Biosecurity Testing of Horizontal Grinders

Paul Lemieux[1], Shannon Serre[1], Joseph Wood[1], Worth Calfee[1], James Thurman[1], Preston Burnette[2], Lori Miller[3], Robert Miknis[3], Sasidhar Malladi[4], Gary Flory[5], Michael Mayes[6]

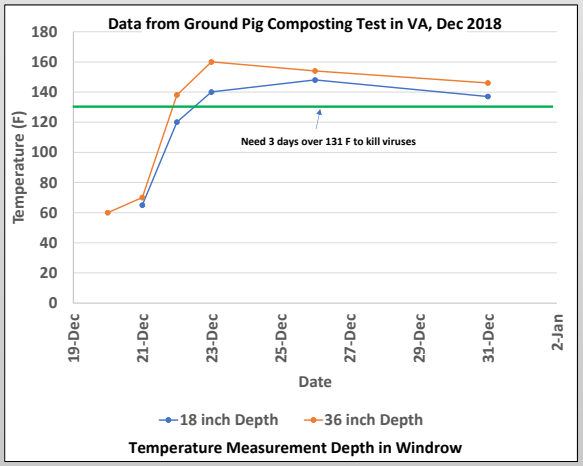
[1] US EPA; [2] Jacobs Technology Inc; [3] USDA, Animal and Plant Health Inspection Service; [4] University of Minnesota Secure Food Systems Team; [5] GA Flory Consulting; [6] North Carolina Department of Agriculture and Consumer Services

Background

- African Swine Fever (ASFv) is a Hemorrhagic fever (similar to Ebola virus) but only affects pigs
- Highly contagious and fatal to pigs
- Threatens $40 Billion Industry in US

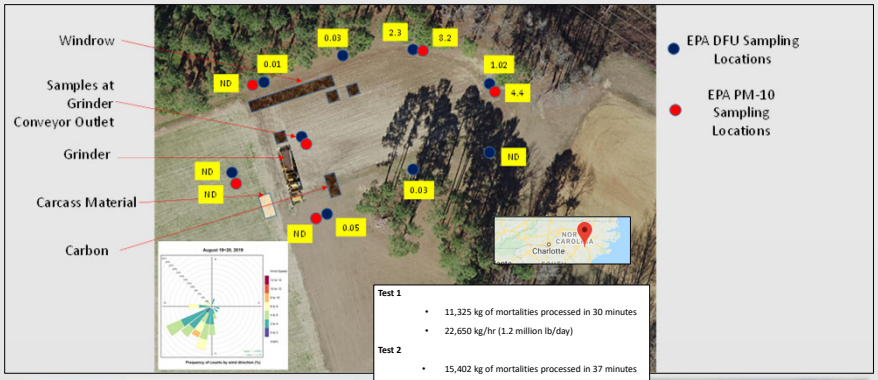
Mortality Management Approaches

- Potential need for 3 million lb/day disposal capacity
- Safe, bio-secure, on-farm management is preferred; composting is popular management technology in NC and other states
- Composting large, whole animals can take up to a year; grinding can reduce the time to a month
- Grinding equipment, such as that used in rendering plants, has high capacity but limited availability and long lead time
- Need evaluation of horizontal grinders (industrial-scale wood chippers) to grind carcasses, along with a carbon source, prior to composting
- Conduct biosecurity evaluation of grinding process



Objectives

- Assess biosecurity of grinding operations
  - Focus on potential air emissions of viral particles
  - Model air dispersion to support development of USDA/APHIS SOP
  - Assess cleaning and disinfection of grinder following use



What We've Learned from Initial Testing

- **Knowns**
  - Size-reduced pigs mixed with carbon source via grinding process compost very well
  - 131 °F for 3 days = target conditions for virus inactivation
- **Unknowns**
  - Can grinders be used off the shelf?
  - Do virus particles escape the grinding process?

Assumptions

- Grinding ASFv-impacted carcasses could result in virus being contained in aerosols, droplets and tissue particles
- Majority of airborne particles produced by grinder are coming off end of conveyor belt as the material falls to ground and some gets entrained into the wind
- Porcine DNA as surrogate for infectious particles – polymerase chain reaction (PCR) analysis of filters can generate numbers in units of ng pig DNA/m^3

Approach

- Measure emissions from grinder for emission factor calculation
  - Particulate matter (PM) sampling devices positioned close to end of conveyor
    - High Volume (1000 L/min) PM_{10} sampler (collect PM < 10 µm)
    - Dry Filter Unit (DFU) (900 L/min) sampler (collect total filterable PM)
  - Emission factor in units of ng pig DNA/kg pigs
- Perimeter air monitoring
  - High Volume PM_{10} sampler/DFU paired
- Meteorological data from Horticultural Research Center
- Air modeling by EPA using AERMOD
- Infectious risk calculations by University of Minnesota Secure Food Systems Team

Future Work

- Perform another round of testing in June 2021
- Improve particle size distribution measurements using cascade impactor samples
- Add mitigation procedures
  - Deflector plate at end of conveyor
  - Misting to minimize aerosolization
- Improve assumptions in risk calculations (e.g., currently assume viral titer in whole pig is same as blood titer)
- Develop Concept of Operations (CONOPS) for Cleaning and Disinfection (C&D) of grinder following use
- Examine potential for use of additives to reduce viral load (e.g., lime, citric acid)

Example Calculations from AERMOD

Landuse	2		Landuse types	Description		class	wind speed (m/s)	wind speed (mph)
Moisture	1		1	crop lands		1	0.5	1.1
Season	3		2	mixture of buildings and vegetation		2	1	2.2
release time	1					3	1.5	3.4
Wind speed class	6		season	Description		4	2	4.5
Distance (m) (50 m to 20 km)	5000	from risk calc worksheet	1	late autumn or winter, no snow		5	2.5	5.6
kg of carcasses	1.00E+05	from risk calc worksheet	2	winter, snow		6	3	6.7
grinding (hours)	6	from risk calc worksheet	3	spring		7	4	8.9
emission factor (ng DNA/kg carcass)	0.67		4	summer		8	5	11.2
dilution adjustment factor	78021		5	autumn		9	6	13.4
emission rate(ng/s)	242009.5833					10	7	15.7
						11	10	22.4
Hourly concentration (ng/m^3)	0		moisture	description				
3-hour concentration (ng/m^3)	0		1	Average rainfall conditions		classes in yellow can only be used with release time code 1; classes in green can only be used with release time code 2; Non-colored classes can be used with either code.		
6-hour concentration (ng/m^3)	0		2	Dry conditions				
8-hour concentration (ng/m^3)	0		3	Wet conditions				
12-hour concentration (ng/m^3)	0							
24-hour concentration (ng/m^3)	0		release time	description				
			1	just before sunrise or just after sunset				
1-hour dry deposition (ng/m^3)	6		2	between sunrise and sunset				
3-hour cumulative dry deposition (ng/m^3)	17							
6-hour cumulative dry deposition (ng/m^3)	34							
8-hour cumulative dry deposition (ng/m^3)	45							
12-hour cumulative dry deposition (ng/m^3)	67							
24-hour cumulative dry deposition (ng/m^3)	134							

DISCLAIMER: The U.S. Environmental Protection Agency through its Office of Research and Development collaborated in the research described here under Interagency Agreement 18-9200-0497 with USDA/APHIS. It has been subjected to the Agency's review and has been approved for publication. Note that approval does not signify that the contents necessarily reflect the views of the Agency. Mention of trade names, products, or services does not convey official EPA approval, endorsement, or recommendation.