Streamlined Environmental Life Cycle Assessment of Canadian Pork Production

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About Groupe AGÉCO

Economic studies

Corporate responsibility

A multidisciplinary team of rigorous and dedicated experts

- Advanced technical expertise
- Field experience for operational support
- Helping organization understand, improve, and valorize their environmental and socioeconomic performance

20
experienced professionals

18
years at the forefront of the agri-food sector

500+
clients in our portfolio

Our Clients: A Diverse Group of Organizations and Industries

Agri-food sector

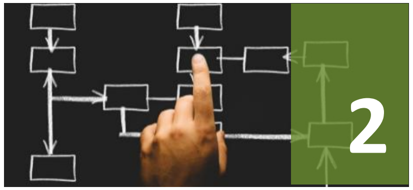
- metro
- Première Moisson
- Nestlé
- Les Éleveurs de porcs du Québec
- Dairy Farmers of Canada / Les Producteurs Laitiers du Canada
- Grain Farmers of Ontario
- Alberta Government
- La Coop fédérée
- UPA L'Union des producteurs agricoles
- crsc Canadian Roundtable for Sustainable Crops
- AQINAC Association québécoise des industries de nutrition animale et céréalière
- Pulse Canada
- Agriculture, Pêcheries et Alimentation Québec

Other sectors

- Banque Nationale
- Lowe's Canada
- Environnement Canada
- Hydro Québec
- RioTinto Alcan
- GARDN
- Bell
- Pratt & Whitney Canada — A United Technologies Company
- Bell Helicopter — A Textron Company
- Bombardier Aerospace

OUTLINE

Goal and scope



Methodology

LCA results of pork production

Results interpretation

Key messages and next steps

Context and Project Description

What is the PVCRT?

The Pork Value Chain Roundtable (PVCRT) was launched in 2003 and brings together leaders of the Canadian pork industry as well as federal and provincial policy makers. The main goal of the PCVRT is to increase the industry's competitiveness and profitability by sharing ideas and addressing priorities.

Why measure the environmental footprint of Canadian pork?

1. To understand the contribution of the Canadian pork industry to environmental issues: climate change, air and water quality, water and resources availability, and biodiversity
2. To meet the needs of consumers who require more transparency and science-based information, as well as national and provincial targets on impact reduction
3. To build public trust by communicating performance and report progress

What can the results be used for?

- → Identify the main contributors to the environmental footprint of the Canadian pork industry
- → Identify measures and BMPs to reduce the industry's footprint
- → Benchmark the industry's footprint over time and with other protein sources or other production regions/countries

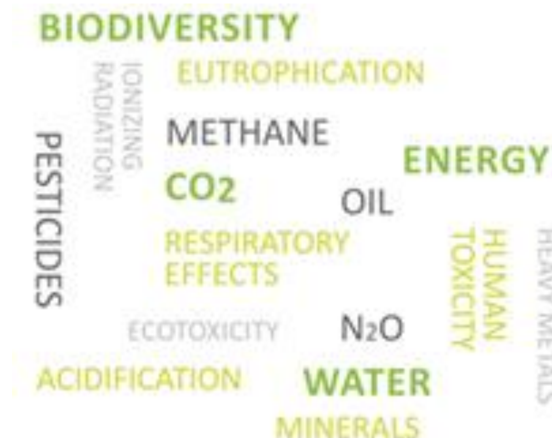
Project Objectives

To provide the Pork Value Chain Roundtable with sustainability facts and figures in order to strategically position the industry

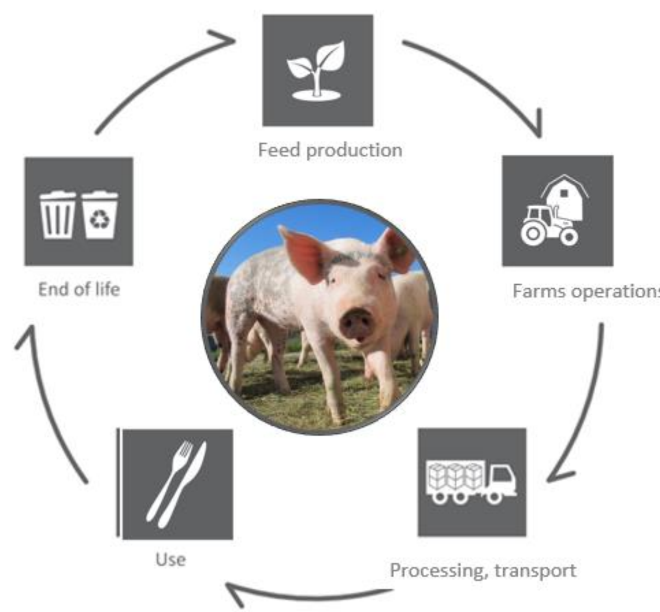
- **Perform a "screening LCA" to identify the environmental hotspots across the Canadian pork value chain**
- **Identify key hotspots (nationally/industry-wide) that require priority attention from the hog industry**
- **Identify areas within the supply chain where improvements could be made**

LCA Methodology

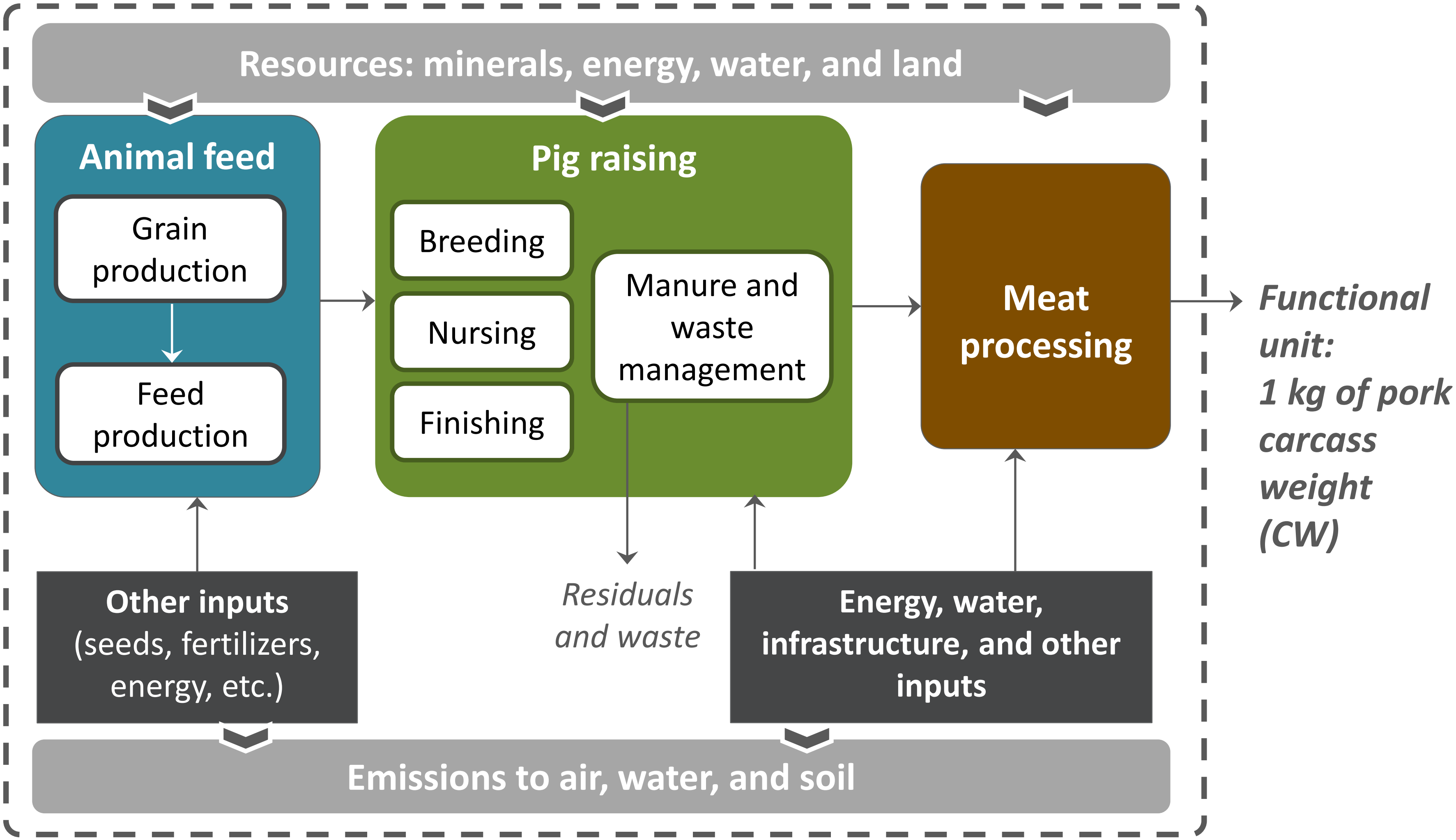
A life cycle assessment (LCA) is a systematic quantitative assessment used by organizations to gauge environmental performance. It is guided by the International Organization for Standardization (ISO 14040/14044) and used to evaluate a broad spectrum of impacts.



An LCA is also the most advanced standardized method to assess and compare claims on the environmental performance of products and services throughout their life cycles. Furthermore, LCAs can be used to identify the relative contributions of life cycle stages, provide opportunities to improve the environmental performances of products at various points in their life cycles, inform decision-making, and support marketing and communication efforts.



SCOPE OF THE STUDY



ENVIRONMENTAL INDICATORS

LCAs can cover a broad range of environmental issues with dozens of different environmental indicators. For this screening LCA, the following four indicators have been selected because they address key areas of concern for the pork industry.

- **Climate change (expressed as kg CO_2 eq.)**

  The climate change impact indicator, or carbon footprint, measures the amount of greenhouse gases emitted in the environment. It is calculated based on the 2013 global warming potential (GWP) factors published by the IPCC in the Fifth Assessment Report (AR5).

- **Water consumption (expressed as L consumed)**

  The water consumption indicator, also known as the “blue water” indicator, measures the sum of all freshwater withdrawals in each watershed minus all water returns to the same watershed. It is expressed in litres of water consumed. The evaluation method is covered by the ISO 14046 standard.

Environmental Indicators

- **Freshwater and marine eutrophication (expressed as kg PO_4 eq. and kg N eq.)**

  The eutrophication indicators are based on the IMPACT World+ LCIA method and measure the potential of nutrient enrichment of the aquatic environment caused mainly by phosphorus and nitrogen compounds in detergents and fertilizers. The freshwater eutrophication indicator is expressed as PO_4 equivalent discharged to water derived from phosphates. Marine eutrophication impacts are expressed as kg N equivalents (N-lime) because nitrogen is the limiting nutrient in marine ecosystems.

- **Freshwater and terrestrial acidification (expressed as kg SO_2 eq.)**

  The acidification indicators are based on the IMPACT World+ LCIA method and measure the sum of air emissions with acidification potential (ammonia, nitrogen oxide, sulphur oxide, etc.) that can affect ecosystems. Both terrestrial and aquatic acidification indicators are expressed in kg of SO_2 equivalents.

Data Sources, Assumptions, and Modelling

Data sources

From previous similar projects

- LCA of pork production in Ontario and Quebec
- LCA of bacon conducted by Maple Leaf Food

Other sources

- National and provincial statistics
- Cost of production studies and Alberta production surveys
- Technical reports and expert consultations
- Ecoinvent life cycle inventory (LCI) database

The most recent data (typically **no older than 2015**) were used. Results are representative of the year **2017**. The model's main parameters for the Canadian average are presented in the Appendix.

Modelling

The parameters correspond to the **pork production weighted average data** from each province, whenever available.

The LCA methodology is in line with the **LEAP guidelines: *Environmental performance of pig supply chains***.

The calculations were performed with the **carbon and water footprint calculator** developed for **Les Éleveurs de porcs du Québec**.

Model Assumptions

- **Provincial parameters:** Due to a lack of data specific for Western provinces, the LCA of bacon conducted by Maple Leaf Food is used to quantify some parameters for Western Canada. Similarly, the Quebec dataset is used to model a number of parameters in the Ontario model.
- **Feed modelling:** Corn, wheat, oat, barley, and soybean meal are modelled with datasets from the ecoinvent LCI database. Canadian national statistics on merchandise trade are used to determine the origin of the feed. For grains produced in the US, the irrigation data at the state level are taken from the USDA LCA commons project (as reported in the Agri-Footprint LCI database).
- **Manure application:** Manure is considered as a residual product since a majority of producers pay to dispose of the swine manure produced at the farm. This implies that the emissions from the use of swine manure as organic fertilizers are not included in the climate change results. These emissions are rather assigned to the crop production system which uses the manure. Nevertheless, these emissions were calculated in a sensitivity analysis presented in the results section.
- **Slaughtering data:** Based on an average of different primary and secondary sources, including the Maple Leaf's LCA study and an ecoinvent dataset regionalized for the energy mix and water consumption.
- **Impact results scale-up:** Results are presented per kilogram of pork carcass weight. Approximately 6 million of the total of 27 million hogs produced in Canada are slaughtered in the United States. However, when scaled to the entire country, the results are calculated assuming that all of the 27 million hogs produced in Canada are slaughtered in Canada. It is therefore assumed that the impacts of slaughtering per kilogram of carcass weight in the United States are similar to those in Canada.

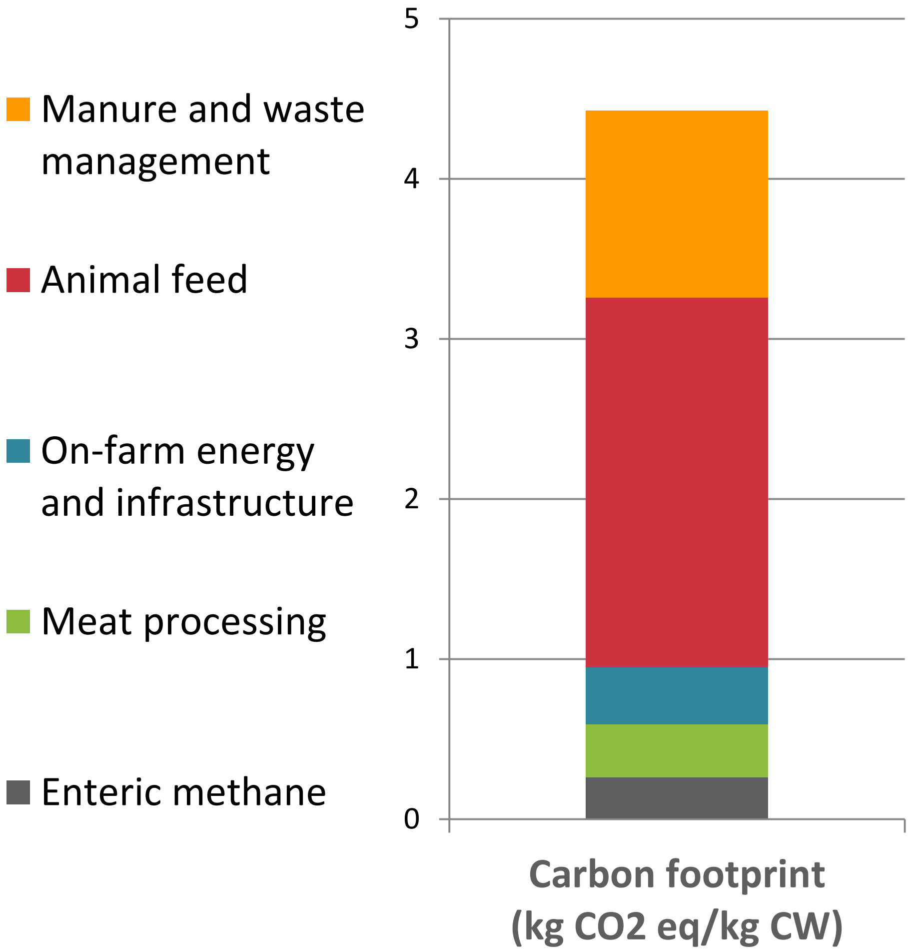
3. LCA Results of Canadian Pork

LCA Results of Canadian Pork (2017)

Carbon Footprint

Carbon Footprint of Canadian Pork

The production of **1 kg of Canadian pork (carcass weight) after primary processing** produces **4.43 kg CO_2 eq**.



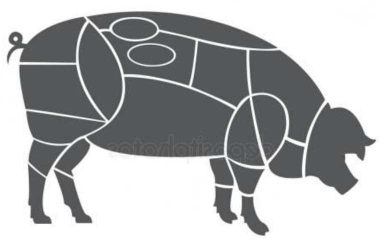
Manure management (26%)
—Methane and nitrous oxide emissions (direct and indirect) caused by the storage and treatment of manure.

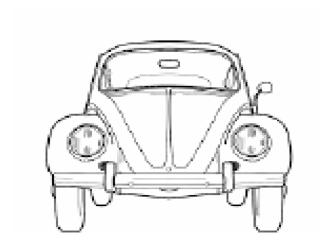
Feed production (52%)
—The environmental impacts related to the feed production stage are sensitive to the composition of the pork diet and the quantity of feed intake.
—Corn is the main contributor to climate change impacts.

Other contributors (21%)
—Include enteric methane, meat processing, on-farm energy use, and infrastructure.

Carbon Footprint of Canadian Pork Equivalencies

4.43 kg CO_2 eq. per kilogram of carcass weight <-----> **17 km by car**

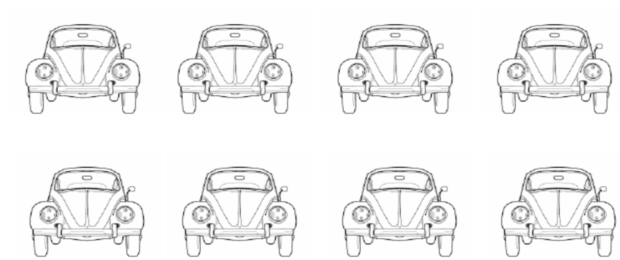




In 2017, the total production of pork in Canada generated:

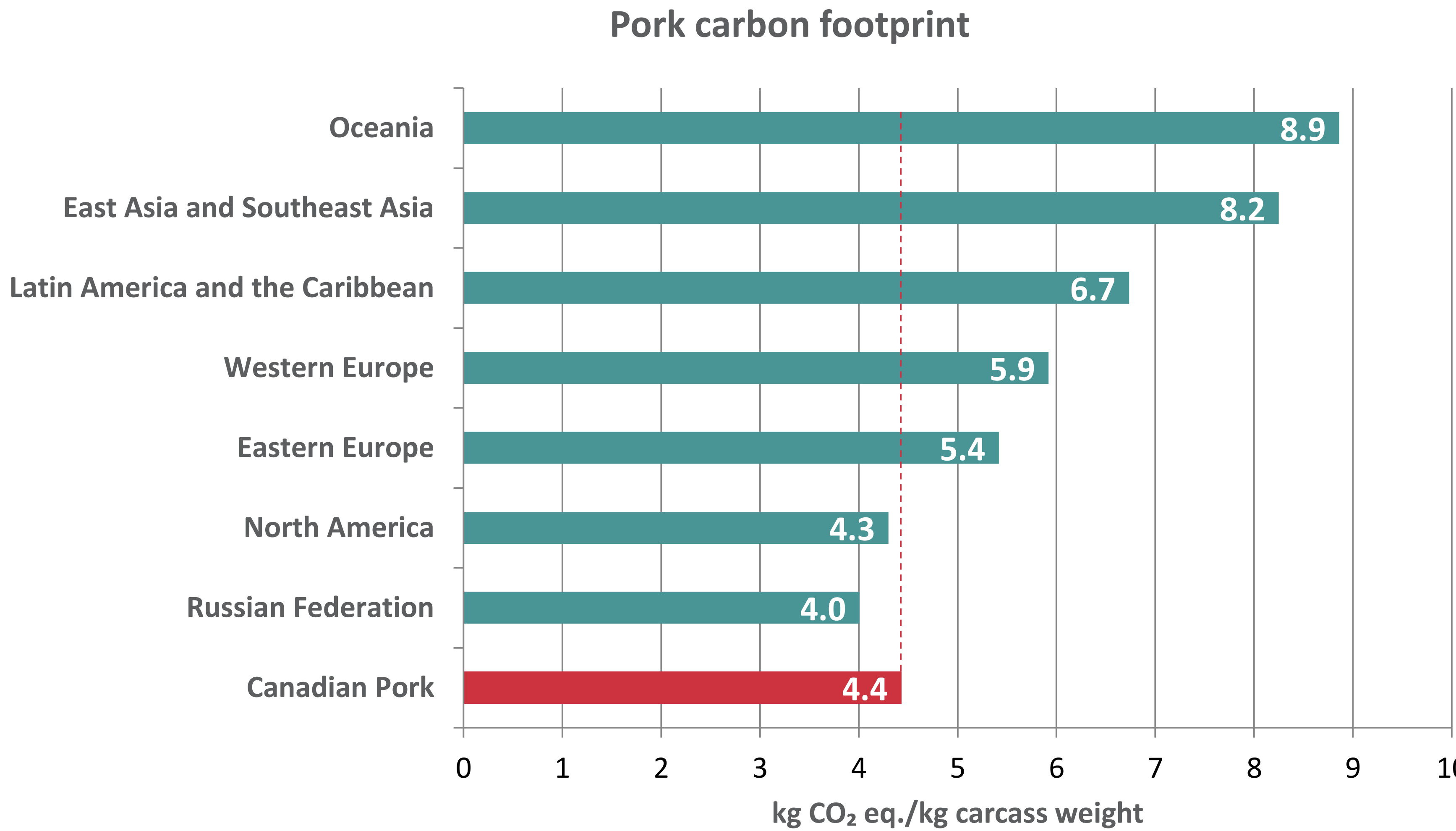
11.6 million tonnes of CO_2 eq.**
Or 1.6% of total Canadian emissions
(NIR, 2016)

<-----> **2.5 million vehicles per year**



**Results for Canada include pork slaughtered in the United States (corresponding to approximately 6 million of the total of 27 million hogs produced in Canada. It is therefore assumed that the impacts per kilogram of carcass weight of slaughtering in the United States are comparable to those in Canada. The actual quantity of GHG emissions generated on Canadian territory is therefore smaller.

Carbon Footprint International Benchmark



Source: FAO. 2017. Global Livestock Environmental Assessment Model (GLEAM) [online]. Rome. www.fao.org/gleam/en/

Carbon Footprint International Benchmark

When considering other international carbon footprint studies of pork production for industrial systems only, Canada remains one of the least impacting sources of pork meat.

The average carbon footprint for Canadian pork is slightly higher than the average North American emissions measured in GLEAM, one of the world regions with the lowest carbon footprint.

However, due to the uncertainty of LCA results and the variability between the data and assumptions used in this study and GLEAM, it is not possible to conclude on the environmental superiority between Canada, North America, and the Russian federation regions.

A closer look at the results for other world regions indicates that one of the main contributors is the use of soybean and palm oil by-products in the pork feed ration. The production of both of these ingredients is often associated with deforestation that generates large land-use change emissions.

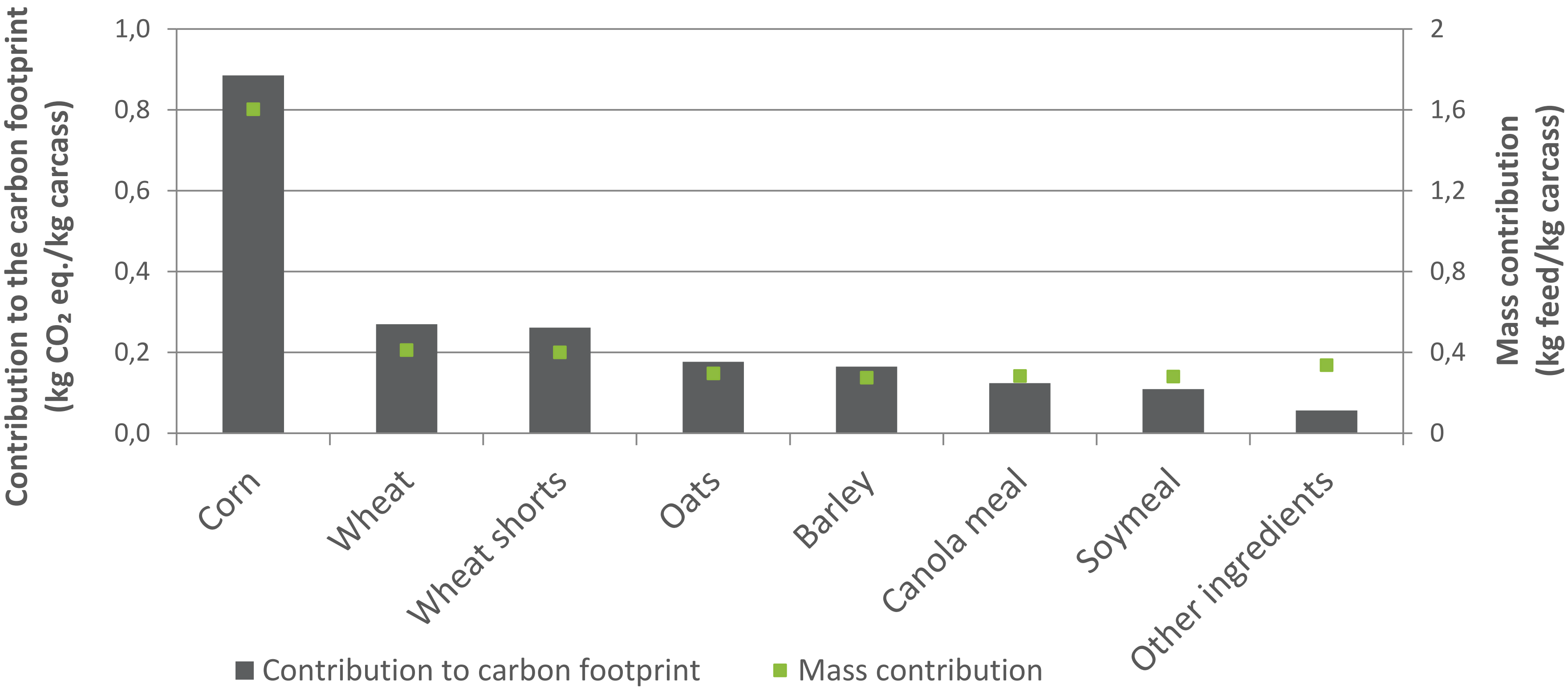
These ingredients produced in Latin America or Southeast Asia are used locally or exported in Europe, Asia, and Oceania. North America, including Canada, is not a significant importer of these ingredients for the production of animal feed.

Based on these observations, it can be stated that Canadian pork has a significantly lower carbon footprint than European, Asian, and Oceanian pork.

Contribution Analysis

Feed production

With a contribution of 52% to the total carbon footprint, feed production is the most significant stage contributor in the life cycle of pork production. The figure below shows the climate change impact generated from the production of 1 kg of each ingredient in the pork's diet formulation as well as the mass contribution of each ingredient.



Feed production

On average, corn is the main crop used in the feed composition of Canadian pork and accounts for approximately 43% of the climate change impacts of feed production. GHG emissions from grain production are mainly caused by fertilizer use as well as diesel consumption and seed production.

Ingredients such as canola meal and soymeal have higher mass contributions to the pork's diet formulation than their contribution to the carbon footprint of feed production. Ingredients that are coproducts or by-products of other industries (such as vegetable oil production) tend to have a smaller footprint. This is explained by the fact that the environmental footprint of grain production is divided between the different products.

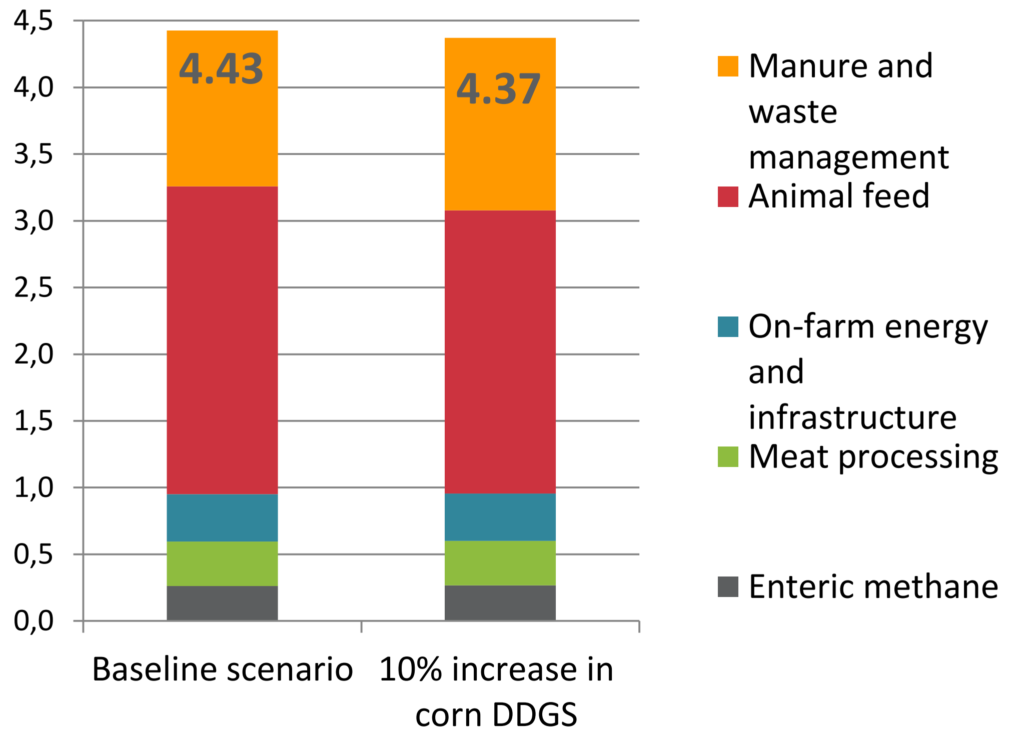
This implies that increasing the quantities of these types of ingredient fed to pork could reduce the environmental impacts related to feed production.

→ A sensitivity analysis was carried out to evaluate the influence of changing the feed ration formulation on the pork production footprint.

Sensitivity analysis: change in ration formulation

Prices for cereal grains have increased in recent years as a result of the expanding ethanol industry. The use of **corn dried distillers' grains with solubles (DDGS)** in commercial pork feed formulation has allowed to reduce diet costs associated with corn and soymeal. Thanks to its high content in energy, digestible amino acids, and phosphorous, corn DDGS can be used as a replacement for corn and soymeal.

A new average ration was modelled with a 10% increase in corn DDGS and a 5% reduction in soymeal and corn.



Sensitivity analysis: change in ration formulation

The analysis results indicate that replacing 5% of the corn and the soymeal with corn DDGS reduced the climate change impacts of the feed production stage by 8%. This translates into an overall **carbon footprint reduction of 1.25%**.

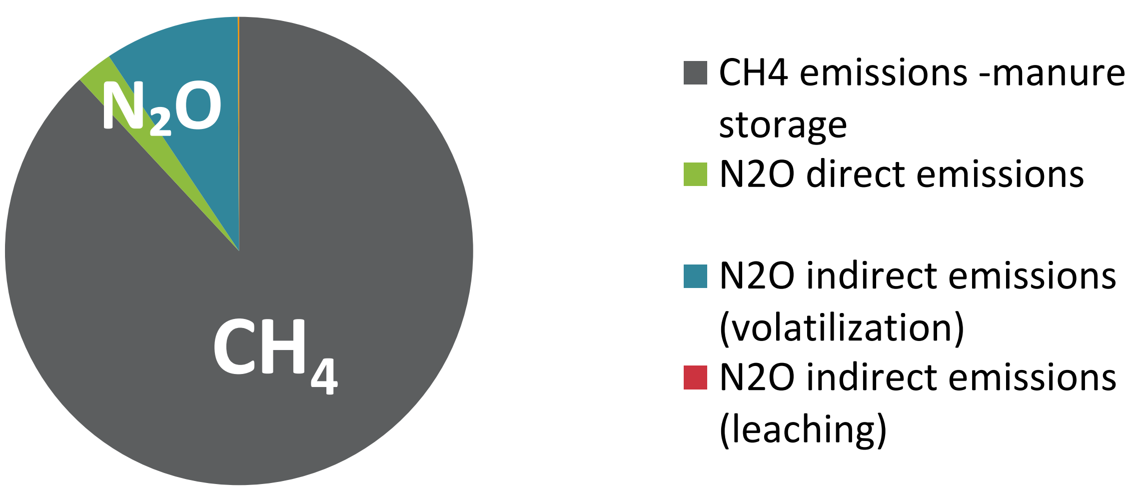
The impact reduction can be explained by the fact that corn DDGS is, on a mass basis, about 15 times less impactful that corn production.

Nevertheless, because of its higher nitrogen content, increasing the proportion of corn DDGS in the ration formulation increases N_2O emissions, leading to an 11% increase in GHG emissions from the manure management stage. Given the interactions between the type of feed consumed and the manure emissions, this highlights the importance of using LCAs as a tool to assess the contribution and interaction of complex issues related to the life cycle of pork production.

Manure management

The manure management stage is the second greatest contributor to the overall impacts on climate change, representing 26% of the carbon footprint. The methane emissions produced in the manure pit account for the bulk of GHG emissions from manure management. Dinitrogen oxide is the second main contributor. Manure application on crop fields is not included in the analysis. The impact from manure transport is negligible.

The manure emissions are calculated based on the assumption that 97% of hog manure in Canada is managed using a liquid manure management system.



Sensitivity analysis: emissions from manure application

Based on the data available and communications with experts, a majority of producers pay to dispose of the swine manure produced at the farm. They may also receive payment for its nutrient value; however, this is insufficient to offset the disposal costs. Given this, manure is modelled as a **residual product**. This implies that the producer does not receive an environmental credit for the displacement of synthetic fertilizers from the use of manure. The emissions related to the use of swine manure as an organic fertilizer for crop production are not included in the climate change results. Instead, these emissions are assigned to the crop production system which uses the manure.

However, the manure is considered **waste** in cases where producers get no revenue at all from it, implying that emissions related to its use as an organic fertilizer would need to be accounted for.

A sensitivity analysis was conducted to evaluate the impact of including the emissions related to manure application on the climate change results.

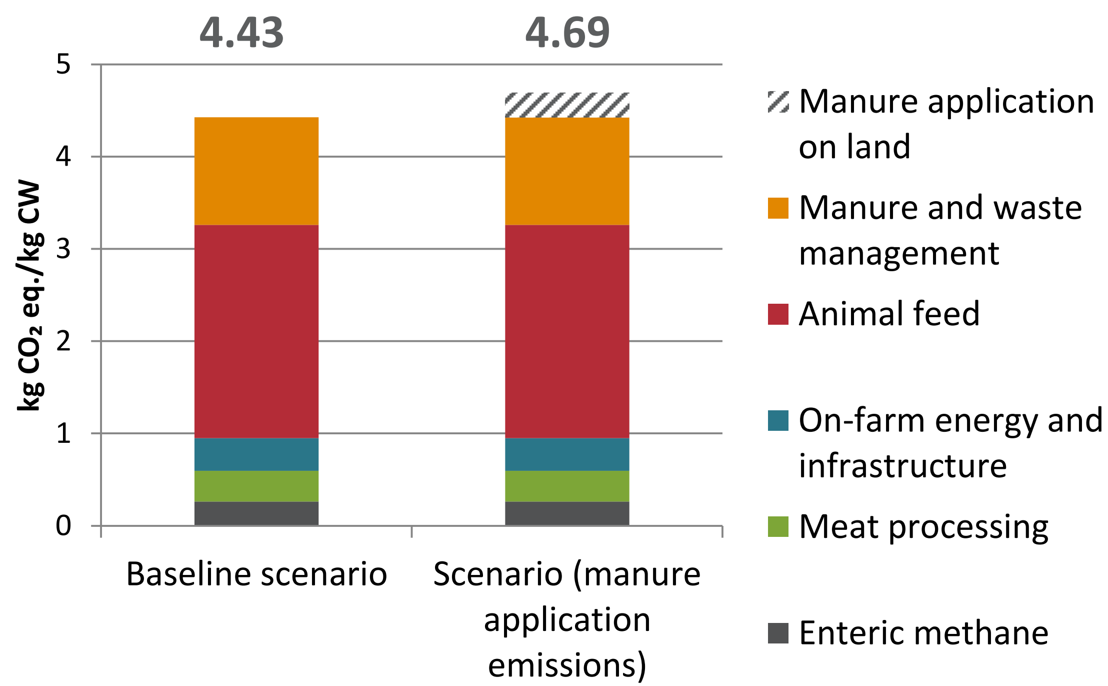
Sensitivity Analysis

Sensitivity analysis: emissions from manure application

Emissions from manure application include the use of machines to spread the manure and the direct air emissions from manure deposited on the crop fields. These emissions include ammonia (NH_3), nitrogen oxides (NO_x) and dinitrogen monoxide (N_2O) that contribute directly or indirectly to global warming. Emissions were calculated based on an average nitrogen loss rate of 16% for Canada. This loss rate was calculated based on the types of application used in each province.

The figure shows the climate change results compared with the baseline scenario.

The inclusion of emissions related to manure application increases the climate change impacts by 6%.



Sensitivity analysis: emissions from manure application

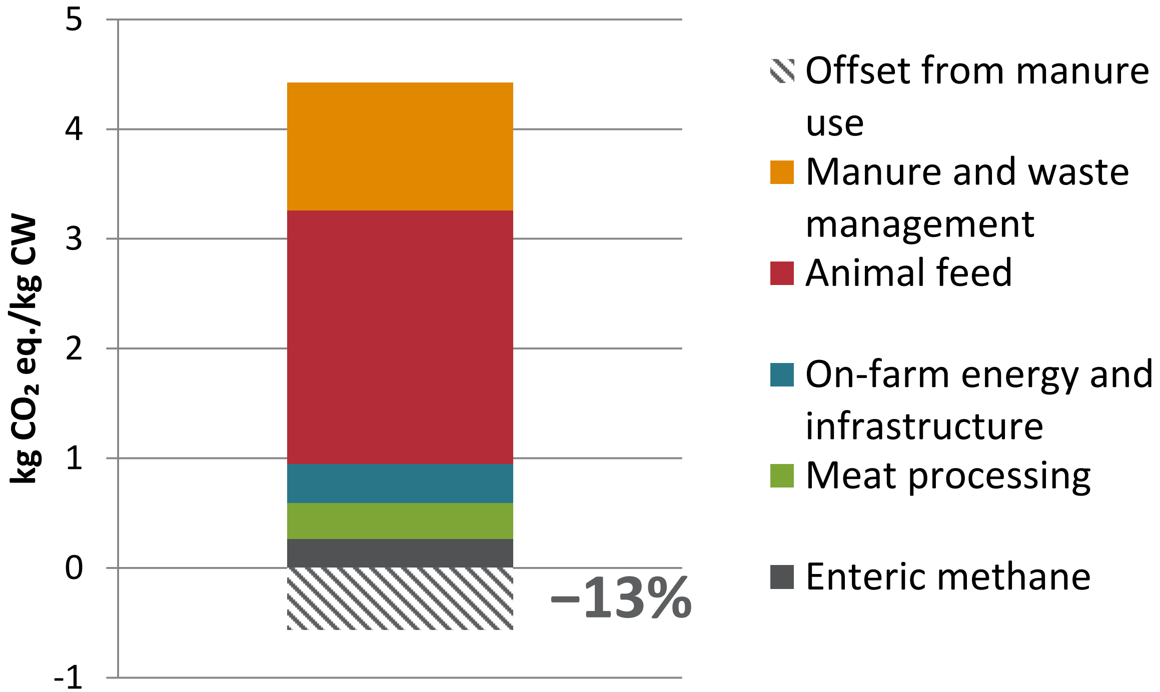
However, the swine manure is not only a source of impacts, it is also a valuable by-product that can be used to fertilize crops and offset the use of synthetic fertilizers.

A net benefit or credit was quantified by calculating the emissions associated with the application and production of an equivalent quantity of synthetic fertilizer and subtracting the emissions associated with the application of the manure. The benefit corresponds to the difference between the emissions avoided from synthetic fertilizers (from use and production) and the emissions produced from fertilizing with the surplus manure.

For this sensitivity analysis, an optimistic efficiency factor of 100% was used to estimate the maximum potential manure use. This means that the NPK content of manure offsets an equivalent NPK content provided by an average mix of synthetic fertilizers.

Sensitivity analysis: emissions from manure application

As seen in the figure below, it was estimated that the benefits associated with the use of manure are equivalent to **13%** of the carbon footprint of pork production in Canada. The analysis highlights the environmental relevance of promoting practices that increase manure use efficiency, whether it is used on the farm, sold, or given to other users.



Contribution Analysis — Other Contributors

On-farm energy use

- → On-farm energy use accounts for 8% of overall GHG emissions and includes the energy used on the farm to power ventilation, lighting, heating, and mechanical machinery.
- → The quantity of energy consumed, the type of heating fuel used, and the provincial electricity grid mix have a direct impact on the carbon footprint of Canadian hog farms.
- → Fuel consumption for farm heating drives the impact of the climate change indicator due to the GHG emissions from fossil-fuel combustion, including natural gas and propane.

Enteric methane

- → Enteric methane emissions represent 6% of overall GHG emissions of Canadian production. Enteric methane is produced from enteric fermentation of the food ingested in the animal's digestive tract or rumen. However, contrary to sheep and cows, hogs do not produce significant enteric emissions.

CONTRIBUTION ANALYSIS — OTHER CONTRIBUTORS

Slaughtering

→ The slaughtering stage represents 8% of the carbon footprint and includes hog transportation between the farm and the primary meat processing plant (with an average distance of 50 km).

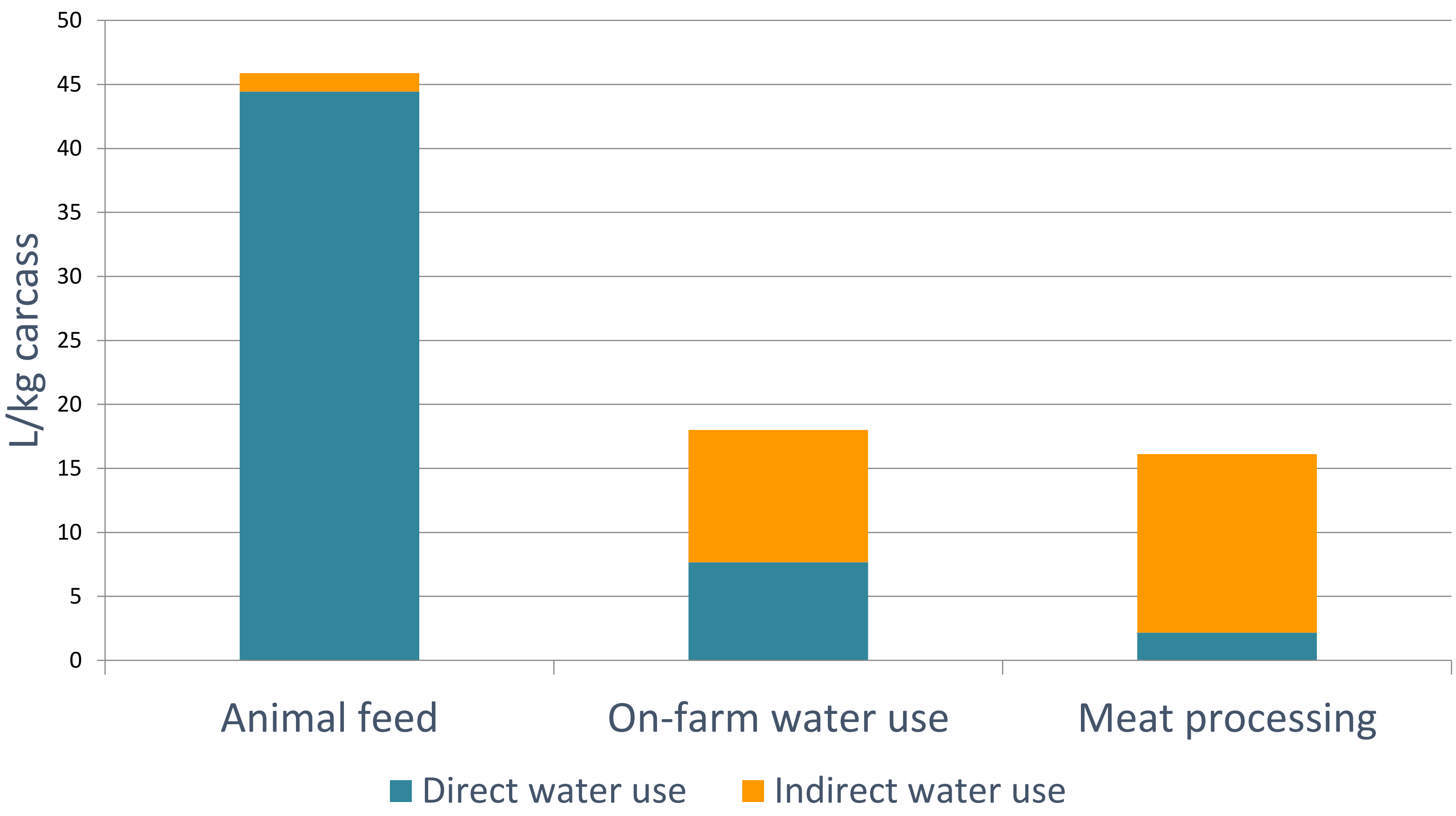
→ The main contributors at the slaughtering stage are the consumption of natural gas to heat the processing plant as well as the production of plastic packaging materials.

LCA Results of Canadian Pork (2017)

Water Consumption

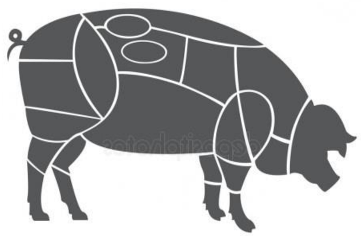
WATER CONSUMPTION OF CANADIAN PORK

The production of **1 kg of Canadian pork (carcass weight) after primary processing** consumes **80 L of freshwater**.



Water Consumption of Canadian Pork Equivalencies

80 L of water per kilogram of carcass weight



8 minutes of shower

In 2017, the total production of pork in Canada generated:

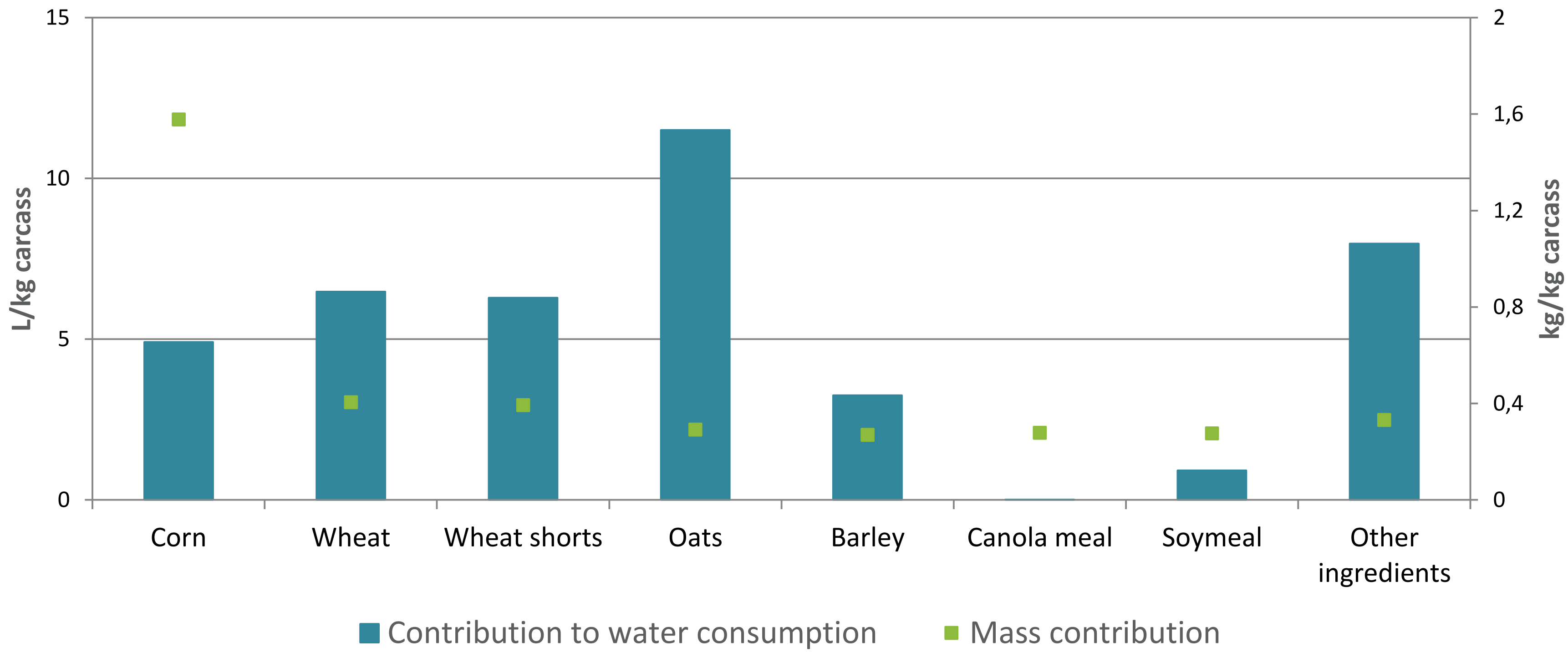
222 million m³ of water**

This corresponds to 0.017% of the total freshwater yield in Southern Canada

**Results for Canada include pork slaughtered in the United States (corresponding to approximately 6 million of the total of 27 million hogs produced in Canada. It is therefore assumed that the impacts per kilogram of carcass weight of slaughtering in the United States are comparable to those in Canada. The actual quantity of water consumed in Canada would therefore be smaller.

Feed production

With a contribution of 57% to the total water use of pork production, feed production is the most significant stage contributor in the life cycle of pork production. The figure below shows the water consumed for the production of 1 kg of each ingredient in the pork's diet formulation as well as the mass contribution of each ingredient.



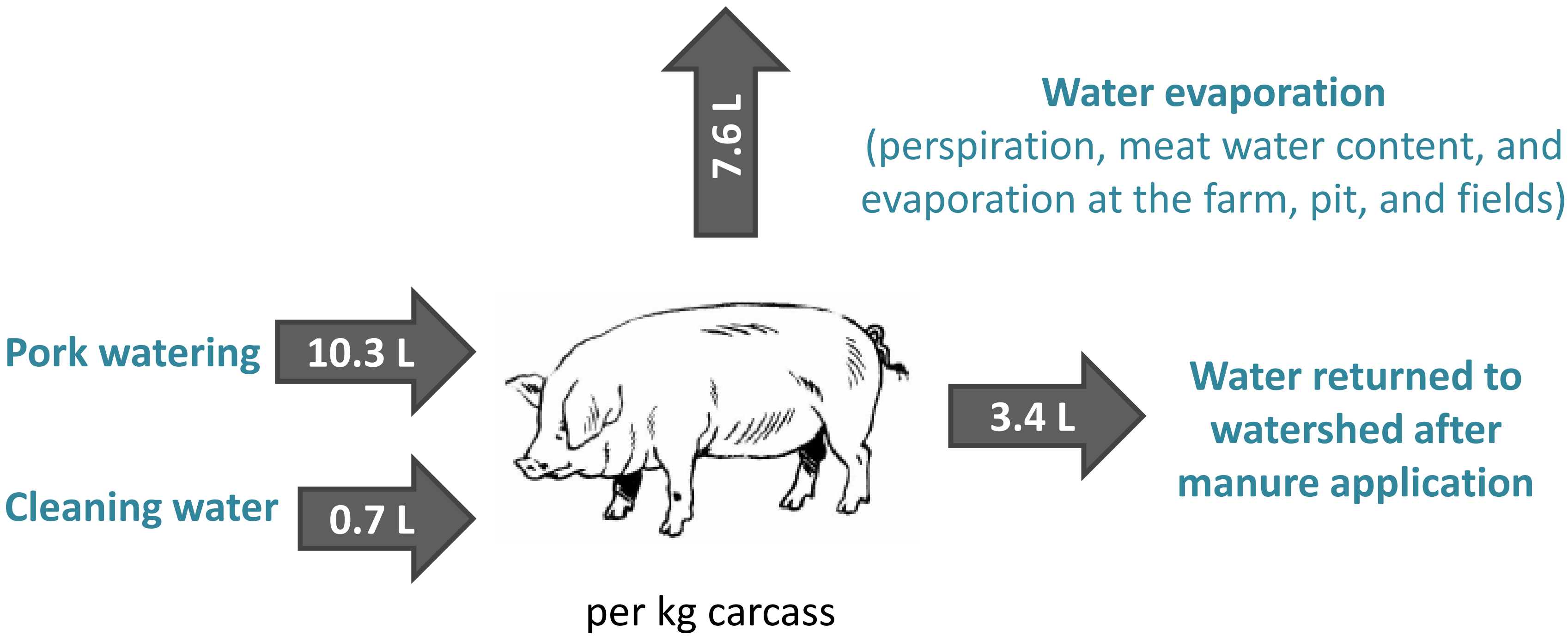
On-farm water use

- The water consumed at hog farms contributes to a significant portion of the life cycle of pork production, with a contribution of 23% of the total water footprint, part coming from direct uses at the barn (42%) and the other part consumed indirectly to produce electricity (58%).
- Most of the water consumed directly at the farm is used for hogs (91%) and for barn cleaning (9%).
- Indirect uses include water used for electricity production. Water consumption associated with energy use is mainly explained by the evaporation of water in dams used for the production of hydroelectricity as well as the evaporation of cooling water in thermo-electric power plant.

Contribution Analysis

On-farm direct water use balance

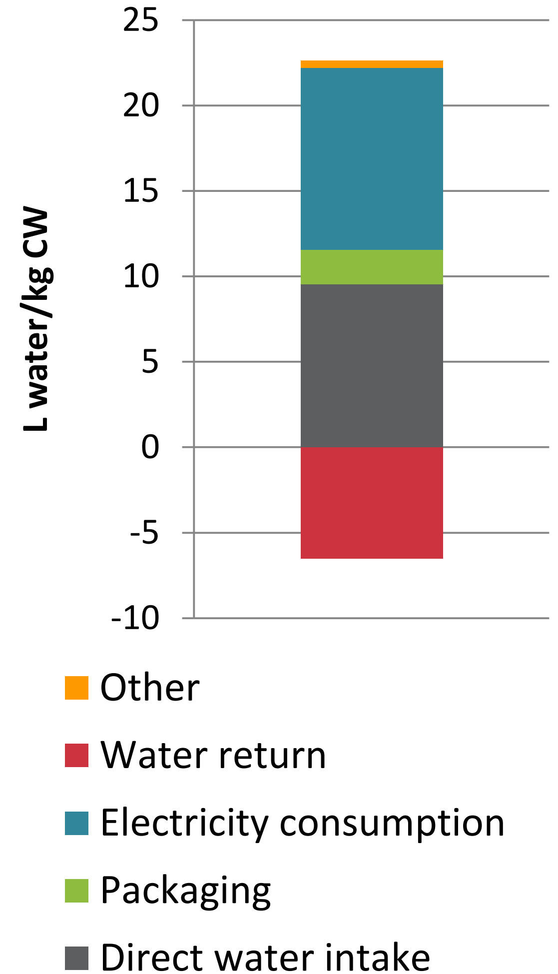
- About 70% of the direct water used at farms is not returned to the watershed. The water is either sweat, captured in the animal (meat water content), or evaporates from the barn, manure pit, or after manure application in the field.



Contribution Analysis

Slaughtering

- The water consumed at the primary processing stage contributes to a non-negligible portion of the life cycle of pork production, with a contribution of 20% of the total water footprint.
- Direct water uses include process water as direct water intake, and indirect uses include water consumed for electricity and packaging production.
- Of the water consumed directly at the processing facility, 68% is returned to the watershed.
- Water consumption associated with energy use is mainly explained by the evaporation of water in dams used for the production of hydroelectricity as well as the evaporation of cooling water in thermo-electric power plant.

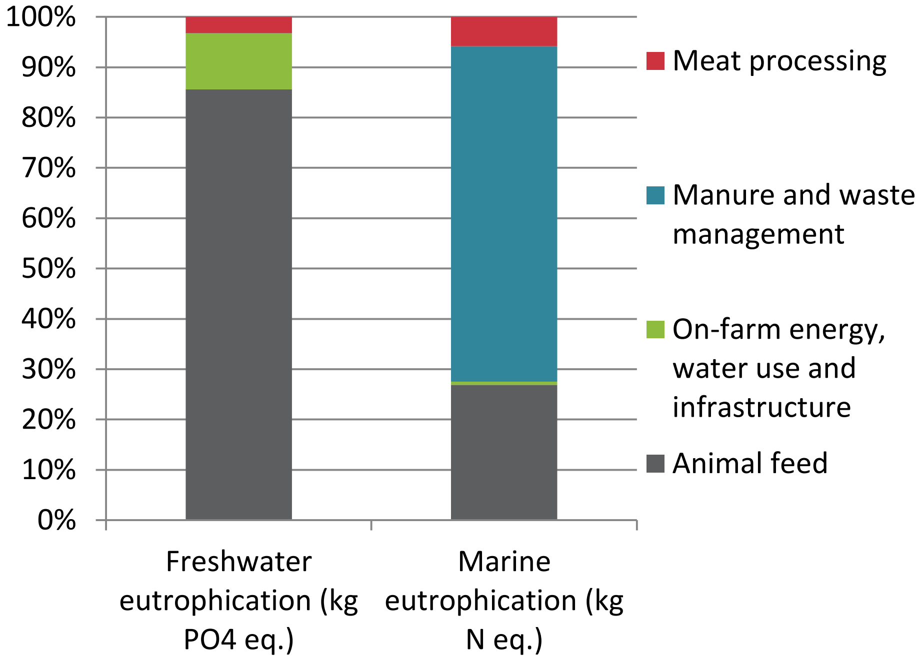


LCA Results of Canadian Pork (2017)

Eutrophication and Acidification

Eutrophication Impacts of Canadian Pork

The production of **1 kg of Canadian pork (carcass weight) after primary processing** generates **0.0048 kg PO_4 eq.** and **0.0033 kg N eq.** in freshwater and marine ecosystems, respectively.



The eutrophication indicators measure the potential of nutrient enrichment of aquatic environments. **Freshwater eutrophication** measures impacts caused by **phosphorus** emissions, while **marine eutrophication** measures the impacts caused by **nitrogen** emissions.

Feed production

Freshwater eutrophication impacts are mainly caused by feed production due to phosphate and phosphorous emissions from the phosphorous-based fertilizers applied on grain crops.

Manure management

Marine eutrophication impacts are mainly explained from ammonia emissions generated from nitrogen volatilization.

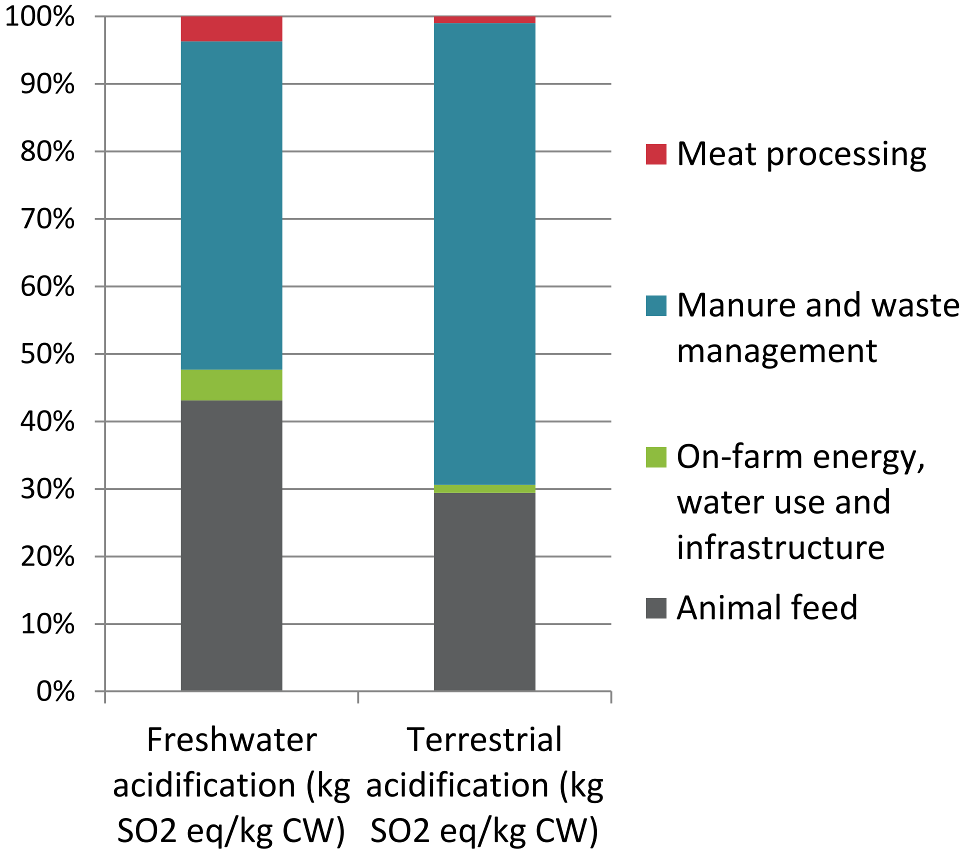
The contribution of other life stages to eutrophication impacts is not significant.

Eutrophication Impacts of Canadian Pork

- Based on the impact characterization models from IMPACT World+ used in this study, it is assumed that eutrophication in freshwater and marine ecosystems is limited by phosphorus and nitrogen, respectively. In other words, only phosphorus compounds are assumed to contribute to freshwater eutrophication, while only nitrogen compounds are considered in the assessment of marine eutrophication.
- It is important to remember that manure is considered as a residual material in this study and that the impact of using manure as a fertilizer is allocated to the production of crops and not the production of pork.
- If manure was considered as waste and the losses of phosphorus and nitrogen compounds were allocated to pork production, freshwater and marine eutrophication impacts would increase by 30% and 9%, respectively.
- Several best management practices (BMP), such as erosion control measures and a nutrient management plan that takes into account the sources of nutrients, the rate, the time, as well as the place of application, can limit the eutrophication impacts.
- The modelling of nitrogen and phosphorous emissions is complex and requires specific information about the field topography, soil characteristics, and farmers' practices. In the context of a Canadian-wide LCA, such specific data are not available, and the model relies on generic assumptions and factors.

Acidification Impacts of Canadian Pork

The production of **1 kg of Canadian pork (carcass weight) after primary processing** generates **0.023 kg SO_2 eq.** and **0.094 kg SO_2 eq.** in freshwater and terrestrial ecosystems, respectively.



The **manure management stage** is the main contributor to acidification impacts due to ammonia emissions generated from nitrogen volatilization.

The **feed production stage** is another significant contributor due to sulphur dioxide, ammonia, and NO_X emissions caused by fertilizer application and production, as well as emissions from diesel combustion in agricultural equipment for feed crop production.

The contribution of other life stages to acidification impacts is not significant.

ACIDIFICATION IMPACTS OF CANADIAN PORK

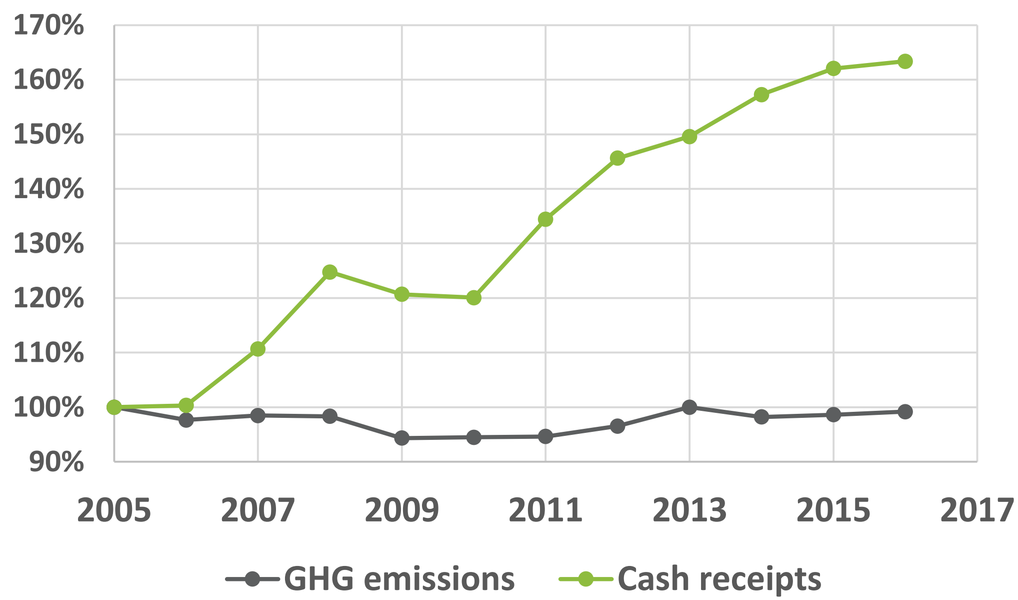
- Although the same unit is used for both acidification indicators, their relative contribution to damages on ecosystems cannot be compared directly due to differences between the impact characterization model behind each indicator.
- Acidification can negatively affect freshwater and terrestrial ecosystems due to the deposition of atmospheric pollution released by activities involved directly or indirectly within the life cycle stages of pork production.
- Again, manure is considered as a residual material in this study, and the impact of using manure as a fertilizer is allocated to the production of crops and not the production of pork. If manure was considered as a waste, the freshwater and terrestrial acidification scores would increase by 7% and 9%, respectively, due to losses of nitrogen compounds from spreading manure on agricultural soils.

4. Results Interpretation

Meeting Canada's GHG Reduction Targets

For the Canadian agricultural sector, GHG emissions have increased by 17% over the last 25 years, from 60.1 MT of CO_2 eq. in 1990 to 72.8 MT of CO_2 eq. in 2015. GHG emissions have remained relatively stable since 2005[1].

When evaluating the production revenues of the agricultural sector, the agricultural sector has become increasingly efficient in terms of GHG emissions per $ of cash receipt. Indeed, as seen in the following figure, the GHG emissions intensity has decreased by 40% from 2.0 kg CO_2 eq./$ of farm cash receipt in 2005 to 1.2 kg CO_2 eq./$ of farm cash receipt in 2016.



[1]https://unfccc.int/files/national_reports/national_communications_and_biennial_reports/application/pdf/82051493_canada-nc7-br3-1-5108_eccc_can7thncomm3rdbi-report_en_04_web.pdf

MEETING CANADA'S GHG REDUCTION TARGETS

Canada's target for 2030 is to reduce GHG emissions by 30% compared to the 2005 levels.

For the agricultural sector only, the current plan assumes that emissions should stay stable between 2015 and 2030. However, at the national level, with the current measures of reduction announced, the plan is still short of 66 million CO_2 eq. (about 9% of the 2016 emissions level). In this context, it can be anticipated that an additional effort will be required from all sectors of the economy.

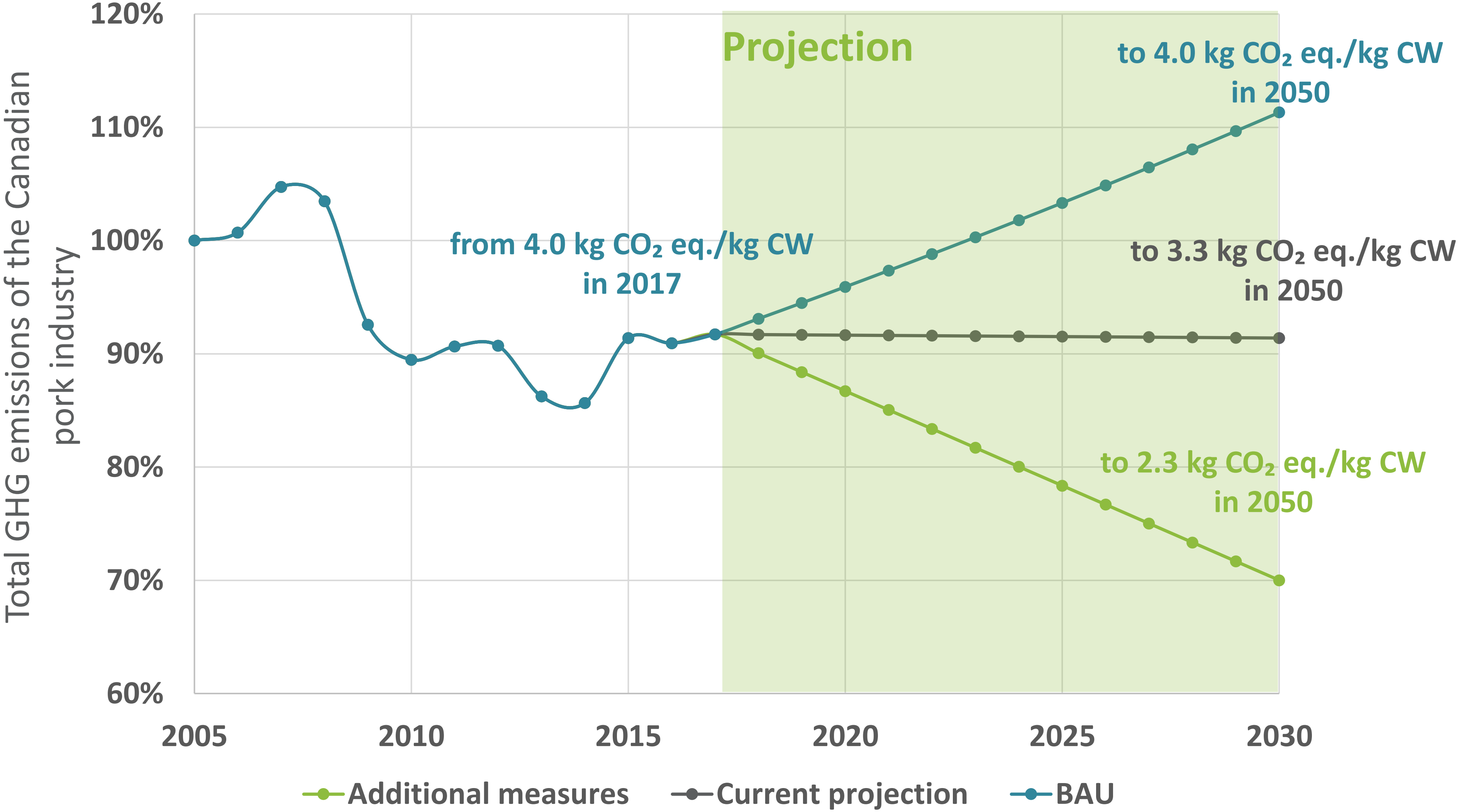
With the current projection, all additional emissions from the production growth of the pork industry will have to be completely offset by gain in GHG efficiency of the industry.

To illustrate the impact and challenge for the pork industry, the result of three projections are presented on the figure on the next page:

- **Business as usual (BAU):** The industry does not achieve any GHG efficiency gain by 2030. Production grows.
- **Current projection:** The GHG emissions of the pork industry follow the Canada's current projection for the agricultural sector, and the emissions stay flat between 2016 and 2030.
- **Additional measures:** Additional effort is required from the agricultural sector, and the global target of GHG reduction (30% less GHG emissions between 2005 and 2030) is applied to the pork industry.

Each scenario assumes that the pork production in Canada will grow at the average rate of 1.5% per year, from 2.74 in 2005 to 3.37 million tonnes of CW in 2030. Also, only the cradle-to-farm gate results are considered for this analysis (4 kg CO_2 eq./kg CW).

Meeting Canada's GHG Reduction Targets



MEETING CANADA'S GHG REDUCTION TARGETS

Results show that to follow the current GHG emission projection for the agricultural sector while ensuring a certain level of growth, the pork industry must decrease its GHG emissions intensity (per kg CW) by 26% in the next 13 years (from 4.0 to 3.3 kg CO_2 eq./kg CW).

In the context of increasing pressure on the government to do more to fight climate change and barrage of criticism on the meat industry in general, the current projection may not be enough to protect the public trust of the Canadian pork industry. In this context, a more aggressive emission reduction scenario is tested where the pork industry applies the average Canadian GHG reduction target (−30%). In this case, the emissions intensity reduction per kg CW must reach 43% by 2050.

On the other side, no gain in GHG efficiency would mean that by 2023, the industry would produce the same amount of GHG emissions than in 2005. By 2030, the sector would produce 11% more emissions than 25 years ago.

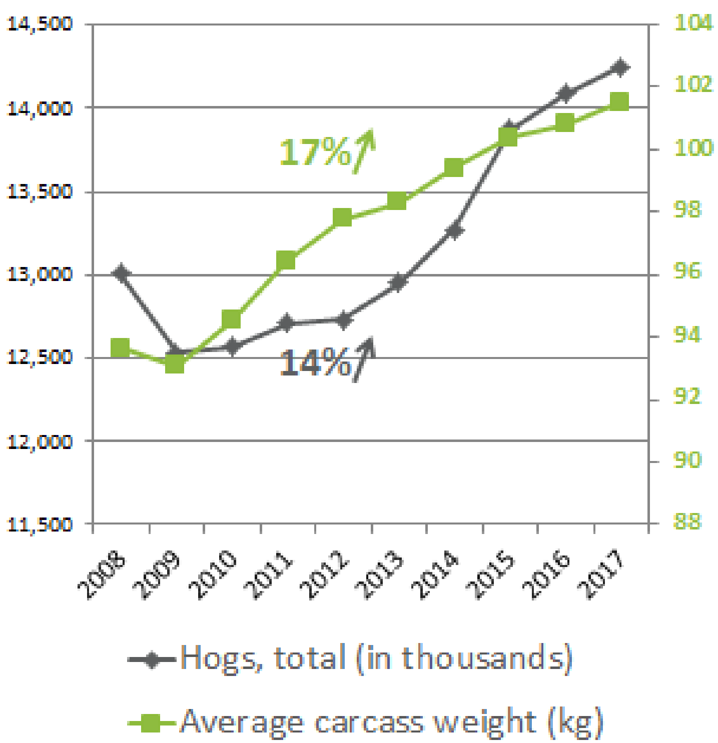
The next pages explore the measures and actions that could help the pork industry achieve either the current projection or a more ambitious target.

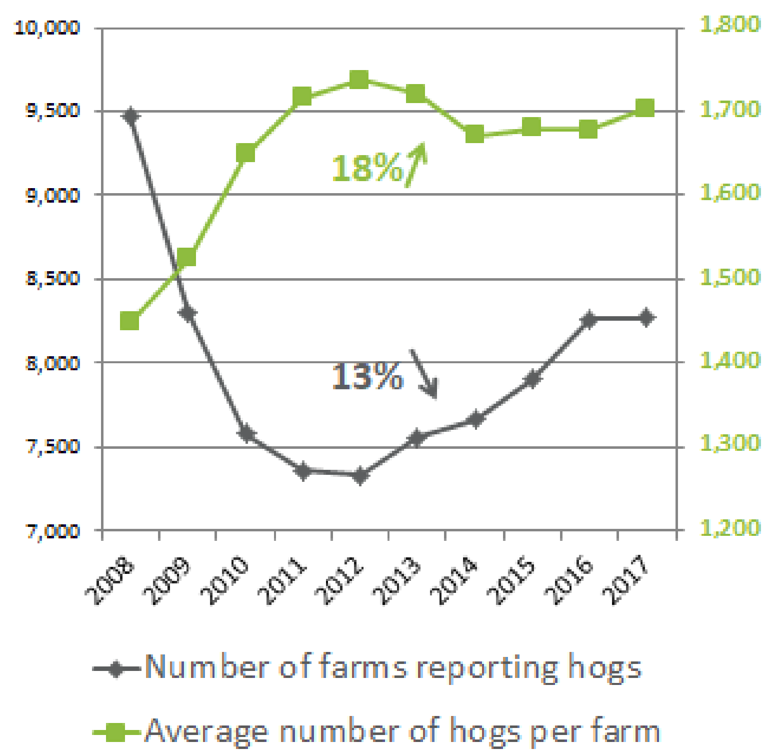
Two visions are presented here:

- **Incremental improvements** consist of an approach to regroup a series of measures and actions to minimize the impact of the current practices and activities.
- **Transformational change** is an approach to more radically change the vision of the industry to create and capture unforeseen opportunities.

INCREMENTAL IMPROVEMENTS: EVOLUTION OF THE PORK INDUSTRY

One efficient and cost-effective approach to reduce GHG emissions is to continue to improve the productivity of pork production. Lower mortality rates, higher feed efficiency, and heavier market weights contribute to reducing the amount of resources and emissions required to produce the same amount of pork. The consolidation of hog operation and the increased productivity of pork production, as seen in the bottom figures, is good news to the industry.





Incremental Improvements: Higher Productivity

The average Canadian farm now produces a higher number of pork that are heavier. This implies a more efficient use of energy and resources at the farm.

Production consolidation and potential implications for the environmental footprint of pork production:

Higher carcass weights, smaller feed conversion ratio, and larger farms	➡	↓ environmental impacts per kilogram of pork carcass
Higher number of hogs per farm	➡	↓ on-farm energy and material inputs per hog head
Smaller number of farms	➡	↓ overall transport along the supply chain (potentially)

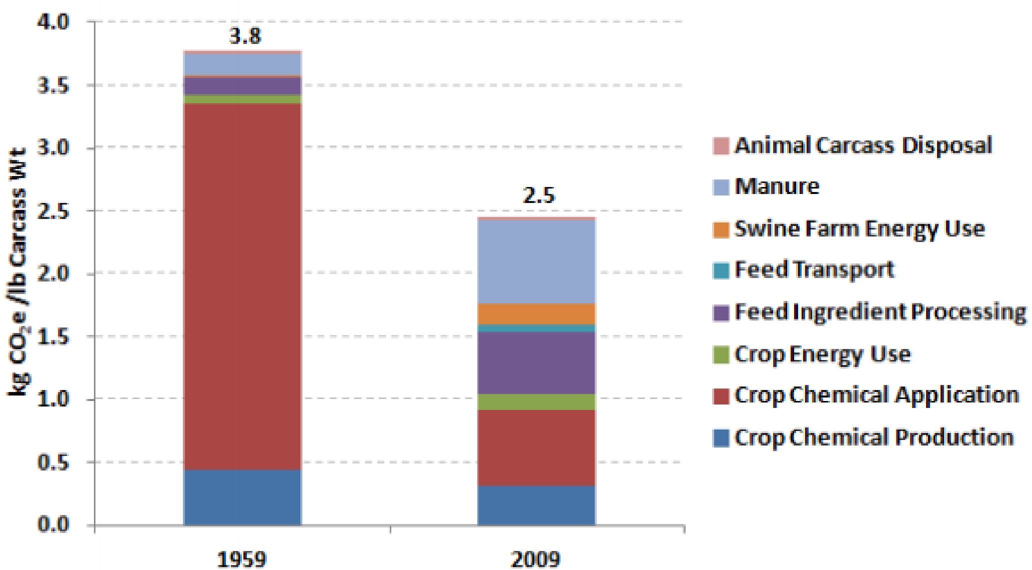
Other LCA studies on pork production have looked more closely at environmental impact reductions of the pork production system through gains in productivity and improved use of resources.

Incremental Improvements: Higher Productivity

The LCA study carried out by the National Pork Board LCA study (US Swine industry) is a good illustration of the impact of the productivity gain of the industry on it is GHG emissions:

- The study assessed the carbon footprint of US pork production between 1959 and 2009.
- The carbon footprint intensity decreased by 34% during this 50-year period, or about 0.8% per year.
- Improved efficiency and higher productivity are key factors for carbon footprint reduction.
- For that period, the number of hogs has increased by 29% from a breeding herd that is 39% smaller, dress carcass yields have almost doubled, and feed efficiency has improved by 33%.

Figure 8: U.S. Swine Industry Carbon Footprint (CO_2e) per Pound of Hot Dressed Carcass Weight



Source: https://www.pork.org/research/a-50-year-comparison-of-the-carbon-footprint-and-resource-use-of-the-us-swine-herd-1959-2009/

Incremental Improvements: Best Management Practices

In addition to continuous productivity gains, the industry will have to increase the rate of improvement of its GHG efficiency to comply with national commitment on GHG emissions reduction while providing additional room for growth.

This can be done through the adoption of best management practices throughout the pork value chain.

The next pages present a list of examples of BMPs, including the ones already presented in the results sections, that could contribute to incremental improvements.

The scenarios tested are not necessarily achievable or realistic in the short term, but they help understand the relative potential of different measures. Also, the modelling may not capture all the trade-offs of each measure, but the use of the calculator developed by Les Éleveurs de porcs du Québec ensures that the key aspects are considered.

Equivalences are based on the assumption that the BMPs are applied to all farms or processing plants across Canada.

Incremental Improvements: BMPs

What is the potential impact reduction of some BMPs?

Best management practices and other measures	Impact on the life cycle score	Equivalences Avoided impact equivalent to
10% decrease in feed conversion ratio	↓ 8.6% on carbon and water footprint	222,000 cars removed from the road Water from 24,000 Olympic pools saved
10% replacement of corn and soymeal with corn DDGS	↓ 1.25% on carbon footprint ↓ 2.8% on water footprint	33,000 cars removed from the road Water from 8,100 Olympic pools saved
100% of main crops are sourced in Canada	↓ 80% on water footprint	Water from 193,000 Olympic pools saved
Use cover on liquid manure management systems	↓ 8% on carbon footprint	214,000 cars removed from the road
Completely emptying a liquid manure storage tank in the spring	↓ 12% on carbon footprint	320,000 cars removed from the road

Incremental Improvements : BMPs

What is the potential impact reduction of some BMPs?

Best management practices and other measures	Impact on the life cycle score	Equivalences Avoided impact equivalent to
10% reduction of energy use at the farm	↓ 0.4% on carbon footprint	9,700 cars removed from the road
Improved sanitary conditions: 10% decrease in mortality rates	↓ 0.8% on carbon and water footprint	19,400 cars removed from the road 2,100 Olympic pools
30% reduction of energy and water consumption at the pork processing facility	↓ 1% on carbon footprint ↓ 2% on water footprint	25,000 cars removed from the road 4,500 Olympic pools

Transformational Change

A transformational change consists in modifying the vision of the industry in greater depth to create and capture unforeseen opportunities. This vision and its associated changes have yet to be defined by the industry, but two main sources of inspiration are:

- **Maximizing the "multifunctionalities" of the pork production system;**
- **Closing the loop of the material and energy resources of the system.**

Innovative approaches can be used to increase the quantity and the value of the coproducts from the meat production and increase revenues for the industry. Enhancing the development of coproducts allows to share the environmental impacts between more products, which translates into lower environmental footprint for each individual product.

The loop can be closed by recycling waste from other industries as feed for animals. In return, the manure can be managed in a way that maximizes the value of its nutrient content. The organic nutrients can be sold as an input for crop production or used in a closed loop to produce feed.

Net zero energy barns and meat processing plants could eliminate the purchase of fossil energy. Using waste and other available resources, renewable energy can be produced on site and surplus can be sold to offset fossil fuel elsewhere.

The development of a new vision should take into consideration not only the approaches to reduce environmental impacts, but also the environmental benefits the industry can generate from its activities. LCAs are one of the tools that can be used to develop and validate a new vision for the industry.

5. Key Messages and Next Steps

Contribution Analysis

Feed production is the most important contributor to the carbon and water footprint of pork production.

- Impacts can be reduced by optimizing feed efficiency, improving the environmental performance of the diet composition, and minimizing the use of irrigated feed crops.
- Due to the high contribution of fertilizers to the climate change impacts of feed production, the adoption of best management practices regarding nutrient management can contribute to reducing the climate change impacts related to feed crop production.

Manure management is the second most important contributor due to methane emissions from manure storage.

- Climate change impacts can be reduced by implementing solid-liquid separation technologies and using covers for liquid manure management systems.
- Improved nutrient management could displace more synthetic fertilizers, leading to additional benefits from a life cycle perspective.
- The industry must continue its promotion of the nutrient management plan (NMP) and develop cost-effective solutions for methane emissions reduction.

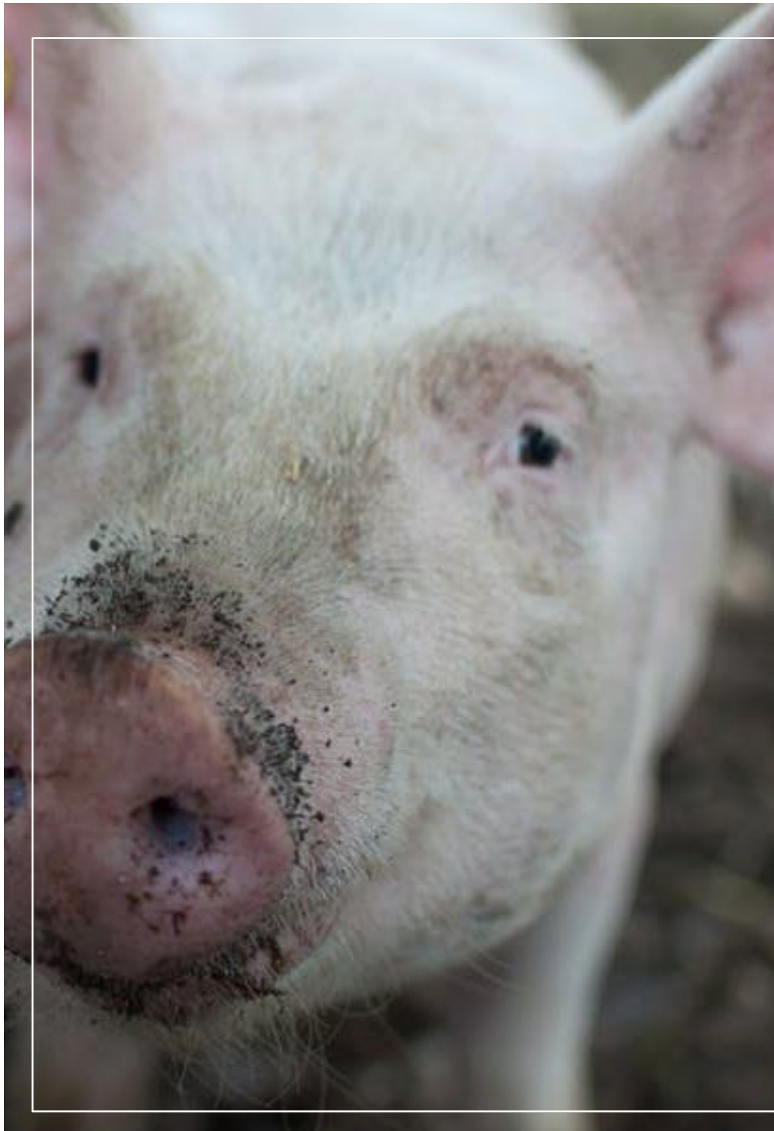
CONTRIBUTION ANALYSIS

Energy and water use at the farm and for meat processing is the third contributor to the impact results.

- Implementing water efficiency measures at the farm and reducing possible water waste for feeding could lead to significant reductions in water withdrawal.
- Prioritizing on-farm energy efficiency measures for space heating, ventilation, and lighting could be beneficial to lower GHG emissions. Installing on-farm renewable energy production capacity or buying green electricity could also help reduce GHG emissions.
- Research and development in net zero energy barns could lead to cost-effective solutions for all farmers.
- Investing in energy and water efficiency at the meat processing plant is one of the most effective solutions for impact reduction within this life cycle stage.

Important: The impact of any solution should be assessed by using a life cycle perspective that takes into consideration its cost effectiveness and other technical or social constraints.

KEY MESSAGES | GENERAL CONCLUSIONS



The preliminary assessment indicates that the **Canadian pork footprint is among the lowest in the world**.

Due to continuous productivity gain in the industry, it is **likely that the environmental performance of the industry has improved overtime**.

However, in order to support the current national commitment on GHG emissions reduction, the **rate of improvement may have to increase in the future**.

Fortunately, **incremental and transformative improvements** have the **potential to deliver significant impact reductions** in the next decade.

Next Steps

This study will establish a first environmental baseline for the Canadian pork industry.

It also illustrates how LCAs can contribute to building public trust for the industry.

However, this task can only be achieved throughout a concertation and with the collaboration of all members of the pork value chain.

Next Steps

- Understanding the **industry's contribution to different environmental issues** and define **science-based targets**;
- Developing tools, platforms, or programs for **evaluating and promoting BMPs**;
- **Communicating** its environmental performance to its stakeholders and measuring progress;
- Evaluating **environmental trade-offs of current market trends** (antibiotic free, organic, slow food, etc.) **and regulations**;
- Developing and validating a **vision for the future** of the industry.

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Appendix — Main model parameters

Productivity parameter	Unit	Canadian average
Weight — breeding males	kg	135.0
Cull rate	%	35%
Weight — culled sows	kg	255.1
Mortality rate — sows	%	8%
Number of piglets per litter	per litter	13
Number of litters per year	per sow	2.4
Weight — weaned piglet	kg	6.4
Mortality rate — weaned piglet	%	12%
Mortality rate — breeding males	%	9%
Mortality rate — piglet	%	4%
Mortality rate — finishing	%	5%
Weight — finishing pork sold	kg	125.9
Weight — carcass weight	kg	101.5

Appendix — Main model parameters

On-farm parameters	Unit	Canadian average
Purchased feed transport-distance[1]	km	20
Electricity consumption[2]	kWh/year	973,285,801
Propane consumption[2]	L/year	84,895,944
Natural gas consumption[2]	M^3/year	20,917,447

Feed parameter	Unit	Sow	Piglet	Finishing
Stage length	days	132.9	47.8	110.7
Amount of feed consumed per cycle	kg (wet basis)/animal	1158.1[3]	35.9	293.8

[1] from feed mill to pig farm
[2] for the total Canadian production
[3] per animal per year

APPENDIX — MAIN MODEL PARAMETERS

Feed ingredient	Hog diet (weighted average for all stages)
Oat	7.46%
Fish meal	0.00%
Soybeans	1.48%
Wheat shorts	10.06%
Oatmeal	0.01%
Lysine	0.02%
Threonine	0.00%
Whey	0.01%
Corn	40.4%
Barley	6.9%
Di-calcium phosphate	0.09%
Limestone	0.3%
Blood plasma	0.0%
Salt	0.11%
Canola meal	7.14%
Soymeal	7.07%
Wheat	10.36%
Corn distillers	5.85%
Feed peas	0.54%
Fats and oils	0.05%
Vitamins, minerals, and premixes	2.00%

APPENDIX — MAIN MODEL PARAMETERS

On-farm water use	Unit	Canadian average
Water consumed by sows — gestation	L/sow/day	12.6
Water consumed by sows — lactation	L/sow/day	16.9
Water consumed by piglets	L/piglet/day	1.7
Water consumed by finishing hogs (growth stage)	L/sow/day	3.8
Water consumed by finishing hogs (finishing stage)	L/hog/day	7.6
Water consumed by breeding male	L/breeding male/day	7.6
Cleaning water	L/day/animal	0.4
Other uses	L/day/farm	1.8

Appendix — Model parameters

Primary processing stage	Unit	Canadian average
Water intake	L/kg CW	9.42
Water returned to the watershed	L/kg CW	7.28
Electricity consumption	kWh/kg CW	0.40
Natural gas consumption	MJ/year	1.57
Plastic packaging	kg/kg CW	0.05