

Manure Management and Greenhouse Gases

Number 11

June 2004

Greenhouse Gases - Things You Need To Know

Why are GHG Emissions important to Agriculture?

In agriculture, the three main greenhouse gases (GHG) of concern include methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2). GHGs impact the earth through their ability to trap heat, which depends on their capacity to absorb and re-emit radiation and on how long the GHG remains in the atmosphere. Most scientists agree that increasing levels of GHGs are caused by fossil fuel combustion, land use changes, and agricultural and industrial activities. All of which contribute to climactic changes in temperature and precipitation patterns, which could impact agricultural production.

In Alberta, the agricultural industry emits about nine percent of the total provincial GHG emissions (Environment Canada, 2003). Primarily, agricultural sources of GHGs originate from livestock and fertilizer sectors. According to the 2001 GHG Emissions Inventory for Alberta Agriculture, methane emissions from manure accounts for 9 percent and livestock methane emissions are approximately 28 percent of the total GHG emissions in Alberta (AAFRD, 2003).

Livestock Manure and GHGs

Livestock manure is a valuable resource for nutrients and an excellent soil amendment to improve soil quality, tilth and productivity. The main GHGs emitted by manure are methane (CH_4), which is emitted during the anaerobic (without oxygen) decomposition of organic matter during storage and nitrous oxide (N_2O), which is emitted during storage and soil application. Additional gases emitted from manure include: ammonia (NH_3) and nitrogen

oxides (NO_x), which contributes to odour and are indirect sources of nitrous oxide.

Manure management is an essential practice in minimizing GHG emissions caused by microbial activities during manure decomposition. Factors that affect GHG emissions from manure include temperature, oxygen level (aeration), moisture, and sources of nutrients. These factors are affected, in turn, by manure type (livestock type), diet, storage and handling of manure (pile, anaerobic lagoon, etc), and manure application (injected, incorporated, etc). It is important to note that proper manure management is essential for any agricultural operation because improper use of manure can lead to negative impacts on the environment.



Manure storage in an earthen lagoon system
(Photo by Brian Sexton, AAFRD)

Methane Emissions from Manure

During anaerobic decomposition of manure, methane is emitted. The amount of methane produced from manure depends on:

- the amount of manure, which depends on the number of animals, the amount of feed consumed, and the digestibility of the feed,
- animal type, the condition of the digestive



Alberta Environmentally Sustainable Agriculture Council

Appointed by the Minister of Agriculture, Food and Rural Development.

Mandated to (1) identify and evaluate environmental challenges and opportunities facing the agriculture and food processing industry; and (2) encourage the industry to proactively address environmental issues.



Greenhouse Gases - Things You Need To Know

- tract, and the quality of the feed consumed,
- the manure handling method (liquid versus solid storage). Liquid manure management systems, such as ponds, lagoons, and holding tanks lead to anaerobic conditions, which can emit up to 80 percent of manure based methane emissions, while solid manure emits little or no methane, and,
- environmental conditions (temperature and moisture).

Mitigation and Management Practices to Reduce Methane Emissions from Manure

General Management Practices

- Avoid adding straw to manure because straw acts as a food source for anaerobic bacteria, resulting in higher methane emissions.
- Apply manure to soil as soon as possible because storing manure for long periods can encourage anaerobic decomposition and result in increased methane emissions.
- Avoid manure application when the soil is extremely wet, as this leads to anaerobic conditions and increased methane emissions.



Injection of liquid manure
(Photo by: Tri-Provincial Initiative)

Feed Management

- Select livestock to genetically improve the efficiency of food conversion by the animal to help decrease GHGs.
- Increase the digestibility of feed by

mechanical (ie. chopping, grinding or pelleting feed), chemical or biological processing. This reduces the time feed remains in the digestive tract, and can reduce methane emissions by up to 75 percent, while increasing animal productivity.

- Feed less frequently.
- Feed cattle additives such as ionophores that act to inhibit methane production by rumen bacteria. Ionophores can reduce methane production by 25 percent and feed intake by four percent without adversely affecting animal performance.
- Add edible oils, such as canola or coconut oil, to the diet. The added oils reduce methane emissions by rumen bacteria.
- Implement grazing management practices such as rotational grazing, which improves the quality of pastures and results in increased animal productivity and lower GHG emissions.
- Feed livestock based on sex, age and stage of production to match diet to nutritional requirements.

Manure Storage, Handling and Treatment Technologies

Methane emissions from manure can be managed by using various technologies to help reduce methane emissions during storage.

Covered lagoons involve placing an impermeable floating cover (e.g. plastic cover) over the surface of the tank or lagoon to capture GHGs. Covers on the surface of the manure reduce the transfer of GHGs to the atmosphere by increasing resistance between the manure liquid surface and the air. To remove methane from under the cover, two treatments are used: flare the trapped gases and exhaust to the atmosphere or burn the trapped gases in a generator, which can produce heat and electricity). In addition to reducing methane emissions by 80 percent (when covers are used in conjunction with negative pressure), covers also provide good odour control.



Alberta Environmentally Sustainable Agriculture Council

Appointed by the Minister of Agriculture, Food and Rural Development.
Mandated to (1) identify and evaluate environmental challenges and opportunities facing the agriculture and food processing industry; and (2) encourage the industry to proactively address environmental issues.



Greenhouse Gases - Things You Need To Know



Lagoon cover at Iron Creek Colony, Alberta
(Photo by: Kendall Tupker, AAFRD)

Digesters process animal waste under anaerobic conditions (no oxygen) to produce methane gas (biogas), which can then be used to generate heat and electricity as an alternative energy source. At the same time, the remaining manure can be used as a fertilizer.

Aerating manure allows microorganisms to breakdown organic material through the addition of oxygen (O_2). Aerobic decomposition of manure lowers or eliminates methane emissions, but may increase nitrous oxide emissions.

Filtering exhaust air from animal houses to remove odour-causing gases, GHGs and dust particles may provide a way to reduce methane emissions. However, more research is needed.

Composting solid manure produces a stabilized product that can be stored or spread on agricultural land with minimal odour, pathogens and weed seeds. Exposure to oxygen will reduce methane emissions, however, it can lead to increased nitrous oxide emissions. More research is needed to determine whether the process of composting emits more GHGs than the application of fresh manure.

Nitrous Oxide Emissions from Manure

During manure storage, handling and application, manure emits nitrous oxide through nitrification or denitrification. Indirect sources of nitrous oxide include volatilization and subsequent atmospheric deposition of ammonia (NH_3) and nitrogen oxides (NO_x). The amount of nitrous oxide emitted depends on:

- the type of manure storage system,
- the duration of time manure is stored,
- manure composition, and
- climatic conditions during storage and application.

Mitigation and Management Practices to Reduce Nitrous Oxide Emissions from Manure

General Management Practices

- Apply manure shortly before crop growth to allow for the maximum amount of available nitrogen to be used by the crop
- Avoid applying manure in the late fall and winter because these conditions lead to high emission of nitrous oxide and high nitrogen loss in the spring.
- Avoid applying manure when the weather is hot and windy, or before a storm, because these conditions can increase nitrogen oxide emissions.
- Implement soil and water management practices such as: improving drainage, avoiding soil compaction, increasing soil aeration, and using nitrification inhibitors for nitrogen gas production instead of nitrogen oxide.
- Spread manure evenly around the pasture.
- Maintain healthy pastures by implementing beneficial management grazing practices to help increase the quality of forages.



Alberta Environmentally Sustainable Agriculture Council

Appointed by the Minister of Agriculture, Food and Rural Development.

Mandated to (1) identify and evaluate environmental challenges and opportunities facing the agriculture and food processing industry; and (2) encourage the industry to proactively address environmental issues.



Greenhouse Gases - Things You Need To Know

- Avoid applying excess amounts of manure because nutrients can be lost to the environment. Testing both the soil and the manure before application ensures the proper nutrient balance for plant needs and can help reduce the loss of nutrients as GHGs.



Application of solid manure
(Photo by: AAFRD)

Feed Management

- Include low protein levels and the proper balance of amino acids in the diet to minimize the amount of nitrogen excreted, particularly in urine. For example, feeding pigs low protein diets with synthetic amino acids can result in less nitrogen being excreted in the urine, reduced ammonia (NH₃) volatilization, and less nitrogen oxide emissions.
- Use phase feeding for swine to match diet to growth and development.

Manure Storage, Handling and Treatment

- Move fresh manure to a covered storage facility to reduce adding moisture, which reduces the amount of nitrous oxide emitted.
- Storage in below ground facilities with lower temperatures reduces microbial activities.

References

Alberta Agriculture, Food and Rural Development (AAFRD) and University of Alberta. 2003. Development of a Farm-Level Greenhouse Gas Assessment: Identification of Knowledge Gaps and Development of a Science Plan. Alberta Agriculture Research Institute Project Number 2001J204. August 31, 2003. 203 pp.

Environment Canada. 2003. Canada's Greenhouse Gas Inventory 1990-2001. Environment Canada, Government of Canada, Ottawa. 205 pp.

Acknowledgements

In addition to AAFRD staff, we would gratefully like to acknowledge the following external reviewers: Dr. Jerry Leonard (University of Alberta /City of Edmonton) and Dr. Xiaomei Li (Alberta Research Council).

To order more copies of this bulletin, contact Conservation and Development Branch, Alberta Agriculture, Food and Rural Development at (780) 422-4385 or visit our website at www.agric.gov.ab.ca.



Alberta Environmentally Sustainable Agriculture Council

Appointed by the Minister of Agriculture, Food and Rural Development.
Mandated to (1) identify and evaluate environmental challenges and opportunities facing the agriculture and food processing industry; and (2) encourage the industry to proactively address environmental issues.

