

# **Greenhouse Gas Mitigation Program- Canadian Pork Council**

Cedric MacLeod

Canadian Pork Council, 1101 - 75 rue Albert Street, Ottawa, ON K1P 5E7

*Email:* macleod@cpc-ccp.com

## **■ Summary**

Improvements in pork production efficiency have always been important to maintaining a viable and competitive Canadian pork sector. Because increasing production costs often outstrip increases in farm gate commodity values, improved production efficiencies assume an important role in maintaining farm profitability.

In the past, marrying environmental stewardship with positive economic spin-offs for the farm has been difficult. In many cases, pork producers have implemented conservation practices, which serve the greater good of society, with little return on investment. An overall industry willingness to provide this societal service has resulted in the generation of a forward thinking and environmentally responsible industry. The emergence of a new area of environmental stewardship, greenhouse gas management, has the potential to offer some quantity of cost recovery for environmental stewardship and, in some cases, potential increased farm income.

## **■ Introduction**

In the past, soil and water quality have been the main drivers for environmental stewardship program and policy development for Canadian agriculture. A more recent national focus, considering air quality, has introduced new concerns encompassing ammonia, hydrogen sulphide, odour and greenhouse gas (GHG) production and management. Parallel to the Government of Canada's pledge to reduce its GHG emissions to 6 per cent below 1990 levels, with the ratification of the Kyoto Protocol, the Greenhouse Gas Mitigation Program for Canadian Agriculture (GHGMP) was funded through Agriculture and Agri-Food

Canada with a mandate to increase awareness throughout the Canadian agricultural sector of GHG production issues and management options.

The Canadian Pork Council has partnered with the Canadian Cattlemen's Association, Dairy Farmers of Canada and the Soil Conservation Council of Canada to deliver the GHGMP. Through the establishment of technology and beneficial management practice (BMP) demonstration sites across Canada, producers can become more aware of the options that exist for them to reduce their on-farm production of GHGs. In conjunction with demonstration site establishment, numerous communications packages are being developed, highlighting the background science for GHG production and outlining the specific practices which may serve to reduce this on-farm production.

In discussions with hog producers, despite the positive environmental benefits which can be proven for specific environmental BMPs, the economic benefits are always of utmost importance. The goal of the Canadian Pork Council, has therefore, been to couple GHG management with other environmental management strategies to provide real, on-farm, economic benefits.

## ■ Overview of Greenhouse Gas Production

GHG management is simply another way to consider how carbon and nitrogen are used on the farm. Carbon is purchased in the form of feed energy and nitrogen as protein. When either energy or protein are not used or consumed as they were intended at 100 per cent efficiency, the production of GHG will ensue. For example, physically wasted feed, or feed carbon which passes through a hog digestive system, will result in this carbon entering the manure stream. Carbon bypass may be the result of feeding a ration which is not nutritionally balanced or contains an excess of feed crude protein. While this carbon rich manure is stored over the warm summer months, manure temperatures will rise, and methane, a potent GHG, will be produced from this wasted feed carbon. Alternatively, if a new low-waste feeder design is installed, rations are re-evaluated and/or phased feeding is initiated, all which can increase the efficiency of feed carbon use in the barn, manure carbon content will be reduced. These practices can, therefore, reduce your overall farm GHG output. GHG management is a matter of managing how efficiently carbon and nitrogen are used on the farm.

There are three GHGs of particular importance to the agricultural industry: carbon dioxide, methane and nitrous oxide. Carbon dioxide is not a gas which is easily managed, and is not recognized as one with significant merit for reduction in the livestock industry. Methane and nitrous oxide are 21 and 310 times more potent than carbon dioxide, however, and can result in significant global warming potential when released into the atmosphere, thus their

management offers significant opportunities for reducing a livestock farm's GHG footprint.

In the pork sector, methane is predominately produced during liquid manure storage. Because oxygen is limited in liquid manure systems, carbon which enters the storage is consumed by anaerobic bacteria when conditions are suitable, such as when manure is warmed in summer due to elevated summer temperatures. As a by-product of this decomposition, methane and odour are produced.

Nitrous oxide is produced from cropland after nitrogen application, either as commercial fertilizer or manure, during periods of soil saturation such as after spring snow melt and thaw. Due to limited oxygen availability in saturated soils, soil bacteria will use nitrate nitrogen ( $\text{NO}_3^-$ ) as an oxygen source in the place of oxygen itself and nitrous oxide is produced as a by-product of the process.

There are a number of BMPs being promoted through the GHGMP, which will reduce the on-farm production of both methane and nitrous oxide. A full production system analysis is used to highlight GHG reduction options for hog operators, with significant emphases on the level of animal production efficiency.

## ■ **Barn Management**

Regular fan and ventilation system maintenance and calibration will minimize inefficiencies in barn heating and air quality maintenance, thus minimizing the use of fossil fuels and energy to power these systems and the resulting GHG emissions from fossil fuel use. Designing facilities capable of rapid removal of manure from the barn to enclosed storage areas will help to reduce GHG production within the barn itself. Efficient water management systems, such as conservation, low-flow rate drinkers or drinker bowls will reduce water wastage, manure pumping costs and GHG emissions from electricity and fuel use to pump water and manure.

Barn scraper systems which can provide frequent manure removal from the barn will help to reduce GHG production under slats. New scraper designs are also capable of separating manure urine and faeces at the source of production, providing effective alternative options for manure nutrient management.

## ■ Feeding Strategies

Several feeding strategy options exist for managing GHG production. Feeder designs should minimize wasted feed, and wet-dry or liquid feed systems should be considered, as wet feeds tend to provide higher feed conversion efficiencies compared to dry feeds. High feed conversion efficiencies will reduce the quantity of feed carbon which is not used by the pig and therefore is transferred into the manure storage where methane production can occur. Including phytase in hog rations is mostly recognized for reducing manure phosphorus output but has also been shown to provide increases in feed use efficiency. Reducing fibre intake or increasing feed fibre digestibility will reduce GHG emissions by reducing methane produced during bacterial fermentation in the hind-gut of the pig and during manure storage. Split sex and phased feeding programs result in increased feed use efficiency and reduced manure nitrogen excretion, both providing GHG emission reduction benefits.

Feed nitrogen (protein) can also be managed to provide reductions, not in manure methane production during storage, but by avoiding field losses of nitrogen (nitrous oxide) during land application. Reducing feed crude protein by 1 per cent will reduce manure nitrogen output by approximately 10 per cent. The Intergovernmental Panel on Climate Change has stated that 1.25 per cent of all soil applied nitrogen, either as manure or fertilizer, will be emitted to the atmosphere as nitrous oxide. Reducing the total manure nitrogen output reduces the requirement for nitrogen application to cropland, and therefore, the overall farm GHG production budget with respect to nitrous oxide.

Consider the nitrogen output for 1000 feeder pigs raised from 50 lbs to 220lbs when the ration crude protein is reduced by 0.5 per cent as demonstrated in **Table 1**.

**Table 1. Manure nitrogen output at two levels of feed crude protein**

Ration	High CP (%)	Low CP (%)
Grower	19.5	19
Finisher I	17.5	17
Finisher II	17	16.5
Manure Nitrogen	5678 kg	4220 kg

## ■ **Manure Storage Management**

GHG emissions from manure storage systems are a result of manure carbon being decomposed to methane in the oxygen-limited conditions which exist in liquid storages. There are two methods of reducing storage methane release to the atmosphere, through avoiding its production altogether or trapping and transforming it to other less harmful forms of gas. As winter ends and spring and summer temperatures warm stored manure, the rate of activity for manure bacteria increases as well, increasing the potential for methane production. Therefore, methane production can be avoided by emptying storages prior to these warming events during spring and throughout the summer.

The second option, involves trapping and utilizing methane as it is produced. Numerous impermeable cover systems are available for application to both earthen basin and round concrete storage systems. Depending on the amount of methane being produced in a covered storage, several options exist for gas utilization. High methane concentrations will allow manure exhaust gas to be flared or channelled to a boiler system to produce hot water for on farm heating applications. Burning manure gas will provide a twenty-fold reduction in GHG output as methane is converted to carbon dioxide. Alternatively, manure gas with lower methane concentrations can be channelled through a biofilter system where methane will again be oxidized to carbon dioxide.

## ■ **Manure Application Management**

Nitrous oxide production occurs after manure is applied to cropland, and as such, management practices which reduce nitrous oxide emissions are specific to manure nutrient management. There are numerous ways to reduce nitrous oxide production from cropland, which generally involve managing the quantity and timing of manure nitrogen application.

Nitrous oxide is produced when soil nitrate is present in warm saturated soils. This condition will generally exist during the late fall and subsequent spring after manure or fertilizer has been fall applied following grain or forage crop harvest. However, when manure is applied in early spring or after crop emergence, the developing crop will be able to use the applied nitrogen immediately, avoiding the presence of free nitrogen during times of soil saturation, and nitrous oxide production can be avoided and/or reduced.

Manure has safely been applied to small grains after crop emergence using low-disturbance opener systems or drop tube application systems. Row-crops such as corn are excellent receptors of manure nutrients due to a heavy nutrient demand and row-cropping allows for inter-row trafficking. Forage crops are also heavy nutrient users and respond well to manure applications. Forage

land will support equipment traffic early in the spring season, despite high soil moisture levels, thus allowing for early manure application with little effect of compaction. In most cases, Canadian cropping systems can support in-crop application of liquid manure.

Besides application timing management, manure application rates can also be managed to avoid the presence of soil nitrate during the fall and spring thaw periods. Applying manure at agronomic rates and avoiding the application of more nitrogen than a crop can effectively use will reduce the potential for post-harvest residual soil nitrogen to be given off as nitrous oxide. Soil testing to determine appropriate nitrogen application rates and analyzing manure to determine the appropriate manure application rate are the first steps to reducing nitrous oxide emissions from cropland.

Equipment calibration is also very important in avoiding over application of manure nitrogen. This can be done quite simply with drag-line application systems equipped with flow-rate monitors. Tanker systems can also be equipped with flow rate monitoring equipment allowing for on-the-go recording of manure application rates. Both of these approaches will first require manure nutrient testing, however, to provide a manure nitrogen concentration to use in calibration exercises.

## ■ Manure Treatment Systems

Anaerobic digestion is a treatment process where liquid manure is heated and mixed on a continuous basis. Added heat will increase the activity of methane producing bacteria in the manure and mixing will ensure contact between manure carbon and this bacterial community. The result of this process is the production of significantly greater quantities of methane gas, compared to that produced from manure storage alone. The biogas produced can be used to produce heat for on-farm use or turn internal combustion engine generator sets capable of producing electricity. Anaerobic digestion is a technology which allows a producer to add value to the farms manure resources by turning GHG emissions into valuable heat and electrical energy. Although these systems have traditionally been cost-prohibitive, forward thinking power policies and new ways of considering on-farm production of heat energy may provide opportunities for wide spread adoption of methane producing technology.

## ■ Shelterbelt Establishment

Establishing farmstead shelterbelts will provide minor GHG reduction benefits, but can increase the rate of on-farm carbon sequestration as growing trees pull carbon dioxide from the atmosphere and store it in woody biomass. Establishing shelterbelts adjacent to hog rearing facilities has been shown to

reduce barn heating costs by sheltering the structure from harsh weather. Reduced loads on heating and ventilation equipment will reduce fossil fuel requirements to provide heat to sow and nursery units, effectively reducing the overall farm GHG production. Shelterbelts are also very effective in reducing the transfer of barnyard odours away from the farmstead.

## ■ **Conclusion**

Many of the management practices that can reduce the production of hog sector GHGs will help to address other contentious issues as well, such as odour production and nutrient management concerns. In many cases however, GHG reductions can provide economic benefit to the farm more so than can be realized through other environmental stewardship activities. Managing the efficiency with which carbon and nitrogen are used on Canadian hog farms will continue to foster the sustainable growth of an environmentally proactive industry while also achieving important GHG reduction goals.

## ■ **Further Readings**

For more information on the Greenhouse Gas Mitigation Program at the Canadian Pork Council, factsheets outlining producer options for reducing on-farm GHG production and/or written articles concerning the implementation of GHG reducing practices and technologies, visit –

<http://www.cpc-ccp.com/envir/GHGMP.htm>

or contact the Canadian Pork Council for additional sources of information.

## ■ **Acknowledgements**

Thanks for the support offered by Canadian provincial pork associations, technology providers and universities who have dedicated time, much effort, and financial support to the Greenhouse Gas Mitigation Program. Special thanks to Agriculture and Agri-Food Canada for financial support of this industry led demonstration and awareness program.