Survey Monitoring of Air Quality from Bedded Swine Systems

A.S. Leaflet R1924

Jay D. Harmon, Associate Professor
Dwaine Bundy, Professor
Tom Richard, Associate Professor
Steve Hoff, Associate Professor
Agricultural and Biosystems Engineering Department

Summary and Implications

Six deep-bedded swine finishing production sites were surveyed for hydrogen sulfide, ammonia and odor concentrations. Each site was observed four different times with readings 6 times over a 36 hour period. Hydrogen sulfide, ammonia and odor were measured at the building edge and downwind 100 feet. Hydrogen sulfide and ammonia were measured 500 feet downwind also. The site averages for hydrogen sulfide were found to range from 25 to 228 ppb at the building edge, 2 to 11 ppb 100 feet downwind and 4 to 8 ppb 500 feet downwind. Ammonia site averages were found to range from 2 to 11 ppm at the building edge, undetectable with the chosen equipment (below 1 ppm) to 3 ppm downwind 100 feet and undetectable at 500 feet. Odor threshold site averages ranged from 130 to 580 at the building and 80 to 500 at a point 100 feet from the building.

Introduction

Deep bedded hoop structures can be an attractive alternative for some farms raising livestock. As compared to more traditional facilities, they have a lower purchase price, they are more flexible for alternative uses, and they provide an alternative management system that may be attractive to some producers. The common perception is that deep-bedded hoop structures used for raising swine produce fewer air quality problems than comparable liquid-manure swine production facilities. However, this assumption has not been proven thus far. Limited air quality monitoring has been done on hoop structures. Types of bedding material, frequency of adding bedding, and amount of bedding and environmental conditions may greatly affect the air quality generated from hoop buildings. A survey of several buildings will help determine the variability of air quality from different producers' facilities.

Materials and Methods

Six different deep-bedded swine finishing production sites were selected which are unencumbered by other swine production units, manure piles and objects which would change the air flow around the site. Producers were asked to keep a production diary that included swine placement and removal from the unit, the bedding type and amount added and any other pertinent management decisions. On a monthly basis a site visit was made to measure the ammonia concentration, hydrogen sulfide concentration and odor threshold detection level at the building, 100-feet and 500-feet down wind from the production system.

Results and Discussion

Data analysis was performed in several different ways. The readings from the site visits were tabulated and averaged.

Four of the sites were monitored during the late summer and early fall of 2001 and then again during the late spring, early summer of 2002. Monitoring continued until near the first frost and resumed in the spring. The IL and MN-2 sites were not located until spring of 2002. The IL site had a wooded area on the north and east of the site which may have influenced the readings. Notes were made of the size, bedding condition and activities during site visits.

Figure 1 shows the averages of the hydrogen sulfide and ammonia readings taken at the building edge during site visits. It appears that the same trend exists for ammonia and hydrogen sulfide in that they are lowest for the Minnesota sites and highest for the Illinois site. One might conclude that this corresponds to facility capacity, however, the Northern Iowa and Nebraska sites were the largest. Since this was a survey project and each site was only visited four times, there were differences in the average weight of pigs on each site at the time of the observations. Pig weight was estimated during survey visits. Pig average weights for the survey trips were as follows: IL: 86 kg (190 lbs); NIA: 82 kg (180 lbs); SIA: 73 kg (160 lbs); NE: 64 kg (140) lbs; MN1: 64 kg (140 lbs); MN2: 48 kg (106 lbs). It is interesting to note that the trend that appears in Figure 1 for gases at the building edge nearly follows the trend in average pig size at the sites. Larger pig sizes correspond with deeper bedded manure packs and greater potential for emissions from manure decomposition. Bedding condition may also be a contributing factor, affecting the rate of decomposition and extent of anaerobic activity.

Figures 2 and 3 show the ammonia and hydrogen sulfide readings at 30 m (100 ft) and 150 m (500 feet) downwind. It is interesting to note that the Southern Iowa site (SIA), while having a relatively low hydrogen sulfide reading at the building edge, had the highest hydrogen sulfide reading at 30 m (100 ft) and 150 m (500 ft). The other sites all tend to follow the same trend they exhibited in Figure 1. Another interesting point is that the average hydrogen sulfide reading at the MN-1 site was actually higher at 150 m (500 ft) than it was at 30 m (100 ft). This does not make intuitive sense but is possible with this limited data set. Since only four visits were conducted, weather conditions may have influenced the plume coming from the building, and influenced the averages. Manure stockpiles may have also contributed.

Figure 4 shows the average olfactometry results from the six sites. The detection threshold is interpreted as parts of fresh air required to dilute one part of the sample to a level where half of the human panelists can detect odors. Therefore, a high threshold would be a very odorous sample. Figure 4 illustrates the point that ammonia or hydrogen sulfide concentrations do not necessarily predict odor concentration. The odor threshold for MN-1 is the highest of the six sites, yet for gas concentrations, it was low. This could be for a number of reasons. One factor could be that this site used paper for bedding.

Figure 1. Survey averages for hydrogen sulfide (ppb), measured with a Jerome meter, and ammonia (ppm), measured with a Draeger PAC III, at the building edge.

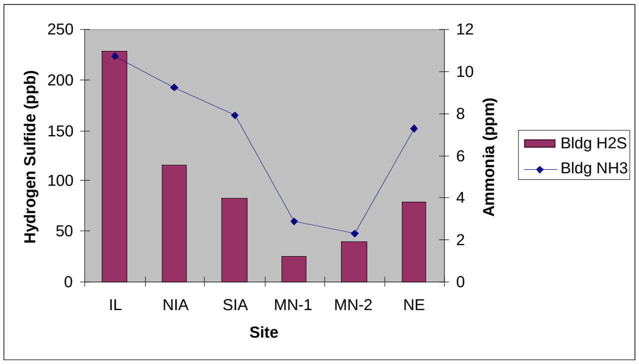


Figure 2. Survey averages of hydrogen sulfide, measured with a Jerome meter, and ammonia, measured with a Draeger PAC III, 30 m (100 ft) downwind.

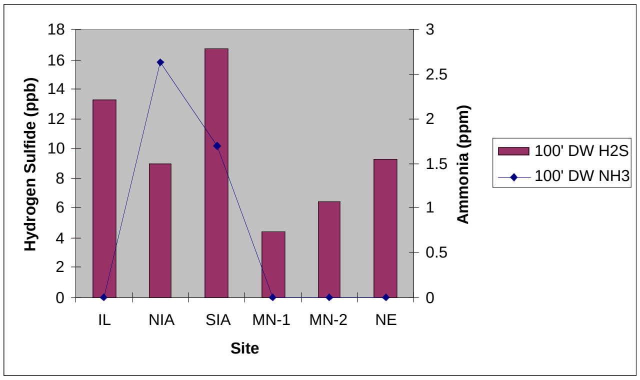


Figure 3. Survey averages of hydrogen sulfide and ammonia using handheld collection devices at 150 m (500 ft) downwind.

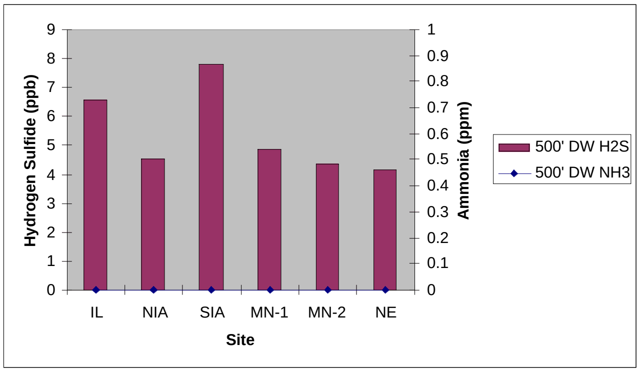
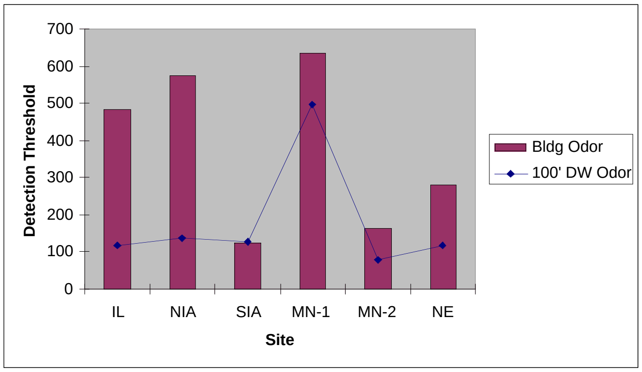


Figure 4. Olfactometry results of the survey visits.



Acknowledgements

The authors would like to gratefully acknowledge funding for this project, which was supplied by Pork Checkoff funds from the National Pork Board, Des Moines, IA.