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Environmental Impact and Biosecurity of Composting for Emergency Disposal of Livestock Mortalities — Year 2 Project Update

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Environmental Impact and Biosecurity of Composting for Emergency Disposal of Livestock Mortalities — Year 2 Project Update

Abstract

Following the foot-and-mouth disease epidemic in Great Britain in 2001, the Iowa Department of Natural Resources asked researchers at Iowa State University to evaluate the potential effectiveness (rate and extent of decay), environmental impacts (air, soil, and water quality), and biosecurity (containment and inactivation of viral pathogens) of using on-farm composting for emergency disposal of beef or dairy cattle carcasses in the event of a disease outbreak in the State of Iowa.

Keywords

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Disciplines

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Environmental Impact and Biosecurity of Composting for Emergency Disposal of Livestock Mortalities — Year 2 Project Update

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Introduction

Following the foot-and-mouth disease epidemic in Great Britain in 2001, the Iowa Department of Natural Resources asked researchers at Iowa State University to evaluate the potential effectiveness (rate and extent of decay), environmental impacts (air, soil, and water quality), and biosecurity (containment and inactivation of viral pathogens) of using on-farm composting for emergency disposal of beef or dairy cattle carcasses in the event of a disease outbreak in the State of Iowa.

Materials and Methods

Windrow-type composting test units are constructed using three alternative cover materials (corn silage, ground cornstalks, and dual layer straw-over-manure cover) that typically would be available in an emergency on most cattle and dairy farms. Each test unit contains four 450-kg (average) cattle carcasses purchased from a cooperating rendering company. To evaluate the effects of seasonal temperature and precipitation patterns on composting performance, test units are initiated 3 times during the year (winter, spring, summer) and all treatments (3 cover materials X 3 seasons) are replicated 3 times.

Composting performance is evaluated by monitoring temperatures and oxygen concentrations throughout the test units, and by temporarily excavating and photographing the test units 100 – 180 days following construction.

Environmental impacts are assessed by analyzing 4-foot soil cores (for $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, and Cl) collected before and after the composting process, by quantifying and testing (for TOC , $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, and Cl) leachate collected at the base of the test units, and by testing (threshold odor determination via olfactometry) odor samples collected from the surface of the test units during the first 4 weeks of each trial.

Process biosecurity (pathogen retention and inactivation) is evaluated by placing vaccine strains of Newcastle Disease Virus (NDV) and avian encephalomyelitis (AE) into the test units and subsequently testing the samples for virus survival. Pathogen retention is tested by placing caged specific-pathogen-free chickens around the test units and checking weekly blood samples for evidence of an immune system response to the two avian vaccine viruses. Viral inactivation is tested through timed withdrawal of virus samples from the composting process and testing for virus viability.

Results and Discussion

The project was begun in August of 2002, and 27 seasonal test units containing approximately 49 metric tons of cattle carcasses have been constructed. Temporary excavation of unturned test units shows that internal organs and soft tissues (but not skeletal remains) are fully decayed in 10–12 months (less in warm weather) using any of the three cover materials. Corn silage consistently produces the highest internal temperatures ($>60^\circ\text{C}$), while cornstalks typically exhibit the lowest temperatures (Figure 1). Although high internal temperatures often are equated with rapid microbial activity and high rates of decay, observation of equivalent decay in silage and cornstalk test units suggests

that decay rates in the cornstalk units are equally good and that heat is being lost convectively as air moves through the relatively permeable cornstalks. This is supported by oxygen concentration data that consistently show higher O_2 concentrations in cornstalk test units than in units constructed with corn silage. Threshold odor data for air samples collected from the surface of test units show that 30–45 cm of cover material is effective at containing odorous

gases released during carcass decay. Immune system responses in less than 2% of caged sentinel poultry stationed near composting test units seeded with avian vaccine viruses indicate that this depth of cover material also is effective in retaining viral pathogens. With one exception, NDV and AE virus samples contained within dialysis cassettes were inactivated within all test units in less than 7 days.

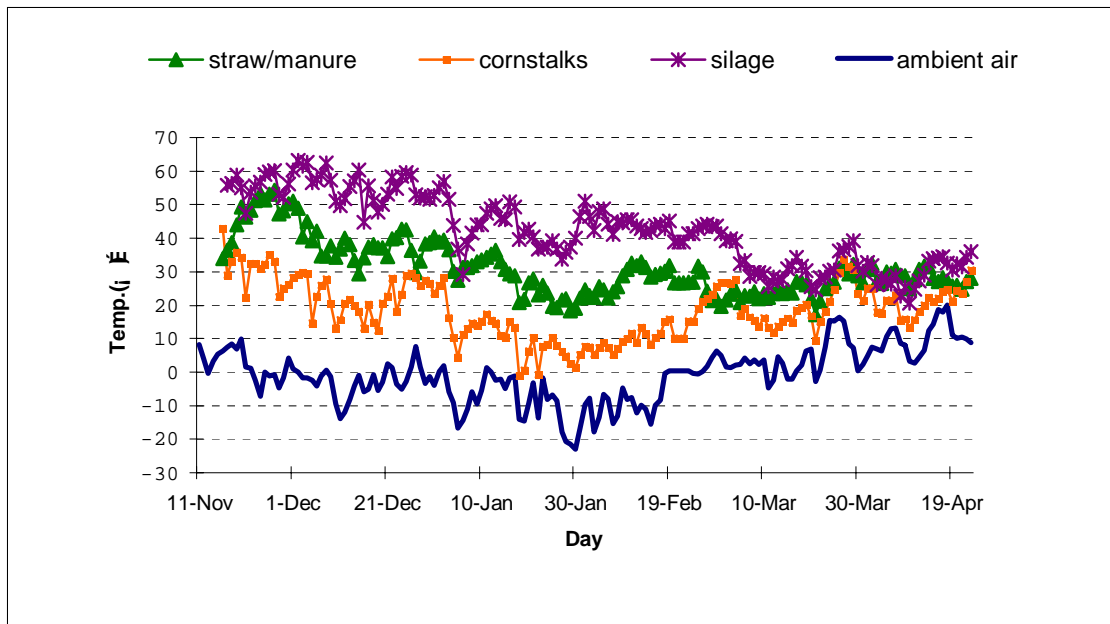


Figure 1. Mean temperatures near carcass surfaces recorded in three test units constructed in November of 2003.