SUBMISSION TO THE

STANDING COMMITTEE ON AGRICULTURE AND FORESTRY

Dairy Farmers of Canada

June 1, 2017

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Dairy Farmers of Canada submission to the Standing Senate Committee on Agriculture and Forestry in view of its study on climate change

On behalf of Dairy Farmers of Canada (DFC), thank you for the opportunity to make this submission to the Standing Senate Committee on Agriculture and Forestry, in view of its study on the potential impacts of climate change on the agriculture, agri-food and forestry sectors.

The Canadian dairy sector is a significant contributor to the Canadian economy. According to the latest study conducted by EcoRessources, in 2015, Canada's dairy sector contributed $19.9B to the GDP, and $3.8B in tax revenues, while sustaining 221,000 full-time equivalent jobs across the country. From 2013-2015, this represents a 5% increase in this sector's contributions to the GDP, a 5% increase in tax revenues, and a 3% increase in jobs. In addition, dairy is either the top or second agricultural sector in 7 out of 10 provinces. Furthermore, unlike other jurisdictions where farmer's incomes are heavily subsidized, Canadian dairy farmers receive no direct subsidies and derive their income from the marketplace.

On-going Efforts to Reduce Greenhouse Gas Emissions in the Canadian Dairy Sector

Canadian dairy farmers are responsible stewards of the land, water and air, and continuously strive to increase their sustainability, and reduce the impacts that their businesses have on climate change and the environment. Based on Canada's National Inventory Report on greenhouse gases[1], released in April 2017, and data supplied by Environment and Climate Change Canada that was developed from the Inventory, in 2015, the Canadian dairy industry contributed 5.5 Megatonnes (Mt) of CO_2-equivalent in greenhouse gas emissions. This represents only 0.76% of Canada's total emissions (722 Mt CO_2-equivalent) over the same period.

Since 1990, the year taken as a base for the National Inventory Report, the Canadian dairy industry has steadily reduced its carbon footprint (-20% between 1990-2015). Over the same time period, milk production in Canada has kept pace with increasing demand, resulting in a corresponding 28% decrease in greenhouse gases per hectolitre of milk produced. Today's average cow can produce roughly 1.6 times the amount of milk that the average cow did in 1990. Going back further, today's dairy cow can produce roughly 3 times the amount of milk as a cow did 50 years ago. The bottom line is that the efforts of Canadian dairy farmers to continuously increase their on-farm productivity has contributed to a significant reduction of the sector's carbon footprint.

Put another way, in a lifecycle analysis of Canadian milk[2] that was conducted in 2012, the average carbon footprint of a litre of Canadian milk was estimated at 1.01 kg CO_2-equivalent. The footprint was found to be one of the lowest in the world at that time. Dairy Farmers of Canada are currently looking into updating this analysis, and hope to have an updated report within the next year. In addition, the industry has recently undertaken to build upon this life cycle analysis by creating an on-farm footprinter, known as Dairy Farms + (dairyfarmsplus.ca), which allows an individual farmer to calculate the carbon

[1] Available from: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/10116.php or directly at http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/can-2017-nir-13apr17.zip

[2] see appendix for summary of the Canadian Milk Production LCA

footprint of their own farm. Using this tool, Canadian dairy farmers can also create different scenarios to evaluate the impact of one activity versus another, meaning that they can continuously improve their on-farm practices to reduce their environmental impacts.

Dairy Farmers of Canada is proud of the continuous improvement of Canadian dairy farmers in the fight against climate change. As an industry, dairy farmers have every intention of continuing their efforts to be innovative and forward-thinking, and will continue to invest in practices and technologies that mitigate the sector's environmental impact. At the same time, Canada's dairy farmers, like all farmers, are also susceptible to the impacts of climate change and continuously work at adapting to any changes in their production which are caused by changing weather patterns or any other potential effects.

Impacts of Climate Change on the Canadian Dairy Sector

On the farm, the effects of climate change can be seen in the form of extreme weather events, which can negatively affect crops. While there may be some benefit to warmer weather and longer growing seasons for crops, those same crops may also be subjected to an unpredictable array of drought events, flooding events, heat and other weather events. Crop pests which have long been controlled by winter weather may also become more prevalent following easier winters. In addition, new types of diseases such as the ones passed on by ticks may appear more frequently in Canadian dairy herds.

It should also be noted that Canada's dairy industry currently has little reliance on crop irrigation, except in a few small areas of the country. However, water availability may become a bigger issue; as a consequence, there may be a need for deeper wells or more irrigation in the future. Furthermore, impacts may be seen on land and infrastructure, should a predicted rise in sea level occur.

Another impact of a changing climate is the effect of heat and temperature fluctuations on the cows themselves. Heat stress can result in decreasing feed intake, increased concern for health and a corresponding decrease in milk production. Improved ventilation, building design and cow cooling will be increasingly important investments as the impacts of climate change increase in scope and frequency. Natural ventilation in barns is likely to become less effective. When it gets hot for longer it will be more expensive to operate mechanical ventilation systems to decrease heat stress. That technology is available, but cooling requires a lot of energy and is costly. Research into better handling of temperature fluctuations, improved cow cooling practices and technologies that do not increase energy use may become necessary. Consider, for example, that in Israel, cows were bred to withstand the heat; as a result, Israel has a new breed of cows, a cross between Holstein and Damascus cows to make an 'Israeli Holstein'.

The Impact of Carbon Pricing on the Canadian Dairy Sector

While DFC is supportive of the goal of reducing greenhouse gas emissions and environmental impacts, and can demonstrate that Canadian dairy farmers have already made progress here, we do have some concerns related to carbon pricing and the way it is proposed to be implemented.

As noted previously, Canadian dairy farmers have been steadily decreasing their carbon footprint over time. As a result of the implementation of certain practices and technologies, farmers, may be able to participate within carbon offset programs. Currently, only Alberta has such a program, but the jury is still out on whether dairy farmers can benefit from it. Offset protocols are also being developed for inclusion within the cap and trade systems of Ontario and Quebec. The structure of these programs will

greatly influence whether farmers' efforts and achievements can be recognized, and they can gain access to available credits, in an efficient way.

The federal government has mandated provinces to develop their own carbon pricing programs, which is leading to a patchwork of provincial carbon pricing programs. Farmers in some provinces, like BC and Alberta, receive exemptions or rebates on the carbon tax of some on-farm fuels. Farmers in other provinces, like Ontario, must pay all costs of the price on carbon. This difference may lead to cost inequalities in the market. This disparity can be further exacerbated when you consider the impact of competing with imports allowed from countries that do not have overarching carbon pricing schemes such as the United States.

Through supply management, it is possible that the Canadian dairy sector could potentially recover the cost of extra expenses related to increases in the price of fuel, fertilizers, pesticides, milk transportation, electricity rates, etc. from the market. However, it must be stated clearly that DFC does not believe it is fair to add and distribute these extra costs throughout the supply chain, as the end result might be an increase in retail prices for Canadians. Milk is a nutritious staple for Canadian families, and milk and dairy products are an excellent source of good quality, sustainable protein. Canadian dairy farmers continue to appreciate the overwhelming support that Canadians have for Canadian milk.

Dairy farmers have made significant reductions in their environmental footprint in the past without carbon pricing, and will continue to do so whether there is a price on carbon or not. In dairy farming, greenhouse gases are a waste, a loss. For example, methane lost through a cow's belching is lost energy that could have been used to make milk or maintain her health; nitrogen lost during manure management is lost fertilization potential for crops. With or without a price on carbon, farmers already have the incentive to reduce energy losses and decrease their carbon footprint. With continued research and knowledge transfer, Canadian dairy farmers will continue to adopt practices and technologies which further increase their production efficiency and reduce their environmental impacts.

How the Government of Canada can Support our Efforts

While DFC recognizes that the federal government has committed to putting a price on carbon, the government should be aware that this policy has significant impacts across the agricultural sector and that, for the Canadian dairy sector in particular, there may be more effective ways to support the reduction of greenhouse gases. Below are five ways DFC believes the government could support the efforts of Canadian dairy farmers:

1. Continue to support research that improve the sustainability of dairy;
2. Support knowledge transfer initiatives;
3. Continue to support the proAction® initiative;
4. Continue to support cross-commodity collaborations in sustainability and climate change;
5. Increase support for beneficial initiatives and cost-sharing programs.

The government's support on each of these five points will facilitate the Canadian dairy industry's continuing efforts to decrease its carbon footprint. The next part of this submission will look more deeply at each of these five recommendations.

1. Support for Sustainability Research

The Dairy Research Cluster

DFC has been investing in research aimed at improving various aspects of farm sustainability since the 1990s, in cost-sharing agreements with the federal government. The first Dairy Research Cluster, the current format for cost-sharing research investments, was put in place in 2010. Today, DFC invests about two million dollars a year in human nutrition and milk production research, leveraging additional funding through our partnership with Agriculture and Agri-Food Canada, the Canadian Dairy Network and the Canadian Dairy Commission under the Dairy Research Cluster initiative. This is a very successful program for the dairy sector, and for other industries too.

DFC's investments in research focus on 4 priority targets:

- The improvement of dairy farm efficiency and sustainability,
- Animal health and welfare,
- Milk composition, quality and safety, and
- The role of milk products and their components in human nutrition and health.

In terms of sustainability specifically, it should be noted that the government has also supported other research initiatives, such as through the Greenhouse Gas Mitigation Program in the early 2000s, or, more recently, through the Agricultural Greenhouse Gases Program (AGGP)[3] and Science Clusters programs.

Some outcomes of past research include helping farmers improve dairy herd production capacity, and helping understand how the cow's rumen (stomach) functions to increase feed efficiency and the related impacts of different practices on manure storage and management emissions. Over the years, a lot of research has been done on ruminant nutrition, which has led to more balanced rations and higher quality feeds. This research has been over a range of topics, such as the inclusion of various fats (e.g. flax, fish, vegetable oils) in the ration in order to reduce greenhouse gases, or the production of higher quality forages that lead to increased digestibility and higher milk production. **These improvements add up to less greenhouse gases being emitted during the production of milk, particularly from enteric activity (cow burps during rumination process).**

Under the theme of "Sustainable Dairy Production" the research work of the Dairy Research Cluster focuses on developing, measuring, benchmarking and improving management practices for water conservation, feeding, cropping and manure storage to improve whole farm sustainability. For example, one key nutrition project under the current Dairy Research Cluster aims at improving calculations for the optimal use of protein in dairy rations to benefit the cow, the farm operation and the environment.

DFC requests that the Government continue to support and fund the work of the Dairy Research Cluster.

Genetics and Genomics

In addition to activities under the Dairy Research Cluster, the Canadian dairy industry has also pursued significant research in genetics and genomics. Dairy farmers have been registering cows since the 1880s

[3] facts sheets in appendix are from AGGP research

and because of this, we can track their genetic potential, as well as their performance over time. As a result of genetic selection, each generation of cows is healthier, more productive and more efficient than the preceding one.

Over many decades, there has been significant research done in genetics. However, the most significant advancement in this area occurred in the last ten years with the advent of genomics. Understanding the genome of the cow has had tremendous impact on our understanding of many productivity traits, and allows for the identification of bulls that have the best genetic potential for such traits. Canadian dairy farmers quickly saw the potential of this tool, and uptake of new technology like genomic testing took off quickly in 2009. **This research has the potential to significantly improve feeding efficiency in cows, which directly contributes to a reduction in greenhouse gases**.

Current research on genomics through the Canadian Dairy Network looks promising for further improvements. *The Efficient Dairy Genome Project (http://genomedairy.ualberta.ca/)*, led by two Canadian researchers based in Guelph and Calgary, is an international collaboration success story with eight countries participating. The research aims to better understand the genome of the cow, so that we are able to select for higher feed efficiency and decrease methane emissions. **This means that emissions will be reduced and less land will be needed to produce the same litre of milk**. **Feed-efficient cows better digest their food into milk, wasting less feed, and as a consequence emit less methane.**

This outcome is a win-win for dairy farmers, industry and society, because reducing feed, feed costs (and the energy/GHG needed to produce this feed) could allow farmers to obtain potential credits for decreasing emissions[4] and it will decrease the environmental impact of dairying. **Preliminary estimates from this research show that breeding dairy cattle with increased feed efficiency and reduced methane emissions can reduce feed costs by $108/cow/year and decrease methane emissions by an estimated 11-26%.** This committee may wish to invite the Canadian Dairy Network to address them to learn more about this work.

Support for continued applied research in improved ruminant nutrition, production efficiency, whole-farm reductions of greenhouse gases, as well as continued funding for genomic research is imperative.

2. Support For Knowledge Transfer Initiatives

One of the challenges to continued reduction of the industry's carbon footprint is Knowledge Translation and Transfer (KTT). The Canadian dairy sector is a very efficient producer of safe, high-quality food; however, there are differences in emissions and carbon footprint from farm to farm, as well as differing geographical realities (climate, soil types) and farm practices. Two main areas which we think show potential for improvements are: cropping or manure management practices that reduce losses of nitrogen, and practices or technologies that reduce methane from enteric fermentation or manure management.

Furthermore, farmers are not one large homogenous group; they have varied learning styles (i.e. visual, audio, practical/mechanical, etc.). Through the communication of research results and knowledge transfer activities, DFC is able to produce materials and tools, such as the fact sheets included in the Appendices of this submission, that summarize research and potential beneficial practices for farmers. In addition, Valacta (a farmer-funded organization in Quebec & Maritimes) does excellent knowledge

[4] Depending on accessibility of carbon offset programs for farmers.

transfer activities delivered via demonstrations on farms given by experts in the field or within interactive small groups facilitated by qualified experts with a specialized skill set. These activities show farmers benefit greatly from these events, which are needed, more so than only print or video materials. Tools need to be adapted to learning styles and needs to continue to advance progress and feed on-farm innovation.

KTT is a key area in the dairy knowledge economy that was considerably gutted in the '90s by provincial and federal governments when agriculture "extension" programs were cut. **We strongly recommend the government consider increasing support for knowledge translation and transfer activities, especially in this field.** The adoption of environmentally beneficial practices and technologies on Canadian dairy farms is dependent upon farmers understanding – from experts or peers - the benefits of green technology. Consequently, to improve knowledge transfer capacity in Canada, we require a skilled workforce knowledgeable in dairy farm production, science and communications. A concerted effort would improve adoption on farms, benefit research institutions (i.e. Universities) and leverage the training and KTT delivery capacity of organizations like Valacta. It would be pertinent to have others service the Western part of the country too.

Knowledge translation, transfer and exchange is an integral part of the research continuum in the dairy farm sector; but additional federal investment is needed to innovate through knowledge transfer and facilitate the adoption of green technology.

3. Support for the proAction® Initiative

The dairy industry uses a number of tools to maintain and encourage greenhouse gas mitigation and other environmental improvements. Among these, the proAction initiative is an industry-led customer assurance program that encompasses various measurable aspects of on-farm sustainability: milk quality, food safety, animal care, livestock traceability, biosecurity, and environment. This initiative was self-imposed by the farmers, and is mandatory for all Canadian dairy farms.

Under the environment module, all dairy farmers in Canada will complete an Environmental Farm Plan (EFP) for their farm[5]. The EFP helps farmers assess various risks on their farms and create a plan to manage and mitigate them. When completing an EFP, farmers need to consider energy efficiency, soil health, water management, nutrient management, and other environmental categories, many of which lead to improved production efficiency or reduction of the farm's carbon footprint. It is a program that is in place in all provinces, and takes into consideration the geographical and regulatory realities inherent to each province. In 2011, Agriculture and Agri-Food Canada data showed that up to 70% of dairy farmers in Canada had completed an EFP.

We applaud the federal, provincial and territorial governments in their continued support of this program. There is also a collaborative initiative across commodities towards the creation of a National EFP, which is still in its early stages. Dairy Farmers of Canada is pleased to be able to contribute to the initiative and provide support and input towards it.

[5] In Quebec, this is called the Plan d'Accompagnement Agroenvironnemental, or PAA.

4. Supporting Cross-commodity Collaboration

There is a lot of very good work being done within the agriculture sector across the country to increase sustainability and reduce emissions. While much of this work will be necessarily specific to the commodity sponsoring the research, there are likely many cases where there is a duplication of efforts across commodities. The federal government may want to consider opportunities to support commodities in their efforts to collaborate.

Following participation in a working group on sustainability and climate change that was directed by the All-Chairs meeting of the Value Chain Round Tables in 2016/17, DFC noted that nearly every agricultural commodity in Canada is engaging in research, knowledge sharing and programming in the areas of sustainability and climate change. This common objective and engagement is also part of the reason DFC is actively engaged as a member of the Canadian Roundtable for Sustainable Beef (CRSB). DFC also collaborates at the international level for dairy, reporting on sustainability initiatives to the global Dairy Sustainability Framework and contributing to various activities within the environment committee of the International Dairy Federation.

Collaboration on the National Environmental Farm Plan is one example, but we believe that there are more opportunities for cross-commodity collaboration that will have additional paybacks in reducing the carbon footprint of the entire agriculture sector.

DFC strongly encourages the Government of Canada to recognize and support the agricultural sectors efforts towards Cross-commodity Collaboration as much as is possible.

5. Support for Beneficial Initiatives and Cost-sharing Programs

Improved on-farm management practices have been a contributor to lowering the industry's carbon footprint, and will continue to play an important role. There are any number of examples of beneficial practices, such as those that lead to increased energy efficiency or improved nutrient management, which reduce input use, and, in turn, GHG emissions. In addition, nutrient management, through precision agriculture tools or programs like the 4R nutrient stewardship program, hold a lot of potential to improve cropping practices, improve fertilization, and reduce greenhouse gases. As referenced previously, there is significant potential to reduce losses of nitrogen with improved fertilization practices or reduce methane losses by modifying manure management practices. On-farm production of renewable energy, through biogas, solar power or wind power, are another area of interest.

The adoption of some of these practices and technologies requires significant upfront investments. For example, building and operating a biodigestor on a farm could mean a capital expenditure of upwards of two million dollars. In addition to the financial outlay, these systems are technically complex and navigating the regulatory and operating environments often brings significant challenges. Which brings us back to the importance of knowledge transfer and its financing. If we expect more farmers to invest in green technology, expert guidance is essential to success.

Further, to manage the negative impacts of climate change on their operations, such as those resulting from extreme whether events, all farmers, regardless of commodity, may need additional support in the form of crop insurance or other support programs.

DFC believes that continued or expanded cost-sharing programs that help farmers invest in low-carbon technologies or improved practices is necessary. Financial and other support for farmers as they navigate provincial regulations and utilities companies, as well as establish partnerships with suppliers of off-farm organic waste for co-digestion, would be a great asset.

Conclusion

Canadian dairy farmers believe that the sustainability of our environment is of critical importance – not only for the success of their businesses, but for their country, for the world, and for the humans and animals inhabiting it. Canadian dairy farmers have always recognized that continuously improving their practices has beneficial long-term impacts. They take great pride in their responsibility as stewards of the land, water and air, and seek to continuously improve in the way that they mitigate the environmental impacts of their farms over time. Preserving the environment matters to all Canadians; with the support of the Canadian government, Canadian dairy farmers can continue to build on their success story.

Thank you for the opportunity to make this submission. Please feel free to contact Dairy Farmers of Canada should you have any questions related to this document, or the Canadian dairy sector.

Nutritional Changes

that Reduce Greenhouse Gases

DAIRY FARMERS OF CANADA

Ontario

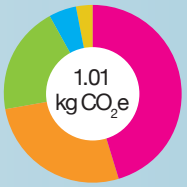
UNIVERSITY of GUELPH

The most significant source of methane from dairy farms originates from cows as they digest feed. As the feed is digested in the rumen, methane is produced by some of the rumen microbes.

Methane represents a loss of energy from the diet that the cow could otherwise have used for milk production.

This loss can vary widely but, for high producing cows, this typically represents about 4-7% of the cows' total energy intake. Most methane escapes from the cow's mouth through eructation (belching) of rumen gases.

CONTRIBUTION OF EACH LIFE CYCLE STAGE



- **Livestock mgmt 46%**
- Manure mgmt **27%**
- Cropping practices **20%**
- Energy and buildings **5%**
- Transportation **3%**

Minimum **0.94** — **1.01** Weighted average kg CO_2e — Maximum **1.10**

*Source: The Environmental and Socioeconomic Life Cycle Assessment of Canadian Milk (2012)

The Dairy Livestock and Cropping Systems Project

identified several key management aspects related to dairy nutrition that could help reduce methane production from cows.

Reducing Methane

Many factors affect the amount of methane that a cow produces, including:

- quality of the forages;
- whether forages have been processed at harvest;
- amount of dry matter consumed;
- amount and type of carbohydrate in the diet;
- amount and type of dietary fats in the diet;
- whether feed additives are fed.

METHANE Reduction

1 Milk Production

Higher production from cows reduces the intensity of greenhouse gas emissions on a kilogram of milk production basis.

Higher producing cows generate less methane per unit of milk than lower producing cows.

? **In Ontario, a study showed that the intensity of greenhouse gas emissions by cows ranged from 0.89 to 1.36 kg of carbon dioxide equivalents per kilogram of corrected milk yield. The wide variation indicates there is good potential to lower emissions on an industry-wide basis.**

2 Forage Quality

Optimal forage quality and forage management at the point of harvest can reduce greenhouse gas emissions on a per kilogram of fat-corrected milk (FCM) basis.

Optimal forage quality improves dry matter intake compared to sub-optimal forages, and better forage quality increases nutrient digestibility. High quality forages can reduce methane production on a per-unit-feed basis.

High quality forage harvested at correct maturity.

Forage quality declines about 0.2% per day in protein and 0.4% per day in digestibility once alfalfa buds appear. Even short delays in cutting can result in significantly lower forage nutrient quality.

Additional Information

www.omafra.gov.on.ca/english/livestock/dairy/facts/greenhousegas.htm

www.omafra.gov.on.ca/english/crops/pub811/3toc.htm

3 Balanced Rations

Feeding some supplemental dietary fat, such as those containing unsaturated fatty acids present in some ingredients and by-products, can suppress methane production in the rumen.

It is important to work with your nutritionist when considering the use of supplemental fat in the cows. While commonly used to increase the energy density of dairy cow rations to support milk production or milk fat content, excess fats or oils can reduce fibre digestion in the rumen and affect milk fat.

As with all ingredients, price will be a factor in choosing the type and amount of fat added to a ration. Generally, inclusion of supplemental fat at 2-4% of dry matter intake is possible without affecting digestion or affecting milk production or quality, depending on the source.

Dairy cows consuming balanced ration to optimize production.

Precision feeding is an approach designed to match nutrient supply with the animal's nutrient requirements. This can be accomplished by regularly monitoring feeds and reformulating diets to match the animal's nutritional requirements. This can save money by eliminating overfeeding of expensive protein and energy which contribute to emissions from cows or from manure.

This project is funded by Agriculture and Agri-Food Canada under the Agricultural Greenhouse Gases Program.

Agriculture et Agroalimentaire Canada Agriculture and Agri-Food Canada

S53 - Latest revision: February 2017

Cropping Practices

to Mitigate Greenhouse Gases

DAIRY FARMERS OF CANADA

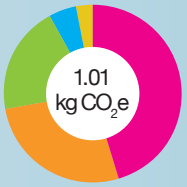
Ontario

UNIVERSITY of GUELPH

Crop production is a major source of greenhouse gas emission, mostly in the form of nitrous oxide (N_2O) gas emitted from soils.

Nitrogen inputs used in crop production are the major contributors of agricultural N_2O emissions. Production of N_2O in soils mainly occurs due to two microbial processes: nitrification and denitrification, and are regulated by several soil factors.

CONTRIBUTION OF EACH LIFE CYCLE STAGE



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*Source: The Environmental and Socioeconomic Life Cycle Assessment of Canadian Milk (2012)

The Dairy Livestock and Crop Systems Project

identified several beneficial soil and crop management practices with large potential to reduce GHG emissions.

1 Spring manure application

Spring manure application is a promising management practice to mitigate GHG emissions.

Compared to fall manure application, spring manure application reduces up to 10% of total N_2O emissions from cropping systems.

Reduction by up to **10%**

Fall application of nitrogen increases the likelihood of nitrate leaching and enhanced N_2O loss.

Spreading nitrogen in the spring reduces nitrogen losses through leaching and N_2O production.

? Example of a manure injection system. Nitrogen leaching can result in indirect N_2O emissions due to processes that take place in groundwater or surface water, but which are linked to field practices.

2 Reduced Tillage

Studies conducted in the Prairies reported lower N_2O emissions from no-till plots compared to conventional tillage. No-till also reduces GHG emissions from western Canadian croplands by increasing the storage of soil carbon.

Example of a reduced tillage field.

Reduced tillage also improves soil quality, promotes biodiversity in and around the soil, reduces soil erosion, and soil compaction.

3 Soil Testing

Optimizing nitrogen application based on soil testing and yield target can reduce N_2O emissions by about 10%.

Yield target helps determine the crop's nitrogen requirement and soil testing gives a better understanding of the nitrogen available for plant growth.

Reduction by up to **10%**

Estimating the nitrogen fertilizer requirement using yield target and soil test results helps add the right amount of nitrogen for plant growth and yield expectations.

4 Perennials in Rotation

Increasing the proportion of perennials in rotation resulted in **TWO times more carbon sequestration** compared to annual cropping with the same nitrogen input.

Though annual crops have higher carbon sequestration rates during the growing seasons, the total sequestered carbon over a year is higher with perennials due to their longer growing season. Compared to annuals, the extensive root mass of perennial crops, particularly in deep soils, helps store more soil organic matter in deeper depths.

Additional Information

Greenhouse gas emissions from soil and cropping systems will vary from year-to-year, but there are clear benefits of soil testing to match crop nutrient needs to inputs; implementing reduced tillage systems; and increasing perennial use in crop rotations; and spring manure application.

Sources

SPRING MANURE APPLICATION

www.gov.mb.ca/agriculture/environment/nutrient-management/pubs/mmf_manuretillage_factsheet.pdf

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www.omafra.gov.on.ca/english/environment/bmp/ghg.htm

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www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/faq7579

REDUCED TILLAGE

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NITROGEN AND SOIL TESTING

www.omafra.gov.on.ca/english/crops/pub811/1fertility.htm#cnrsheet

https://www.gov.mb.ca/agriculture/environment/nutrient-management/pubs/mmf_calcmanureapprates_factsheet.pdf

www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop4689

www.gov.mb.ca/agriculture/crops/soil-fertility/test-your-soil.html

PERENNIALS

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www.gov.mb.ca/agriculture/crops/production/forages/benefits-of-including-forages-in-your-crop-rotation.html

This project is funded by Agriculture and Agri-Food Canada under the Agricultural Greenhouse Gases Program.

Agriculture et Agroalimentaire Canada Agriculture and Agri-Food Canada

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Manure Management Practices

to Mitigate Greenhouse Gases

DAIRY FARMERS OF CANADA

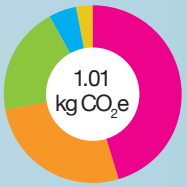
Ontario

UNIVERSITY of GUELPH

Manure management – handling and storage of manure – is an important source of agricultural greenhouse gas (GHG) emissions. Methane is the most important GHG associated with liquid manure management.

Manure methane emissions occur as a net result of microbial production and consumption of methane. 'Wetter' (less oxygen) conditions favour the production of methane, while drier conditions (such as in a crust on manure) result in methane consumption. Management practices to avoid optimal conditions for methane production and/or to provide favourable conditions for methane consumption are helpful in reducing GHG emissions from dairy manure.

CONTRIBUTION OF EACH LIFE CYCLE STAGE



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The Dairy Livestock and Crop Systems Project

identified the following promising management practices to help reduce methane emissions from dairy manure.

1 Straw Cover on Liquid Manure

Applying a straw cover on the liquid manure surface has the potential to reduce methane emissions during storage by up to 15%.

A straw cover reduces methane emissions by creating an environment where there is enough oxygen for microbes to break down the methane that is produced at the bottom of the tank before it rises to the surface and into the atmosphere.

Reduction by up to **15%**

Benefits

- They are simple to put into practice and inexpensive;
- Adaptable and immediately usable;
- Decrease ammonia emissions, and reduce odour and hydrogen sulfide production.

Drawbacks

- They are susceptible to wind and rain damage;
- Straw has limited buoyancy time. *(it can be made more durable by providing floating supports)*

Example of straw covering on liquid manure.

A straw cover reduces methane emissions by creating an environment where there is enough oxygen for microbes to break down the methane that is produced at the bottom of the tank before it rises to the surface and into the atmosphere.

2 Complete Emptying of Stored Manure

Completely emptying a liquid manure storage tank in the spring eliminates the inoculum (or aged manure) in the tank and reduces the methane emissions from the newly loaded manure in the following months by up to 40%.

The more manure removed, the better. Even emptying to 5% of the total tank volume will reduce emissions, as compared to 15 percent left in the tank.

Reduction by up to **40%**

3 Anaerobic Digestion

In this process,"methane-producing" bacteria use volatile manure solids as "food" to produce methane under enhanced environmental conditions in a digester. This leads to lower methane production during storage of the digestate, the liquid portion of the digested manure, due to lack of "food" for "methane-producing" microbes. The methane produced during anaerobic digestion is captured and used as an energy source in a generator.

Benefits

- Reduces methane emissions from the tank storage component by up to 60%;
- Odour control;
- Conversion of organic nitrogen to inorganic nitrogen;
- Production of homogeneous effluent.

Drawbacks

- Capital costs for installation of anaerobic digestion systems are high but the associated GHG benefits are substantial.

4 Solid-Liquid Separation

Separating solids from the liquid manure and composting the solid fraction has the potential to reduce overall methane emissions by about 30 %.

Reduction by up to **30%**

Caution has to be exercised because storage of the solid fraction could increase nitrous oxide emissions; however, by supplying sufficient oxygen in manure heaps and implementing good composting practices, emissions can be reduced.

Applying a straw cover, complete emptying of tanks to eliminate inoculum, producing biogas using anaerobic digestion and separating solids can significantly reduce greenhouse gas emissions from dairy farms.

? **Farm size and the amount of manure produced by the herd will impact the cost-benefit bottom line.**

Anaerobic digestor with methane trapped under the dome cover.

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