



Research Update 698

Hog Lagoon Odour Control -A Treatment Using Floating Straw

(Funded by: SDA&F, SPI, and District 21 ADD Board)¹

WHAT'S THE PROBLEM?

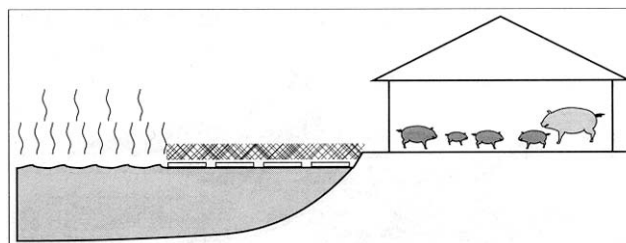
The ability to control odours, from agricultural waste storage, has always been a problem for the agricultural industry. The need to control odours has intensified. Environmental issues, such as manure utilization and air quality can no longer be ignored.

Saskatchewan annually produces over one million hogs, which generate about 83 million fts (2.3 million m³) of manure. Manure storage in open lagoons with the resulting noxious odours have become increasingly annoying to neighbouring farms and towns. Any cheap, practical method to reduce or eliminate these odours would be welcomed by both the hog producers and their neighbours.

In 1992, PAMI concluded a series of five projects to develop effective odour controlling coverings for hog manure lagoons. Studies were conducted on the effectiveness of supported and unsupported covers, with emphasis on cover durability, straw type, odour reduction period, and management problems. In the final project, several straw types were used in full scale tests on lagoons.

Project reports are available by contacting PAMI at 1-800-567-PAMI. (See Page 4, "Further Information", for details).

NOTE: The reader is cautioned that the following information is only a summary of the test results.



WHAT DID WE DO?

PAMI conducted detailed tests using straw covering systems on four lagoons located at Abernethy, Lucky Lake, Spalding, and Humboldt. Observations were also made on covers applied by a commercial contractor at four sites near Spiritwood. Studies were done to determine:

- performance of various straw types and qualities;
- performance of artificial flotation devices for straw support;
- performance of a shredder/blower device for straw application on lagoons;
- problems during lagoon pump-out, caused by straw or flotation devices;
- costs of straw covering systems for lagoons,

IN BRIEF... THE CONCLUSIONS

- Only "the best of quality" barley straw is considered suitable for unsupported straw covers.
- With barley straw, odour control is excellent as long as the straw floats and is dry on top.
- Odour reduction still occurs even after the barley straw sinks just below the surface.
- As the straw cover deteriorates, odour problems return in proportion to the increasingly exposed manure area.
- A second application of straw effectively extends the cover life of unsupported covers.
- Polystyrene floats (in sheets) work well to support a straw cover system which could possibly be reused for more than one season. The polystyrene maintained the cover in a dry state for the entire summer.
- With polystyrene floats, some care is required in the choice of pump-out equipment. Also, a method is needed to provide cover maintenance.
- Oil bottles gave good support to the covers. However, some oil bottles sank and could cause pump-out problems. This method should not be used unless the bottles can be tightly sealed.
- A straw applicator device is required to place the straw uniformly over the entire lagoon, especially when float systems are used.
- Pump-out is not a problem if reasonable procedures are followed. Proper agitation and straw chopping at the manure pump will accommodate most situations.
- If a supported cover is used, lower quality straw may be suitable.
- Annual costs for at 25,000 ft² (2320 m²) lagoon were estimated at \$1100 for unsupported covers, and \$2050 for supported covers. Costs can be reduced through further system research and development.

¹ Funding for this research project has been provided by the SPI Marketing Group, PAMI, Saskatchewan Department of Agriculture and Food - Environment and Engineering Branch, and Watson District 21 ADD Board, supported by the Saskatchewan Agriculture Development Fund.

Straw Type and Quality: The Abernethy site was used to test unsupported straw over a large area. Combinations of good barley and good oat straw provided the cover material.

The Lucky Lake site was covered with good flax and good durum straw.

The site at Spalding used a good barley straw cover over polystyrene floats on the liquid cell. The solids cell was covered with unsupported barley.

The Humboldt site used poor oat and poor barley straw over a support system of recycled oil bottles.

The four Spiritwood locations were covered with a single application of unsupported good barley straw.

Straw Application: Straw was applied for both flotation supported covers and non-supported covers by using a device initially designed to spread straw for surface erosion control in road construction (FIGURE 1).

The applicator consists of a conveyor moving square bales through a flail shredder into a paddle fan blower which blows the straw through a moveable spout.



FIGURE 1. Straw Applicator.

Straw Flotation Devices: Two flotation devices under the straw layer were tested; polystyrene sheets 1 in (25 mm) thick (FIGURE 2), and plastic engine oil bottles (FIGURE 3). They were simply dumped onto the lagoon and allowed to drift into position to provide a uniform covering of the liquid surface. A floating barrier was used to keep them in the liquid cell of the 2-cell lagoon.

Lagoon Pump-Out: The test lagoons were closely observed during agitation and pump-out to determine any problems introduced by the various straw types or the flotation devices.



FIGURE 2. Floats in Place on Liquid Cell.



FIGURE 3. Oil Bottle Floats.

WHAT WERE THE RESULTS?

Straw Type and Quality: Barley straw of good quality was the only effective material for unsupported covers. To be considered of good quality, barley straw should be fresh, unweathered, relatively dry, with as many whole stalks as possible. The tubular stalks act as flotation devices, and surface life is reduced if stalks are shredded or shattered excessively. Barley straw can give effective odour control over the entire season with only one or two reapplications to small areas of the lagoon surface to recover areas of straw sinkage.

Flax straw forms a mat which is too porous for odour control purposes. Also, flax straw sinks quickly and may cause pump-out problems. Oat straw also sinks quickly.

Durum straw is better than oat or flax straw but is similar to wheat straw which floats approximately one third the time of barley straw.

Any type of cereal straw and even poor quality straw may work effectively when float systems are used to support the cover.

FIGURE 4 shows a lagoon immediately after covering with barley straw. FIGURE 5 shows the same lagoon several weeks later. The damp areas will have effective, although not excellent, odour control, while open liquid areas will provide no odour control. When about 15% of the lagoon area has open liquid because of straw sinkage, odour will be significant enough to require reapplication of straw.



FIGURE 4. Unsupported Straw Cover.

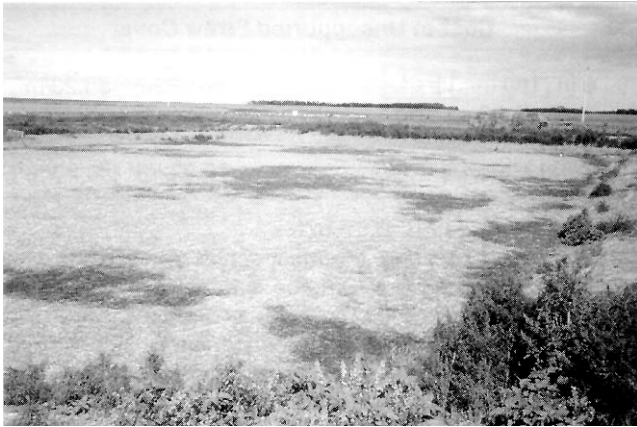


FIGURE 5. Sinkage of Unsupported Cover.

Straw Applicator: The straw applicator used in these tests needed a strong wind to improve throwing distance. The average application rate was 2 square bales per minute. The straw was blown 150 ft (45 m) with wind assistance and 80 ft (25 m) in calm conditions. The applicator shredded the straw to 6 to 8 in (150 to 200 m) which would tend to reduce flotation time slightly.

Straw applied directly to the lagoon surface is free to drift with the wind to cover areas which are well beyond the applicator's range. In this case, the applicator's coverage doesn't have to extend over the entire surface area. When applying onto a flotation system, the straw must be uniformly placed by the applicator over the entire area of the lagoon. To operate successfully in this case, the applicator's range must extend further and the straw stream must be easily and accurately controlled.

On the first application of unsupported straw, about 45 ft² (4.2 m²) can be covered to a 6 in (150 mm) depth with each square bale (FIGURE 6). When the straw is supported or when straw is reapplied, 55 ft² (5.2 m²) can be covered to a 5 in (125 mm) depth (FIGURE 7).

The need for reapplication of straw depends on the initial straw depths and on the quality of straw. Preliminary estimates indicate that 2 or 3 reapplications would be required if the initial straw depth were 4 to 6 in (100 to 150 mm). Initial depths of 6 to 8 in (150 to 230 mm) of good quality straw would only require 1 to 2 reapplications. It is estimated that an initial covering of 8 to 10 in (230 to 250 mm) would probably not require further applications.

Straw Flotation Devices: The polystyrene floats kept the straw cover supported and dry for nearly the entire season, with excellent odour control.

Since the cover floats downwards at pump-out and back to the surface on refill, multiple-year usage of the floats is possible. Reapplication of straw may be required each year to repair damaged areas.

Oil bottle support systems worked well, but one problem needs to be solved. A number of bottles leaked and sank because their caps were not properly tightened. Tightening of individual caps would be necessary to ensure best performance.

Lagoon Pump-Out: The lagoons, where unsupported straw was used, were agitated before and during pump-out to break up the straw. Manure pumps with chopping blades had no problems producing a product which would flow through conventional pumps. Land application employed a continuous flow injection system delivered from trucks with pressurized tanks and diverter nozzles. No pumping problems occurred at this stage.

At sites where agitation was insufficient, straw wads would plug the pump's outlet nozzle. As well, the transport tank and outlet nozzle would partially plug with straw. It may be possible to modify the pump-out equipment to handle product from unagitated lagoons.

With a liquid cell, using a polystyrene float and straw system, a transfer pump was used to pump the liquid into the dry cell and no auxiliary agitation was required. As the liquid was removed, the straw/float cover settled, intact, to the bottom of the cell. The floats and the straw could be used for the next season.

Pump-out employing agitation was used on the liquid cell with the oil bottle/straw cover system. Agitation shook the cover straw of the bottles and into the slurry. Also, a number of oil bottles sank, requiring their removal from the lagoon to avoid damaging the pump system. Oil bottles should not be used in lagoon cells where agitation will be required unless they can be completely sealed.

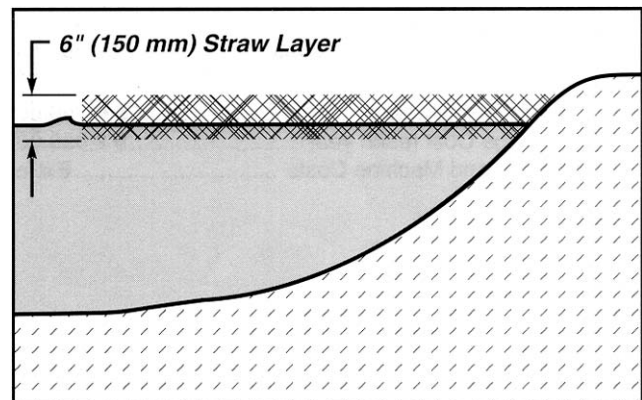


FIGURE 6. Unsupported Straw Cover.

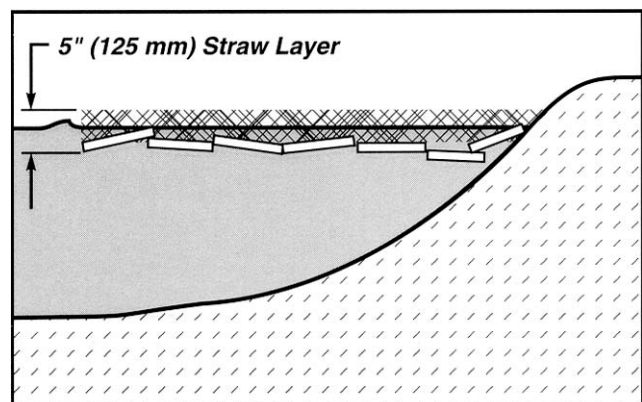


FIGURE 7. Straw Cover With Flotation.

Cost of Straw Coverings: Cost of the two types of straw coverings (supported, unsupported) were estimated and based on current material costs and recommended application practices determined during the project. Only material costs were computed. Labour and machine costs are extra and were not precisely determined at the time of this report.

Generally, the cost of an unsupported system cover was about half the cost of a supported one. Cost of supported covers may be reduced by possible use of thinner float material and use of lower quality straw.

Cost of Straw Cover with Flotation	
1 in (25 mm) polystyrene	\$0.210/ft ² (\$2.26/m ²)
5 in (125 mm) barley straw	\$0.018/ft ² (\$0.19/m ²)
@ \$1.00/sq. bale	
Total Material Costs	\$0.228/ft² (\$2.45/m²)

Example: To apply a straw cover with flotation system to a 25,000 ft² (2320 m²) lagoon. The lagoon would receive a single full depth coverage of straw over polystyrene floats in the first year, and reapplications of straw to about 50% of lagoon area in each of the second and third years. Resulting costs would be as follows:

Material Costs (1st yr, straw & polystyrene)	\$ 5700.00
Material Costs (2nd yr, 50% straw)	225.00
Material Costs (3rd yr, 50% straw)	225.00
Total Cost (3 years)	\$ 6150.00
Average Cost (each year)	\$ 2050.00
Labour and Machine Costs	Extra

Cost of Unsupported Straw Cover	
6 in (150 mm) barley straw	\$0.022/ft ² (\$0.23/m ²)
@ \$1.00/sq.bale	
Total Material Costs	\$0.022/ft² (\$0.23/m²)

Example: To apply an unsupported straw cover to a 25,000 ft² (2320 m²) lagoon. The lagoon would receive an initial full depth coverage of straw, and over the period of use would receive a complete reapplication in the form of cover touch-ups. The straw cover would be destroyed during pump-out and would have to be reapplied annually. Resulting costs would be as follows:

Material Costs (initial straw applicator)	\$ 550.00
Material Costs (reapplication of straw)	\$ 550.00
Cost (each year)	\$1100.00
Labour and Machine Costs	Extra

FURTHER INFORMATION

For detailed information, contact PAMI at 1-800-567-PAMI and ask for any of the following reports (cost \$5.00 per report).

- "Application Methods for Manure Lagoon Coverings"
PAMI #RH0490 - Sponsor: Saskatchewan Agriculture Development Fund.
- "Methods for Enhanced Straw Flotation"
PAMI #RH0390 - Sponsor: Saskatchewan Agriculture Development Fund.
- "Lab Scale Tests of Straw Floats"
PAMI #RH0391 - Sponsor: PFRA- Biofilter Research, in co-operation with UMA Engineering.
- "Economic Analysis, Swine Manure Disposal"
PAMI #DH0491 - Sponsor: Saskatchewan Department of Agriculture and Food
- "Straw Covering Methods for Swine Manure Lagoons"
PAMI #RH0292 - Sponsor: SPI Marketing Group Saskatchewan Department of Agriculture and Food, and the Watson District 21 ADD Board.

 <p>ALBERTA FARM MACHINERY RESEARCH CENTRE</p> <p>3000 College Drive South Lethbridge, Alberta, Canada T1K 1L6 Telephone: (403) 329-1212 FAX: (403) 329-5562 http://www.agric.gov.ab.ca/navigation/engineering/afmrc/index.html</p>	<p>Prairie Agricultural Machinery Institute Head Office: P.O. Box 1900, Humboldt, Saskatchewan, Canada S0K 2A0 Telephone: (306) 682-2555</p> <table> <tbody> <tr> <td>Test Stations: P.O. Box 1060 Portage la Prairie, Manitoba, Canada R1N 3C5 Telephone: (204) 239-5445 Fax: (204) 239-7124</td> <td>P.O. Box 1150 Humboldt, Saskatchewan, Canada S0K 2A0 Telephone: (306) 682-5033 Fax: (306) 682-5080</td> </tr> </tbody> </table>	Test Stations: P.O. Box 1060 Portage la Prairie, Manitoba, Canada R1N 3C5 Telephone: (204) 239-5445 Fax: (204) 239-7124	P.O. Box 1150 Humboldt, Saskatchewan, Canada S0K 2A0 Telephone: (306) 682-5033 Fax: (306) 682-5080
Test Stations: P.O. Box 1060 Portage la Prairie, Manitoba, Canada R1N 3C5 Telephone: (204) 239-5445 Fax: (204) 239-7124	P.O. Box 1150 Humboldt, Saskatchewan, Canada S0K 2A0 Telephone: (306) 682-5033 Fax: (306) 682-5080		