Filling the Research Gap Program

National Agricultural Manure Management Program

Pork GHG Mitigation

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NAMMP Outcomes to Industry

This project has filled knowledge gaps by providing baseline data to compare conventional flushing piggeries using a long hydraulic retention time (HRT) effluent treatment pond (the main piggery effluent system in Australia) to either short HRT effluent systems or deep litter housing.

The main outcome from this project is the identification of three potential, practical and viable Emission Reduction Fund (ERF) methods for reducing GHG emissions in piggeries for subsequent implementation by pork producers.

The short (<30 days) HRT treatment reduced the total GHG emissions by about 87% compared to a long (>200 days) HRT. Furthermore, the deep litter manure management system and the deep litter plus stockpiling the litter reduced the GHG emission potential by 85% and 56%, respectively, based on emission factors derived directly from the Project.

The project provides strong scientific basis to assist with the potential development of new ERF methods for Australian piggeries, as well providing emission factors to update the industry standard model PIGBAL and National Accounts Inventory.

Aims and Outcomes

The aim of this research project was to develop strategies to mitigate GHG emissions from piggery effluent systems. The GHG emissions were determined in two manure handling systems:

In the conventional open effluent pond system, the GHG emissions generated from ponds with the traditional long (>200 days) hydraulic retention time (HRT) were compared to those from an effluent system that had a much shorter (<30 days) HRT. These two systems were compared during two seasons, winter and summer.

As an alternative to open anaerobic pond systems, the Australian pork industry has developed alternate housing where the pigs may be raised on deep litter. The second approach was to determine the GHG emissions from the deep litter housing system to ascertain whether GHG mitigation could be achieved by preferentially housing pigs in deep litter compared to conventional housing and manure management by the open anaerobic pond system.

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The outcome of the project was the delivery of novel scientific findings that could underpin the possible development of additional 'carbon credit' methodologies for Australian pork producers. These would be in addition to the presently approved Emission Reduction Fund (ERF) mitigation approach that involves the reduction of GHG emissions by covering effluent ponds and destroying the methane that is produced.

Key Activities

Using open path Fourier transform infrared spectrometry, continuous gas measurements of methane, nitrous oxide, carbon dioxide and ammonia were conducted over a 30 day period during summer and winter from:

- Conventional flushed piggery sheds with long and short HRT effluent systems; and
- Deep litter piggery and deep litter stockpiles.

Nitrogen and volatile solids mass balance studies were run concurrently with the continuous gas measurement experiments for the long HRT, short HRT and deep litter systems.

Key Findings

GHG emissions from a conventional piggery with short and long HRT effluent storage.

The common HRT for open anaerobic ponds may vary with season and irrigation practice, but generally exceeds 200 days. In this study in SE Queensland, the long HRT treatment was compared to a short HRT where the effluent was diverted to a 10,000 L polyethylene tank, and stored for less than 30 days. These two HRT treatments were compared over a 30 day period in both winter and summer.

The results revealed that GHG emissions were reduced by 87% when the HRT was shortened from at least 6 months to 30 days. These mitigation results are supported by international calculation methods recommended by the IPCC.

	Long HRT Pond	**Short HRT**
Total GHG emissions (t CO2-e/10,000 SPU/yr)	5,254	669
% Mitigation compared to Long HRT Pond		87%

Although the emissions were substantially less from the short HRT compared to the long HRT, there were seasonal differences with higher emissions during the warmer summer months. These substantial differences correlate well with the ambient temperature change and the subsequent warmer effluent temperatures in the summer months.

The short HRT system is relatively low cost and easy to implement and manage. Pork producers that have anaerobic pond systems may utilise the short HRT system for part of the year by diverting effluent away from the pons, leaving the ponds as a back-up in case of wet weather when the effluent cannot be irrigated onto land. New ERF methods based upon short HRT treatment of effluent may be developed so that smaller pork producers that cannot justify covering ponds, can participate in the ERF.

Emission, particularly nitrogen emissions may arise from both the long HRT and short HRT systems after effluent removal from the ponds for land application. However the size and impact of these emissions will vary depending upon the application method, soil type, region and cropping system to which the effluent is applied. Further research or modelling of impacts in this area may be necessary to apply the findings from this Project to a potential ERF method.

GHG emissions from pigs housed on deep litter including litter stockpiles

A method identified by industry that may reduce GHG emissions is the use of alternative housing such as deep litter in preference to conventional slatted floor systems with flushed effluent and anaerobic effluent treatment in open ponds. A second study was undertaken in this project to determine emissions of methane, nitrous oxide and ammonia from Australian deep litter housing and manure management systems and to compare these emissions to those from the long HRT system examined in the first study of the Project.

Emissions were again measured using open-path Fourier transform infrared spectrometry from a deep litter piggery and litter stockpile over a summer and winter period in southern NSW. Methane and ammonia emissions in winter were slightly lower that comparable emissions in summer, while nitrous oxide emissions in summer were about 10 times higher than in winter months during which nitrous oxide emissions were negligible. For emissions from the stockpile of litter, both methane and ammonia emissions were again substantially higher in summer compared to winter. In contrast, nitrous oxide emissions were about 7 times higher in winter, indicating that there was a greater partitioning of nitrogen into nitrous oxide in the stockpile when temperature driven ammonia emissions are low.

The results revealed that GHG emissions were reduced by 85% for a deep litter system compared to the long HRT pond for manure management in piggeries. Furthermore, where the litter had been stockpiled, GHG emissions were reduced by 56% compared to the long HRT pond.

	Long HRT Pond	**Deep Litter**	**Deep Litter + Stockpile**
Total GHG emissions (t CO2-e/10,000 SPU/yr)	5,254	768	2,320
% Mitigation compared to Long HRT Pond		85%	56%

Considering the variability in response to temperature and possible variation in bedding litter conditions from one piggery to another, caution should be applied when extending these data to other regions of the country. Further studies are required to provide a larger range of emissions data under different seasonal conditions throughout the country to provide more robust regional prediction methods.

Conversion of piggeries from anaerobic pond systems to deep litter systems may also mitigate emissions considerably, resulting in similar mitigation potential and returns as the short HRT system may provide. Although emissions were quite high from the manure stockpiling stage, further mitigation strategies may be applied either by covering stockpiles or by applying the litter to land more rapidly and avoiding lengthy periods of stockpiling

Additional Benefits

The Project also provided substantial new data for the National Accounts inventory and the PigBal model, which is currently used in the ERF method for determining GHG emission reductions via the destruction of methane from covered anaerobic ponds. PigBal can reasonably predict total solids, volatile solids and nitrogen at the farm scale both for conventional and deep litter housing systems. This is an important outcome for the pork industry and Government, as it provides confidence that some baseline data can be modelled rather than measured, dramatically reducing the compliance costs for participating in the ERF.