Environmental Challenges and Opportunities to Manure Handling

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▪ Introduction

For many generations, animal manure has been used as organic fertiliser to grow various crops on Canadian farms. After numerous developments in manure treatments and technologies over the last 20 years, a large portion of swine manure produced every year is still land applied, as this agricultural practice continues to represent a sustainable way of managing nutrients.

More recently, areas have emerged where swine production is concentrated and where it is no longer possible to simply handle manure as a raw crop fertiliser. Some of the factors responsible for that concentration include a decrease in the number of farms, increasing average farm size, access to feed, labour, packing plants, etc. Consequently, it is crucial to develop new production practices or manure treatment techniques to help the industry and protect the environment.

This breakout session will review the potential impact various aspects of manure handling may have on the environment and what might be the promising options to mitigate it. More importantly, this discussion will underline the importance of using the “big picture approach” when a new management technique is considered.

▪ Environmental Impacts: A Quick Review

Numerous research projects completed in Canada and elsewhere have clearly showed that excessive manure application rates can deteriorate soil conditions and water quality. Long-term trials completed over 30 years now provide all the information required to validate models capable of predicting the phosphorus, nitrogen, copper and zinc soil concentrations over the years when swine manure is annually applied (Godbout et al., 2006). The same authors also indicate that too much manure applied in bad conditions, without manure incorporation or just prior to heavy rain falls are all very important factors that may lead to infiltration or runoff water contamination.

Gaseous contaminants emitted from swine manure handling include, in addition of others, ammonia, hydrogen sulphide and odours. Carbon dioxide, methane and nitrous oxide are also released and contribute to the greenhouse gas (GHG) emissions from livestock production. In a recent study comparing GHG emissions from different manure treatment scenarios, GHG emissions from land application represented at least 40% of total farm emissions (Godbout et al., 2006). Odours emitted by manure handling continue to be a major concern for swine farm neighbours. In most cases, odour emissions will represent a nuisance to local residents more than a health hazard.

Raw swine manure can also contain pathogens representing some risks for human health. Under Québec conditions, a one-month storage period decreases the E. coli population by 90% (Coté and Quessy, 2005). Therefore, applying manure that was stored for some time is an effective way of reducing the spread of pathogens into the environment.

Under certain conditions, applying manure to the land can represent an environmental risk. When this risk is increased to a certain level by the combination of various factors, alternatives to land application need to be considered.

▪ Opportunities for Manure Management

In-Barn Manure Handling

Handling liquid manure still reduces labour and building capital costs, as was the case in the early eighties. However, liquid manure also brings numerous challenges and one option recently considered is the separation of feces and urine right at the source without producing liquid manure.

For pigs, 94% of the phosphorus is excreted in the feces while urine contains the remaining 6% (Von Bernuth 2001). With a perforated belt installed under the slats, Marchal (2002) collected 90% of the manure phosphorus into the isolated solid phase with a 25% dry matter content. Belzile et al. (2005) obtained similar results with four different separation systems.

Manure removal combined with phase separation slows down the manure degradation processes, which will reduce odour emissions. Kroodsma (1986) reported a 50% reduction in odour emissions between a room equipped with a net separation system and a conventional room where manure was stored in a pit.

A new housing concept, including a belt conveyor (BC) system to separate feces from urine at the pen level, has been successfully developed at IRDA by Lemay et al. (2006). Without any detrimental effect on animal performance or comfort, the BC system has been very effective at isolating 80% of the phosphorus excreted by the pigs within the solid phase of excreta representing 20% of the total manure mass.

Liquid/solid separation

Many equipment suppliers offer mechanical liquid/solid separators for swine manure. According to Pelletier (2000), seven mechanical separators were already available in Québec in 2000 and could be divided in four different groups: the screen, the screw, the centrifugal and the vacuum separators. This type of equipment can benefit the producer who owns a limited land base and has a manure surplus. A centrifugal separator tested at IRDA was capable of isolating 48 and 75% of the dry matter and phosphorus content, respectively, in the solid phase of excreta (Martin et al., 2006). This low mass, solid phase can then be transported over longer distances in a more economical way to access supplemental fields otherwise not available.

Various manure treatments require some kind of liquid/solid separation early in the process. Therefore, the development of separation technologies is likely to be pursued as manure treatment technologies evolve.

Manure Treatments

If only few technologies were available to treat swine manure in Canada 10 years ago, there are now all kinds of options available on the market. Most of these treatment systems are based on the following basic principles: mechanical separation, aerobic or anaerobic digestion, nitrification/denitrification processes, aggregation, ultra-filtration, reverse osmoses, and biological treatment. Some of the technologies are ready to be used on farms and others are still in development.

The goal of the following discussion is not to analyse manure treatments in details but rather to point out the importance of considering the overall impact and performance of treatments. Some aerobic treatments will promote ammonia emissions, impacting the environment and decreasing manure fertiliser value. Godbout et al. (2006) calculated GHG emissions of seven manure management strategies. The considered aerobic treatment exhibited total emissions equivalent to the conventional manure land application. Based on that same study, the simulated anaerobic treatment showed the lowest GHG emissions of all studied strategies. However, in most applications of anaerobic digestion and methane production, phosphorus does not disappear and still has to be exported from the farm. In a manure surplus scenario, anaerobic digestion does not always improve the situation for the producer. The previous statements illustrate the importance of considering all environmental impacts of a specific technology before considering its wall-to-wall application.

Promising manure treatment technologies are becoming more applicable for pig producers. However, the selection of the best manure treatment system for a particular farm will require the professional assistance of competent and complementary resources.

Alternatives for Solid By-Products

To develop production practices that are sustainable for the industry, solid by-products originating from in-barn handling or manure treatments have to be properly recycled or used. Various techniques like land application and composting have permitted producers to dispose of these solids in a reasonable manner but in the perspective where a larger proportion of swine manure would be treated, new alternatives have to be identified.

Companies like Swiss Combie Technology AG do propose a technology to pellet bio-solids from municipal waste (Gies, 1995) whereas other groups are interested in drying techniques. Some by-products from treatment processes may have the potential to be transformed in bio-fuels. There are exciting opportunities for bio-solids derived from manure treatments and many groups have already initiated research activities to find out what is the real potential of these by-products.

▪ Research and Development Needs for the Industry

Research teams should continue to dedicate efforts in developing new production practices for the swine industry. Although more work has to be done to bring existing and promising manure treatment technologies to a level where they are more applicable and practical for farms, we need to think outside the box and review the overall production system. Can we avoid producing liquid manure in a realistic way? Can we reduce the overall manure production or can we safely recycle water or nutrients from excreta? This process will guide us in doing production practices differently, and then different results can be expected.

Considering the current status of various technologies, it will become essential for researchers and producers to sort out options on a more rational basis. Such a process could only be achieved through an integrated analysis and approach for selecting manure management strategies. Many parameters should be considered in choosing one strategy over another; thus, further research has to be completed to develop such an integrated analysis method or system.

Conclusions

The potential impact of swine manure on the environment can be reduced using manure handling technologies. For example, these technologies may concentrate nutrients into a solid fraction, allowing the introduction of innovative approaches to produce by-products from manure. These technologies will improve the ambient air, water and soil quality. Continuous research and development efforts to identify new integrated strategies for manure handling will help the Canadian swine industry becoming even more sustainable.

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