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Greenhouse Gas Emissions from Pig Production Facilities

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Introduction

Agriculture as a whole could account for 9.5% of the total Canadian greenhouse gas (GHG) emissions. It is also estimated that 42% of the agricultural GHG emissions originate from livestock operations and one third of these are associated with manure management. There exists a need to better determine the relative contributions of the different stages of livestock production and manure management to the GHG emissions caused by this agricultural sector. Another important emission issue for livestock operations, particularly in swine production, is odours. As for GHG emissions, there is a need to better assess the effects of the different components of livestock operations (animal housing and diet, manure management) on the overall operation emissions.

Objectives

The general objective of this study was to evaluate methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions, and also odours emissions for swine operations in two provinces (Québec and Saskatchewan) under liquid manure management. More specifically, the research has been targeted at: 1. determining GHG and odour emissions from different types of swine production buildings and building floor designs; 2. determining GHG and odour emissions from different types of manure storage facilities, and 3. determining GHG and odour emissions from two manure treatment systems. Greenhouse gas and odour emission results have been expressed in terms of unit animal mass in order to allow for direct comparisons between the different sources.

Greenhouse gas and odour emissions from intensive swine housing gestation, farrowing, nursery and grower-finisher rooms were determined at both the

PSC Floral and Elstow sites, with grower-finisher rooms with both partially and fully slatted floors at Elstow. In Saskatchewan, GHG and odour emissions were measured at four different sites that make use of an uncovered concrete tank (1 site), an uncovered 2-cell earthen manure basin (EMB; 1 site) and covered 2-cell EMB (2 sites). Blown chopped straw was used to cover the EMB facilities at those last two sites. One uncovered concrete

Table 1. GHG emissions from different room types in two swine production buildings.

Room type	GHG emission (g/day-kg$_{pig}$)			GHG emission CO_2 equivalence (g CO_2 equivalent/day-		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
PSCI Floral site						
Farrowing	49.2	0.63	0.000	49	13	0
Gestation	21.0	0.27	0.000	21	6	0
Nursery	89.0	1.96	0.000	89	41	0
Grower-Finisher	144.5	0.14	0.002	145	3	1
PSC Elstow Research						
Farrowing	36.8	0.10	0.000	37	2	0
Gestation	26.9	0.07	0.000	27	1	0
Nursery	30.4	0.39	0.000	30	8	0
Grower-Finisher (Partially slatted floor)	90.5	0.24	0.000	90	5	0
Grower-Finisher (Fully slatted floor)	92.3	0.43	0.001	92	9	0

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Low Phytic Acid Corn Impacts on Nutrient Excretion

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Feeding low phytic acid corn and soybean meal can significantly improve phosphorus availability and effectively reduce phosphorus excretion

Introduction

About 85% of the phosphorus (P) in a normal corn-soybean meal diet fed to swine is not utilized because it is bound as phytate phosphate. Hogs lack the digestive enzyme phytase, which is responsible for the release of the bound P from the phytate; therefore, large amounts of inorganic P are commonly supplied to swine diets in an attempt to meet the P requirements of the developing pig.

However, when diets are supplemented with inorganic P, large amounts of P that are unavailable to the pig (bound to phytate) are excreted and, if not properly managed, could have potential negative consequences on the environment.

Results

Total fecal dry matter excreted (%DM) of feces, and %DM digested were not different between pigs fed the control diet or the low phytic acid diets. However, pigs consuming low phytic acid (LPA) soybean consumed less total dry matter than pigs fed normal soybean meal, 3.21 vs. 3.30 lb/d respectively. In addition, pigs fed diets containing phytase consumed less dry matter per day 0.016) than those without phytase inclusion, 3.20 vs. 3.30 g/d respectively.

Nitrogen digestibility, fecal N, urinary N, and total N excreted were not significantly different between treatments. However, N absorbed was significantly higher for diets containing no phytase than for those with phytase inclusion, 46.9 vs. 43.3 g/d respectively. In addition, N retained was higher for pigs fed diets without phytase ($P < 0.009$) compared to those diets with phytase inclusion, 26.3 vs. 23.5 g/d respectively. These increases are predominantly due to the increased overall dry matter and N intake of pigs fed diets without phytase as demonstrated by no detectable differences among treatments for N retained as a % of intake and N retained as % absorbed. Ammonium N excreted in the feces was significantly higher for pigs fed diets containing LPA soybean meal compared to normal soybean meal, 1.90 vs. 1.53 g/d respectively.

Fecal phosphorus excretion was reduced 10% for pigs fed LPA corn compared to normal corn, 2.87 vs. 3.22 g/d, 17% for pigs fed LPA soybean meal compared to normal soybean meal, 2.74 vs. 3.34 g/d, and 18% for pigs fed phytase vs. non-phytase diets, 2.74 vs. 3.35 g/d. In addition to these main effects, there were additive benefits of reduced P excretion which were a 28% reduction for pigs fed LPA corn and LPA soybean meal vs. normal corn and normal soybean meal, 2.51 vs. 3.47 g/d, and a 43% reduction for pigs fed LPA corn, LPA soybean and phytase compared to normal corn and normal soybean meal without phytase, 2.13 vs. 3.76 g/d. No significant differences were detected among treatments for urinary P excretion. Phosphorus digestibility was, increased 21% for pigs fed diets containing LPA corn vs. normal corn, 48.3 vs. 39.9%; 16% for pigs fed LPA soybean meal vs. normal soybean meal, 47.3 vs. 40.9%; 22% for pigs fed phytase compared to phytase diets, 48.5 vs. 39.7%; and 78% for pigs fed LPA corn, LPA soybean meal, and phytase versus normal corn, NRM soybean meal; and no phytase, 60.2 versus 33.9% ($P < 0.0001$) respectively.

Potassium (K) excreted in the feces was significantly less for pigs fed LPA corn vs. normal corn, 0.73 vs. 1.01 g/d and for pigs fed LPA SBM. No significant differences were detected for K excretion in urine or for total K excretion among the dietary treatments. However, K digestibility was significantly increased for LPA corn fed pigs compared to normal corn fed pigs, 94.8 vs. 92.7%.

Take Home Message

This study suggests that the feeding of any combination of LPA corn, LPA soybean meal, and phytase can significantly improve P digestibility while dramatically decreasing P excretion. In addition, the feeding of LPA corn can reduce fecal K excretion while improving overall K digestibility. The modifications of commercial swine diets with LPA corn, LPA soybean meal, and or phytase can significantly improve P utilization and thus reduce the potential negative impacts of swine production on the environment.

Managing Livestock Mortalities in Manitoba

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Introduction

Mortalities are a common part of livestock production. The ultimate goal of each livestock producer is to minimize the number of mortalities, as mortalities could represent a large financial cost. Mortalities are greater with some classes of livestock such as poultry when compared to other classes such as beef cattle. Regardless of livestock species, all mortalities must be properly stored and then disposed of safely in an environmentally sound manner, as required by the Livestock Manure and Mortalities Management Regulation.

What is Proper Storage of Mortalities?

The regulation requires that mortalities be stored in a secure manner. Secure storage includes:

1. Prevents access by dogs, foxes, coyotes, raccoons and crows
2. Helps to prevent the possible spread of infectious disease
3. Prevents contamination of groundwater and surface waters

If mortalities cannot be disposed of within 48 hours after death, mortalities must be stored in a frozen state. As a result many intensive livestock operations have incorporated a freezer or refridgeration storage into their operation for this reason.

What is Proper Disposal of Mortalities?

The Livestock Manure and Mortalities Management Regulation stipulates mortalities must be handled in one of four predetermined ways: rendering, composting, burial, or incineration.

Rendering

Rendering is a high temperature process where materials, such as dead stock, are sterilized and converted into various end products, such as meat and bone meal.

Composting

Composting promotes the decomposition of animal and plant material by naturally occurring bacteria in an aerobic environment. Composting requires the proper balance of carbon, nitrogen, oxygen, and water to promote bacterial growth. Typically, carbon sources such as straw or wood shaving must be added in order to balance the nitrogen present in the animal tissue. In addition, the compost pile needs to be turned on a scheduled basis in order to provide an adequate amount of oxygen to the bacteria. Active compost piles often reach temperatures in excess of 65^{0}C, this facilitates the destruction of most disease-causing organisms that may be present. Overall, composting of dead stock takes approximately 2-3 months to produce a stable, nutrient rich end product which than can

be used as a fertilizer source for crops.

Regulations state the composting sited must be in excess of 100 metres from any watercourse, sinkhole, spring or well. In addition the composting site must include the following:

1. A base of clay or other material that prevents the leaching of nutrients into ground water
2. Contained on three sides by concrete or wooden timbers
3. Site should be fenced to prevent access by scavengers
4. A roof to prevent excess rainfall from entering the compost pile

Burial

This option is one often used by smaller producers. It can pose some risk to groundwater in cases where a sufficient amount of clay is not present in the soil. Requirements state that buried livestock must be at least one metre above the water table and covered by at least one metre of soil. In addition the burial site must be mounded and maintained to prevent rain from entering the burial site, and requires the site be at least 100 metres away from any watercourse, sinkhole, spring or well.

Incineration

Incineration does not mean open air burning of carcasses, rather disposal of carcasses in specially designed container. All incinerators must be registered and meet the requirements of the Incinerators Regulation under the Environment Act. This ensures equipment meet minimum standards to achieve complete and proper combustion. Regulations also restrict the amount of smoke and particulate matter that may be emitted.

Summary

While livestock mortalities cannot be eliminated they can be handled in the most environmentally sound manner possible. The Livestock Manure and Mortalities Management Regulation requires all mortalities are stored in a secure manner prior to disposal.

Rendering, Composting, Burial, and Incineration are all approved methods of mortality disposal in Manitoba.

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All emission data has been reported in terms of mass (g) of CO_2-equivalent per day per unit animal mass (kg_{pig}). Based on the respective global warming potential (GWP) of the three GHG, the conversion factors are as follows: 1 g of CO_2 = 1 g of CO_2-equivalent; 1 g of CH_4 = 21 g of CO_2-equivalent; 1 g of N_2O = 310 g of CO_2-equivalent.

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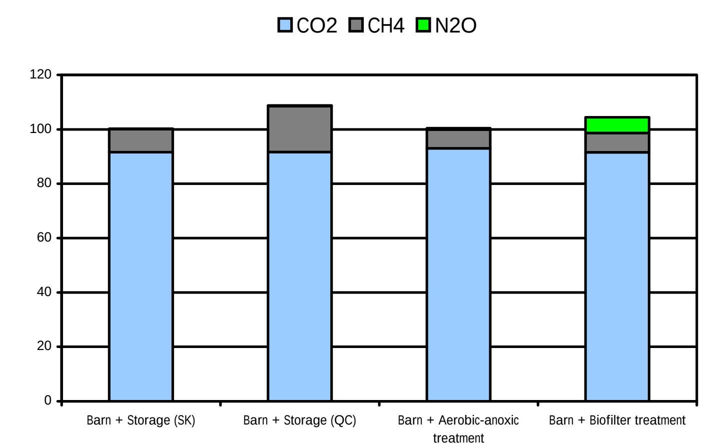
Figure 1. GHG emissions from different production systems.



tank and two manure treatment facilities were monitored in Québec. One of those treatment facilities uses the bio filtration principle and the other one uses alternate periods of aerobic and anoxic phases.

The most important contributor to GHG emissions from swine buildings was carbon dioxide. On an animal mass basis, methane emissions were much lower than CO_2 emissions, and nitrous oxide production was found to be negligible. The lowest CO_2 production was measured in gestation rooms, and the largest was in grower-finisher rooms.

Greenhouse gas emissions from different types of manure storage facilities (i.e. earthen manure storage basins (EMB) uncovered or covered with blown chopped straw; concrete storage tanks) were measured during the 2001, 2002 and 2003 seasons in Saskatchewan. Average (range) GHG emissions from manure storage facilities were as follows: 2.41 (0 to 25.00) for methane; 0.94 (0 to

Continued from page 1, *Greenhouse Gas*

7.00) for carbon dioxide and, <0.01 for nitrous oxide. Average total GHG emissions from uncovered EMB, covered EMB and uncovered tank storage facilities measured in this study were 4.23, 2.52 and 6.65 respectively. Average total GHG emissions from EMB primary cells measured in this study were 1.90 (uncovered) and 1.41 (covered) while corresponding values for EMB secondary cells were 10.08 and 1.46 respectively. These two series of results confirm the positive impacts of blown chopped straw covers on GHG emissions from manure storage facilities. Average total GHG emissions during the spring, summer and fall seasons respectively amounted to 0.47, 3.91 and 3.49. Finally, average total GHG emissions during the daytime (between 06:00 and 18:00) and night (between 18:00 and 06:00) periods, as measured in this study, were 9.35 and 13.92 respectively.

Greenhouse gas emissions from a concrete tank manure storage facilities were monitored during the 2001, 2002 and 2003 seasons in Québec. Average GHG emissions were as follows: 10.81 (1 to 40) for methane and 1.03 (0.1 to 4) for carbon dioxide. Nitrous oxide emissions were found to be negligible. Greenhouse gas emissions were not affected by the depth of manure in the storage facility, Similarly, no diurnal/nocturnal effects on GHG emissions could be determined from the experimental results. However, summertime methane and carbon dioxide emissions were respectively ten and five times more important than those observed during the fall.

Greenhouse gas emissions from an aerobic-anoxic manure treatment system were monitored during the 2002 and 2003 seasons. Average GHG emissions were as follows: 0.77 for methane, 2.39 for carbon dioxide and 0.38 for nitrous oxide. No diurnal/nocturnal or seasonal effects on GHG emissions were detected. However, treatment phases (aerobic or anoxic) did influence GHG emissions. Carbon dioxide emissions were more important during the aerobic phase while nitrous oxide and methane emissions were more important during the anoxic phase. Greenhouse gas emissions from a biofilter manure treatment system were monitored during the 2002 and 2003 seasons. Average (and range) GHG emissions were as follows: 1.05 (0 to 3.59) for methane, 0.87 (0 to 3.35) for carbon dioxide and 5.63 (0.13 to 35.79) for nitrous oxide.

Implications

Measurements of GHG and odour from intensive swine housing, manure storage and manure treatment facilities were collected to determine the seriousness of the contribution by the swine industry, and to provide a baseline against which to gauge the effectiveness of future GHG and odour reduction technologies. These measurements also help to pinpoint the major contributing sources by swine production to GHG and odours, which will help to focus future research efforts to effectively reduce the emissions.