Environmentally Responsible Hog Manure Management

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Summary

Research conducted over the past 8 years by the Prairie Agricultural Machinery Institute has resulted in the development of hog manure management methods that reduce odour, improve pumping and transport efficiency and will allow the optimum crop application of this valuable nutrient source. Straw covered lagoons and soil injection dramatically reduces odor while improved pumping and handling systems result in reduced cost of application. In addition, research in soil application methods and rates of application will result in optimizing the fertilizer value of the manure while maintaining environmental quality.

Introduction

Swine manure has frequently been regarded as a waste product that must be disposed of rather than as a valuable fertilizer resource. In the past, hog operations sometimes dumped excessive quantities of the liquid manure on a small land base resulting in potential contamination of the soil and water resource. Part of the reason for this was due to a lack of guidelines for the environmentally sustainable application of swine manure.

With the planned expansion of the hog industry in Saskatchewan, it is essential that the expansion be handled in an environmentally friendly manner (including odor) if the expansion is to succeed without a major public backlash. Government has responded to these concerns by the strict regulation of new developments and funding research into manure storage, handling, application, agronomics and odor control.

The Prairie Agricultural Machinery Institute (PAMI) has been involved in hog manure management and odour control research since 1990. This paper summarizes PAMI's hog manure research including: lagoon odor control, lagoon agitation and pumpout, transportation and field application.

Lagoons (Earthen Manure Storage)

Concerns have been frequently expressed that hog manure lagoons are and will be a source of nutrients leaching into the local aquifers and contaminating the water supplies with nitrates and other contaminants. Recent research by Terry Fonstad, Agricultural and Bioresource Engineering, University of Saskatchewan indicated that nutrient seepage is not a problem if the lagoon is constructed in soils with sufficient clay content.

Straw Covers for Lagoons

PAM1 research has shown that a 6-l 0" cover of good. fresh, dry barley straw can significantly reduce odour from a hog manure lagoon. Ideally, the straw should be less than one year old, and should not be wet or rotted. Early research in this area used a forage harvester to apply the straw, but this machine chopped the straw into small pieces and it sank sooner than if the straw was longer. PAM1 and High-Line Manufacturing of Vonda, Sask. developed the Top Gun round bale blower to apply straw covers to manure lagoons. This machine consists of a round bale unroller that passes the straw to a fan that blows the straw through a large nozzle that can be aimed from the tractor cab. It does a very effective job of taking the bale apart and applying the straw to the storage surface without chopping the straw into small pieces. The suggested retail price for this machine is $26,000.00. With barley bales costing $13-$20 each, and each bale covering from 500 to 1000 sq. ft. of surface area, the cost for straw to cover a typical lagoon would be about $800.00 - $1,200.00.

Barley straw has a low bulk density so it is difficult to blow entirely across large lagoon surfaces. Wind can be used to assist the straw across the surface to ensure complete coverage. On small lagoons, the straw can be blown to all parts of the liquid surface. On larger lagoons, some operators have had better success creating a good, uniform cover by making a thick layer of straw on the upwind shore of the storage and allowing it to migrate across the surface while straw is added to the trailing edge of the straw mat.

With a thick layer of good quality barley straw, the cover can reduce odour for up to six weeks. As parts of the cover sink, the odour increases in proportion to the area of exposed liquid. To increase cover longevity, a top-up of straw can be applied about 4-6 weeks after initial application. Also, some operators have extended cover life by applying canola oil to the straw as it is being blown on. A drawback to applying canola oil is the cost of the oil. In previous research, PAM1 tried increasing cover longevity by placing flotation devices such as used oil bottles, Styrofoam sheets and plastic bubble pack under the straw. Some of the devices helped keep the straw floating, but they presented a major problem during lagoon pumpout, as they were difficult to collect and keep away from the pump inlet. During pumpout, a chopper blade on the agitation pump must be used to chop up the straw cover. When this equipment is used, operators have had few problems with pumping the straw through their application equipment.

Pitsweep

The conventional method for removing solids from lagoons is to use an agitation pump to mix up the entire storage and to get the solids into suspension. The solid material can then be pumped out along with the liquids. The agitation pump must be started before pumping can begin and must be operated continuously during the pumpout process. This procedure works, but it is a large energy consumer and excessive odour is created before and during pumpout. To address this problem. PAM1 has developed a Pitsweep. This machine is basically a Houle manure pump with a sweep auger attached to the pump inlet. This auger is hydraulically driven, and pivots around the pump inlet. As it pivots, the auger moves solids toward the pump inlet where they are pumped out to the tank or pipeline with the liquids. The entire unit can be powered with a single tractor, and is easy to move in and out of the storage. It is intended that the unit be moved to various places in the lagoon so the solids can be removed from the storage without having to perform other agitation. An advantage of the Pitsweep is that it only needs to operate when the manure is pumped out of the storage. Also, the sweep itself consumes much less power than a conventional agitation system. PAM1 is presently looking for a manufacturer to commercialize the unit.

Pumpout Options

In any materials handling problem, the three basic systems that can be investigated are a batch system. a continuous flow system, or a hybrid of the two. All three systems exist for transferring manure from the storage to the field.

The batch system involves using conventional pull type or truck mounted tanks to move the manure from the storage to the field. This system is very versatile and is adaptable to many situations. The manure can either be injected directly into the soil, or broadcast on the surface for later incorporation. The system has been used for many years. and the equipment is well developed. An advantage of this system is that setup time is very small and it is very versatile. Disadvantages of the system include large amounts of agitation, travel time, soil compaction, and possible road damage.

The continuous flow system uses a pump at the storage that pumps the manure through irrigation piping directly to the field. The manure can then be injected directly into the soil with a cultivator attached to a drag hose system (umbilical). The umbilical is a heavy-duty flexible hose system that is hooked between the end of the pipeline and the injection system. Alternatively, an irrigation gun can be connected to the end of the pipeline for surface application. Setting up the irrigation piping is labour intensive, but once it is set up, pumping is continuous. Therefore, this system lends itself to large volumes of manure. Field compaction problems are minimized, and no damage is done to the road system. If the manure is to be pumped long distances, a second pump and more pipeline may need to be added. One drawback of the system is that equipment for flow control and a good start/stop system has not been developed.

A hybrid system involves using a pipeline to continuously pump the manure to a temporary storage tank in the field, and then uses a large pump to quickly transfer the manure from this tank to a standard pull type or truck mounted tank unit. This system has some advantages of both tanker and pipeline systems, in that road damage and travel time are minimized and the manure pumpout from the storage is continuous. Disadvantages include setup time similar to the continuous flow system, and some of the system components are not readily available.

All of the above systems have their advantages and disadvantages, which makes choosing a system to fit a particular operation difficult. An initial analysis indicated that when hauling distances increased, the continuos flow systems were more economical to operate than using tanks. PAM1 has recently developed a more detailed spreadsheet that accounts for commercial fertilizer prices, soil nutrient requirements. custom applicator rates. storage type, and other factors, and compares the costs to transfer manure to the field with several different systems. Other agencies are working to configure this spreadsheet to become an add-on to PorkPlan and it will be available to producers, consultants and others to aid in their manure management decisions.

Field Application

In the field, manure can either be spread on the surface or injected directly into the soil. When the manure is spread on the surface, there is a great deal of odour released, and if the manure is not incorporated into the soil within 24 hours of application, 25% or more of the nitrogen may be lost. Because of these drawbacks, many operators are injecting the manure directly into the soil either with toolbars mounted on the manure tank or with a cultivator that is fed by a pipeline system. Because manure can contain long straw, hair, and other debris, most of the injector units use large (2" diameter) hoses and a wide shank row spacing (18-24"). Wide row spacing may result in uneven manure distribution in the soil and subsequent stripping of the crop. To reduce this problem, PAM1 has developed an injector that has the shanks spaced at 12", and uses 1 ½" diameter hoses. The manifold also incorporates a cutting mechanism to cut the straw and hair and reduce plugging in the injector nozzles. Testing to date indicates that the unit works well and can evenly inject manure without plugging.

PAM1 has recently initiated a project where swine manure is applied to pasture land using the Greentrac low disturbance injection system. This machine uses a cutting coulter in front of a narrow opener to inject the swine manure into the forage crop. Preliminary results show that soil disturbance with the injector was very low with a ½ inch wide slot, 4%" deep in the forage crop. Liquid fertilizer rates up to about 6,000 gallons/acre were applied without any liquids left on the soil surface. As the plots were applied in the fall of 1997, no results are available.

Manure Agronomics

PAM1 and the University of Saskatchewan are cooperating in a three-year research project to maximize the agronomic and environmental benefits of the application of swine and cattle manure. Liquid swine manure and solid feedlot manure will be injected or incorporated at four different application rates and these rates will be compared to equivalent rates of banded Urea (46-O-O) fertilizer. In the first year, rates of application included 0. 50. 100 and 200 lb/ac available N. In the second and third years the same plots will be overlaid with either the same application rates or with no additional fertilizer to measure the effect of carryover and slow release of nutrients in the subsequent crops. The Soils Department will conduct detailed analysis of the plots including nutrient leaching, release rate of nutrients. crop quality and grain yield. Visual assessment of the plots in year 1 indicates equivalent crop response to swine manure and urea fertilizer.

At the completion of the three-year project the results will be used to provide guidelines for the optimum economic and agronomic use of swine manure.

The Future

PAM1 is continuing the development of machinery and practices to make the most of manure as a resource. Research on the agronomics of manure application will be ongoing for two more years, as well as the grassland injection research. A new project to begin in the fall of 1997 will address the problem of low disturbance injection of swine manure into zero till stubble. Up to 25% of Saskatchewan seeded acres are now seeded using low disturbance seeding methods and current injection systems result in very high soil disturbance during the injection process. As the move to reduced tillage continues, there is a requirement to develop low disturbance injection systems. Five different low disturbance injection systems will be assessed including three types of coulter injectors, a wide blade injector and inverted T injector. These systems will be evaluated for surface roughness, residue retention, power requirements and injection efficiency (how much volume can be injected into the ground). Following preliminary assessment of the equipment the machine(s) with the best potential will be evaluated on a field scale basis in the spring of 1998. Funding is also in place to develop a remote control start/stop system for a manure pipeline system. Other gaps in manure handling include an in-line nutrient sensor and a more detailed systems analysis of various application system options.

Conclusions

Research currently underway will result in manure management guidelines that will allow the expansion of the hog industry in an environmentally sustainable manner with agronomically efficient crop application and low odor emissions.