Atlantic SWINE RESEARCH PARTNERSHIP Inc.

Nova Scotia Agricultural College

fact sheet

Negative Air Pressure Covers for Earthen Swine Manure Storages

Introduction

Over the past few decades the intensification of farm areas and rural encroachment have lead to considerable nuisance complaints from odours with swine operations often being the most frequently targeted. In some cases the public has been able to successfully lobby government to cease the construction of new operations or halt the expansion of existing ones due to nuisance odours. More recently however, gaseous emissions such as methane, nitrous oxide and ammonia (NH_3) are becoming more highly regulated as a result of their direct and indirect impacts on global warming and air quality.

Management options to reduce gaseous emissions from swine operations are vital. While the major source of odour is liquid manure stored in open lagoons, these and other gaseous emissions can be controlled through the use of manure storage covers. For this purpose negative air pressure (NAP) covers (Fig. 1) have recently become extremely popular. These covers, developed by DGH Engineering Ltd., consist of a high density polyethylene material that floats on the surface of the liquid manure and is anchored to the top of the storage by burial in a trench (Fig. 2) underneath the topsoil. Plastic perforated tile is laid under the cover and around the perimeter of the storage with several laterals extending inwards. This tile is connected to a fan (Fig. 3) which supplies the negative pressure to hold the cover at the surface of the manure.

Figure 1. Installed NAP cover with precipitation water on surface.

Figure 2. Plastic perforated tile and burial trench.

Figure 3. Centrifugal fan supplying negative pressure.

While the original purpose for the NAP cover was strictly to reduce odours from manure storages, there are a number of additional benefits such as overall manure volume reductions, reduced NH_3 losses and the resulting nutrient benefits this creates.

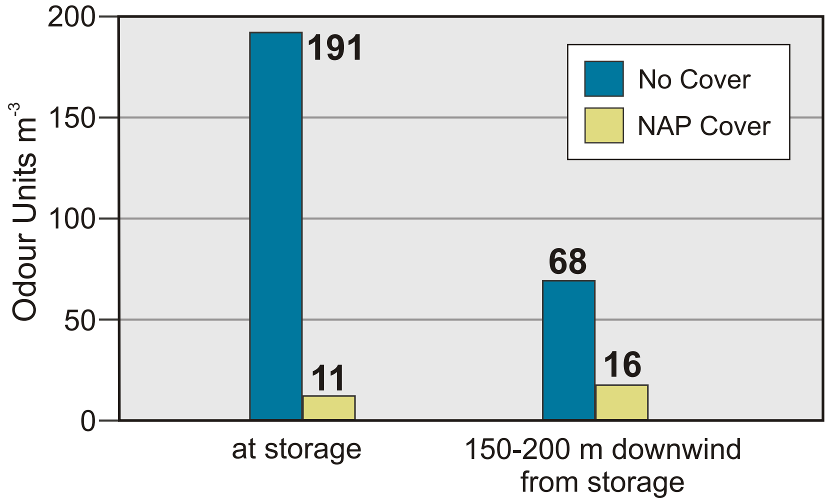

Figure 4. Odour units (OU m^{-3}) comparisons with and without a NAP cover.

Odour Reductions

NAP covers have been found to reduce odour levels significantly at the storage (Fig. 4) as well as downwind. The data in Fig. 4 is from a farm in Nova Scotia that was monitored for odours.

The highest odour levels from storages occur during agitation and spreading. This is a concern with this system as the cover must be removed. Therefore, a below cover air agitation system has recently been developed in which perforated pipe is installed within the storage prior to installation of the cover. Agitation of the manure is achieved by introducing air through the piping system from a compressor creating the mixing action (Fig. 5). As a result, the NAP cover never needs to be removed. Although these agitation systems still need to be fully tested, they have the potential to allow these NAP covers to be even more effectively used.

Figure 5. Air agitation of manure through piping system on storage bottom. Photo courtesy DGH Engineering.

Manure Volume Reduction

NAP covers can also help reduce the volume of manure which has to be handled for storage and spreading. The cover essentially acts as a barrier preventing precipitation from mixing with the stored manure. Although they limit the evaporation from the surface of the manure storage, they do allow for less overall manure because of this precipitation barrier, especially for Atlantic Canada. With average annual precipitation ranging from 1000 to 1200 mm and evaporation rates of approximately 500 to 700 mm, NAP covers provide for approximately 700 mm of reduced manure volume (Fig. 6). Water contained above the NAP cover can be pumped off prior to removal of the cover. This water can be stored and later utilized in the barn or discharged.

Manure reduction potential of the covers depends on the storage surface area. For every square metre of storage approximately 0.7 m^3 of precipitation, on average, can be diverted from the storage.

Spreading costs are associated with the total volume which is required to be spread and the cost per unit of spreading. The cost per unit can increase significantly with the distance from storage manure must be hauled. For example using a 2¢ per gallon spreading cost for a storage with a surface area of 3,000 m^2 would realize an annual savings of greater than $9,000 (Fig. 7). Depending on the size of the storage and spreading costs payback periods can be in as short as three years. Larger systems are more efficient to install, and therefore have a faster rate of return. Payback periods are dependant on cost of spreading and the cover staying on continuously. With the cover removed precipitation can enter the storage increasing volumes and labour costs associated with removal and installation. Damages to the cover can decrease performance for precipitation exclusion and NH_3 retention. A slight increase in spreading costs would quickly increase the savings from having a NAP cover in place.

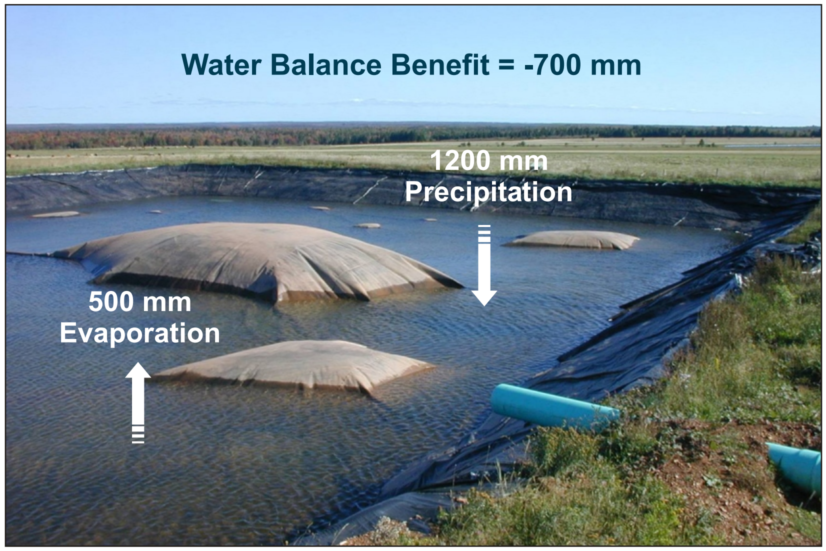

Figure 6. Net water gain from an uncovered manure storage.

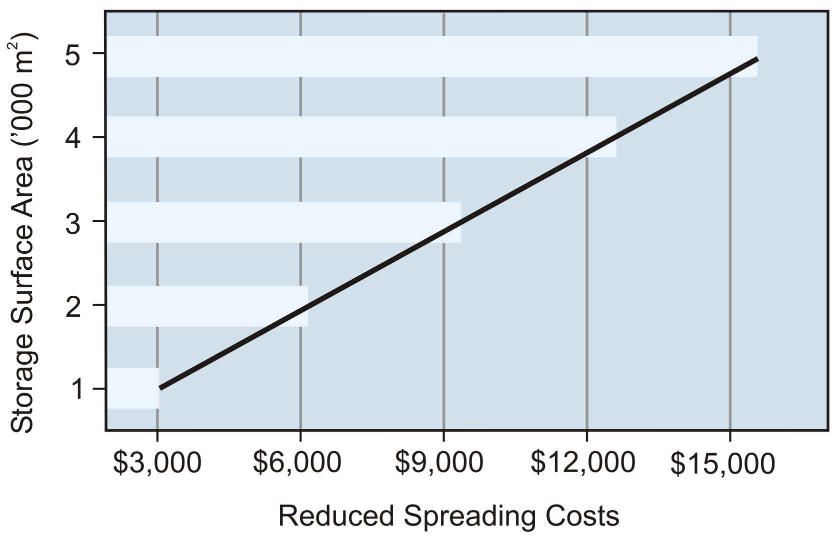

Figure 7. Reduced spreading costs from a NAP covered manure storage compared to an uncovered storage.

Ammonia Emissions

Manure N is partially lost (10-50%) through NH^3 volatilization from the manure surface. A NAP cover has the potential to reduce NH3 emissions by 70–95%.

The loss of N reduces the fertilizer value of manure. Therefore, reductions in NH^3 emissions increases manure N content under a covered storage. Figure 8 shows the potential savings in fertilizer value based on uncovered and covered storage NH^3 losses. For example a 200 sow farrow-to-finish operation would produce 5,000 m3 of manure per year. If N fertilizer was estimated to be worth $0.73 per kg, a farmer could improve the fertility value of his manure by $4,000 annually by using a NAP cover through improved NH3 conservation.

Management Considerations

NAP covers can reduce odours and other gaseous emissions to negligible levels however, the cover must be removed during periods of agitation. Cover removal has led to several problems including: the need for several labourers to assist in pulling off the cover; ripping of the cover during removal resulting in decreased life expectancy and performance; rainfall ponding on the pulled off cover and the difficulty in putting the cover back on especially when any wind exists; and delays in replacing covers due to difficulty in doing so. Also, covers have been damaged by the dried stems of goldenrod and other woody stems during removal and re-installation.

A below cover agitation system exists which allows the cover to remain on the storage during periods of agitation and manure spreading. Life expectancy of the NAP cover is approximately eight years. This could be significantly increased through the incorporation of a below cover agitation system as the cover would not have to be handled once installed.

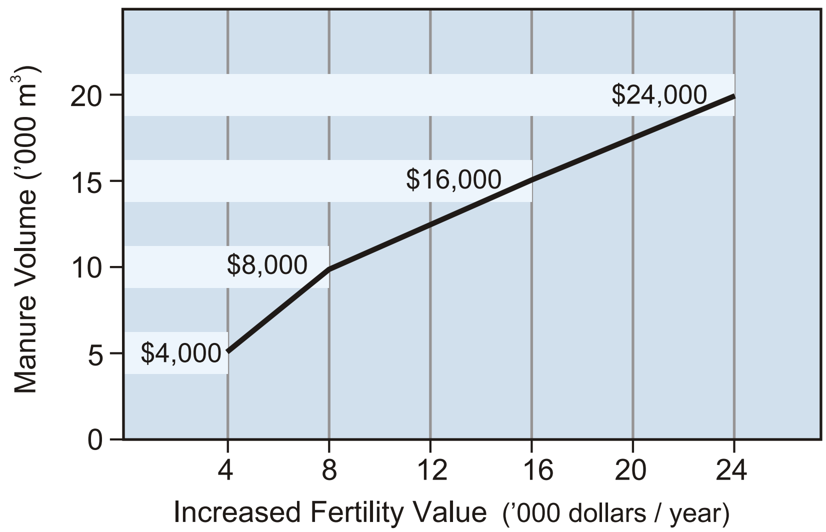

Figure 8. Manure N savings based on NH_3 losses from a NAP covered manure storage compared to an uncovered storage.
(adapted from Small, D. and Danesh, S. 1999. Development of a negative air pressure cover system for swine earthen manure storages in Manitoba. DGH Engineering Ltd., St.Andrews, Manitoba.)

Conclusions

Based on manure volume reductions the cover system has the potential to save thousands of dollars annually depending on the size of the system. The cover also increases the value of manure as a fertilizer by the reduction of NH_3 volatilization resulting in significant savings based on fertilizer costs.

These covers offer a host of benefits which may help justify the initial costs of implementing the technology. In addition, there has also been recent interest in the potential of bio-gas production from these systems.

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