GROUPE AGÉCO

WELCOME TO *DAIRY FARMS +*

THE CANADIAN DAIRY PRODUCTION SUSTAINABILITY ASSESSMENT TOOL

STRUCTURE AND METHODOLOGY V1.0
LAST UPDATE: MARCH 2016

Dairy Farms +

www.dairyfarmsplus.ca

ACKNOWLEDGEMENTS AND DISCLAIMER

About Dairy Farmers of Canada
Run for farmers by farmers, Dairy Farmers of Canada is the voice of Canadian dairy farmers. Dairy Farmers of Canada (DFC) is the national policy, lobbying and promotional organization representing Canada's farmers living on approximately 12,000 dairy farms. DFC strives to create stable conditions for the Canadian dairy industry, today and in the future. It works to maintain policies that foster the viability of Canadian dairy farmers and promote dairy products and their health benefits. Dairy farmers fund its operations, including promotional activities.

About Dairy Farms +
Dairy Farms + is funded by Dairy Farmers of Canada (DFC), Agriculture and Agri-Food Canada, the Canadian Dairy Network and the Canadian Dairy Commission under the Dairy Research Cluster Initiative.

The tool was developed by Groupe AGÉCO. In the consulting field for nearly 15 years, Groupe AGÉCO has been at the forefront of the agri-food economy and corporate responsibility sectors. The AGÉCO team helps clients make the right decisions to capitalize on their business environments. In addition to being the very first consulting firm to specialize in economic studies in the agri-food sector, Groupe AGÉCO is a pioneer in social life cycle analysis. With the acquisition of the activities of Quantis Canada in 2015, AGÉCO is able to provide a comprehensive range of corporate responsibility services focused on social, economic and environmental aspects.

Dairy Farmers of Canada and its partners would like to thank all the individuals involved in the development of the tool:

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Privacy statement and disclaimer

All farm-level information, including data on practices and environmental footprints, and all personal contact information ("Confidential Information") entered into the *Dairy Farms +* tool shall be maintained in confidence by Dairy Farmers of Canada and remain strictly confidential. Such Confidential Information is collected anonymously at the provincial and national levels as part of an aggregated sample and will be only used as necessary to support reporting and the demonstration of continuous improvement in sustainable practices in the Canadian dairy sector.

The *Dairy Farms +* tool is provided to assist you with your measurement, benchmarking and self-assessment and action plans to determine the environmental footprint of your farm. Dairy Farmers of Canada does not guarantee or warrant, in any manner whatsoever, any outcome, results, application, use or otherwise of any such assessment (hereinafter referred to as "Use"). Accordingly, Dairy Farmers of Canada will not be liable to you or anyone else for any loss or damage, whether indirect or direct or otherwise, arising from the Use of the *Dairy Farms +* tool.

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1. GOAL AND PURPOSE OF DAIRY FARMS +

Dairy Farms + is an innovative and interactive online tool developed to support Canadian dairy farmers in meeting their sustainability goals by adopting best practices to reduce their environmental footprints and maximize farm efficiency and productivity for the benefit of all Canadians.

Through a user-friendly interface, the tool provides **self-assessment questionnaires** and a **best management practices (BMP) library** with useful information and resources on the following key sustainability topics:

- environmental stewardship (field operations and on-farm activities)
- farm management
- economic performance
- relations with local communities
- workers' well-being
- animal health and care

The tool's three main modules will enable you to:

- **LEARN** about best managements practices (BMPs) and **ASSESS** your performance
  - understand sustainability issues and compare your management practices with industry best practices
  - access a list of key resources to help you improve your performance and understand the potential benefits of these BMPs
  - help Québec's dairy farmers complete their risk evaluation and agri-environmental action plan (PAA equivalent) questionnaire as part of the proAction initiative

- **MEASURE and BENCHMARK** your environmental footprint
  - understand the environmental issues facing dairy farms and compare your farm's environmental performance with the sector average

- **TAKE ACTION** to improve your performance
  - quickly identify priorities based on the tool's recommendations
  - use the action planning tool to address priorities and improve your sustainability performance

2. ABOUT THE BEST FARM MANAGEMENT PRACTICES (BMPS) LIBRARY

The BMPs library is part of the tool's *Learn and assess* module.

The BMPs library provides useful information and resources on the following key sustainability topics:

- environmental stewardship (field operations and on-farm activities)
- farm management
- economic performance
- relations with local communities
- workers' well-being
- animal health and care
- risk evaluation and agri-environmental action plan (PAA equivalent)

This section provides an overview of the approach used to develop the library.

WHAT ARE THE OBJECTIVES OF THE BMPS LIBRARY?

The objective of the BMPs library is to consolidate available information on sustainability-related best farm management practices in order to serve as a hub for knowledge transfer among Canadian dairy farmers. The content of the library is therefore aimed at Canadian dairy producers and their advisors in order to:

- raise their awareness of the key sustainability topics relevant to the Canadian agricultural sector
- provide a list of BMPs addressing these topics
- provide information on the importance and potential benefits of adopting these BMPs

The structure and content of the library are in line with recognized sustainability and corporate social responsibility (CSR) standards applied to the agri-food sector, as well as on available BMP resources.

This tool follows a CSR approach by looking at the farm-level actions that can affect surrounding stakeholders, such as workers, local communities and society as a whole. From a CSR perspective, it is assumed that a socially responsible behaviour not only reduces the risk of generating negative social impacts on stakeholders and society but also increases the chances of creating benefits for the social and natural environment. This perspective differs from one focused on the impact of the economic, natural and social environment of a farm's sustainability over time and generations. In other words, the tool is about what farmers can do to improve and capitalize on their impacts on stakeholders.

The library is not comprehensive nor does it replace existing resources on the topics addressed. The objective is rather to facilitate access to the information by adopting an overarching sustainability perspective at a Canadian level.

HOW IS THE LIBRARY STRUCTURED?

The library is organized around 7 dimensions, 30 themes and 102 practices (see Figure 1). For producers operating in Québec, a dimension (with 6 themes and 49 practices) is proposed for the risk evaluation and agri-environmental action plan – PAA equivalent.

Figure 2.1
Example of dimension, theme and practice

Worker's well-being	→ Dimension
Working hours	→ Theme
Leaves and bonuses	→ Practice

Dimensions are broad sustainability topics. They address all the universally accepted pillars of sustainability—namely the social, environmental, economic and governance pillars—by adapting them to the context of agricultural production. For instance, the environmental dimension distinguishes operations at the farm or in the field and a dimension was added to specifically address the topic of animal health and welfare.

Themes are specific sustainability issues that define the scope of each dimension. They provide a more concrete understanding of what sustainability means at the farm level by addressing all the main concerns that farmers face in their practices to minimize the potential negative impact of their activities and increase the positive ones.

Practices are examples of recognized BMPs that could be implemented to address each theme. These practices are concrete actions that farmers could integrate in their action plans as part of a continuous improvement process. Practices are also measurable variables used to assess the degree of social responsibility of farmers with regards to each theme and dimension.

The content of the library is presented according to a standardized layout. Each dimension includes a list of themes. Each theme is associated with a list of practices. Each practice proposes a definition and supporting references, in addition to a list of potential benefits. These benefits are those that can be expected from the implementation of the practice. Each practice is associated with one or more of the ten following benefits:

- Profitability: implementing this practice could help improve your profitability over time by increasing your revenue and/or reducing your costs
- Business risk: implementing this practice could help anticipate, avoid and mitigate business risks and their potential costs
- Biodiversity: implementing this practice could help maintain or create conditions that favour the development of a rich fauna and flora in agricultural areas

- Climate change: implementing this practice could help reduce greenhouse gas emissions and their impacts on climate change.
- Soil health: implementing this practice could help decrease erosion, land degradation and loss of organic matter and protect the soil's health.
- Water quality: implementing this practice could help reduce the risk of surface, ground and drinking water (from wells) contamination and ensure water quality
- Animal welfare: implementing this practice could help improve your animals' health and well-being
- Good neighbourliness: implementing this practice could contribute to the social acceptability of your activities and strengthen your presence in the community
- Workers' well-being: implementing this practice could help enhance your workers' well-being and their satisfaction at work.
- Farmers' well-being: implementing this practice could positively impact your quality of life and that of your family members

Two other tags are used in the library to further qualify the practices. The first tag is a priority level: priority practice. A priority practice is one that should be implemented as a priority by farmers to meet their sustainability goals. The priority level is attributed to practices that are regulated and/or promoted by the proAction initiative. The second tag provides information on ease of implementation: easy to implement. Practices with this tag are those that should not require extensive resources to adopt. They were identified as part of the literature review.

HOW WAS THE LIBRARY DEVELOPED?

The library is based on the specific analysis framework used in the socioeconomic life cycle assessment (S-LCA) of Canadian milk published in 2012 (Quantis, Groupe AGÉCO, CIRAIG, 2012). The framework was used to assess dairy producers' social commitment to stakeholders by examining farm-level practices.

In keeping with the UNEP/SETAC guidelines on S-LCA (UNEP/ SETAC, 2009) and based on a review of the literature on the sustainability schemes developed for the agri-food sector, a framework addressing 29 practices and 14 themes affecting 4 stakeholder categories was developed.

This original framework was adapted and expanded in Dairy Farms + in response to the latest developments in the field of CSR applied to the agri-food sector. More specifically, the framework was modified to be in line with the Sustainability Assessment of Food and Agriculture Systems (SAFA) Guidelines. Released in 2013 by Food and Agriculture Organization of the United Nations (FAO), SAFA constitutes an international reference tool to assess the sustainability performance of food and agriculture businesses. Developed in accordance with all the main sustainability references and standards, it aims to provide a global scope and alignment to assess sustainability at the farm level.

The SAFA framework includes 4 dimensions, 21 themes, 58 sub-themes and 116 practices addressing all the main sustainability issues in agriculture. A similar structure was considered in

Dairy Farms +. The number and nature of the dimensions, themes and practices were adjusted following the original framework used in 2012 and are also based on other sustainability frameworks so that they may be adapted to the Canadian dairy farming context.

Table 1 lists the main sources considered to build the library used in Dairy Farms +. They include schemes, assessment tools and studies proposing sustainability frameworks from which dimensions, themes and practices were drawn. Particular attention was paid to sources proposing frameworks that address every aspect of sustainability (e.g. social, economic, environmental, governance) and which are adapted to Canadian dairy production.

Given the tool's objective to consolidate information on best farm management practices in terms of sustainability, the proposed definitions used in the library are drawn from publicly available sources. The references are listed under each text in the library.

Practices and references are not regionalized or meant to be comprehensive. They were selected based on their ability to support the themes of each dimension, their representativeness and their relevance to the Canadian dairy sector. Sources such as provincial environmental farm plans (EFP), proAction's reference manuals (draft versions) and research results from other projects conducted under the Dairy Cluster (e.g. the Agriculture Greenhouse Gas Program – AGGP) were considered in priority to align Dairy Farms + and sector initiatives. Other references, such as government agency and agricultural association websites, were also considered.

A review process was carried out to validate and complete the library. In addition to representatives from the Dairy Farmers of Canada, the following experts were consulted:

- Valérie Bélanger, Ph.D., Transfer Coordinator, Novalait
- Renée Bergeron, Ph.D., Associate Professor, Animal Biosciences, University of Guelph
- Martin Chantigny, Ph.D., Soil Scientist, Soils and Crops Research & Development Centre Agriculture and Agri-Food Canada
- Doris Pellerin, Ph.D., Professor, Animal Science Department, Laval University
- Claudia Wagner-Riddle, Ph.D., Professor, School of Environmental Sciences, University of Guelph
- Karin Wittenberg, Ph.D., Dean, Professor, Faculty of Agricultural and Food Sciences, University of Manitoba

Each of these experts reviewed one or more dimensions of the library based on their field of expertise. They were specifically asked to check whether:

- the themes in each dimension were clearly described and thoroughly covered sector issues
- the best practices identified were the most significant ones to consider
- additional resources could be suggested to producers
- the priority level and effort to implement the practices were realistic

- there were other relevant context questions to add to better contextualize the answers from producers

Their recommendations and comments were taken into account in the final version of the library.

HOW TO USE THE LIBRARY?

There are two ways to access the content of the library: by visiting the *Learn and assess* section on the home page of Dairy Farms + or by clicking on *BMPs library* link at the top of the page.

The *Learn and assess* section provides access to the content of the library for each dimension. Users can then read up on each theme and practice and access all the definitions and resources. The section also supports self-assessment and action plan development (see section 3).

The BMPs library provides access to the full content of the library at the practice level. Clicking a practice opens a new window in which the definition, potential benefits, references, priority level and effort to implement are described. Users can also add practices to their action plan from the BMPs library once they have completed the self-assessment questionnaires for each dimension.

The BMPs library section includes a system to filter practices according to different criteria:

- priority level
- effort to implement
- potential benefits
- themes
- keywords

This prioritization system is meant to help farmers access practices that meet their specific needs and goals.

3. ABOUT THE SELF-ASSESSMENT QUESTIONNAIRES

Dairy farmers seeking to better understand where they stand in terms of sustainability can fill out self-assessment questionnaires, which are available in the *Learn and assess* section by clicking each dimension.

OBJECTIVES OF THE SELF-ASSESSMENT QUESTIONNAIRES

The objectives of the questionnaires are to:

- assess the level of social responsibility at the farm level by exploring the number of BMPs adopted by theme and dimension
- compare a farm's performance to the dairy sector's best practices
- access recommendations on relevant practices that farmers could adopt to increase their level of social responsibility
- develop a tailored action plan based on the farm situation and priorities

USING THE QUESTIONNAIRES

A questionnaire is set out for each dimension. It starts with context questions to customize the questionnaire to a farm's specific situation (e.g. use of hired labour or not). Users can answer a list of questions by checking the yes/no boxes that apply to their situation.

Farmers can save their answers and return to the questionnaire later. All questions must be answered to move forward. A bar at the top of the section informs users of the completion rate.

QUESTIONNAIRE DEVELOPMENT

In keeping with the CSR perspective adopted to develop the library, the self-assessment questionnaires are exclusively practice-based. Only information on the BMPs adopted at the farm level must be provided and no quantitative data is required to carry out the assessment.

The number of questions varies according to the number of BMPs considered in each dimension. All the BMPs listed in the library are considered in the questionnaires in at least one question.

RESULTS INTERPRETATION

After completing a questionnaire, farmers have access to a results page. The top section shows the results as a percentage. The percentage indicates how many applicable practices are already implemented based on the total number of practices outlined in the tool (non-applicable practices are not considered in results calculation). The higher the rate, the more the farmer has taken actions to address the main sustainability issues on his/her farm.

The results are also compared to the national and provincial average scores (except for the Risk evaluation and agri-environmental action plan dimension). Default scores are set at 25%. Provincial and national average scores will be updated as farmers fill out questionnaires over time.

It is important to note that the results are for information purposes only and do not detail a farm's environmental or economic performances. Farmers should always discuss any potential changes to

their operations with their team of advisors and experts in order to adapt the practices to their situation.

The lower section of the results page proposes a detailed overview of the performance per theme and practice. Farmers can then review the practices they have adopted (or not) for each dimension (non-applicable practices are tagged N/A), see where they stand as compared to the average adoption rate in their province or at the national level (default scores are set at 25% but are not available for the Risk evaluation and agri-environmental action plan dimension) and edit their answers if need be. Note that editing an answer will bring the user back to the questionnaire.

The section also proposes an action that farmer may implement to improve their performance for each BMP (e.g. ensure accurate and up-to-date records keeping on all farm activities). These actions can be added to or removed from the action plan by checking the box at the right of the page.

All priority practices flagged in the results section and which are not already implemented are automatically added to the action plan. The priority practices are those that are tagged as such in the BMPs library section and also include those that are considered priorities based on the questionnaire results. Specifically, a practice will be considered as a priority if:

- it is promoted by proAction or regulated (as identified in the BMPs library)
- the context in which farmers operate strongly justifies the adoption of the practice (e.g. farmers living close to neighbours might face cohabitation issues if they do not adopt practices to reduce farm nuisances)
- the practice is not implemented on the farm but is already adopted by over 75% of the other farmers in the province

The results may be downloaded in PDF format and printed by clicking *Get my results* (PDF) at the top of the page.

4. ABOUT THE ACTION PLAN TOOL

The action plan tool is part of the *Take action* module of the tool.

OBJECTIVES OF THE ACTION PLAN TOOL

The action plan tool is used to customize a user's action plan and prioritize the actions based on the tool's recommendations and the user's own preferences, goals or expected benefits.

The tool automatically compiles actions based on self-assessment results. These actions are identified by a green checkmark. The practices should be considered as top priorities since they represent areas for improvement for the user or indicate that the farm may be at risk if certain practices are not adopted. All other practices are in shade-grey.

Note that actions are proposed only for the dimensions for which the self-assessment questionnaires have been filled out. Users can access the complete list of BMPs by clicking *See all practices*, which returns to the BMPs library.

STRUCTURE OF THE ACTION PLAN TOOL

On this page, users can customize their action plans by checking or unchecking the box next to each recommended best practice. It is also possible to use the filter to only select the practices that meet specific criteria (e.g. practices to reduce greenhouse gas emissions or enhance worker well-being).

Once the action plan is completed and customized, the user can click *Generate my action plan* to create a PDF document and fill out the template with specific actions, dates and any other information that will be useful to manage the implementation of the best practices.

5. ABOUT THE ENVIRONMENTAL FOOTPRINTER

The environmental footprinter is part of the *Measure and benchmark* module of the tool.

OBJECTIVES OF THE ENVIRONMENTAL FOOTPRINTER

The footprinter enables dairy producers to measure their environmental footprints and compare them to the provincial and national averages.

By estimating a dairy farm's environmental footprint, the user can establish a basis to monitor and assess sustainability performance from year to year and identify hot spots and areas for improvement.

STRUCTURE OF THE FOOTPRINTER

The environmental footprint is calculated based on input data, which must be provided through a questionnaire covering the following dairy farming activities:

- farm and milk
- livestock
- ration
- feed production
- manure management
- infrastructure, energy, water

The environmental footprinter module offers two different pathways: a simplified version of the tool (less time-consuming and requiring less data) and a more advanced version.

The environmental footprint may be displayed in terms of greenhouse gas emissions, water withdrawal, land use or a set of on-farm environmental indicators. For the first three environmental indicators, the results may be detailed for on-farm and off-farm activities:

ON-FARM (DIRECT)

- Feed (direct emissions)
- Manure management
- Livestock management
- Building and machinery
- Water for watering
- Water for washing
- Water for irrigation
- Feed self-produced

ON-FARM (INDIRECT)

- Feed
- Feed (indirect emissions)
- Electricity
- Transport
- Feed purchased
- Other

DEVELOPMENT OF THE FOOTPRINTER

The footprinter is built on the results of the environmental and socioeconomic life cycle assessment (LCA) of Canadian milk prepared for Dairy Farmers of Canada (Quantis et al., 2012). Certain adjustments were made to the previous model in order to be up-to-date with best practices and available data. Earlier provincial and national average calculations may therefore differ from those presented by *Dairy Farms +.*

SCOPE OF THE FOOTPRINTER

The scope of evaluation considered in the footprinter is from "cradle to processing plant gate", which begins with the extraction of the raw materials required in the life cycle of the main inputs and operations at the farm up to transportation to the milk processing plant. It excludes transformation.

The footprinter follows the rules of life cycle assessment, which uses the concept of a functional unit to translate and report the results of each indicator to a common basis.

The functional unit used in this footprinter is:

1 kg of fat and protein corrected milk (FPCM) from a Canadian farm to the processing facility

The correction is made according to the equation provided by the International Dairy Federation (IDF) for conversion to 4.0% fat and 3.3% true protein content:

FPCM (kg/yr) = Production (kg/yr) x [0.1226 x Fat% + 0.0776 x Protein% + 0.2534]

Always with respect to the main functional unit, the footprinter results may be scaled and displayed for the following reference units:

- 1 kg of corrected milk
- 1 L of corrected milk
- 1 hL of corrected milk
- Farm
- 1 dairy cow
- 1 hectare of arable land

DATA SOURCES

Default data that are not provided by the farmer are sourced from the 2012 Quantis et al. study. Other activity data were sourced from on-farm surveys, generic databases (such as ecoinvent 2.2) and discussions with provincial federations. A model based on the ecoinvent database was adjusted to the North American context.

LIFE CYCLE ASSESSMENT METHODOLOGY

The environmental life cycle assessment used to build the footprinter follows the International Dairy Federation (IDF) Guidelines (IDF, 2010) on carbon footprints, which, in turn, are in keeping with the guidelines of the ISO 14040-14044 LCA standards.

Potential environmental impacts and indicators are grouped under three categories: **greenhouse gas (GHG) emissions** (CO_2 indicator), **water withdrawal** and **land use**. The methods used in *Dairy Farms +* are described below.

Greenhouse gas (GHG) emissions (CO_2 indicator)

Greenhouse gases trap part of the sun's rays, keeping some of the heat in the atmosphere and making life on earth possible (average global temperature is 15°C). According to the Intergovernmental Panel on Climate Change (IPCC), human activities intensify the concentration of greenhouse gases (e.g. CO_2) in the atmosphere, trapping the solar radiation to a greater extent. Consequently, the earth's temperature is modified. This phenomenon is called climate change. The indicator measures the mass of CO_2-eq. (carbon dioxide equivalent)—the reference unit to which other greenhouse gas emissions are converted and add up.

Water withdrawal

Water withdrawal is an inventory indicator that sums up the different water volumes withdrawn in the milk production life cycle. It includes the water used at farm as well as water used in background processes, such as raw materials mining, farm input production and electricity generation (with the exception of the water used in turbines for hydropower production).

Land use

Land use is an inventory indicator that refers to the use of arable land area for a clear human activity (e.g. agriculture) during a specific period of time (measured in m^2.year).

On-farm indicators

A series of key farm-level performance inventory indicators were set out and may be used to measure and benchmark a farm's performance over time. The list below presents the available indicators:

Farm and milk

- Amount of milk sold (FPCM) produced
- Total surface of arable land used

Energy

- Amount of electricity consumed
- Amount of natural gas consumed
- Amount of fuel consumed

Feed production

- Amount of pesticides used
- Amount of nitrogen fertilizers (N) used
- Amount of phosphate fertilizers (expressed in P) used
- Amount of potassium fertilizer (K) used

Ration

- Amount of silage used
- Amount of concentrate food used

ALLOCATION PROCEDURES

The allocation methods are in line with IDF Guidelines (IDF, 2010). For feed production by-products such as canola meal and corn distillers grain, an economic allocation was used to allocate the impact between the different products. Because of their variable costs and small contributions (less than 5% of total feed), the default economic allocation model in ecoinvent was used as is and not adapted to local values.

The impacts for milk and meat were allocated using an equation based on energy needs (physical allocation): allocation factor = 1 – 5.7717 x (Weight of Live Animals Sold / Weight FPC Milk).

For manure spread on crops not destined for the dairy herd, a system expansion was used (also in line with IDF Guidelines), where the amount of nitrogen exported was deemed to replace urea, the most common nitrogen fertilizer (Sheppard et al., 2009).

EXCLUDED PROCESSES

Some inputs and processes were excluded from the study since their expected contributions were lower than 1% of the total mass, energy or economic contribution to total farm inputs or due to a lack of reliable information.

Manure types

Not all manure types are available in the footprinter. There are certain cases in which dairy farms spread other types of manure (e.g. hog manure) onto feed crops. Because of these particularities and the significant variability between farms, the practice was excluded from the scope.

Prescription drugs

Prescription drugs were excluded from the study due to a lack of data on the amount and types of drugs used on farms. In addition, no LCA data were available on prescription medication given to livestock. In terms of mass, they represent much less than 1%. From an economic perspective, few data were available for medication only. It is expected that veterinary, breeding and medical costs add up to less than 5%, where medicine is assumed to represent a small share of the total (Johnson & Schwartz, 2002). However, due to medicine's role in eradicating bacteria, for example, the use of drugs could have a non-negligible environmental significance for ecosystems that may be affected through emissions to water and soil. Current research results do not include this cause-effect chain in the overall impacts and this consideration therefore constitutes one of the study's limitations.

On-site waste

Waste generated at the farm is not included in this study. Most of it is related to silage (e.g. plastic wrap and strings). A 400-kg ball of haylage uses, on average, 1 kg of plastic. Landfilling this plastic has a climate change impact equivalent to less than 1% of the impact of the ball of hay, which confirms that the contribution is below the criteria for exclusion. Milk waste is accounted for inherently with the inclusion of all the impacts generated for its production. Its disposal is added to manure storage for spreading.

Soil carbon

In accordance with IDF Guidelines, soil carbon was excluded from the boundaries. Despite the fact that better soil management may represent an important opportunity for carbon sequestration, the uncertainty of existing models is too significant.

LIMITATIONS

The **environmental footprinter** in *Dairy Farms +* is intended to provide reliable macroscopic insight with a high level of efficiency. However, several processes such as land management, enteric fermentation and manure management, are complex systems to model with several parameters that differ from one farm to the next. In order to keep the tool as simple as possible, several assumptions and simplifications were made. These simplifications lead to certain limitations that must be considered in the interpretation and use of the results. In general, the results should be interpreted as an approximation of the footprint of the milk of a given farm. All comparisons should be limited to the ones provided by the tool and comparisons with other studies are not recommended. Also, it is not recommended to use the results for comparative assertions for marketing purposes. Finally, the footprinter evaluates a specific range of environmental indicators. Conclusions should not be drawn regarding environmental issues that have not been directly addressed by the tool.

In addition, the following points list the tool's main simplifications. These simplifications should be considered when using the results in any way.

- Hay (dry and silage) is the most significant source of feed for cows. However, hay production varies greatly, not only in the grass type itself (tame hay, alfalfa, clover, etc.) but in its management (permanent or semi-permanent pasture or in crop rotation) and fertilization.

As such, it brings an important uncertainty to emissions from crop production since only an average mix of tame hay is modelled in the tool

- The potential of soil degradation and the use of crop rotation are partially considered in this tool, since the model evaluated the system in a one-year production timeframe. However, they are a topic of great interest that is directly linked to best practices in soil fertilization.
- The IPCC Tier 2 model is used to model land management in the tool. This approach does not differentiate between the different types of land management, period of spreading or spreading technique. Consequently, the tool cannot capture the full benefits of the best land management practices in terms of GHG emissions reductions.
- The enteric fermentation model used in the tool is an approximation of methane emissions and does not differentiate between different types of feed. There are many limiting factors in this model that affect the methane emissions results, such as the methane conversion factor, digestible energy of the diet and body weight of the cattle. As such, they only provide a scale of emissions useful for comparisons with other sources of GHG emissions.
- The methane conversion factor (Ym) for the enteric fermentation of cattle can drive the total methane emissions. In this tool, the Ym is calculated using one of the many equations developed by Ellis (2007). The equation is based on dry matter intake and the provided results below and is higher than the 6.5% suggested by the IPCC (2006). More accurate models exist but require information on the chemical composition of the diet that was not available in the context of this study.
- The dry matter intake was previously calculated based on the body weight of the cattle and digestible energy (DE%) of the diet. This tool uses the means of the digestible energy (DE%) ranges provided for each feed class by the IPCC (2006). More precise DE% data would have be preferable since a 1% change in DE% can cause a variation of up to 4% in the methane conversion factor (Ym). According to the IPCC (2006), a 10% error in the average diet DE% can cause a variation in the range of 12 to 20% in methane emissions. Also, on a farm-per-farm basis, more specific data on the body weight of the cattle is required to refine the calculation of the dry matter intake. It is important to note that the model does not take into account the decrease in DE% when more feed is consumed daily. The feed intake of high producing cattle is therefore underestimated.
- In light of the lack of specific national or regional values available in the data collected or the literature, many default values were included in the calculations of the IPCC Tier 2 model for manure management. The IPCC (2006) reports a ±20% uncertainty range in the emissions factors when the Tier 2 method is applied.
- Although the user can choose various types of manure management systems, only one system may be selected at a time. As such, the tool cannot model manure processed through different management systems.

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APPENDIX 1
REVIEW OF MAIN SUSTAINABILITY SCHEMES, TOOLS AND STUDIES

REVIEW OF MAIN SUSTAINABILITY SCHEMES, TOOLS AND STUDIES

Source	Author	Type	Issues considered	Comments
Socioeconomic Life Cycle Assessment (S-LCA) of Canadian milk	Quantis, Groupe AGÉCO, CIRAIG	Study (2012)	- Workers (e.g. working hours, health and safety, professional accomplishment, etc.) - Local communities (e.g. community engagement, cohabitation, etc.) - Society (e.g. agro-environmental practices, animal welfare, etc.) - Value chain stakeholders (e.g. procurement practices, supplier practices, etc.)	This study sets out the original framework of social responsibility for dairy farming in Canada and addresses 29 practices and 14 themes affecting 4 stakeholder categories.
SAFA (Sustainability Assessment of Food and Agriculture Systems)	Food and Agriculture Organization of the United Nations	Sustainability schemes Assessment tool	- Good governance - Environmental integrity - Economic resilience - Social well-being	These guidelines were developed to assess the environmental and social impacts of food and agriculture operations. This holistic framework mainly builds on existing sustainability schemes.
Principles and **Practices for Sustainable Dairy Farming**	SAI Platform Dairy Working Group	Sustainability schemes	- Sustainable farming system - Economic sustainability - Social sustainability - Environmental sustainability	This guide provides a set of principles and practices for sustainable dairy farming for the mainstream market in all regions of the world.
Guide de gestion durable d'une entreprise agricole [Guide to sustainable farm business management, in French only]	Centre québécois de développement durable (CQCD), Coop fédérée et Groupe conseil agricole (CGA) Saguenay Lac-St-Jean	Sustainability schemes Assessment tool	- Governance - Human consideration - Economic sustainability - Resources management	This guide summarizes issues and good practices that may be adopted by businesses to improve their sustainability.
RTRS Standard – Canadian interpretation document	Round Table for Responsible Soy	Sustainability schemes	- Legal compliance and good management practices - Responsible working conditions - Responsible community relations - Environmental responsibility	The RTRS Standard is a certification specifically designed to certify sustainable soy production. This certification is an international initiative with adapted versions for different countries, including Canada.

Source	Author	Type	Issues considered	Comments
Social LCA of grain production in Québec	Producteurs de grains du Québec	Study (2015)	- Governance - Economic resilience - Environmental integrity - Relations with the community - Workers' well-being	This study assesses the degree of social responsibility of grain producers in Québec with regards to 5 aspects, 24 themes and some 100 practices.
Ben & Jerry's Caring Dairy Program	Ben & Jerry's	Sustainability schemes Assessment tool	- Soil health - Soil loss management - Nutrients - Farm financials - Social human capital - Pest management - Biodiversity - Animal husbandry / welfare - Energy - Water - Local economy	A program implemented by Ben & Jerry's to measure and monitor the socio-environmental performances of dairy farmers
DairySAT (Dairy Self-Assessment Tool)	Dairy Australia	Assessment tool	- Soils - Fertilizers - Effluent management - Irrigation - Greenhouse gas emissions - Biodiversity - Energy and water - Pests and weeds - Chemicals - Farm waste	DairySAT is an environmental self-assessment and action-planning tool for Australian dairy farmers. It covers 10 key topic areas.
SMART (The Sustainability Monitoring and Assessment RouTine)	Research Institute of Organic Agriculture	Assessment tool	- Soil sciences - Crop production - Crop protection and biodiversity - Animal health - Livestock management - Socioeconomics - Food quality and processing - Consultancy - Communication - Development and cooperation	Tool for the sustainability assessment of food companies. Farm-level assessments are conducted with a special sub-tool: the SMART-Farm-TOOL

Source	Author	Type	Issues considered	Comments
Construction d'un outil d'évaluation de la durabilité des fermes laitières Québécoises [Development of a tool to assess the sustainability of Québec dairy farms, in French only)]	Valérie Bélanger	Study (2012)	- Environmental sustainability (e.g. soil quality, cropping practices, fertilisation management, etc.) - Social sustainability (e.g. quality of life, social integration, entrepreneurship, etc.)	This PhD dissertation reviews existing studies on sustainable dairy farming and indicator sets to measure the socio-environmental performance of Canadian dairy farmers.