Closing the agricultural loop:
Capturing and utilizing compost gas exhaust from aerated static pile composting

Allison M. Leach[1], John D. Aber[1], Matthew Smith[1]
[1]University of New Hampshire, Durham, New Hampshire, USA

University of New Hampshire

INTRODUCTION

Aerated static pile (ASP) heat recovery composting is one strategy that can be used to promote the reuse of resources within a farm and potentially divert environmental pollution. Preliminary studies at the University of New Hampshire ASP heat recovery composting facility at an organic dairy farm have demonstrated the potential for heat recovery (Smith and Aber 2014), and such a facility could ultimately be connected to a greenhouse to heat and fertilize crops.

Research objectives:

1. Characterizing compost gas exhaust: Measure the NH_3, CO_2, CH_4, and O_2 concentrations and the temperature of the air exhaust from an aerated static pile heat recovery composting facility over the 60-day composting process.
2. Estimating avoided pollution: Explore methods to quantify the potential of this facility to divert NH_3, CH_4, and CO_2 emissions from environmental loss.

STUDY SITE

- The University of New Hampshire (UNH) Joshua Nelson Energy Recovery Compost Facility located in Lee, New Hampshire, USA, will be the site of compost gas exhaust measurements **(Figure 1).**
- The compost facility is located at the UNH Burley-Demeritt Organic Dairy Research Farm, which has 100 head of Jersey dairy cattle and spans over 100 ha (55 ha pasture, 50 ha forest) **(Figure 2)**.

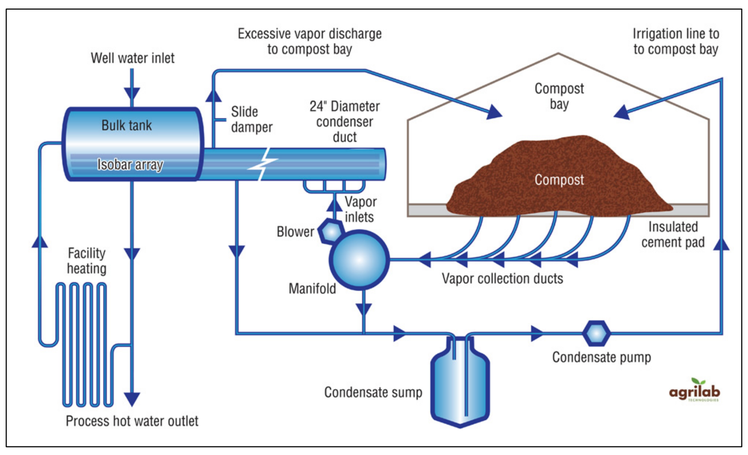


Figure 1. Flow diagram of UNH heat recovery aerated static pile composting system. *Source: Smith and Aber 2014*

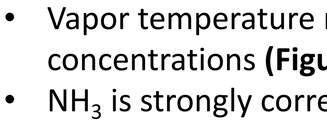
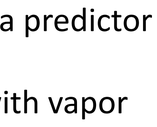
Figure 2. UNH Burley-Demeritt Organic Dairy Research Farm and Joshua Nelson Energy Recovery Compost Facility. *Source: Smith and Aber 2014*

METHODS

1. Characterizing compost gas exhaust vapors

Data set	Measurement	Analysis
• **Gas concentrations** • NH_3, CO_2, O_2, CH_4 • **Gas temperatures** • For 60-day compost cycle on paired bays	• Draeger and RAE Gas Detection Tubes (NH_3, CO_2) • RKI Eagle gas analyzer (CH_4, O_2)	• Compare trends and drivers across data sets • Determine total gases emitted

2. Estimating avoided pollution (future work that will not be presented here)

a) Compost	b) Biofilter	c) Greenhouse
CH_4 N_2O NH_3 Emissions avoided by **using manure for compost**	 Emissions **captured by a biofilter**	 Emissions that **crops could use**

The potential for avoided pollution will be explored with theoretical calculations in a future study.

RESULTS

Gas exhaust concentrations

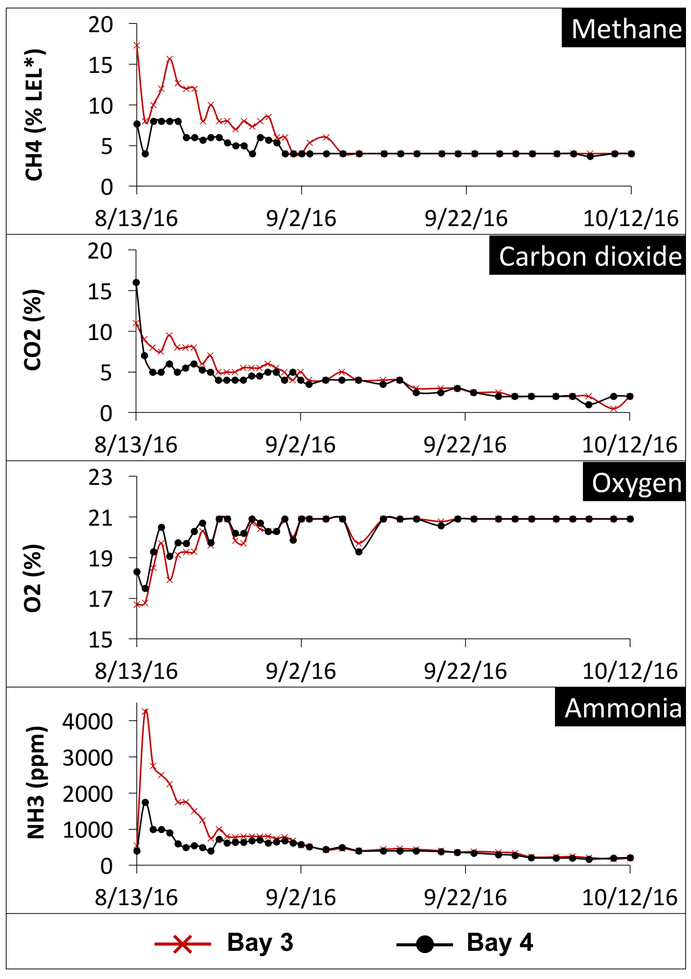


Figure 3. Compost gas exhaust concentrations. Concentrations shown (CH_4, CO_2, O_2, NH_3) are for two paired bays for the 60-day composting cycle in fall 2016.
*%LEL (Lower Explosive Limit) for CH_4 is 5%

Correlations with temperature

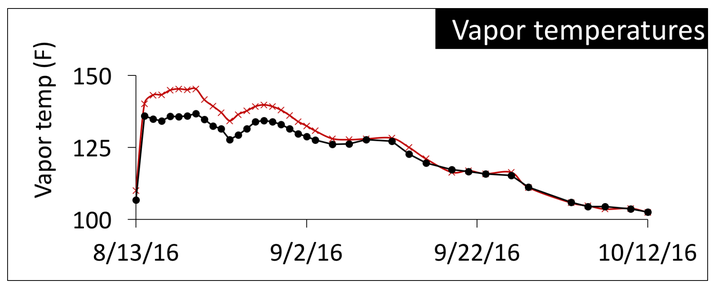


Figure 4. Vapor temperatures of compost exhaust. Temperatures are recorded every minute using sensors. Temperatures recorded at the same time as gas sampling (Figure 3) for bay 3 (red line) and bay 4 (black line).

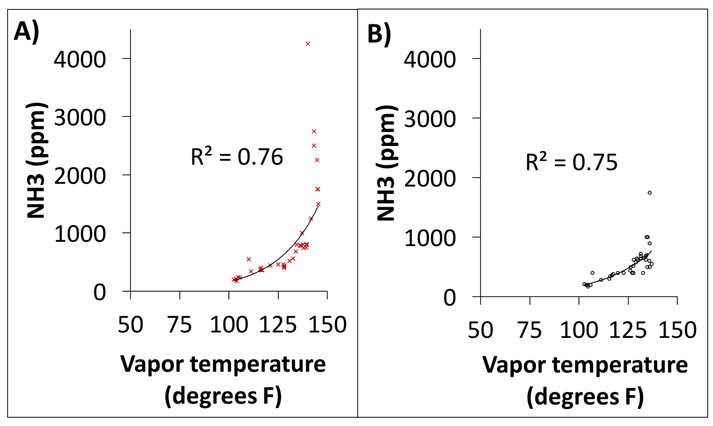


Figure 5. Correlations between vapor temperature and ammonia concentrations for A) bay 3 and B) bay 4. Trendlines are fitted using exponential linear regression.

Summary & next steps

Compost gas exhaust:

- Emissions of pollutants (NH_3, CO_2, CH_4) peak early in composting cycle and then stabilize **(Figure 3)**
- Early peak in CO_2 and CH4 due to anaerobic conditions
- → Important to capture composting emissions early in composting life cycle

Correlations with temperature:

- Vapor temperature may be a predictor of NH_3 concentrations **(Figure 4)**
- NH_3 is strongly correlated with vapor temperatures **(Figure 5)**

Next steps:

- Collect more measurements
- Determine the total gases emitted across composting life cycle
- Estimate potential for pollution avoidance from:
  a) Composting manure instead of direct land application;
  b) Constructing a biofilter to capture emissions; and
  c) Connecting the compost facility to a greenhouse

FOR MORE INFORMATION

Smith M and Aber J (2014). Heat recovery from compost. BioCycle 55, 27.

Visit our website: **http://aberlab.net/**

Watch a video about the UNH compost facility: **https://youtu.be/YNTX5vqN2Fs**

Contact information: **Allison.Leach@unh.edu**

ACKNOWLEDGMENTS

We appreciate data collection and analysis support from interns Andrew Moriarty, Margaret Phillips, and Nicole Williamson.

Funded by the USDA Sustainable Agriculture & Research Education Program