



Novel pilot-scale composting system allows for a variety of composting testing and air emissions measurements



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Introduction

Idaho's dairy industry ranks third in milk production in the U.S. The majority of dairy cows are located in a high-desert area, ideal for dairy production, but with insufficient carbon-rich feedstocks to balance the nitrogen content of manure for composting. Evaluating alternatives to carbon balancing requires benchmark-scale systems that can replicate on-farm techniques, manage composting parameters, capture and analyze air emissions, and measure other process parameters. This project developed a pilot system to test manure composting with amendments and other substrates and processes.

Project Objectives

- Designing and implementing a functional pilot-scale composting reactor system.
- Simulating windrow composting at the pilot scale.
- Test the ability to implement changes to the composting system and processes during composting.
- Determining if successful composting can be achieved at the pilot scale with dairy manure as feedstock with and without carbon correction and the addition of diverse amendments.
- Measuring gas emissions from the processes tested in the reactor.
- Measuring and controlling parameters during the composting process.

The main hypotheses were:

- The pilot-scale composting system will be able to replicate on-farm mechanically turned composting of dairy manure.
- Composting parameters, process evolution, and air emissions could be measured during the whole composting process.
- The pilot-scale system will allow for testing of manure composting with the addition of diverse amendments and carbon corrections.

Materials and Methods

Experimental Design

- 10 composting reactors
- Randomized complete block design
- 2 Blocks
- 5 Treatments
- Additional 2 blocks for amendments testing

The pilot-scale composting system was developed using ten individual 55-gallon reactors to simulate on-farm composting of dairy manure. The experimental design included two replications of five different amendment treatments: control (manure), biochar, pumice, wood chips, and zeolite.

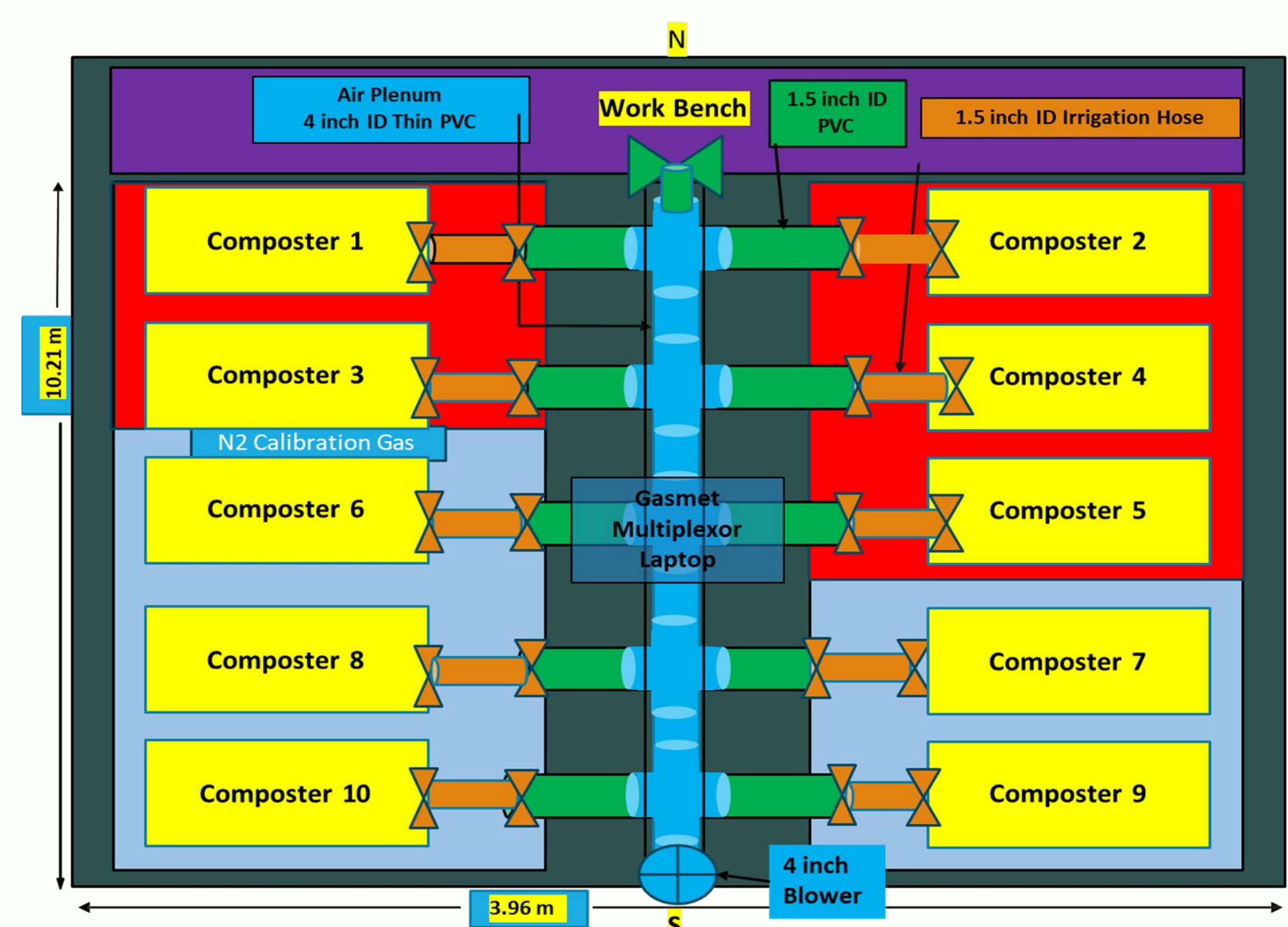
Data collection

Gas emissions were measured twice a day using a FTIR Gasmet DX4015 analyzer.

Materials and Methods

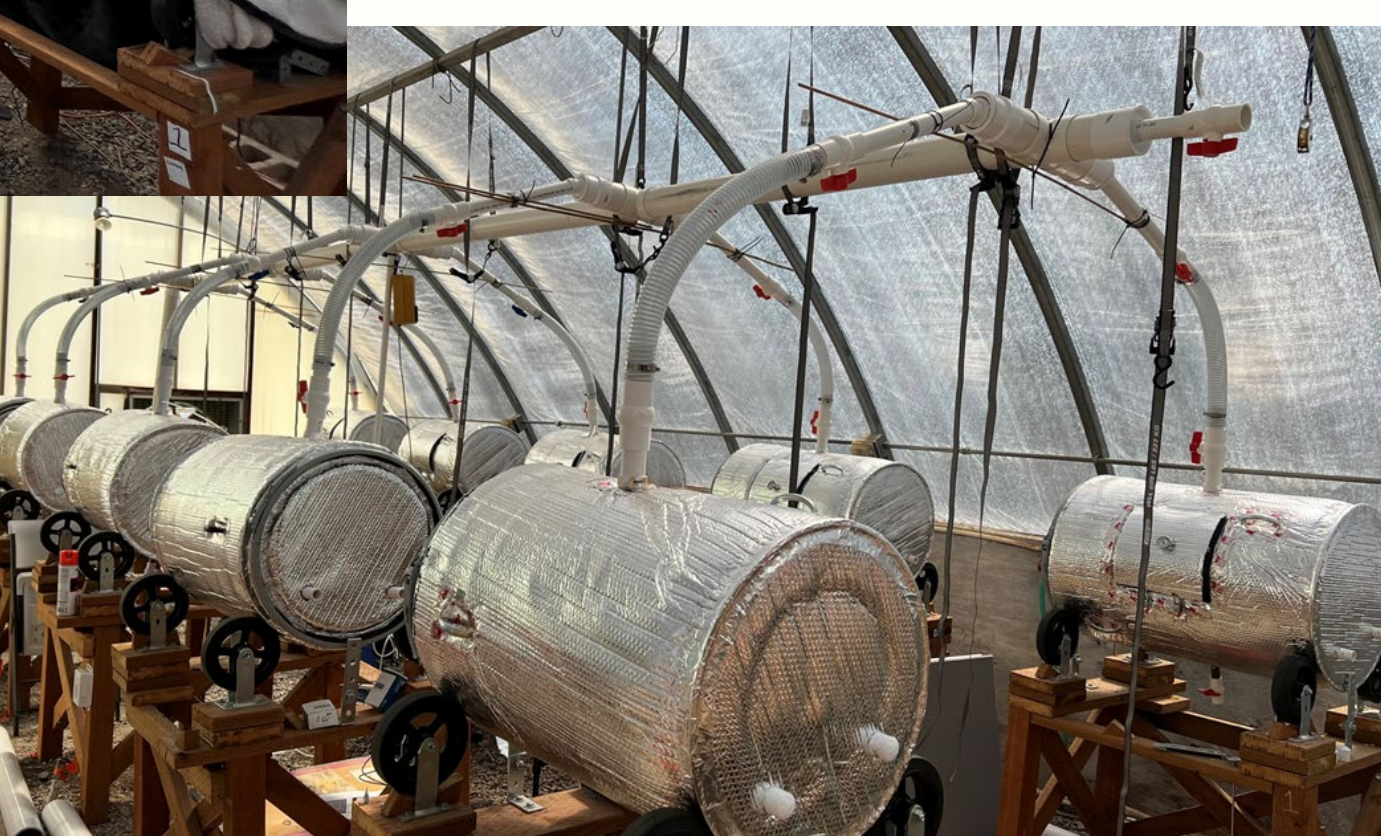
Compost temperature (internal and headspace) and ambient temperature were monitored using data loggers and analog thermometers. Moisture content was assessed through squeeze tests, a moisture probe, and lab analysis. Other parameters measured included oxygenation, air velocity, headspace volume, and differential pressure. Manure and compost nutrient content were determined by lab analysis of samples taken throughout the trial. Gas concentration was recorded using Calcmeter software. Eosense software (eosLink-MX and eosAnalyze) managed multiplexer functions and combined data. Preliminary data analysis, including single-factor ANOVA, was performed on temperature and air velocity data. Future analysis will involve static chamber flux calculations for gas emissions and repeated measured ANOVA to determine treatment effects. Compost maturity will be evaluated using a Solvita test.

Schematic of Pilot Scale Composting System



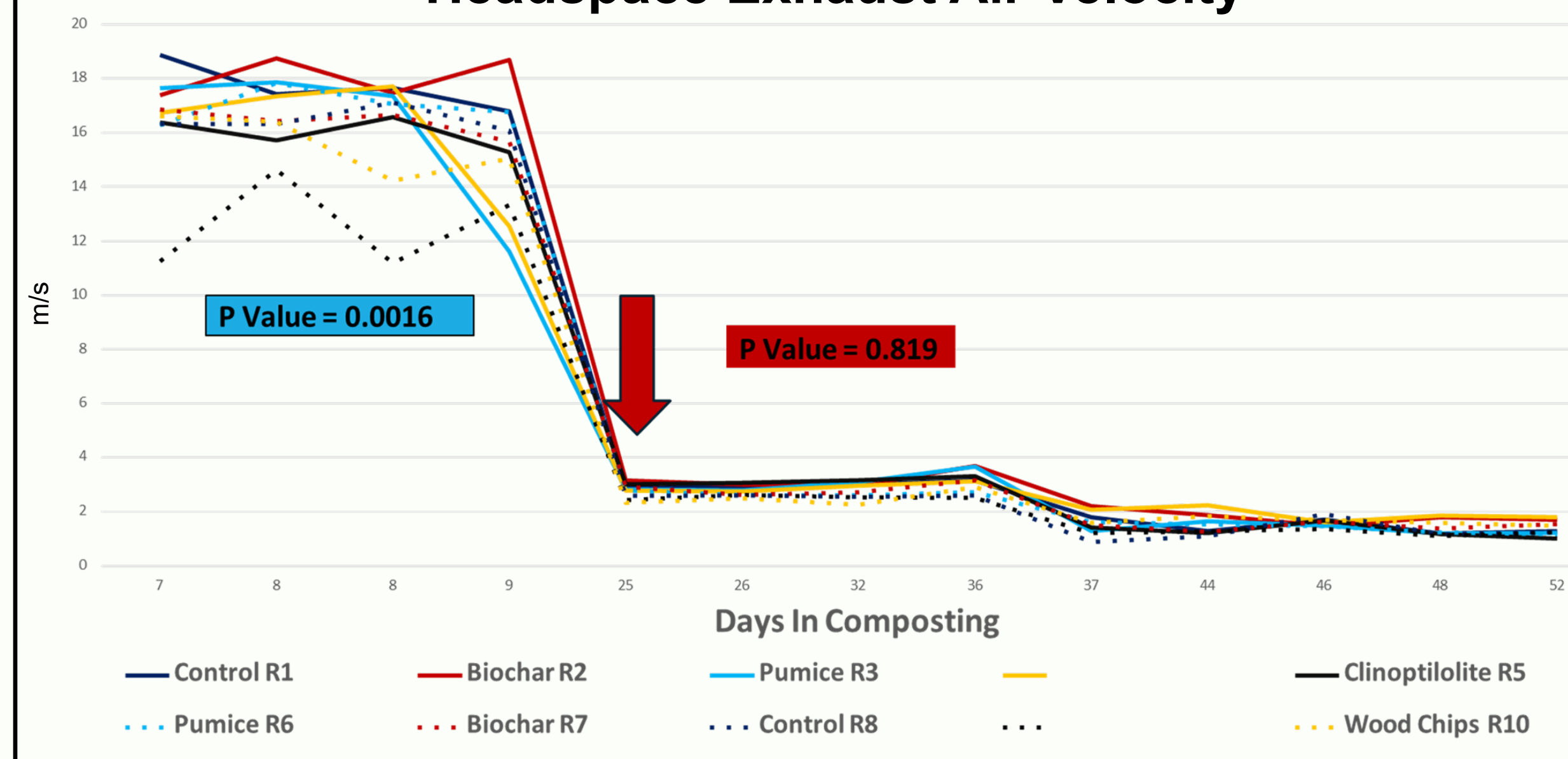
Heating blankets covering half of the reactors

View of the reactors and air plenum system



Results

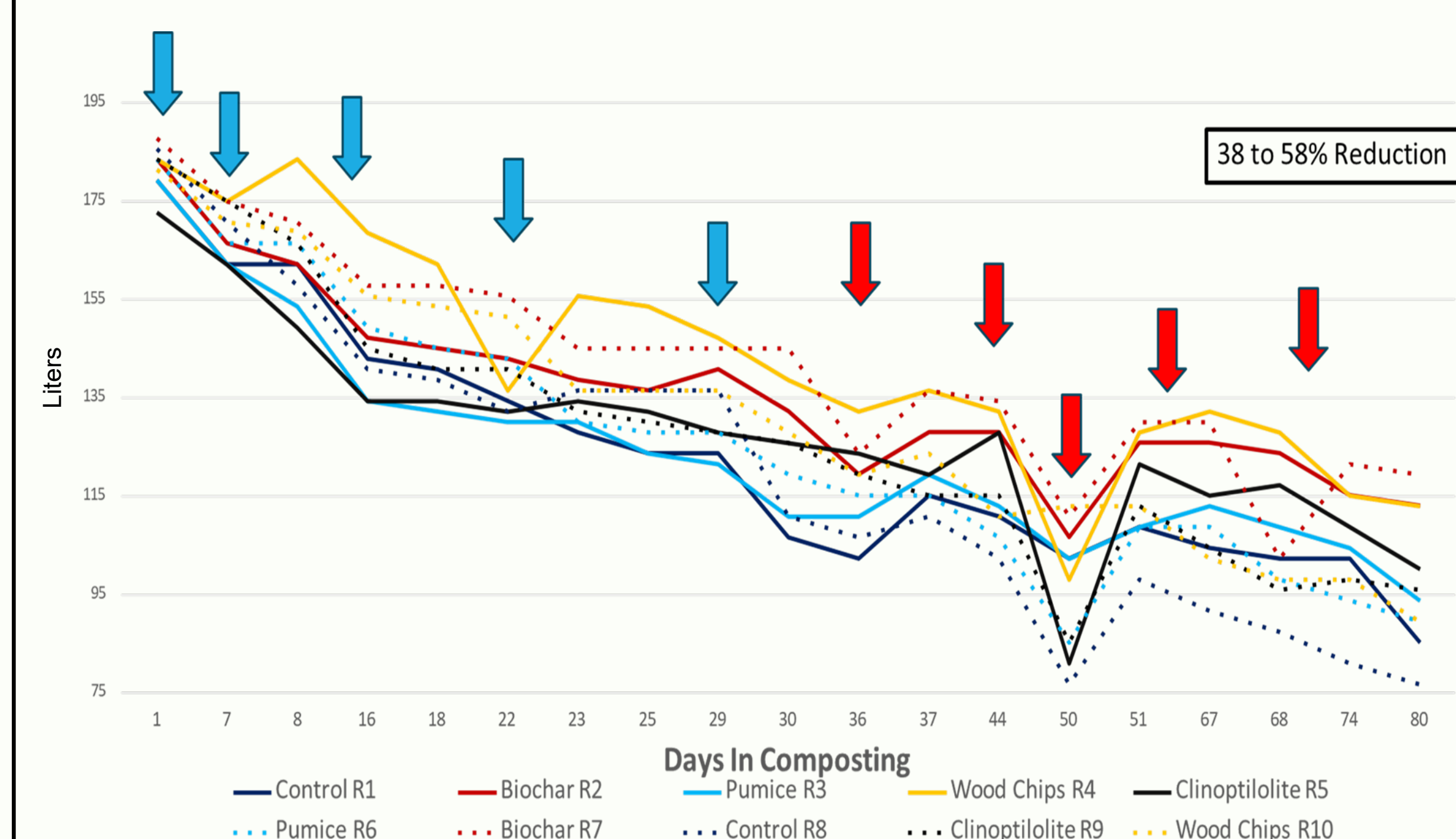
Headspace Exhaust Air Velocity



Results

- Intensive thermophilic composting was achieved for the first two weeks of the trial in the reactors.
- Subsequent turnings showed increasing temperatures, but not enough to maintain high temperatures. Heating mats were added to maintain reactor temperatures and reduce heat loss.
- A significant reduction in compost volume, ranging from 38% to 58%, was observed, as expected in a full-sized composting system.
- Modifications to the air exhaust system allowed for the control of airflow between reactors. Airflow dynamics were significantly different before the blower was replaced, after which they were not significantly different. Furthermore, preliminary measurements of different pressures suggest that the type of amendment may influence the vacuum within the reactors.

Headspace Volume



Conclusions

- The pilot-scale composting system demonstrated its functionality and adaptability for simulating on-farm composting processes.
- Composting of dairy manure and amendments and the observed reduction in compost volume indicate the system's effectiveness.
- The ability to monitor and control key composting parameters and measure gas emissions provides a valuable tool for developing and optimizing dairy manure management practices.
- Preliminary findings suggest that amendments may influence the internal composting environment, as indicated by differential pressure trends and lab analysis results.
- This research establishes a foundation for future studies to further investigate the impacts of different amendments, composting techniques, and other processes at the pilot scale.

Acknowledgements

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