will load the dead animals for a specific time period while continually extending the length of the compost pile and will mound the compost material to shed rainfall, control moisture loss and maintain adequate biofilter cover. Turning of any portion of the pile is delayed until that portion has met acceptable times for the primary stage (1^{st} turn) or secondary stage (2^{nd} turn). Specific size and number of windrows and management will be based on site parameters of layout and loading rates. Recommended depth for a windrow system is 5 to 7 ft. Static pile composting is similar to windrows except the pile is not extended in length. Fencing may be required to keep scavenging animals away from the pile.

Mini-composters - Mini-composters are a smaller version of a bin composter. Generally these facilities are about 40 in. x 40 in. square and 36 in. high and handle disposal of very small animals and/or birth materials. Animal size is usually limited to under 40 lb and primary bin requirements would be less than 70 ft^3. For a Northern climate, some additional insulation under winter conditions may be needed to enable the composter to reach the desired temperatures (>131 ^oF) for pathogen destruction and effective degradation.

Figure 3. Four Bin Arrangement for Poultry Mortality. Bins are for primary (2), secondary and amendment storage. Additional space is for storage of material prior to land application.

Figure 4. Windrow (pile) system used for swine mortality. Site is well drained and all surface water is diverted away from windrow.

Sizing Guidelines

Procedures and equations developed for sizing of the composting system for dead animals are given in OSUE (2000). Table 2 shows required volumes of the primary bin or windrow for various daily loss rates and animal sizes.

TABLE 2. Primary volume vs. body size and mortality rate, lbs. /day Adapted from OSUE, 2000)

Body Size (lb)	3.0	4.5	10	35	50	100	150	220	500	1000	1500
Cycle Time (days)	10	11	16	30	35	50	61	74	112	158	194
Mortality Rate (lb/day)	Volume, cubic feet[1]										
1	2	2	3	7	10	20	30	44	100	200	300
5	10	11	16	30	35	50	61	74	112	200	300
10	20	21	32	59	71	100	122	148	224	316	387
50	100	106	158	296	354	500	612	742	1118	1581	1936
100	200	212	316	592	707	1000	1225	1483	2236	3162	3873
200	400	424	632	1183	1414	2000	2449	2966	4472	6325	7746

[1] Shaded area is minimum time or minimum volume based on the size of the animal.

Monitoring

Monitoring and recording temperature is important to measure progress of the composting process. Temperatures can be measured easily with a three ft. probe thermometer (1/4 inch probe diameter is recommended) and should be taken at several points near the animals placed in the pile. Temperatures should rise to 135-150^{o} F and remain there for several weeks for pathogen kill. In addition, animal placement, pile turning times, and disposal methods and locations should be documented.

More Information

Composting has been demonstrated to be an economical and environmentally sound method of mortality disposal in Ohio. If you desire additional information please contact Steve Moeller (moeller.29@osu.edu).

References:

Bender, R.F., S.J. Moeller and S.S. Foster. 1998. Composting mortality: An environmentally friendly dead animal disposal option. In: Proceedings of Animal Production Systems And The Environment. Des Moines, Iowa. pp 3-8.

Elwell, D.L., S.J. Moller and H.M. Keener. 1998a. Composting large swine carcasses in three amendment materials. In: Proceedings of Animal Production Systems And The Environment. Des Moines, Iowa. pp15-20.

Foster, S. S., S. J. Moeller, R. F. Bender, and J. Rausch 2001. Animal Mortality Composting Program: Participant Follow-up (unpublished). Ohio State University Extension.

Fulhage, C. and C.E. Ellis. 1994. Composting Dead Swine. WQ 225. University of Missouri Extension.

Glanville, T.D. and D..W. Trampel. 1997. Composting alternative for animal carcass disposal. JAVMA 210(8). pp. 1116-1120.

Keener, H. M., D. L. Elwell and M. J. Monnin. 2000. Procedures and equations for sizing of structures and windrows for composting animal mortalities. Applied Engineering in Agriculture 16(6): 681-692.

Keener, H.M., S.S. Foster, S. J. Moeller and D.L Elwell. 2002. Dealing with dead livestock. Resource 9(8):9-10

Murphy, D.W., and L.E. Carr. 1991. Composting dead birds. Fact Sheet 537. Cooperative Extension Service, University of Maryland System.

NPPC. 1997. Swine mortality composting module. National Pork Producers Council, Clive, IA.

OSUE. 2000. Ohio’s livestock and poultry mortality composting manual. Extension Publication. Ohio State University Extension, Columbus, Ohio. (January)

Plenary Session: Emergency Response Planning – Session Chair: Andrea Szylvian

Maine's Emergency Disease Response Plan: Are We Ready?

Submitted by: Don Hoenig, MDAFRR, 28 State House Station, Augusta, ME 04333, phone: (207) 287-7610, email: Donald.E.Hoenig@maine.gov

This talk will focus on the progress of our state's emergency preparedness drawing on lessons learned from our three test exercises held over the past three years. I pay particular attention to the recent Equinox 2005 exercise in which we partnered with NH, VT, Quebec and New Brunswick to simulate an FMD outbreak.

Decision Matrix for Emergency Planning

James B. Howard
Consultant to States and Organizations such as,
North Carolina Department of Agriculture and Consumer Services
Emergency Programs Division
6117 Riverside Drive
Wake Forest, NC 27587-7337
Telephone: 919/556-4439
E-mail Address: annehoward0@earthlink.net

Regardless of what emergency may occur, there are basic decisions that must be made by any organization responsible for responding to the emergency. The following information is intended to help identify some of these decision areas and thereby assist organizations in better preparing for such emergencies. The high level decisions include:

1. What is the emergency?
2. What is my organization's role in this emergency? When?
3. Who is in charge of the activities related to this emergency? When?
4. What needs to be done? When?
5. What resources are available?
6. Who is paying for activities related to this emergency? When?
7. When is the emergency over? What does this mean?

There are hours of training for emergency response organizations and individuals in how to answer these questions under the Federal Emergency Management Administration's Incident Response System and the new Department of Homeland Security's National Incident Management System. For the purpose of this symposium this presentation will focus on agricultural organizations and predominately agricultural emergencies.

What is an emergency?

An emergency is an unplanned event negatively affecting or potentially affecting life, health, the environment or economic welfare.

What is an agricultural emergency?

An agricultural emergency is and unplanned event negatively affecting human, animal, or plant life or health, the environment around them, or the total economy they support.

What might be an agricultural emergency?

An agricultural emergency may be but are not limited to weather event, flood, earthquake, disease, fire, explosion, radiation, nuclear, terrorist activity, war, product tampering, or suspicion threat, or rumor of any of these. The occurrence does not even have to be local.

What is the agency's role in such emergencies?

The simplest answer to this question is to protect the food chain and the confidence of the public therein.

What is the first priority in any emergency?

The first priority is always protection of human life and health?

Who is in charge during the emergency?

The agency or individual in charge during an emergency historically has been the local fire or law enforcement official at the scene, referred to as the incident commander. With the changes in emergency response management brought about since September 11, 2001, the agency and individual in charge has moved away from the scene to Incident Command or Unified Command Centers and involve committees made up of individuals experienced in the command process, representatives from agencies with responsibility for the area involved, and experts in the hazards present. This command structure is often referred to as Multiple Agency Command or MAC. The MAC may involve local, state, and/or national agencies and organizations. Initially funding is not critical, but ultimately the organization providing the greatest funding caries the highest level of influence in the MAC.

In any non-nature caused emergency event, law enforcement must first determine whether terrorist activity is involved before or in conjunction with other agencies performing initial response roles and establishing a command structure.

In any emergency the agencies or organizations making up the MAC are very much determined by who and what is affected, and by what agencies and organizations can provide positive contributions to the management and response efforts.

If an emergency affects or potentially affects the safety, availability of food or feed, or the perception thereof, then agricultural agencies will play a major role in managing the response to and the recovery from the event. The determination of the actual safety and availability is a critical responsibility that must be carried out as quickly as possible. The human health consequence, public perception, source, size, and length of an event will determine whether the agricultural agencies are lead or support in the incident management structures.

What needs to be done?

As stated above the first and most important priority is protection of human life and health. In order to accomplish this priority emergency must be safely and accurately evaluated.

The next priority is protection of and the perception of the safety of the food and feed chain. Because perception is as dangerous as fact, it is critical to communicate accurate information to the public as quickly as possible.

The emergency must be contained to minimize spread and to maximize the effectiveness of response efforts. Containment is based on first determining the extent of the event, requiring surveillance, epidemiology, geographic and demographic information, sampling and analysis.

In determining what needs to be done it is important to consider what will be gained by doing it, what the consequences for not doing it, and are there better alternatives.

The second critical consideration in determining what needs to be done is when is it needed. The need for food and water may be critical, but if storage and distribution methods and locations have not been identifies the food and water will likely be wasted.

Response needs must be identified and prioritized because response resources are limited and the systems for obtaining, transporting, storing, and distributing them are also planned activities. The larger the event the more limited the resources will be. In major emergencies it is important to plan activities and resource commitments for today, tomorrow, and the days and possibly weeks after that. Early commitment of key resources may rob your response of critical resources later in the event. Do not forget the "Do Nothing" option!

What resources are available?

The nature and size of an emergency will influence the resources available and how they are used. The bigger the emergency the more limited the resources, and the more complex or dangerous the event the more limited the resources. The same resources may be committed to more than one agency or organization. The emergency itself may limit or remove the availability of a resource. Remember Plan A is where you go on your way to Plan B. Don't forget about Plans C and D. Murphy developed his law while dealing with or creating emergencies.

Wear and tear must be taken into consideration on resources, especially human. Maintenance, repair, and rest and recuperation must be included in any resource mobilization or commitment.

Public opinion may not provide major influence in the initial commitment of resources, but will ultimately influence every resource utilization decision.

Resource acquisition, commitment, consumption, repair, recovery and replacement are activities that require documentation in order to assure proper funding.

Who is funding the activities related to the emergency?

Funding is the second most important in responding to an emergency. Funding is characterized by amount, source, and requirements. In the case of some emergencies the response may be limited or not even begin until the funding source is identified and funding committed. In other emergencies are not addressed until after the event is over. In this situation the recovery of expended funds and spent resources is usually unsatisfactory. Individuals will volunteer their efforts, equipment, and supplies to save lives, but such generosity has limited capacity to address major emergencies. Effective emergency response requires effective planning for funding sources, expenditure authorization, and spending documentation.

All resources are limited. Funding can influence this level, but will have only limited influence in large events.

When is the emergency over?

Normally an emergency is over when the threat to life, health, and environment ceases, and there is no new threat to the industry or food supply. At this point the response organization may have a great deal yet to do, but it is now considered recovery or mitigation and will require long-term commitment of programs and resources. The organizations and their roles initially responding to the emergency may change significantly as well as the funding source. As the initial response to an emergency is undertaken, the definition of the scope and mission of the effort usually defines when the emergency is over. Specific restriction on the expenditure of funds may define when the emergency is over. During the emergency response activities, situations are sometimes discovered that result in separate emergencies being declared. In closing an emergency it is important to remember that the job is not finished until the paper work is done.

In order for any agency or organization to be prepared to effectively and efficiently accomplish the response activities required by an emergency, they must plan, train, practice, and refine their activities and procedures for all types of emergencies. With the potential for larger and more complex emergencies, it is important that these organizations conduct the preparations in coordination and cooperation. Be careful though, it is great to depend on others, but what do you do if they do not show up?

In closing, remember the “six P’s”. Proper prior planning prevents particularly poor performance. Every emergency results in some level of response. The success and efficiency of this response is directly related to the preparedness of the agencies involved.

Composting Mortalities and Slaughterhouse Residuals Symposium
PRESENTERS

Bartenfelder, David – USEPA – Washington, D.C.
email: bartenfelder.David@EPA.gov

Bendfeldt, Eric - Virginia Cooperative Extension – Harrisonburg, VA
phone: 540-564-3080 email: ebendfel@vt.edu

Bonhotal, Jean – Cornell Waste Management – Ithaca, NY
phone: 607-255-8444 email: jb29@cornell.edu

Brinton, William – Woods' End Lab – Mt. Vernon, Maine
phone: 207-793-2457 email: will@woodsend.org

Brusca, Joeseph – Wisconsin Dept of NR – Fitchburg, WI
phone: 608-275-3296 email: joeseph.brusca@dnr.state.wi.us

Doesken, Kathy – CSU, Dept Soil & Crop Sciences – Fort Collins, CO
phone: 970-491-6994 email: corwindoesken@juno.com

Early, Gregory – A.I.S., Inc. – New Bedford, MA
phone: 617-678-8940 email: gearly@mercury.who.whoi.edu

Glanville, Thomas – ISU-Dept. of Agriculture & Bio Engineering – Ames, IA
phone: 515-294-0463 email: tglanvil@iastate.edu

Goldstein, Nora – Biocycle – Emmaus, PA
phone: 610-967-4135 x 26 email: noragold@jgpress.com

Gordon, Robert – Nova Scotia Agricultural College – Truro Nova Scotia, CANADA
phone: 902-893-6561 email: rgordon@nsac.ns.ca

Hoenig, Donald – ME Dept. of Agriculture, Food & Rural Resources – Augusta, ME
phone: 207-287-7610 email: Donald.E.Hoenig@maine.gov

Howard, James – North Carolina Dept. of Agriculture & Consumer Services – Wake Forest, NC
phone: 919-556-4439 email: Jim.Howard@ncmail.net

Hutchinson, Mark – University of Maine Cooperative Extension – Waldoboro, ME
phone: 207-832-0343 x116 email: markh@umext.maine.edu

Jewell, William – Cornell University, Dept. of Biological & Environmental Eng. – Ithaca, NY
phone: 607-255-4533 email: wjj1@cornell.edu

Keener, Harold – Ohio State University – Wooster, OH
phone: 330-263-3856 email: keener.3@osu.edu

Kolb, Elisabeth – New York DOT
phone: 845-575-6158 email: ekolb@dot.state.ny.us

Kremmer, Fran – EPA
phone: 513-569-7346 email: kremmer.Fran@epa.gov

King, Mark – ME Dept. of Environmental Protection – Augusta, ME
phone: 207-287-2630 email: Mark.A.King@Maine.gov

Matthews, Chuck – Washington State Dept. of Ecology – Olympia, WA
phone: 360-407-6383 email: cmat461@ecy.wa.gov

Seekins, William – Maine Dept. of Agriculture, Food & Rural Resources – Augusta, ME
phone: 207-287-7531 email: bill.seekins@maine.gov

Shih, Jason – North Carolina State Univesity, Dept. of Poultry Science – Raleigh, NC
phone: 919-515-5521 email: JasonShih@NCSU.edu

Teachman, Mark – USDA APHIS
Email: mark.e.teachman@aphis.usda.gov

Wilson, Daniel – NCDA & CS, Emergency Programs – Raleigh, NC
phone: 919-740-4476 email: Daniel.Wilson@ncmail.net