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ALBERTA AGRICULTURE CARBON REPORT CARD

Prepared for the
Simpson Centre for
Food and Agricultural
Policy.

DATE
December 31,
2021

STUDENT
Alberta
Agriculture
Sector

**LEARNING SKILLS
& WORK HABITS**
Climate Change
& Greenhouse
Gas Emissions
Reduction Study

**REPORTING
PERIOD**
2021

TOTAL ALBERTA AGRICULTURE EMISSIONS LEVEL

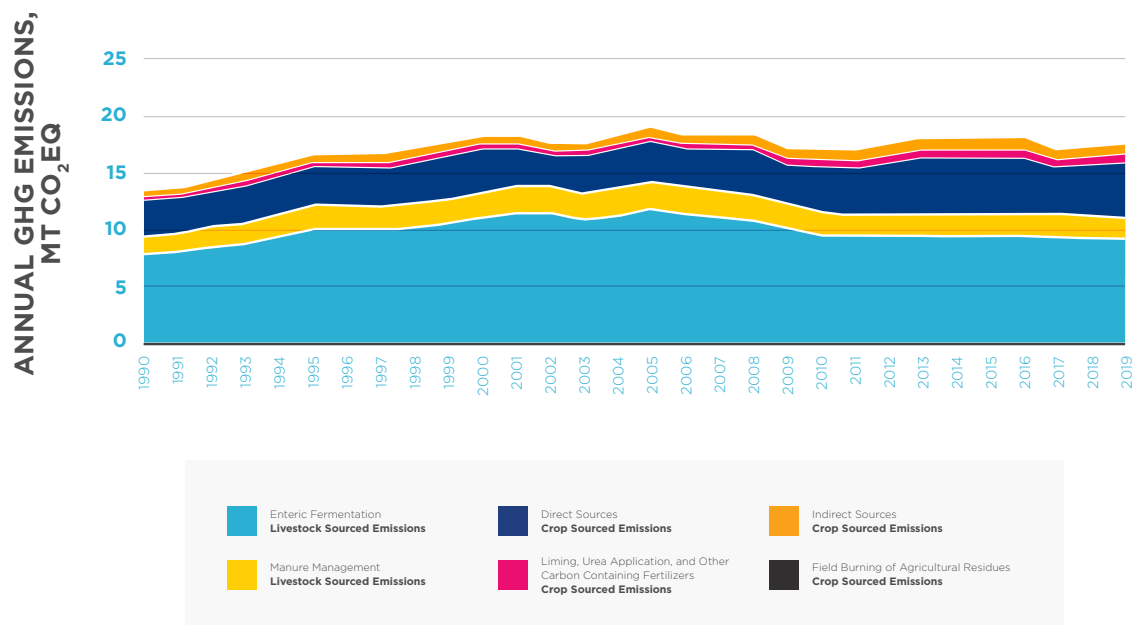
Alberta Greenhouse Gas (GHG) Emissions - 2019¹:
17.8 Mt CO₂eq

Percent Change Since 2005: -7.4%

Comments - Strengths/Next Steps for Improvement: Alberta has shown promise in its commitment to reduce its GHG emissions while continuing to grow the agriculture sector of its economy. It is noted that policy initiatives must be specific to the area to be impactful and suited to the existing practices of the area; many emissions figures that appear similar to that of Alberta on a per unit basis may be comprised of very different factors due to variations in local practices¹⁵.

The next step in this work will be to delve into the quantitative study of existing GHG emissions mitigation practices in agriculture that are used elsewhere, and drawing from this work find areas of further consideration.

FIGURE 1: ALBERTA AGRICULTURE SECTOR GHG EMISSIONS (IPCC CATEGORIES)



¹ Environment and Climate Change Canada 2021. "National Inventory Report 1990–2019: Greenhouse Gas Sources and Sinks in Canada - Canada's Submission to the United Nations Framework Convention on Climate Change - Part 3." Gatineau. <https://publications.gc.ca/site/eng/9.506002/publication.html>

BEEF

Farm-to-Gate Analysis GHG Emissions (see NOTE 1):

29 kg CO₂eq per kg retail beef

AB Estimated Beef Sector Total GHG Emissions - 2020 (see NOTE 2):

15.6 Mt CO₂eq

COMPARISON OF OTHER JURISDICTIONS:

COUNTRY	GHG EMISSIONS PER KG RETAIL BEEF (KG CO ₂ EQ/KG) (see NOTE 3)	REFERENCE
Canada	29	2
European Union	30	3
Australia	32	4
United States	35	5
Brazil	54	6

2 Legesse, G., K.A. Beauchemin, K.H. Orminski, E.J. McGeough, R. Kroebel, D. MacDonald, S.M.Little, T.A. McAllister. 2015. "Greenhouse gas emissions of Canadian beef production in 1981 compared with 2011." *Animal Production Science*. December 2015. https://cattlemen.bc.ca/docs/paper_greenhouse_gas_emissions_of_cdn_beef_production_1981-2011.pdf

3 Leip, Adrian, Franz Weiss, Tom Wassenaar, Ignacio Perez, Thomas Fellmann, Philippe Loudjani, Grancesco Tubiello, David Grandgirard, Suvi Monni, Katarzyna Biala. "Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS). 2010. https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/ext-study-livestock-gas-exec-sum_2010_en.pdf

4 Wiedemann, S.G., B.K. Henry, E.J. McGahan, T.Grant, C.M. Murphy, G. Niethe. 2014. "Resource use and greenhouse gas intensity of Australian beef production: 1982-2010." November 21 2014. <https://www.sciencedirect.com/science/article/pii/S0308521X14001565>

5 Rotz, C.A., B.J. Isenberg, K. R. Stackhouse-Lawson and E.J. Pollak. 2013. "A simulation-based approach for evaluating and comparing the environmental footprints of beef production systems." *Journal of Animal Science*. 2013. 91:5427-5437. <https://pubmed.ncbi.nlm.nih.gov/24146148/>

6 Pastori D'Aurea, Andre, Abmael da Silva Cardoso, Yuri Santa Rosa Guimaraes, Lauriston Bertelli Germandes, Luis Eduardo Gerreira, Ricardo Andrade Reis. "Mitigating Greenhouse Gas Emissions from Beef Cattle Production in Brazil through Animal Management." *Sustainability*. 2021. 13, 7207. <https://www.mdpi.com/2071-1050/13/13/7207/pdf>

WHEAT

Farm-to-Gate Analysis GHG Emissions (see NOTE 1):

0.22 kg CO₂eq per kg wheat

AB Estimated Wheat Sector Total GHG Emissions - 2020 (see NOTE 4):

2.4 Mt CO₂eq

COMPARISON OF OTHER JURISDICTIONS:

COUNTRY	GHG EMISSIONS PER KG WHEAT (KG CO ₂ EQ/KG)	REFERENCE
Australia	0.20	7
Canada	0.22	8
United States	0.27	9
Italy	0.29	10
China	0.75	11

⁷ Brock, Phillipa, P. Madden, G. Schwenke, and D. Herridge. 2012. "Greenhouse gas emissions profile for 1 tonne of wheat produced in Central Zone (East) New South Wales: a life cycle assessment approach." *Crop & Pasture Science*. https://www.researchgate.net/publication/268631847_Greenhouse_gas_emissions_profile_for_1_tonne_of_wheat_produced_in_Central_Zone_East_New_South_Wales_A_life_cycle_assessment_approach

⁸ Canadian Roundtable for Sustainable Crops. 2017. "CRSC Major Crop Carbon Lifecycle Assessment, 2017." <http://metrics.sustainablecrops.ca/home/criterion/2>

⁹ Field to Market: The Alliance for Sustainable Agriculture, 2016. *Environmental and Socioeconomic Indicators for Measuring Outcomes of On Farm Agricultural Production in the United States (Third Edition)*. ISBN: 978-0-692-81902-9 http://fieldtomarket.org/media/2016/12/Field-to-Market_2016-National-Indicators-Report.pdf

¹⁰ Alhaji Ali, Salem and Luigi Tedone, Leonardo Verdini, Guiseppe De Mastro. 2017. "Effect of different crop management systems on rainfed durum wheat greenhouse gas emissions and carbon footprint under Mediterranean conditions." *Journal of Cleaner Production*. 140 (2017) 608-621. <https://www.sciencedirect.com/science/article/pii/S0959652616304231>

¹¹ Zhang, Dan, and Jianbo Shen, Fusuo Zhang, Yu'e Li, Weigeng Zhang. "Carbon footprint of grain production in China." 2017. *Scientific Reports* 7:4126. <https://www.nature.com/articles/s41598-017-04182-x.pdf>

CANOLA

Canola Farm-to-Gate Analysis GHG Emissions:

0.38 kg CO₂eq per kg canola

AB Estimated Canola Sector Total GHG Emissions - 2020 (see NOTE 7):

2.0 Mt CO₂eq

COMPARISON OF OTHER JURISDICTIONS:

COUNTRY	GHG EMISSIONS PER KG CANOLA (KG CO ₂ EQ/KG)	REFERENCE
Canada	0.38	12
Australia	0.50	13
Iran	0.30 - 0.71	14
China (Case 1)	0.64	15
China (Case 2)	1.02	16

¹² Canadian Roundtable for Sustainable Crops. 2017. "CRSC Major Crop Carbon Lifecycle Assessment, 2017." <http://metrics.sustainablecrops.ca/home/criterion/2>

¹³ Eady, Sandra. 2017. "Greenhouse gas emissions from the cultivation of canola oilseed in Australia." Commonwealth Scientific and Industrial Research Organisation, Australia. <https://publications.csiro.au/publications/publication/Plcsiro:EP179698>

¹⁴ Soltani, Afshin and Ebrahim Zeinali. 2014. "Optimal crop management can reduce energy use and greenhouse gases emissions in rainfed canola production." International Journal of Plant Production 8(4). October 2014. 1735-8043. <https://doi.org/10.1016/j.energy.2016.10.010>

¹⁵ Uusitalo, V., S. Vaisanen, J. Havukainen, M. Havukainen, R. Soukka, M. Luoranen. 2014. "Carbon footprint of renewable diesel from palm oil, jatropha oil and rapeseed oil." Renewable Energy, 69 (2014) 103-113. <https://www.sciencedirect.com/science/article/pii/S0960148114001657?via%3Dihub>

¹⁶ Ji, Changxing, Yijie Zhai, Tianzuo Zhang, Xiaoxu Shen, Yueyang Bai, and Jinglan Hong. 2021. "Carbon, energy and water footprints analysis of rapeseed oil production: A case study in China." Journal of Environmental Management. 287 (2021) 112359. <https://www.sciencedirect.com/science/article/pii/S0301479721004217>

DRIED PEAS

Dried Peas Farm-to-Gate Analysis GHG Emissions:

0.16 kg CO₂eq per kg dry weight

AB Estimated Dried Peas Sector Total GHG Emissions - 2020 (see NOTE 7):

0.28 Mt CO₂eq

COMPARISON OF OTHER JURISDICTIONS:

COUNTRY	GHG EMISSIONS PER KG DRIED WT. (KG CO ₂ EQ/KG)	REFERENCE
France (Spring Pea, Organic)	0.16	17
Canada	0.16	18
Sweden	0.18 - 0.20	19
United States	0.32	20

¹⁷ Nitschelm, Laure, Blanche Flipo, Julie Auberger, Helene Chambaut, Solvie Dauguet, Snadrine Espagnol, Armelle Gac, Cecile Le Gall, Caroline Malnoe, Aurelie Perrin, Paul Ponchant, Christel Renaud-Gentie, Aurelie Tailleux, Hayo M. G. van der Werf. 2021. "Life cycle assessment data of French organic agricultural products." Data in Brief. 38 (2021) 107356. <https://www.sciencedirect.com/science/article/pii/S2352340921006387>

¹⁸ Canadian Roundtable for Sustainable Crops. 2017. "CRSC Major Crop Carbon Lifecycle Assessment, 2017." <http://metrics.sustainablecrops.ca/home/criterion/2>

¹⁹ Tidaker, Pernilla, Hanna Karlsson Potter, Georg Carlsson, Elin Roos. 2021. "Towards sustainable consumption of legumes: How origin, processing and transport affect the environmental impact of pulses." Sustainable Production and Consumption. 27 (2021) 496-508. <https://www.sciencedirect.com/science/article/pii/S2352550921000178>

²⁰ Putman, William and Gregory Thoma. 2022. "Cradle-to-grave life cycle assessment of production and consumption of pulses in the United States." Journal of Environmental Management, 302 (2022) 114062. https://www.researchgate.net/publication/356107831_Cradle-to-grave_life_cycle_assessment_of_production_and_consumption_of_pulses_in_the_United_States

NOTES

NOTE 1: The farm-to-gate system is considered here, which is a partial lifecycle analysis method, accounting for all farm operations of beef cattle production. This includes the direct impacts due to on-farm operations and the indirect impacts from the production and transport of synthetic fertilizers, diesel, electric energy, and pesticides. We consider the emissions from growing the feed crops, but not from land use change if that was required to create the fields either for crops or pasture. These figures are estimates, modelled using various assumptions and scientific methods. One of the challenges is we cannot just use a “GHG meter” to measure emissions from cattle or a farmer’s field.

NOTE 2: Alberta Beef Sector Emissions are estimated here as a product of the province’s 2019 tonnes of production and the estimated emissions per kg noted above. This figure includes GHG emissions related to feed inputs and production, so it includes some emissions from grains such as wheat; it therefore includes a small amount of the wheat sector emissions. See sources noted²¹.

NOTE 3: Different Weight Basis: You might see the “carbon footprint” of a kilogram of beef based on one of three different foundations. First, the “live weight” of the cattle, representing the highest weight of that animal as it goes to be processed. Next, the emissions may be expressed per kilogram of the “carcass weight” of the cattle, which represents the animal’s weight after removal of the head, hide, GI tract, and internal organs. The smallest weight considered would be “retail beef”. This represents the packaged meat that goes to the market in Canada. These numbers are tracked meticulously through the livestock industry, and the government has some industry averages as follows:

CARCASS WEIGHT TO LIVE WEIGHT RATIO: 0.56

RETAIL WEIGHT TO CARCASS WEIGHT RATIO: 0.73

RETAIL WEIGHT TO LIVE WEIGHT RATIO: 0.41

What this means is if we express our GHG emissions per kilogram of retail weight, it is 29kg CO₂eq per kg. However, if we express that per kilogram of live weight, it is 12kg CO₂eq per kg. We need to know the basis of the emissions calculation²².

NOTE 4: Alberta’s total Wheat Sector GHG Emissions were estimated here as a product of the province’s 2020 tonnes of production²³ and the estimated emissions per kg noted above. That factor includes estimated changes in soil carbon, emissions from energy use, fertilizer manufacturing, nitrous oxide (N₂O) emissions and seeds and pesticides indirect emissions. These factors were estimated for the three Regional Units found in Alberta, resulting in an emissions estimate specific to this province.

²¹ Statistics Canada. Table 32-10-0130-01 Number of cattle, by class and farm type (x 1,000). <https://www150.statcan.gc.ca/t1/tbl/en/tv.action?pid=3210013001>

²² Government of Canada. “Red meat conversion factors.” Accessed Sept. 23, 2021. <https://agriculture.canada.ca/en/canadas-agriculture-sectors/animal-industry/red-meat-and-livestock-market-information/slaughter-and-carcass-weights/conversion-factors>

²³ Statistics Canada. Table 32-10-0359-01 Estimated areas, yield, production, average farm price and total farm value of principal field crops, in metric and imperial units. <https://www150.statcan.gc.ca/t1/tbl/en/tv.action?pid=3210035901>



NOTE 5: WHY IS THERE SUCH A RANGE IN VALUES FOR WHEAT PRODUCTION?

Different factors affect the GHG emissions for crops in different areas. There are site-specific factors that can make significant differences such as average rainfall, soil type, irrigation usage, no-till farming practices, application of nitrogen fertilizer and in what amount, straw burning practices (a factor in China where much of the straw in wheat fields is burned after harvest), and other factors. Because of the wide range of emissions per kg of wheat that may be seen, a jurisdiction may have mitigation measures specific to smaller regions that are most efficient for those regions²⁴.

NOTE 6: WHY IS THERE SUCH A RANGE IN VALUES FOR CANOLA PRODUCTION?

Different factors affect the GHG emissions for crops in different areas. There are site-specific factors that can make significant differences such as average rainfall, soil type, irrigation usage, no-till farming practices, application of nitrogen fertilizer and in what amount, straw burning practices (a factor in China where much of the straw in fields is burned after harvest), and other factors. Because of the wide range of emissions per kg of canola that may be seen, a jurisdiction may have mitigation measures specific to smaller regions that are most efficient for those regions.

NOTE 7: FOR ALBERTA'S CANOLA AND DRIED PEAS ANNUAL GHG EMISSIONS.

The figure is a product of the province's 2020 tonnes of production and the estimated emissions per kg noted. That factor includes estimated changes in soil carbon, emissions from energy use, fertilizer manufacturing, nitrous oxide (N₂O) emissions and seeds and pesticides indirect emissions. These factors were estimated for the three Regional Units found in Alberta, resulting in an emissions estimate specific to this province.

²⁴ Alhaji Ali, Salem and Luigi Tedone, Leonardo Verdini, Guiseppa De Mastro. 2017. "Effect of different crop management systems on rainfed durum wheat greenhouse gas emissions and carbon footprint under Mediterranean conditions." *Journal of Cleaner Production*. 140 (2017) 608-621. <https://www.sciencedirect.com/science/article/pii/S0959652616304231>; Zhang, Dan, and Jianbo Shen, Fusuo Zhang, Yu'e Li, Weigeng Zhang. "Carbon footprint of grain production in China." 2017. *Scientific Reports* 7:4126. <https://www.nature.com/articles/s41598-017-04182-x.pdf>