Efficient Agriculture as a Greenhouse Gas Solutions Provider

Paper prepared for CAPI

by

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Joint Research Paper
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1. Introduction

Canada has signaled its intent to follow a progressive agenda on climate change at the federal level, with mixed approaches employed by various provinces. At the Paris Conference of the Parties (Paris Accord), in December 2015, Canada agreed to federal targets that contemplate a 30% reduction in greenhouse gas (GHG) emissions by 2030, relative to 2005 levels.

Climate change is one of the key issues facing the Canadian agriculture and agri-food sector. At the same time, global population growth and increased demand for more and higher quality food products, including meat, dairy and protein alternatives imply that Canadian agriculture has an opportunity to produce and export more agriculture and agri-food products. The challenge is how to do so sustainably.

Agriculture stands to be impacted by Canadian climate change policy as a significant user of fossil fuels and petrochemical products. The magnitude of costs and relative competitiveness impacts of alternative climate change policies need to be understood and evaluated. Agriculture and food are key elements of the Canadian economy and economic growth, especially when viewed on a regional basis. Hence, concerns exist that Canada will place itself at a cost disadvantage, especially relative to its major competitors, such as the United States, which is no longer a party to the Paris Accord.

Canada has a large land base, ample natural resources, and a highly efficient agriculture and agri-food industry. The role of the agricultural sector in addressing climate change has been given little attention, if not ignored. This is unfortunate as agricultural land operates on very large stocks of stored carbon and has the potential to sequester carbon- not just mitigate emissions- unlike most other sectors.[1] In addition, agricultural producers have been making significant progress in adopting new technologies and practices to reduce environmental impacts including GHG emissions. Whether more sacrifices will need to be made by the agricultural sector to help meet Canada's climate change targets, or conversely whether agriculture can readily adjust and provide far-reaching GHG storage, sequestration, and mitigation services as an opportunity for the sector, continues to be a critical issue.

This paper surveys the situation facing Canadian agriculture, particularly livestock production, in terms of how it is addressing climate change by reducing GHG emissions and emissions intensity, and the measures being taken to achieve them. This is occurring in a context of renewed concerns, especially given the recent report by the Intergovernmental Panel on Climate Change (IPCC, 2019) indicating high emission rates for certain sub-sectors based on global averages. The IPCC approach fails to acknowledge the important differences in emission intensity in production processes across various countries and regions, and that the Canadian agriculture sector has made significant progress in making the soils in crop and animal production a net carbon sink, as well as reducing emission intensity of animal agriculture. It also lacks balance by focusing on GHG emissions to the exclusion of other kinds of environmental effects. This needs to be better understood so that the role of agriculture as a prospective solutions-provider rather than a source of emissions can inform the policy debate around achieving Canada's climate change goals.

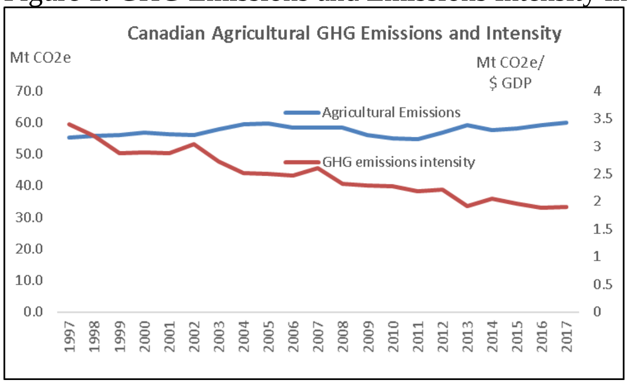
2. Current Situation

GHG emissions in the Canadian agriculture sector peaked in 2005 and have ranged around 60 Mt CO_2eq in the last twenty years. Over the same period, agricultural production has steadily increased, leading to a substantial reduction in GHG emissions intensity, measured as a unit of output. This measure, GHG

[1] Forestry is the other sector that operates on carbon stores and has the prospect of sequestering carbon in the terrestrial context.

emissions per unit of output, is a more appropriate measure of Canada's progress towards achieving its climate change goals (Figure 1). Canadian agricultural producers have improved their environmental performance, aided by a willingness to adopt new technologies and Best Management Practices (BMPs) along with new regulations, policies and programs, and investment in R&D.

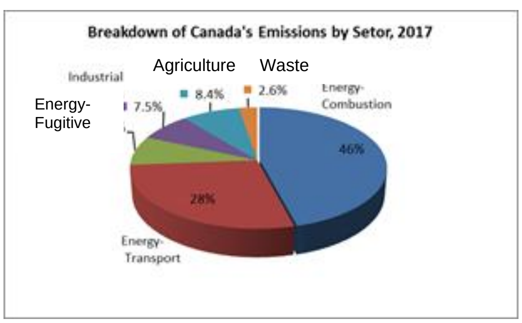
Figure 1: GHG Emissions and Emissions Intensity in Agriculture



Emissions Intensity is measured as GHG emissions /Agriculture Gross Domestic Product (GDP)
Source: ECCC, NIR and Statistics Canada

Agriculture and Agri-Food Canada (AAFC) estimates that crop and livestock production accounts for about 8.4% of Canada's total GHG emissions (716 Mt CO2e). This measure excludes on-farm energy use and energy used in the production of fertilizer. In contrast, the recent IPCC report notes that globally, agriculture accounts for about 23% of the world's GHG emissions. This global estimate is an average and includes emissions resulting from land use change (e.g. deforestation) and from on-farm energy use, as well as energy used in the production of farm machinery and fertilizer (IPCC, 2019, para. A3, pg. 7). Therefore, it tends to exaggerate GHG emissions from agriculture, especially when compared to a country such as Canada, which has become increasingly efficient. As an aside, Canadian agriculture stands well behind the "energy from combustion industry" (327 Mt) and the transportation (201 Mt) industries as sources of GHGs (Figure 2).

Figure 2: Breakdown of Canada's Emissions by Sector, 2017

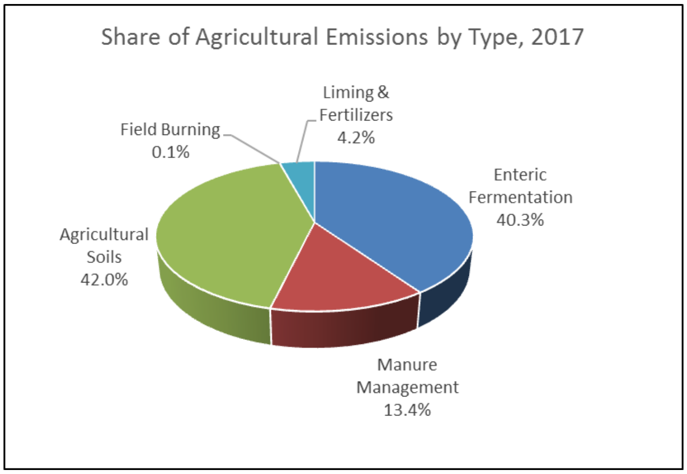


Source: ECCC, NIR, 2019

GHG emissions from agriculture are directly related to animal and crop production (Figure 3). Animal agriculture contributes emissions through enteric fermentation from cattle and manure deposition and management, while crop production leads to emissions from fertilizer application and soil cultivation. GHG emissions from enteric fermentation (24 Mt CO_2e or 40.3% of the total) and manure management (8 MtCO2e or 13.4%) accounted for a little more than half of agricultural emissions while 25 Mt (42%) came from agricultural soils. Methane (CH_4) from animal agriculture accounted for about 30% of total Canadian CH_4 emissions, but these only represented about 14% of the total GHG emissions in Canada

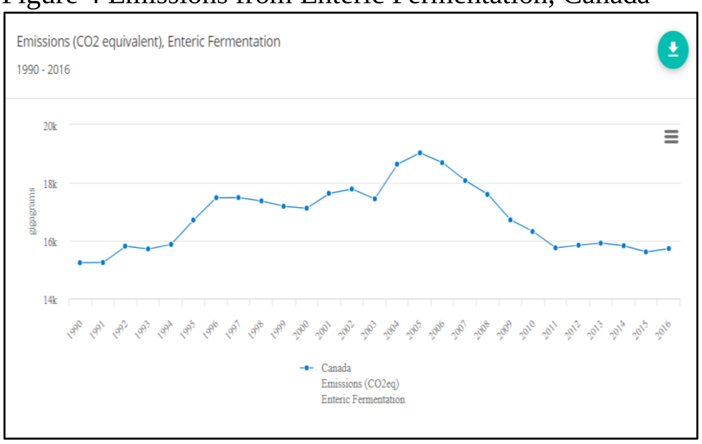
(716 Mt). This implies that GHG emissions from livestock account for only about 4% of total Canadian GHG emissions with methane emissions from enteric fermentation having decreased sharply since 2005 (Figure 4).

Figure 3 Emissions from Crop and Animal Production, Canada, 2017



Source: MWG, 2016

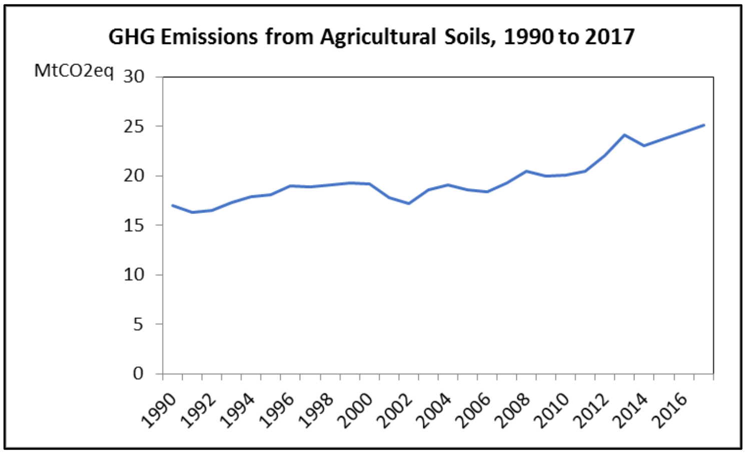
Figure 4 Emissions from Enteric Fermentation, Canada



Source: FAO

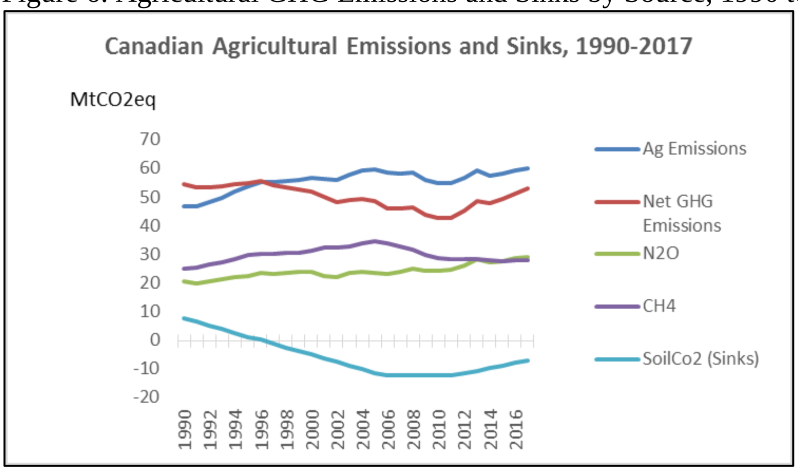
Crop production contributes to GHG emissions through the application of synthetic fertilizers, manure, tillage, irrigation and summer fallow, as well as through fertilizer runoff and leaching. Because of the increase in arable land cultivated for crops in Canada over time, and the increase in fertilizer use, emissions from this source have been rising as well (Figure 5). However, because of the adoption of BMPs, new rotation and cover crops (e.g. pulses), new technologies and precision agriculture, no-till practices and the reduction in summer fallow, there have been significant increases in soil organic carbon levels. Consequently, emissions from land use changes on croplands have actually declined sharply since the 1990s (Figure 6).

Figure 5: Emissions from Crop Production



Source: ECCC, NIR, 2019

Figure 6: Agricultural GHG Emissions and Sinks by Source, 1990 to 2017



Source: OECD, Agri-Environmental Indicators, 2019.

3. Agricultural BMPs and Policy Measures to Reduce Emissions

Agriculture producers have a range of options available to them to facilitate reduction of GHG emissions. These include reducing inputs (e.g. fertilizer), using different inputs (e.g. manure), innovating and adopting BMP's that reduce GHGs and emissions intensity. They also have the potential to sequester carbon which continues to be important going forward.

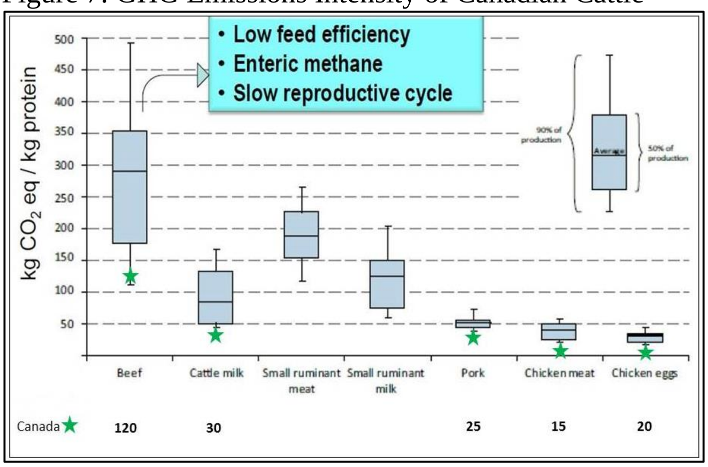
3.1 Fertilizer Use

Input savings can occur through the improved timing, rates and accuracy in fertilizer applications. A key initiative is the development of 4R Nutrient Stewardship, which promotes improved management of nutrients (nitrogen (N), phosphorous (P) and potassium (K)) in crop production.[2] Better timing, placement and application rates under 4R practices can mitigate the loss of GHG's from fertilizer, leaving more to be used by crops. This allows for greater yields from a given fertilizer input, allowing the same yields from reduced fertilizer inputs and/or facilitating production increases without the expansion of the agricultural land base. For example, in Ontario, applying the 4Rs in corn production was found to increase yields by nearly 20% and reduce GHG emissions by 75% (Fertilizer Canada, 2018). Farm equipment manufacturers are increasingly developing equipment that can apply fertilizer and manure with greater accuracy for placement in subsurface bands, and within the growing season using split applications. Precision agriculture and equipment that allows for these types of applications, particularly at variable rates and in real-time, present an important option for improving environmental performance and reducing emissions.

3.2 Livestock Production

Improvements in animal genetics, which can lead to feed efficiencies and adjustments to agricultural production systems, can lower GHG emissions from livestock production while also reducing costs of production. Livestock diets can be manipulated to reduce GHG emissions from enteric fermentation and manure. For the most part, these can be accomplished without significant reduction in animal performance (e.g. daily gain, feed conversion, milk production, etc.). Emission reductions can be even greater if animal diets make more use of perennial forages as feed and if grains for feed use do not need to be dried. As recent research demonstrates, Canadian beef production has become much less emissions intensive as a result of new genetics, increased feed efficiencies and better pasture management. [3] Canada is now one of the lowest emitters for animal protein, particularly beef, in the world. (Figure 7)

Figure 7: GHG Emissions Intensity of Canadian Cattle



Source: FAO and AAFC

[2] 4R Stewardship is a trademarked system of improving the source, rate, timing, and placement of nutrients in order to reduce environmental impacts and optimize yields. Available at: https://fertilizercanada.ca/nutrient-stewardship/

[3] Basarab, J. A., Beauchemin, K. A., Baron, V. S., Ominski, K. H., Guan, L. L., Miller, S. P., & Crowley, J. J. (2013). Reducing GHG emissions through genetic improvement for feed efficiency: effects on economically important traits and enteric methane production. Animal, 7(s2): 303-315.

3.3 Crop Production

Emission reductions in the crop sector are also possible through the adoption of specific farming technologies that reduce the release of GHGs. The development of direct seeding in western Canada is a prime example. While the motivation behind this innovation was originally to conserve soil moisture, it also resulted in net reductions in GHG emissions. Tillage gives rise to GHG emissions by releasing soil organic carbon into the atmosphere. Direct seeding/low-till practices provide for planting and fertility management without the need to break the soil with a disk, cultivator chisel, or moldboard plough. As such, compared with more traditional farming systems in Canada involving multiple tillage passes, these approaches can provide significant reductions in GHG emissions in many, but not necessarily all soil types. On the Prairies where zero- and low-till practices have taken off, net GHG emissions have declined dramatically since 1996, contributing to substantial carbon storage and sequestration in Canadian soils (Figure 6).

Another development in Canadian agriculture that is contributing to significant reductions in GHG emissions from the sector is "regenerative agriculture," a system of production that can increase the carbon content of soils. At least five important regenerative practices are essential for improving carbon in the soil: planting cover crops, no-till farming, increased crop rotations, reducing chemicals and best practice fertilization including incorporating livestock. These practices are proven to both drive carbon into the soil, and to keep it there. The resulting carbon-enriched soils are healthier, demonstrating better resilience to extreme weather, improving water permeability, increasing microbial diversity, raising yields, lowering input requirements and producing even more nutritious harvests- all of which improve the land and the farmers' bottom line.[4] While only a small percentage of farmers in Canada are already doing this, regenerative agriculture has great potential for contributing to agriculture as a solutions-provider for climate change. [5]

These and other practices that can reduce GHG emissions are not used by all farmers. Many farmers continue to farm in much the same way that they have for many years. Our free-enterprise agricultural system allows for broad independence of decision-making. However, policy incentives can encourage farm practices that can reduce GHG emissions. Well-designed policy instruments can be very powerful in creating incentives and inducing change, and Canadian agriculture has a great deal of experience with these. Examples include the National Environmental Farm Plan and National Farm Stewardship programs introduced by provincial and federal governments under previous Agricultural Policy Frameworks over the period 2009-13.[6] Analysis of the effectiveness of these programs shows how they have helped improve the environmental performance of Canadian agriculture.[7] The quest for sustainable production still has a long way to go but it is also important to acknowledge the progress that has been made in Canadian agriculture.

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[4] Regenerative agriculture was described in this article by David Perry of Indigo Agriculture at the World Economic Forum. Available at: https://www.weforum.org/agenda/2019/07/agriculture-climate-change-solution/

[5] For a better understanding of the state of the art in soil potential to sequester carbon, please see https://www.nature.com/articles/nature17174

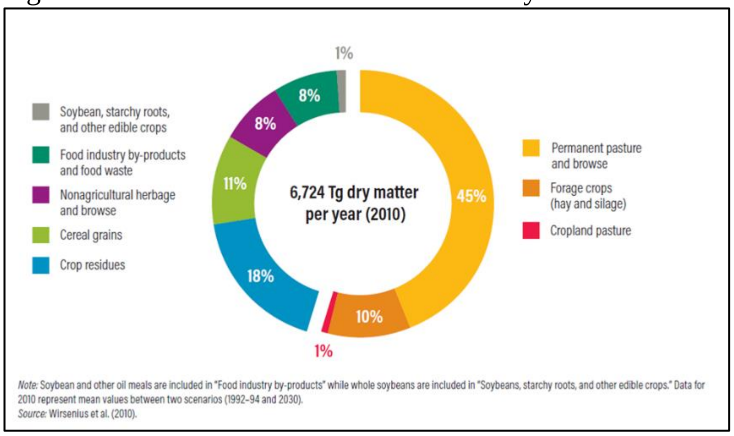
[6] For a description of these programs, see CAPI paper "Clean Growth in Agriculture" available here: https://capi-icpa.ca/wp-content/uploads/2019/03/2019-05-15-CAPI-CEF-FINAL-Report-WEB.pdf .

[7] See for example: Boxhall, P.C., "Evaluation of Agri-Environmental Programs: Can We Determine If We Grew Forward in an Environmentally Friendly Way?", Canadian Journal of Agricultural Economics, 66 (2018) 171-186.

4. Understanding Livestock's Role

The view espoused by many activists and some consumers in recent publications (e.g. Eat Lancet) and the media is that meat, especially beef, is an energy inefficient, pollution-causing food product that is worsening global warming due to its GHG emissions.[8] This assertion is rather simplistic, and demonstrates that there is a lack of understanding of the role livestock plays in agricultural production systems, such as providing nutrients for the soil, sequestering carbon and protecting wildlife habitat. Those who argue that reducing livestock production would lead to more crops for human consumption, do not understand how little of what livestock actually eat could be consumed by humans. This is because ruminants convert a much broader range of feeds into milk and meat than any other animal group. For example, grasses provide more than half of all livestock feed, while food industry by-products, such as Dried Distillers Grains (DDGs) from ethanol production and other food production by-products, that would simply be disposed of, are an important source of livestock feed (8%) (Figure 8).

Figure 8: Sources of Livestock Feed Globally



Source: World Resources Institute, 2019

4.1 The Long Shadow of *Livestock's Long Shadow*

In 2006, the United Nations Food and Agriculture Organization (FAO) published *Livestock's Long Shadow* (Steinfeld et al.), a report which really targeted animal agriculture, reporting that meat production was responsible for 18 per cent of GHG emissions globally – more than transportation. The report was particularly severe on beef, as cattle were directly connected to deforestation in the Amazon rainforest region, as well as the largest source of methane. Moreover, cattle in feedlots were seen as poor converters of feed, therefore driving the need for more feed grain production, which requires increasingly large amounts of nitrogen fertilizer and deforestation. The plausibility of this perspective was heavily influenced by the 2006 Inter governmental Panel on Climate Change (IPCC) Report, in which land use change was grouped with agriculture, and created the impression that agriculture represented at least a quarter of GHG emissions. Moreover, methane and nitrous oxides were singled out as the largest contributors to agriculture's emissions.

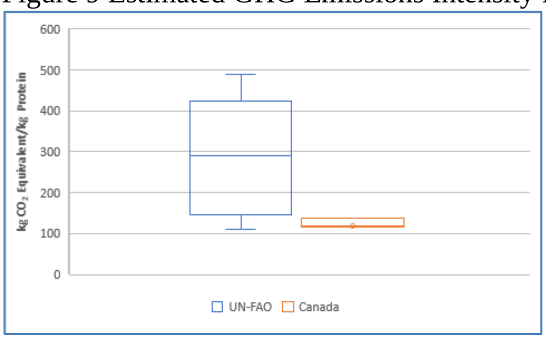
It took several years for the FAO to walk back the *Long Shadow* report, even though the FAO had clarified what was included in its meat figure of 18% in its 2013 publication, *Tackling Climate Change*

[8] EAT Lancet report entitled "Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems" available here: https://eatforum.org/eat-lancet-commission/eat-lancet-commission-summary-report/.

Through Livestock (Gerber et al., 2013). This included all of the GHG emissions associated with meat production, including fertilizer production, land clearance, methane emissions and vehicle use on farms. This compared to GHG calculations for the transportation sector, which only included the burning of fossil fuels. However, the horse had left the barn, and some in the public have developed and still tenaciously hold onto this rooted vision of meat as a major driver of climate change for over a decade.

The walk back of the *Long Shadow* report has triggered much needed research with an increasing number of studies beginning to take a more nuanced and less sinister view of meat's role in climate change. This started with the recognition that not all meat, and particularly, not all cattle, from various regions in the world have the same GHG footprint. For example, Agriculture and Agri-Food Canada's (AAFC) analysis showed dramatic reductions in Canadian agriculture GHGs emissions, particularly emissions from cattle GHGs, versus the reference values in the first IPCC report and the *Long Shadow* publication. [9] AAFC research estimated that Canada was among the most efficient producers, in the bottom 90th percentile range of GHG-emissions intensity for beef production compared to global figures. The UN-FAO estimated that GHG emissions per unit protein worldwide averaged 290 kg CO_2eq, with a range from 110 kg to 490 kg CO2eq. For Canada, using beef protein yields in 2001, GHG emissions intensity was 119 kg CO_2eq, with a range between 115.8 kg CO_2eq in western Canada to 137.5 kg CO_2eq in eastern Canada.

Figure 9 Estimated GHG Emissions Intensity for Beef; Global vs. Canada

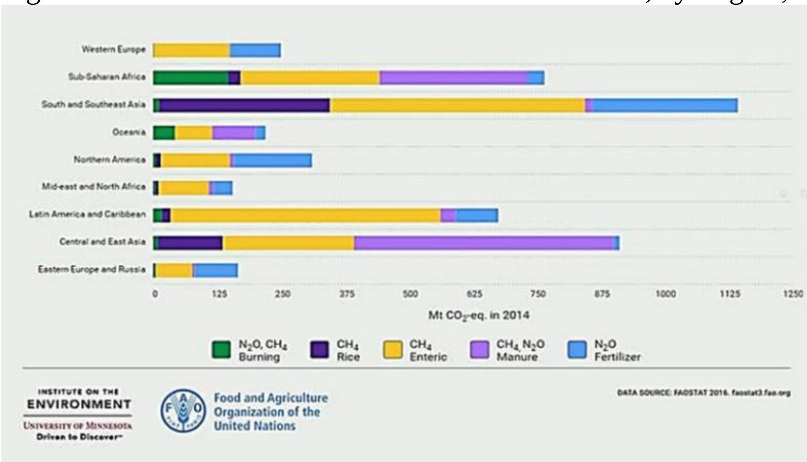


Sources: Adapted from Gerber *et al* (2013) and Dyer *et al* (2010)

Furthermore, despite Canada and the U.S. being large livestock producers and exporters, GHG emissions from livestock (i.e. enteric fermentation and manure management) tend to be significantly lower in Canada and the U.S. than in many other regions in the world (Figure 10).

[9] G. Legesse, K. A. Beauchemin, K. H. Ominski, E. J. McGeough, R. Kroebel, D. MacDonald, S. M. Little and T. A. McAllister, "Greenhouse gas emissions of Canadian beef production in 1981 as compared with 2011," Anim. Prod. Sci. 56, 2015, pg. 153-168. Accessed at: http://dx.doi.org/10.1071/AN15386.

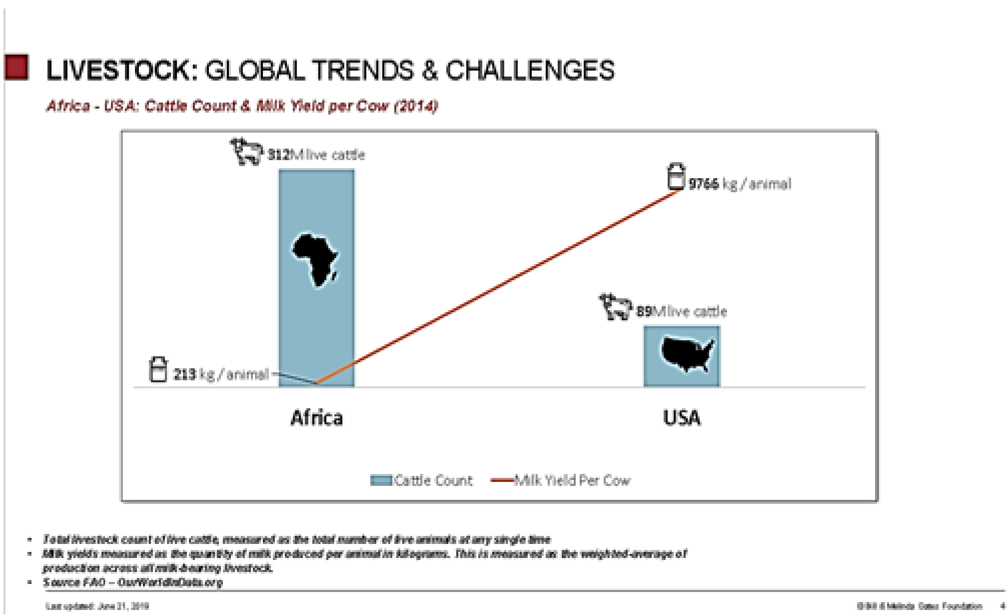
Figure 10: GHG Emissions from Livestock Production, by Region, 2015



Source: FAO

Hence, opportunities exist for agriculture to be a solutions-provider, not just domestically but internationally as well, by transferring new technologies to those countries which are less efficient at livestock production. Africa is one such example of a region that could benefit from the technological progress made in North American livestock production, in this case dairy, to significantly increase its productivity and reduce GHG emissions from its cattle herd (Figure 11).

Figure 11 Differences in Livestock Productivity, Africa vs U.S.



At the same time, more recent research finds that grazing livestock do not have as negative GHG effects as espoused in the *Long Shadow* and other literature critical of meat production on GHG grounds. Plant growth and soils naturally release their own GHG's; animals grazing on these plants (whether domestic or wild) influence these GHG emissions, but then contribute their own GHG emissions through enteric fermentation and excretion. But overall, animals running on pasture actually increase carbon sequestration in the grazed plants.

A recent meta-analysis of grazing grasslands worldwide (Tang *et al*, 2019) found that heavy grazing reduced emissions of methane, CO_2, and N_2O- light or moderate grazing had no effect. A similar meta-analysis conducted by Byrnes et al. (2018) noted that "the positive responses of soil organic carbon to rotational grazing could create climate change mitigation opportunities." Also, in a study of soil carbon and cattle grazing in Alberta using grazing enclosures, in which grasslands are compared side-by side with and without grazing, Stolnikova et al. (2016) concluded that:

> The cattle industry has been criticized for its contribution to GHG emissions. However, our data suggest that grazing did not increase CO_2 emissions, and instead the potential exists due to the widespread nature of beef production across the Canadian prairies for grazing to lower overall CO_2 emissions.

Other studies, using global data, appear less optimistic on cattle grazing and GHG emissions (Garnett et al., 2017). However, this may only serve to underscore a Canadian comparative advantage. As stated by Searchinger et al. in a 2019 World Resources Institute (WRI) Report, there will be beef produced somewhere, so it is critical that production occurs in regions with high GHG-efficiency. Overall, the findings of the current literature are mostly in contrast to both the *Long Shadow* report and the public attitudes it has shaped.

4.2 IPCC Report of August 2019 "Climate Change and Land"

In August 2019, the IPCC released a report on *Climate Change and Land*. IPCC Reports are by nature extensive, and address the complexity of agricultural systems, social systems and food security, and GHG emissions/global warming potential.

This IPCC Report emphasizes that agriculture can be, *and must be*, a solutions-provider to climate change challenges. The Report develops a range of alternatives within which agriculture can contribute to climate change adaptation and mitigation. Conversion of pristine land for agricultural use is identified as among the highest of GHG-emitting land management activities. It identifies several agri-food options for climate change mitigation and adaptation, including increased food productivity, improved cropland management, grazing land management, livestock management, agroforestry, increased soil organic carbon content, and reduced post-harvest losses.[10] These are consistent with multiple socio-economic objectives, quite apart from GHGs and climate change, and the IPCC Report puts further urgency and focus around these issues.

However, it is the matter of implied dietary change and the reduction in meat consumption to reduce GHG emissions that has thus far drawn the most attention. The Report finds that:

> A dietary shift away from meat can reduce greenhouse gas emissions, reduce cropland and pasture requirements, enhance biodiversity protection, and reduce mitigation costs. Additionally, dietary change can both increase the potential for other land-based response options and reduce the need for them by freeing land. By decreasing pressure on land, demand reduction through dietary change could also

[10] Chapter 6: Interlinkages between Desertification, Land Degradation, Food Security and GHG fluxes: synergies, trade-offs and Integrated Response Options.

> allow for decreased production intensity, which could reduce soil erosion and provide benefits to a range of other environmental indicators such as deforestation and decreased use of fertilizer (N and P), pesticides, water and energy, leading to potential benefits for adaptation, desertification, and land degradation. [11]

However, elsewhere, the report recommends that:

> Balanced diets, based on plant-based foods, such as those based on coarse grains, legumes, fruits and vegetables, nuts and seeds, and animal-sourced food produced in resilient, sustainable, and low-GHG emission systems present major opportunities for adaptation and mitigation.[12]

This recommendation is controversial and warrants further analysis and interpretation. The report identifies that just over 75% of global farmland (e.g. cropland, grazed savannahs and pastures) is land used or available for grazing. It indicates much of the 25% of farmland used to grow crops grows feed for livestock. The report assumes this could be switched to growing foods for direct human consumption, reducing emissions from livestock related to conversion of feed crops to livestock proteins. However, in doing so, we would substitute crops directly for human consumption- largely starches and carbohydrates- for meat proteins. In many developed countries, high levels of carbohydrate consumption are linked to obesity. In many developing countries, protein deficiency in diets is more of a concern than carbohydrates and starch. Moreover, in developed countries the current trend toward vegetable-based meat alternatives involves the extraction of protein isolates from pulse and oilseed crops, such as peas or soybeans. These are highly processed foods, something which the new *Canada Food Guide* cautions against and which can have potentially allergic downside effects for some people.[13]

Conversely, grazing lands are generally areas that cannot sustainably support higher agricultural uses such as increased fruit and vegetable production (for reasons such as climate, soils, drainage, slopes, etc.), otherwise they would previously have been converted. In the face of a growing population, a reduction in meat consumption will reduce the use of pasture and grasslands but will add little to the stock of highly productive cropland that can be used for plant-based foods. Moreover, it is unclear what use would be made of pasture and grassland from which grazing is removed and other benefits of this type of land – most notably wildlife habitat and biodiversity- could be adversely affected.

4.3 The Broader Context for Livestock, Meat and GHG Assessment

With a growing awareness and focus on GHG emissions- whether from meat or from other food supply chains- comes the potential concern that this comes at the exclusion of other environmental effects. This was illustrated by Halpern et al. (2019) in a recent article in Proceeding of the National Academies of Sciences (PNAS). They observe that not all food supply chains have been assessed on their environmental effects in recent studies, and that connections among food supply chains can create great complexity. In livestock, assessments have focused heavily on GHG emissions, rather than other effects such as acidification potential, eutrophication, and biodiversity. The lack of diversity within a given food supply chain, and gaps in assessment across supply chains, undermine the ability to tradeoff environmental effects of food production. For example, foods that are relatively high GHG emitters but provide for biodiversity could offset others with negative biodiversity attributes but reduced GHG emissions. Focusing solely on GHGs for directing individual behavior such as dietary change, could risk

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[11] Table 6.10 *Integrated response options based on value chain management through demand management*.
[12] Paragraph B6.2, Summary for Policy Makers.
[13] Health Canada, *Canada Food Guide* available at: https://food-guide.canada.ca/en/healthy-food-choices/

unintended consequences without a broader basis of information and consideration of trade-offs between environmental effects across food supply chains.

5. Conclusion

Canada finds itself in a precarious position with commitments to a progressive climate change agenda and clear targets for achieving it. This is precarious given that one of our key customers and competitors (the U.S.) is at odds with this agenda, as a non-signatory to the Paris Accord. The challenge will be to find a means by which Canada's progressive agenda on climate change can be sustained economically in this environment, despite producers facing increased costs and a cost competitiveness gap vis à vis the U.S. As price-takers on international markets, producers will not be compensated for the increased costs of Canada's climate change targets through price increases. Farm groups have been organizing to communicate their concerns about the costs and opposition to certain climate change policies. Hence, a further challenge will be to illustrate and make the benefits of climate change initiatives more tangible to the sector.

Yet Canada may also seize an opportunity from this precarious situation. It is within this context that Canadian producers need to avail themselves of the options available to them to reduce GHG emissions and prevent costly adaptation to climate change. Unbeknownst to many, agriculture has already made substantial progress in reducing GHG emissions intensity of livestock production and has increased soil carbon through the wide-scale adoption of BMPs, precision agriculture, new crops, new technologies, and education and training.

Nevertheless, livestock production faces pressure on climate change. The Canadian beef sector has made significant efficiency gains and has become one of the lowest emission-intensive producers in the world as a result of research, new breeds, feeding efficiencies and manure management. This is why it is essential that comparable metrics and data are developed to accurately measure agriculture's contribution and role in climate change. This will become particularly important as Canadian producers attempt to market their products with quality attributes that reflect our comparative advantage in GHG emissions efficiency. Industry cooperation at precompetitive levels will be essential for measuring and marketing these attributes.

Finally, certain facts about livestock production are ignored in discussions around meat consumption and climate change. A reduction in meat consumption will not necessarily mean there will be more productive farmland on which to grow alternative crops. Much of what livestock eat would not be consumed by humans as it is grown on marginal land that is not available for crops (e.g. grass). Also, a small percentage of what livestock eat would otherwise be wasted since it is derived from food waste or industrial byproducts (e.g. DDGs). In addition, livestock grazing has its environmental benefits, such as preserving wildlife habitat on pastureland, and sequestering carbon, which are also not acknowledged in the IPCC Report.

Research on the environmental effects of livestock has tended to focus on GHG emissions rather than environmental effects more broadly, and the context of environmental effects of other food supply chains. This not only threatens a lack of balance in assessment, but also removes the ability to use policy instruments to balance off the effects of different food supply chains, and ultimately to mitigate or improve overall environmental effects of the food system.

Nevertheless, buried deep within the IPCC Report is a statement that holds promise for the Canadian agriculture and agri-food sector. This refers to their conclusion that major opportunities for adaptation and mitigation can come from balanced diets composed of not only plant-based foods, but also "animal-sourced foods produced in resilient, sustainable and low-GHG emissions systems." Given the Canadian agriculture sector's progress made thus far on this front, there is reason to be optimistic that Canada can be a leader in this area, and that the agriculture sector will continue to be a climate change solutions provider as Canada strives to achieve its climate change targets in 2030. What remains is for the sector to better understand its role as a solutions-provider, along with the economics and policy to support it.

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