What is the Greenhouse Gas Contribution from Agriculture in Alberta?

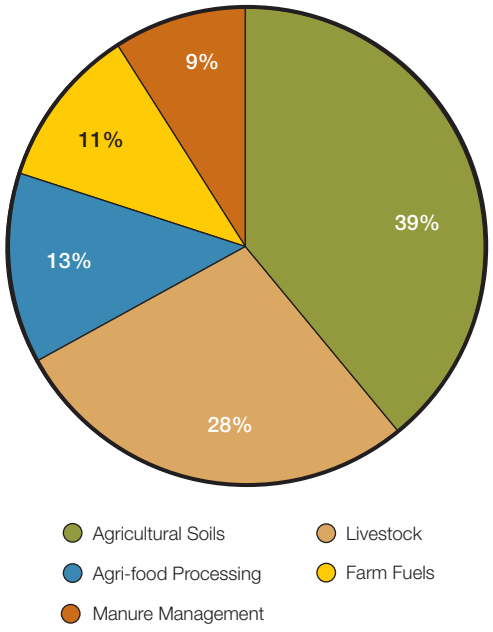
The most recent greenhouse gas inventory estimated that in 2003 nationwide, agricultural related greenhouse gas emissions contributed about 62 Mt (megatonnes) of carbon dioxide equivalents (CO_2e), which is about eight percent of Canada's emissions.[2] Of Alberta's total 2003 greenhouse gas emissions, the agricultural sector contributed about eight percent.[3]

In 2003, Alberta Agriculture and Food and the University of Alberta completed the Alberta Agricultural Greenhouse Gas Assessment Emissions Inventory (Figure 2). From this report, total greenhouse gas emissions from the agriculture sector in Alberta were estimated to be 26.3 Mt of CO_2e per year. Although the agricultural sector emits greenhouse gases, Alberta's agricultural soils, along with pastures and rangelands can sequester an estimated 5.9 Mt CO_2e and 23.4 Mt CO_2e per year, respectively. These large amounts of carbon sequestered by pasture and rangeland soils results in a net negative greenhouse gas emission estimate for Alberta's agriculture industry as a whole. The rate of carbon sequestration by these soils will continue to increase as more producers adopt sustainable management practices that reduce carbon losses associated with soil cultivation and overgrazing.[4]

What Greenhouse Gases are Produced by the Livestock Sector in Alberta?

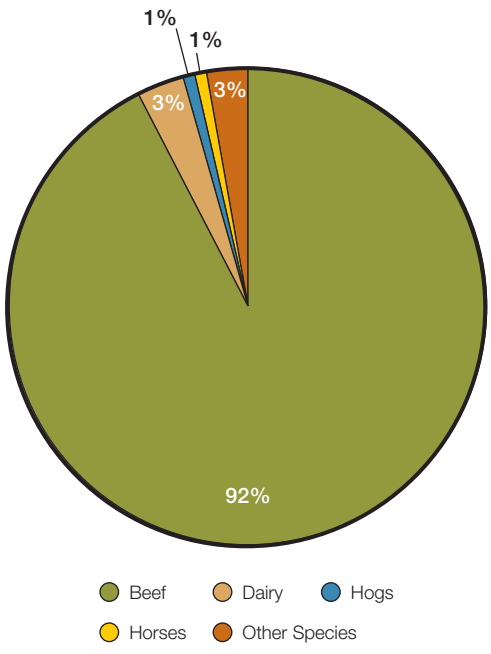
The main greenhouse gases emitted by the livestock industry are methane (CH_4) from the digestive process (enteric fermentation) and methane and nitrous oxide (N_2O) from manure. Methane produced during digestion contributes an estimated 7.4 Mt CO_2e per year, approximately three percent of Alberta's total greenhouse gas emissions. The large methane contribution may be attributed to the fact that beef cattle make up the largest portion of livestock in Alberta, producing about 92 percent of the provincial livestock sector's greenhouse gas emissions (Figure 3). This compares with greenhouse gas emissions from manure management, which contributes 2.4 Mt CO_2e per year. Because greenhouse gas emissions from all livestock represent a loss of costly feed energy and nutrient inputs, the livestock industry has an economic stake in reducing its greenhouse gas emissions.[5]

Figure 2 – Percent Contribution of GHG Emissions from Alberta's Agricultural Sector



Source: Alberta Agriculture and Food and University of Alberta 2003[2]

Figure 3 – Percent Contribution of 2001 GHG Emissions from Alberta's Livestock Sector



Source: Alberta Agriculture and Food and University of Alberta 2003[2]

How Can the Cow/Calf Sector Help to Address Greenhouse Gas Emissions?

In general, implementing certain management practices can address greenhouse gas emissions in the agricultural sector. The strategies involve management practices that would:

- **Reduce** emissions (e.g. improve feeding efficiency or manure management)
- **Remove** emissions (e.g. increase carbon in soils, pastures or trees)
- **Replace** fossil fuels (e.g. use renewable energy)

Opportunities exist for the beef sector to be a significant part of the greenhouse gas solution in agriculture and research is ongoing to determine the best methods to do this. In the meantime, a number of common sense approaches can be taken that both improve efficiency and minimize greenhouse gas emissions.

In addition to reducing greenhouse gas emissions, the cattle industry is an integral component of the forage and rangelands that sequester carbon through photosynthesis, a natural process involving the uptake and storage of carbon carried out by both plants and trees during the growing season. According to the 2001 Agricultural Census carried out by Statistics Canada, there were 10.72 million hectares of such lands in Alberta:

- 1.98 million hectares of tame pasture
- 2.06 million hectares of hayland
- 6.68 million hectares of rangeland[6]

It is estimated that:

- tame pasture may sequester 1.10 tonnes of carbon per hectare per year
- hayland may sequester 0.9 tonnes of carbon per hectare per year
- rangeland may sequester 0.35 tonnes of carbon per hectare per year[7]

Based on these numbers, Alberta's forage and rangelands may be sequestering 23.4 Mt CO_2e per year, bearing in mind that one tonne of carbon (C) equals 3.667 tonnes of carbon dioxide equivalents. This data then suggests that in 2001 Alberta's livestock/forage systems sequestered 13.8 to 14.2 Mt CO_2e more than they emitted.[8]

Credit: Delaney Anderson

Are You Familiar With These Terms?

Anthropogenic
An action or activity caused by humans.

Carbon Dioxide Equivalent (CO_2e)
A universal standard of measurement against which the impact of different greenhouse gases in the atmosphere can be evaluated. It is calculated using the global warming potential (GWP); a measurement of how much heat is retained by the earth's ecosystem through the addition of a particular gas to the atmosphere. Nitrous oxide (N_2O) and methane (CH_4) are 296 and 23 times more powerful, respectively, than carbon dioxide (CO_2) at trapping heat in the atmosphere.

Carbon Sequestration
The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen, and store the carbon through photosynthesis. Carbon is sequestered in soil organic matter (SOM). The more soil organic matter, the healthier the soil and the better the nutrient cycling capacity of the soil. This translates into better the soil quality.

Climate
The average weather for a specific region over time. Elements of climate include temperature, precipitation, sunshine, humidity, and wind velocity.

Climate Change
A slow change in the composition of the global atmosphere, caused directly and indirectly by various human activities that are additional to the natural climate variability that occurs over time.

Denitrification
A process, that occurs in the absence of oxygen, where nitrate ($N0_3$) is converted to nitrous oxide gas, a potent greenhouse gas and to dinitrogen gas (N_2).

Global Warming
An average increase in the earth's atmospheric temperature, caused by increasing levels of atmospheric greenhouse gases trapping more and more of the sun's heat energy in the atmosphere as it is reflected off the earth's surface.

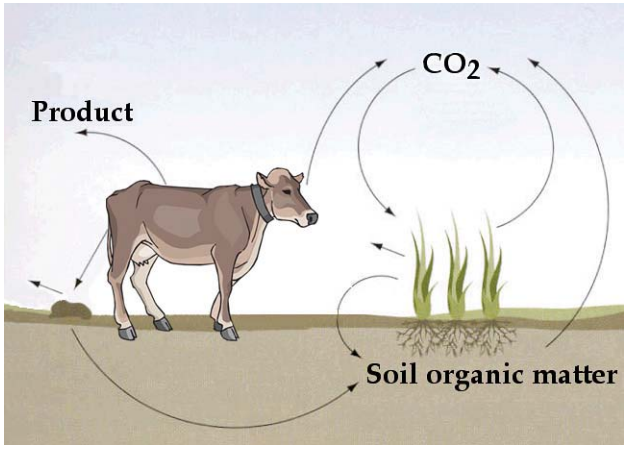
Global Warming Potential
The relative potential of a specific greenhouse gas to trap the sun's heat energy in the earth's atmosphere relative to carbon dioxide. The global warming potentials of methane (CH_4) and nitrous oxide (N_2O) are 23 and 296, respectively.

Greenhouse Gases (GHGs)
Gases that trap the sun's heat in the atmosphere, preventing its release into space, thus creating a warming effect on the surface of the earth. While greenhouse gases such as water vapour, carbon dioxide, nitrous oxide, and methane occur naturally, human activities increase the levels of these gases and are responsible for creating new ones (e.g. hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride).

- ***Carbon Dioxide (CO_2)***
  The most common greenhouse gas that is produced from respiration (Figure 4) and when any carbon-containing compound is burned. Its atmospheric levels have increased by 30 percent above levels known to exist before the industrial revolution.[9]
- ***Methane (CH_4)***
  A greenhouse gas produced by bacteria when organic matter decomposes in the absence of oxygen (anaerobic). Some of the main sources of methane include wetlands, digestion of livestock feed (Figure 4), and fossil fuel extraction. Methane is 23 times more potent a greenhouse gas than carbon dioxide and its atmospheric levels have increased by 145 percent above pre-industrial levels.[10]
- ***Nitrous Oxide (N_2O)***
  A greenhouse gas produced naturally in soils and water without the presence of oxygen through incomplete denitrification (Figure 5). Humans contribute to nitrous oxide through the application of nitrogen fertilizers and manure. Nitrous oxide is 296 times more potent a greenhouse gas than carbon dioxide. Its atmospheric levels have increased by 17 percent above pre-industrial levels.[11]

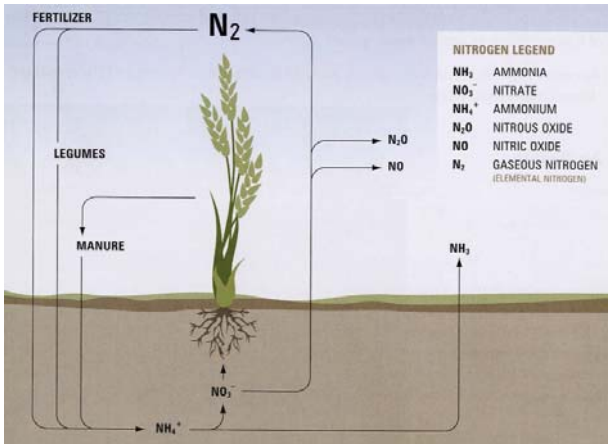
Greenhouse Effect
The warming of the earth's atmosphere caused by the presence of greenhouse gases in the atmosphere that trap the sun's heat energy. This effect is responsible for maintaining the earth's surface at a temperature that makes it habitable for life, as we know it. However, the concentrations of greenhouse gases in the atmosphere lare increasing and as such, they are preventing more heat from escaping meaning the earth slowly heats up. This is called the enhanced greenhouse effect, which causes global warming and it is changing our climate.

Figure 4 – The Carbon Cycle



Credit: Adapted from: Figure 9 in Janzen, H.H., Desjardins, R.L., Asselin, J.M.R., and Grace B. (eds). 1999. The Health of Our Air: Toward Sustainable Agriculture in Canada. Agriculture and Agri-Food Canada, Publication 1981/E. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2005.

Figure 5 – The Nitrogen Cycle



Credit: Adapted from: Figure 21 in Janzen, H.H., Desjardins, R.L., Asselin, J.M.R., and Grace B. (eds). 1999. The Health of Our Air: Toward Sustainable Agriculture in Canada. Agriculture and Agri-Food Canada, Publication 1981/E. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2005.

Net Feed Efficiency (NFE)

The difference between an animal's actual feed intake and its expected feed requirements for maintenance and growth. NFE has been proposed as a measure of feed efficiency that is moderately heritable and independent of growth and body size. It is used to select beef cattle for improved efficiency of feed utilization.

Offsets

Greenhouse gas reductions and/or removals arising from an eligible beneficial management practice that a producer has implemented (e.g. conservation tillage).

Removal

The process of removing greenhouse gases from the atmosphere and storing them long term in sinks. An example would be planting tree shelterbelts, which would remove some carbon dioxide out of the atmosphere.

Sinks

A process that removes greenhouse gases from the atmosphere, either by destroying them through chemical processes or storing them long term in another form. As an example, carbon dioxide is often stored in ocean water, plants or soils.

Sources

Any process or mechanism which release greenhouse gases into the atmosphere; the opposite of sinks.

Weather

The state of the atmosphere with respect to temperature, moisture, sunshine and wind velocity for a certain period of time at a specific location.

Volatilization

A process where a substance is converted from liquid to a gaseous state. For example, nitrogen exists in the liquid ammonium (NH_4+) form in liquid livestock manure but can be given off, or volatilized as ammonia gas (NH_3) when liquid manure is surface applied.

how to use this booklet

This booklet provides information on various management strategies associated with the reduction and removal of greenhouse gases from the atmosphere. A decrease in an agricultural operation's production of greenhouse gases can help to reduce its environmental footprint, improve production efficiencies, and may offer a return on investment. The following tables allow a producer to evaluate different management practices that could be implemented. Section references are supplied indicating where additional details about the management strategy can be located within the booklet. It is important to note that while many of these practices are already in use within the cow/calf sector and have the potential to improve production efficiency, they also have positive results in the removal or reduction of agricultural greenhouse gas emissions. Please note the management strategies are listed in no particular order in terms of their efficacy or efficiency.
As you proceed through the booklet you will make several observations:

- the cow/calf sector is already making a significant contribution to the removal and reduction of greenhouse gases, both within the agricultural industry and the greater global arena
- there are numerous ways to reduce and remove greenhouse gases that will show positive results on the bottom line
- no single producer can make a huge difference in the overall reduction or removal of greenhouse gases but each producer can be part of the solution
- no single management practice can make a huge difference in the overall reduction or removal or greenhouse gases, but each one can factor into the solution
- research is ongoing on a variety of fronts within the cow/calf sector with potentially new and exciting results becoming available on a regular basis

Table 1 – Management Practices that Reduce Greenhouse Gases and/or Sequester Carbon

Put a check (✓) in the box that best reflects your management strategy.

Description of Management Practice	Is this a Current Management Practice?	Is this a Management Practice to Consider?	For More Information See
Herd Health • Implement strategies to: - Increase the percentage of live births and weaned calf survival rates; - Pregnancy test cows; - Evaluate bulls for breeding soundness; - Adopt a strict culling program, and - Implement a cow/calf vaccination program.			***Section 1*** Page 10
Grazing Management • Improve your grazing management			***Section 2*** Page 12
• Reduce or eliminate cultivation on pasture lands			Page 13
• Incorporate legumes into tame pasture mixes			Page 14
• Maintain a litter cover			Page 15
• Extend your grazing season: - Stockpile perennial forage; - Swath graze; or - Seed annuals.			Page 16
• Carefully manage riparian areas			Page 19
Feed Management • Feed high quality feeds and balance rations			***Section 3*** Page 21
• Chop, grind or pellet low quality feeds			Page 21
• Use genetics to select for feed efficiency			Page 22
• Feed silage rather than dry feed			Page 22
• Add grain to the diet			Page 23
• Add lipids to the diet			Page 23
Manure Management • Recognize the nutrient value of manure			***Section 4*** Page 24
• Fertilize tame pasture using manure or compost			Page 25
• Encourage healthy populations of beneficial insects that breakdown manure			Page 26
• Carefully select wintering sites: - Feed rations over a large area; - Frequently move the bedding pile/area; - Feed on level ground or gentle slopes; and - Ensure adequate protection from the elements.			Page 27