Section 4 Manure Handling and Storage Management

On the farm, pig manure is the largest single source of GHG emissions. Numerous ways to reduce GHG emissions from manure exist however, many of which provide significant non-GHG benefits as well. Hog manure, being a mixture of urine and feces, is primarily composed of undigested and indigestible feed nutrients, wasted drinking water, wash water, and wasted feed. The GHGs produced by manure are methane (CH_4) and nitrous oxide (N_2O). Methane is produced during manure storage, where anaerobic (without oxygen) conditions occur, and where the organic carbon left in the manure is decomposed. Nitrous oxide, on the other hand, is emitted following manure application to cropland and will be discussed in subsequent sections.

The amount of methane emitted from manure is influenced by different manure management practices (e.g. collection, storage, application, treatment). Also, many of the feeding strategies mentioned earlier, impact the amount of methane produced from manure and the amount of manure produced. Generally, any improvement in feeding efficiency will reduce the feed carbon that enters a manure storage structure, therefore reducing the potential for methane production.

Credit: Agriculture and Agri-Food Canada

Manure Storage Cover Systems

Greenhouse Gas Benefit

The majority of hog manure is stored in a liquid form either in an earthen storage basin, in deep pit under barn storages, or in round concrete or steel storage structures. A liquid storage system creates anaerobic (oxygen free) conditions. Under these conditions, specific anaerobic bacteria breakdown organic matter (waste feed and feces), producing methane as a by-product. Impermeable cover systems, installed on the manure storage's surface, reduce the transfer of manure gases to the atmosphere; therefore minimize GHG emissions from the manure storage. However, the cover does not actually reduce GHG emissions by itself, as the cover provides a better environment for the decomposition and the stabilization of the organic material in the manure[26]. In addition, the manure gases need to be captured and flared in order to reduce GHG emissions. This methane gas can be captured by using a negative pressure blower and fed into a small power generation facility, heating unit, or simply flared[4]. This provides a revenue stream[4].

Several types of covers exist that can be used on manure storage systems. However, the costs of these systems can be expensive to establish, maintain, and to replace.

Organic covers from straw work by establishing an aerobic (oxygen rich) layer between the manure and the atmosphere, which allows for the break down and release of less offensive gases and odour causing compounds. Straw covers are a low cost option to control emissions of manure gases including ammonia and odours. However, the straw must remain dry to be effective and a reapplication of straw may be required a number of times before emptying the manure storage facility. In addition, this type of cover does not allow for the capture of methane.

Further, weather dynamics dictate whether straw covers reduce or increase the GHGs produced during storage and are therefore not recommended as a GHG reduction strategy.

The most effective option for reducing manure storage GHG emissions are the impermeable covers mentioned earlier. Several designs exist depending on the type of storage to be covered. Positive pressure covers are available and form a dome over the storage but are prone to damage by heavy snow loads or during power outages, which causes the dome to deflate. Several system designs allow the cover material to rest on the surface of the manure and use either negative air pressure or a series of weights to maintain the cover on the manure surface to avoid weather damage. One benefit of an impermeable cover is that less manure nitrogen will be lost to the atmosphere from storage. In Manitoba, an earthen manure storage basin covered with a negative air pressure cover, was able to reduce nitrogen loss by 82 percent compared to an open earthen manure storage basin[26].

To facilitate manure removal from a covered storage, the Canadian Pork Council recommends installing a below cover agitation system capable of agitating manure without removing the cover itself. Several below cover agitation systems are commercially available using forced air agitation for earthen storage basin covers or a modified pump for round concrete or steel storage systems.

Impact on Odour

Covering the manure storage system reduces the release of odour causing compounds from the manure into the atmosphere above the storage. Cover systems allow gases to be managed in a controlled manner, reducing the escape of odourous gases off of the farm site.

Credit: Nova Scotia Agricultural College

Did You Know?

The benefits of impermeable covers include:

- *Addition of rainwater to manure is eliminated, thus reducing manure volume and application costs.*
- *Improved odour control.*
- *Increase of the manure's nitrogren content for land application due to less ammonia loss.*
- *Allows for collecting and utilizing the trapped methane gas as a heat and electricity source or to burn the gas.*

Anaerobic Biodigester Technology

Greenhouse Gas Benefit

Anaerobic digestion uses naturally occurring bacteria to transform organic material into a source of combustible gas. Manure is warmed and mixed in a tank that is free of oxygen, or anaerobic, which is the same condition that exists in liquid manure storages. In these warm conditions, bacteria become very active and begin to digest carbon. In the case of hog manure this consists of the feed carbon not used in the animal digestive system, which has become part the manure stream. The goal of anaerobic digestion is to produce methane, a combustible GHG, for use in producing heat or electrical energy. New technology allows methane from anaerobic digestion to be purified to the same quality as natural gas.

The on-site production of methane can be used to fire a boiler system where the hot water is used to heat hog barns and/or other farm buildings, reducing the need to purchase other sources of heating fuel. Small generator sets may also be operated on digester methane, reducing the need for importing electricity to the farm site. A large digester will be capable of producing sufficient methane to produce power for export to the local grid. Some Saskatchewan research has determined that for about every 1 m^3 of biogas generated from digestion per day about 6.5 to 6.7 kilowatt hours of energy are produced per day[27]. However, it is hoped that down the road, new technologies will exist to address the biodigester size and feasibility issues.

Digestion systems will reduce GHG emissions through:

- The capture and combustion of manure storage methane.
- Heat and energy generated on-farm reduces the need for generating heat and energy off-farm using GHG intensive fossil fuels.
- Manure that has been digested intensively in an anaerobic system has an altered chemical composition. Due to this, digested manure will produce less nitrous oxide gas after manure application to cropland compared to raw, undigested manure. In Quebec, after 3 years of research, soil nitrous oxide emissions were reduced by 50 to 75 percent where anaerobically digested manure was applied to the crop as compared to applied undigested raw manure[28].

Impact on Odour

Digestion systems utilize the carbon compounds responsible for odour production to produce methane and carbon dioxide gas instead. As a result manure odours during storage and application are significantly reduced. It is important to note however that digested manure has an increased tendency to produce ammonia gas and should therefore be stored in a covered storage system to prevent significant nitrogen gas loss.

Credit: Agriculture and Agri-Food Canada

Compost Manure

Greenhouse Gas Benefit

Composting is a controlled biological process that changes manure into a stabilized, safe, odourless, and organic rich product[29]. Composting also eliminates any potential pathogens and weed seeds that are in the manure. In order to compost the manure, dry and carbon rich material needs to be added so that its humidity and carbon:nitrogen ratio are balanced. This may involve mixing and/or forced ventilation in which the costs of adding the carbon source (straw or sawdust) and of new machinery are important factors to consider. To get more information on how to compost hog manure, see AAFRD and Alberta Pork's publication titled Environmental Manual for Hog Producers in Alberta (Agdex 440/28-1)[21]. Composting hog manure would reduce GHG emissions during storage and land application if the composting process is done correctly. The composted manure is also more concentrated which means that the manure can be transported further from the sites of manure production, and would offset commercial fertilizer needs. Compared to composting solid manure, there is little research into composting liquid manure. However, currently research is still determining if composting liquid hog manure has an effect on GHG emissions.

Credit: Alberta Agriculture, Food and Rural Development

Manure Storage and the Barn

Greenhouse Gas Benefit

Removing manure from animal rooms to separate long term storage locations reduces the risk of exposing animals and barn workers to toxic and odourous gas emissions produced in the barn environment. Past research has determined that the weekly removal of manure in the barns allows for reductions of ammonia and methane emissions by approximately 10 percent[30]. Manure stored in the barn for extended periods will tend to be maintained at a higher temperature, encouraging the rapid growth and activity of methane producing bacteria. Removing manure to a cooler, covered manure storage will ensure that methane production potential is minimized and any GHGs produced during storage are trapped and managed.