Economic Evaluation of Manure Storage Covers

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FINAL REPORT

INTRODUCTION

Odor emissions from outdoor manure storage basins remain a major issue for animal producers whose manure-handling systems include them. Although limited data exists to verify outdoor air quality problems, the ambient odor and gas levels at or near animal production systems that have been indicated as a concern, are often presumed to originate from manure storage sources. This is especially true for outside, uncovered manure storage units (i.e. earthen storage basins, and below and above ground concrete or steel pits or tanks).

One method of reducing the odor released from outdoor manure storage basins that has had some success is the use of a floating cover. Based on research conducted in small tanks, various covers on outdoor manure storage units do reduce odor concentrations from this important odor source (Clanton, 1997). With the information collected to date, covers offer the best practical option for reducing odors from a manure storage source. Various research projects have shown the benefits of covering manure storage units to reduce the odor concentrations and emissions. Experiments in the laboratory and/or with small tanks at Iowa State University (Bundy et al., 1997), the University of Minnesota (Clanton, 1997), and Purdue University (Heber, 1997) have shown that a floating cover of straw or other materials do reduce odors. In addition to these control studies, several investigations (Mannebeck, 1985 and Miner, J.R., 1995) have shown odor reductions resulting from covers on farm manure storage systems.

OBJECTIVE

The objective of the project was to evaluate the use of primarily straw floating covers on commercial manure storage units to control odor and gas emissions and to identify the management requirements and cost of the covers.

MATERIAL AND METHODS

To evaluate the performance of the straw covers on existing manure storage units, five different pork producers with outdoor storage systems in Minnesota were selected. Producers were selected from a group of participants with manure storage units in two different odor-monitoring projects that were carried out in 1996-97. This provided past information of the particular manure storage unit so some retrospective analysis could be accomplished before and after a cover was installed.

During June and July of 1998, the five Minnesota pork producers participating in this project had straw blown on their manure storage unit to reduce odor and gas emissions (Figure 1).

Figure 1. Blowing straw on an earthen basin for odor and gas emission control.

Several commercial companies (Haybuster Products and Highline, Ltd.) were contacted and agreed to supply a machine to apply the straw and an operator to run it free of charge as a demonstration of their equipment. Both barley and wheat straw were used by the participants, with a preference to barley as indicated by past experience with straw covers in Canada (Pami, 1993). All but one (above ground tank) of the manure storage units was earthen basins and the application of straw was fairly simple and successful as shown in figure 1. The ability to get the straw evenly distributed was a function of basin size. The smallest manure storage unit to be covered in the project was an above ground tank (about 2/10 of an acre), while the largest was about 1.5 acres (Figure 2). The producer did experience some difficulty in getting this large basin completely covered.

Figure 2. Largest straw covered earthen basin (about 1.5 acres) in project

To evaluate the technical performance of the covers, air samples were collected at the surface of the manure storage unit each season (spring, summer, and fall) for odor measurement with an olfactometer. Hydrogen sulfide (H_2S) was also measured from these same air samples with either an electronic (Jerome^{TM}) meter or colorimetric tubes.

To evaluate the economic feasibility and manageability of the covers, producers were asked to record expenses to maintain the covers during the warm weather "odor season." This included both out-of-pocket expenses and labor costs to maintain the cover. A budget for the first year of operation was estimated. Also, responses from the producers were recorded as to the ease or the difficulty in operating or maintaining the cover.

RESULTS AND DISCUSSION

Large round bales of barley or wheat were mostly used to accommodate the application equipment and to save on shipping and handling costs. One producer did use some small square bales of straw he previously had stored at his farm. Most of the project participants were located in southern Minnesota and the straw was purchased from the northwestern (Red River Valley) area of the state, and in one case from Canada. Straw costs varied from a low of $23 (for the

producer closest to the straw source) up to $50 per large bale (average of 800 lbs). An application rate of roughly one large bale per 500 ft^2 (100 bales per acre) was suggested to the participants to obtain a 12-inch depth of straw on the manure storage units. Using an average of $40 per bale, this would translate to a cost of about $0.08 / ft^2 of storage area, which does not include the application costs. Straw application costs will range from $0.01 to $0.02 / ft^2 depending on the size of the storage. If the $0.08/ ft^2 figure is used, the initial cost to cover the manure storage units in this study would vary from $500 for the smallest (above ground storage tank) to about $6000 for the largest (1.5 area earthen basin) in the study.

The length of time that the straw covers remained floating varied between units. One storage unit needed additional straw only six weeks after the initial application of barley straw. This unit was actually one of the smaller storage units in area and was possibly caused by a large rainfall (over 7 inches) event. Another participant had two basins covered, one with barley and one with wheat straw, and both lasted four months. Factors such as the amount of rainfall, depth of storage units, surface area, access to surface winds, and manure characteristics may explain some of the variations seen in how long straw floated on the manure storage units.

Four of the five participants agitated the full storage units in the fall with the intention to chop up the straw cover and remove it with the manure slurry. All but one of the four was successful in accomplishing this (i.e., breaking up the straw mat). The fifth producer pumped down the manure storage but did not intentionally plan to break up the straw cover and had about 50% area coverage of straw on the storage unit going into the winter. The one individual who tried to chop up the straw and was unsuccessful had the straw mat sitting at or near the bottom of the storage basin going into the winter. We don’t know the extent to which this will cause problems with pumping or removing of manure from this storage units in future years.

One of the participants in the demonstration project decided to try a more permanent cover than straw and applied a geotextile material (about 1/8 inch thick) on two different manure storage basins. The cost of using this material to cover a manure storage unit ranges from $0.15 to $0.25 / ft^2 of storage area depending on the size of the storage. One of these basins had a small amount, 2 to 3 inches (5 to 8 cm) of straw blown on top of the geotextile material to aid in odor control (Figure 3).

Figure 3. Geotextile cover with thin layer of straw (2 to 3 inches) blown on top of an earthen manure storage basin.

This basin was the 2nd stage of a two stage unit (first stage was covered by just straw) and is typically not agitated and pumped directly. Instead, the level is controlled by allowing the slurry in the storage to drain back into the first stage and be removed by a standard manure pump. Because of this procedure, the geotextile material and thin layer of straw did not need to be removed for pumping manure.

The other manure storage basin cover with the geotextile material had no straw blown on top of it. This material was partially removed or "pealed back" during the pumping of the manure during the fall of 1998 and did create some additional work during the pumping process but was manageable. Both of the geotextile covers did survive the winter of 1998-99 and are still floating this summer (1999). The geotextile cover with the thin layer of straw sank slightly early this spring during some large rainfall events, but resurfaced and seems to be providing good odor and H_2S reduction although measurements have not been taken during 1999.

Odor and H_2S Reduction Data

The odor reduction performance of the straw covers was noticeable as subjectively noted by the producers, their neighbors, and others working near the units. Air samples were collected from the surface of the storage units at least twice during the summer and fall and analyzed for odor using olfactometry. Results of these measurements for odor and gas concentrations were

inconsistent due to difficulty in collecting a representative sample at the surface of the straw cover.

Even though there was difficulty in sampling from the surface of the storage units with covers, Tables 1 and 2 gives performance data from one of the earthen basin with just straw (Table 1) and one with the geotextile and straw combination (Table 2). The tables list both the surface concentrations and emissions from the surface for hydrogen sulfide (H_2S) and odor. Odor concentrations are given in odor units (o.u.) which is the number of air dilutions needed to obtain the detection threshold of the sample (the higher the number the stronger the odor). The odor emissions are given in a unit of (o.u. m^3/s m^2), which means the number of odor units per second (when multiplied by a flow rate of m^3/s) per square meter of surface area of the manure storage unit.

Both tables show one sampling done before the covers were applied to provide some measure of effectiveness. The other data shows two or three measurements taken at different sites on the storage and in some cases using different airflow from the flux or wind tunnel hood used to collect air samples. Although not every sampling collected shows a reduction, the general trend is for lower odor and H_2S emissions from these storage basins after they were covered.

Table 1. Odor and H_2S concentrations and emissions from a manure storage basin before straw was applied (June 1998 data) and after applied (Aug. & Sept. 1998 data).

Date	H_2S, ppb	H_2S emission, $\mu g/s/m^2$	Odor units, o.u.	Odor emission, o.u m^3/s m^2
01-Jun-98 –No straw	200	13.6	34	1.56
04-Aug-98	72	3.33	25	0.76
10-Sep-98	17	0.79	132	4.02
10-Sep-98	39	1.8	51	1.55

Table 2. Odor and H_2S concentrations and emissions from a manure storage basin before a geotextile material with a thin layer of straw was installed (June 1998 data) and after it was applied (Aug. & Sept. 1998 data).

Date	H_2S, ppb	H_2S emission, $\mu g/s/m^2$	Odor units, o.u.	Odor emission, o.u. m^3/s m^2
16-Jun-98- No cover	300	20.4	153	7.04
12-Aug-98	23	0.35	26	0.26
14-Sep-98	16	1.09	66	3.03

SUMMARY

This project showed that straw and a geotextile material covered with a thin layer of straw can be successfully used on outside manure storage units to provide some reduction in odor and H_2S emissions. There are application problems in applying the straw on the storage, from being able

to reach all sections of the basin or tank if it has a large surface area, to being able to judge the depth of straw on the basin during the application process. The average cost of the straw used in this project was \$0.08/ft^2, not including application cost, while the cost of the geotextile was approximately \$0.25/ft^2, which did include application. The straw stayed afloat from two to four months and did not provide much trouble when the storage units were agitated and pumped in the fall. One of the geotextile-covered basins (without a thin layer of straw) was "peeled" back during the pump-out process in the fall, which did take extra time and effort. A straw cover does offer producers a reasonably low cost solution to odor and H_2S emission problems. A geotextile cover offers a longer-term solution but for more cost and potentially greater maintenance requirements.

Further evaluation of both straw and geotextile covers on manure storage basins needs to be done to identify problems that may develop over time. Also, other more permanent floating covers (lasting longer than one year), like floating clay balls (Leca or Macrolite) or other geotextile materials, needs to be investigated.

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