REDUCING GHG EMISSIONS FROM CANADIAN AGRICULTURE

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A Symposium on
Environment in the Courtroom:
Enforcing Canadian GHG Emissions Laws

October 25 - 26 2018
Université Laval

Université Laval
Faculté de droit
Chaire de recherche du Canada
en droit de l'environnement

University of Calgary
Faculty of Law

Canadian Institute of Resources Law
Institut canadien du droit des ressources

This project was undertaken with the financial support of:
Ce projet a été réalisé avec l'appui financier de :

Environment and Climate Change Canada
Environnement et Changement climatique Canada

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Introduction: Agriculture and Global Climate Law

"To ensure that food production is not threatened" would not be widely recognized as one of three explicit considerations applicable to the UNFCCC's over-arching objective of "stabilization of greenhouse gas concentrations …" [1] Equally noteworthy is recognition in the Paris Agreement of "the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to … climate change." Combining concerns for mitigation and adaptation, the Paris Agreement refers specifically to "Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production"[2]

More generally, policy makers have been advised of three global limits: "the quantity of food that can be produced under a given climate; the quantity needed by a growing and changing population; and the effect of food production on the climate."[3] While we can therefore assume that global climate law encompasses agriculture, it is noteworthy that the activity mentioned is food production rather than agriculture. Noting the tendency to focus on adaptation and resilience, this presentation seeks to highlight opportunities and challenges associated with mitigation.[4]

Delineating the Scope of the Agriculture Sector for Climate Change

On the assumption that you cannot confidently regulate what you cannot define, it is worth asking about the relative scope of food production and agriculture. A recent analysis explains that GHG emissions attributed to agriculture for purposes of *UNFCCC* instruments originate from a range of sources - some but not all involving land-use, and some involving CO_2 as well as other gases, notably methane and nitrous oxide. These sources were not being treated in "an integrated, sector-specific way," with the consequence that the IPCC eventually formulated the AFOLU category (Agriculture, Forestry and Other Land Uses) to address inconsistencies and double counting.[5]

Challenges of categorization also arise within domestic arrangements. Agriculture and Agri-Food Canada (AAFC), for example, explains that its Agricultural Greenhouse Gas Indicator: "does not attempt to capture carbon dioxide emissions from fossil fuel consumption by farm machinery, as these emissions are typically reported by the manufacturing and transportation sectors."[6] More recently, for purposes of the federal *Greenhouse Gas Pollution Pricing Act*, agriculture is equated with "farming," the latter defined to include "tillage of the soil, livestock raising or exhibiting, maintaining of horses for racing, raising of poultry, fur farming, dairy farming, fruit growing and the keeping of bees, but does not include an office or employment under a person engaged in the business of farming."[7]

A description of agriculture, to inventory highlights, may involve: land preparation, seed planting, nutrient application, pest management, irrigation, harvesting or collection, storage and delivery. If delivered for processing or as an ingredient, agricultural produce will then be processed, packaged and distributed to retail, commercial or industrial consumers. The continuing story-line at the household level includes purchase, transport, preparation, consumption and waste. Appropriate modifications would produce a livestock narrative.

This approach to agriculture extends its scope significantly beyond activities on the farm. This broader approach was adopted by FAO in its formulation of Climate Smart Agriculture (CSA). CSA activities might involve on-farm activity including land management practices, plus food-processing arrangements, as well as retail distribution processes and consumption.[8] The agriculture and agri-food system as understood by AAFC is also multi-dimensional: "a complex and integrated supply chain that includes input and service suppliers, primary producers, food and beverage processors, food retailers and wholesalers, and foodservice providers."[9]

CSA has gained some traction in Canada and is of interest for present purposes: "agriculture that sustainably increases productivity, resilience (adaptation), reduces/ removes GHGs (mitigation), and enhances achievement of national food security and development goals."[10]

The extent to which mitigation initiatives in agriculture merit attention depends ultimately on their potential to make a difference. Canada is 7th ranked by arable land surface after India, the US, Russia, China, Brazil, and Australia. Some Canadian farming operations are large on an individual basis. If, in addition, a successful initiative on one not-necessarily-large farm might be replicated across 200,000 Canadian farms with 36 million hectares of active cropland you make a difference. Regrettably, it is not quite so straightforward.

The scale point – with reference to adaptation - was addressed in the Working Group II contribution to the Fifth IPCC Assessment Report: "adaptations can occur at a range of scales from field to policy."[11] WGII further observed: "effective adaptation will often require changes in institutional arrangements and policies to strengthen the conditions favorable for effective adaptation including investment in new technologies, infrastructure, information and engagement processes." Also noteworthy is reference to "the sector-specific nature of many adaptations". Similar considerations apply to mitigation.

GHG Emissions from Agriculture

With reference to yet another conceptual category, it has been suggested that as much as 29% of global GHG emissions can be attributed to "food systems."[12] Setting aside divergent understandings of food systems and agricultural sectors, let alone the challenge of orderly reconciliation, it is possible to report Canadian data. Prominent conventional assessments allocate about 10% of Canadian GHG emissions to agriculture.[13] Viewed provincially, however, agriculture is recognized as a far more significant contributor, 30% in Manitoba, for example.[14]

The 10% assessment differs somewhat from the *National Inventory Report for 1990-2011* as communicated by AAFC:

> "In 2011, the net GHG emissions (emissions minus absorption by soils) from Canadian agricultural activities, excluding fossil fuel use, amounted to 42 million tonnes of CO_2 equivalents (Mt CO_2e) which is equal to about 6% of Canada's overall GHG emissions. Total agricultural GHG emissions (not factoring in carbon sequestration by agricultural soils) comes to 8% of Canada's total emissions."

In addressing trends, AAFC noted that the contribution of methane (largely attributable to livestock operations) had increased by 2% with nitrous oxide emissions (associated with fertilizer use and manure) up 31%. These GHGs are highlighted for their dramatically greater greenhouse effect in comparison with the benchmark CO_2. Noting a long-term decline in net agricultural GHG emissions AAFC, summarized long-term findings:

"The index illustrates a relatively constant trend since 1981, with emissions caused by increased production being largely countered by improvements in production efficiency and by enhanced carbon storage in soils due to tillage reductions."

Accompanying analysis identified several relevant trends. Firstly, prairie farmland is functioning more effectively as a carbon sink, a change attributed to adoption of improved land management practices. Reduced GHG emissions were also associated with declining animal populations, notably beef and dairy cattle. Countering the declines were increased emissions associated with increased volumes of nitrogen fertilizer[15] and Eastern Canadian farm activity.[16]

Mitigation in Agriculture

National Framework

The *Pan-Canadian Framework on Clean Growth and Climate Change* combines agriculture with forestry and waste in a highly generalized statement noting opportunities for carbon storage through land management practices and bioenergy. "Continued innovation and clean technology in agriculture will build on past GHG reduction successes of decreasing emissions per unit of production."

Subsequently, the framework was elaborated through the 2017 Canadian Agricultural Partnership, including a projected investment of $3 Billion. Pursuant to this arrangement, provinces "will make investments to enhance carbon storage in agricultural soils, generate bioproducts and biofuels, and advance research and innovation to support GHG emission reductions in the agriculture sector."[17]

Several national research initiatives are seeking supportive insights, including a 2013 report by the Council of Canadian Academies. The project surveyed research oriented in part around climate change impacts and irrigation efficiencies using less energy to meet water requirements in the primary agricultural sector.[18] That invitation for research around the inter-section of climate/ water/ energy and agriculture[19] was echoed and elaborated in NSERC's 2016 call for Strategic Partnership Grant Applications. In connection with the theme of "Adapting agricultural production systems to climate change," NSERC invited researchers to identify adaptation options and risk management tools while encouraging attention to synergies and trade-offs between adaptation and mitigation.[20]

AAFC's Agricultural Greenhouse Gases Program has sponsored GHG reduction or removal projects on livestock systems and cropping practices. Among the former are studies of cattle grazing systems, beef cattle diets and hog manure application. One of the cropping studies seeks to increase soil carbon sequestration and reduce nitrous oxide emissions by comparing perennial cereal crop systems with annual cropping.[21]

Provincial Mitigation Initiatives

Implementation of specific operational initiatives is most apparent provincially. Alberta, for example, echoing FAO's Climate Smart Agriculture (CSA) framework, anticipates improved productivity, strengthened resilience, and reduced GHG emissions. With a specific focus on GHGs, Alberta seeks to:

1) Reduce emissions from livestock, fertilizer, manure and fuel
2) Replace fossil fuels with bio-based renewable energy

3) Remove atmospheric carbon and store it in soils.

Most other jurisdictions are pursuing a comparable suite of measures directed at croplands, livestock and energy, with the latter divisible into energy efficiency initiatives and renewable production.[22] Renewable biofuel programs, in turn, have on-farm and off-farm dimensions.

Croplands:

The emphasis in relation to croplands and GHG emissions/ carbon retention is on farm practices, notably tillage, nutrient management, and irrigation. Conservation or "one-pass" tillage reduces soil disruption and lowers energy use. Agronomic improvements, particularly in relation to fallowing and cover crops offer opportunities to reduce nitrous oxide emissions. The timing and monitoring of fertilizer applications via precision agriculture similarly offers benefits associated with lower fuel consumption and avoidance of unnecessary distribution of fertilizer.

Turning to irrigation, the individual farmer's search for water efficiencies may initially be driven by the prospect of adapting to shortages, but the resulting innovations typically involve reduced energy use. This is a farm-level cost saving that contributes to substantial emission reductions.

Statistics Canada distinguishes several types of irrigation (sprinklers, micro-irrigation, and surface) and analyses their use in relation to separate categories of crops (field crops e.g. canola and soybeans; forage crops such as hay and alfalfa; fruit operations where irrigation is also used as protection against frost and heat; and vegetable crops).[23]

In addition to conventional water-conservation practices such as night/morning watering; water/ energy saving nozzles; pressure reduction; and soil enhancement, soil monitoring innovations are now being introduced with a view to refining information on irrigation needs for particular crops in precise soil conditions with reference to current weather forecasting.[24]

Livestock

Ruminants (aka cows or cattle) and their diets are a second centre of innovation. This activity, in the assessment Alberta's Ministry of Agriculture and Forestry, has potential to increase feed utilization, lower costs, and reduce methane emissions. This represents the Canadian domestic equivalent of Clean Development Mechanism projects that Trans Alta Utilities initiated with Indian and Ugandan farmers nearly two decades ago in the *Kyoto Protocol* context.[25]

Manure is a further focus of attention. Legislation designed to reduce nutrient flows into waterways and thereby prevent pollution has hugely expanded the use of manure management systems including storage tanks.[26] Many of these are now being viewed as viable sources of methane-based biogas.

Energy Efficiency and Biofuels

In addition to the energy savings noted in connection with cropland management, a number of highly particularized energy efficiency programs and proposals are being developed, as illustrated by guidance provided by the Ontario Ministry of Agriculture, Food and Rural Affairs that is specifically relevant to corn, grains, and hay.[27] On the livestock side, specific advice is targeted at dairy producers, or exclusively designed for poultry operations, or aimed uniquely at hog farms. A similar approach is evident elsewhere, British Columbia, for example, where energy saving

guidance is directed to dairy, field crop, grain, greenhouse, nursery, orchard, poultry, and vineyard operations.[28] Even more general guidance documents promoting energy savings within the climate response agenda underscore the complexity of agricultural operations. Instructional materials include efficiency guidance for lighting, for fuel efficiency, for ventilation, for irrigation, for crop drying and storage and for stand-by emergency powers systems.[29]

As noted above, improved manure management arrangements facilitate methane capture for on-farm use, or allow transfer off-site to centralized facilities. Threshold-based requirements along these lines have been introduced in some US states or projects may be encouraged where offset arrangements operate to support the necessary capital investment.[30] In Canada, agricultural biogas is promoted alongside other green energy opportunities in Ontario,[31] while in Alberta – with financing from major GHG emitters in the province – Lethbridge BioGas draws on an abundance of local manure (dairy, hog and poultry) in combination with other organic materials to produce power for the energy market-place.[32]

Agriculturally-related Non-Farm Mitigation

Additional mitigation opportunities involving the agricultural sector as producer, supplier and shipper may also be noted.

The Canola Council of Canada emphasizes new market opportunities in biodiesel, including the EU renewable fuels market.[33] More generally, in terms of market enhancement, the constitutionality of Canada's *Renewable Fuels Regulations*, SOR/2010-189 was recently upheld with specific reference to the strategic inter-relationship between energy, environment and agriculture.[34]

A California company (Apeel Sciences) is developing fruit and vegetable coatings from natural materials. This innovation offers the possibility of lower energy requirements for shipping and refrigeration accompanied by reduced wastage.[35]

Continued improvements to rail transportation – involving substantial food shipments – offer significant opportunity for emissions reduction.[36]

The Legal Framework

Through nutrient management legislation, regulations calling for emissions reporting[37] or requiring the use of renewable fuels in specified circumstances,[38] for example, certain supports for mitigation initiatives in agriculture have been firmly established. Pricing of methane emissions federally is now addressed, together with specified exemptions for "farming" in the *Greenhouse Gas Pollution Pricing Act*. At the provincial level, BC exempted agriculture from the carbon tax regime, while Manitoba has expressed concern that exempting agriculture from GHG reduction initiatives would place a disproportionate burden on other sectors.[39] Other observers point to differential impacts on a large agricultural sector as an argument for cap-and-trade over carbon taxes.[40] Other mitigation support measures with firm legal foundations include the availability of favourable tax treatment (accelerated capital cost allowances) on investments in renewable energy equipment.[41]

Generally, however, GHG mitigation measures in agriculture, (more narrowly defined) have been encouraged or facilitated through policy rather than formally required. A software program made available through AAFC at no charge allows users at the farm level to estimate their current GHG emissions and then, by making an online substitution of a current practice for an

alternative (adopting a new cropping rotation, for example) to obtain information estimating new GHG emission levels accompanied by a cost-benefit analysis.[42] A farm practice alteration offering GHG mitigation in a cost advantageous manner would presumably be adoptable on a voluntary win-win basis.

Conclusion

While agriculture has not been overlooked from the mitigation perspective, its potential significance may not be fully appreciated. Given the internal diversity and complexity of the sector - with food production systems as a still more challenging consideration - it is easy to under-estimate the extent of the agricultural or agri/food sector and its intersection with energy, water, transportation, and waste – on-site and off.

At least partially in consequence, governmental measures have tended towards facilitation rather than prescriptive regulation.[43] Large-scale agricultural and food processing operations obviously have industrial attributes which invite appropriate regulatory interventions. But aspects of the overall agri/food landscape may be culturally distinctive because of the number of individual and smaller-scale operations involved.

To the extent that BMPs offer both environmental and efficiency/ economic benefits research to identify these and measures to enhance awareness and encourage adoption are highly attractive. In the same way that agricultural sustainability might benefit from a comprehensive, high-level national vision,[44] wider efforts to advance climate mitigation may be attractive alongside adaptation measures that have thus far tended to receive more attention.

[1] *The United Nations Framework Convention on Climate Change*, 12 June 1992, 1771 UNTS at 107 arts 2 and 2.1(b) (21 March 1994) [*UNFCCC*] Article 2. See also *Kyoto* Art 10 (b)(i).
[2] *Paris Agreement*, Preamble and 2. 1 (b).
[3] Beddington, J *et al*, "Achieving food security in the face of climate change: Final report from the Commission on Sustainable Agriculture and Climate Change" (March 2012) at 7, online (pdf): *CGIAR Research Program on Climate Change, Agriculture and Food Security* (CCAFS) <www.cgspace.cgiar.org/bitstream/handle/10568/35589/climate_food_commission-final-mar2012.pdf>.
[4] On adaptation in Canadian agriculture, see Wall, Ellen, Barry Smit & Johanna Wandel, eds, *Farming in a Changing Climate: Agricultural Adaptation in Canada*, (Vancouver: UBC Press, 2007).
[5] J Verschuuren, "Climate change and agriculture under the United Nations Framework Convention on Climate Change and related documents," ch 2 in MJ Angelo and A Du Plessis, *Research Handbook on Climate Change and Agricultural Law* (Cheltenham, UK: Edward Elgar, 2017), 22-3.
[6] Agricultural Greenhouse Gas Indicator online at: http://www.agr.gc.ca/eng/science-and-innovation/agricultural-practices/climate-change-and-agriculture/agricultural-greenhouse-gas-indicator/?id=1461014704763.
[7] *Greenhouse Gas Pollution Pricing Act*, SC 2018 c12 s186, section 3. For applicable exemptions see ss 17 (2)(a)(iii) and 36 (1)(b)(vii).
[8] Macharia, Joseph & Hope Johnson, "Co-producing climate smart agriculture knowledge through social networks: Future direction for climate governance" in Tim Cadman, Rowena Maguire & Charles Sampford, eds, *Governing the Climate Change Regime: Institutional Integrity and Integrity Systems* (Abingdon: Routledge, 2017) 212 at 215. The second edition of the FAO's CSA Sourcebook is online at: http://www.fao.org/climate-smart-agriculture-sourcebook/en.
[9] See AAFC, *An Overview of the Canadian Agriculture and Agri-Food System 2016*, http://www.agr.gc.ca/eng/about-us/publications/economic-publications/an-overview-of-the-canadian-agriculture-and-agri-food-system-2016/?id=1462288050282.
[10] FAO 2010 as quoted in Macharia and Johnson, supra 214.
[11] Porter, John R., *et al*, "Food Security and Food Production Systems" in *Climate Change: 2014 Impacts, Adaptations and Vulnerability. Part A: Global Security and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (2014) at 485, online (pdf): *Intergovernmental Panel on Climate Change* <www.ipcc.ch> [perma.cc/6S72-NW49].
[12] Schutter, Olivier De & Emilie Frison, "Modern agriculture cultivates climate change – we must nurture biodiversity", *The Guardian* (9 January 2017), online: <www.guardian.co.uk> [perma.cc/7MC3-PN56]. IPCC WG III in the Fifth Assessment Report attributes roughly 25% of anthropogenic GHG emissions to the AFOLU category. See also, Green Budget Coalition, "Recommendations for Budget 2019," ch 3.
[13]
[14] McKay, Todd & Robin Speer, "Farmers worry about climate change, but a Prius can't pull an air seeder", *The Globe and Mail* (17 May 2018) online: <www.theglobeandmail.com> [perma.cc/ECA9-Y6E2]

[15] The application of nitrogen fertilisers increased more than twice as fast as agricultural production since the early 2000s, and faster than in any other OECD member country. OECD, Canada Review, 2017, 23.
[16] Environment Canada, generally distinguishing on-farm fuel use, crop production and animal production, presents a somewhat different historical narrative accompanied by projections to 2030. See online: https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=1F24D9EE&offset=2&toc=show.
[17] Pan-Canadian Framework, *First Annual Report.*
[18] Council of Canadian Academies, "Water and Agriculture: Towards Sustainable Management of Water Resources", *The Expert Panel on Sustainable Management of Water in the Agricultural Landscapes of Canada*, online: <www.scienceadvice.ca> [perma.cc/9M3Q-46P8]
[19] Allan, Tony, Martin Keulertz & Eckart Woertz, "The water-food-energy nexus: an introduction to nexus concepts and some conceptual and operational problems" (2015) 31:3 Intl J of Water Resources Development 301.
[20] "Strategic Partnership Grants Target Area Descriptions" (last modified 12 December 2016), online: *Natural Sciences and Engineering Research Council of Canada* <www.nserc-crsng.gc.ca> [perma.cc/WMU2-74HD].
[21] Agriculture Greenhouse Gases Program – Approved Projects online at: http://www.agr.gc.ca/eng/programs-and-services/agricultural-greenhouse-gases-program/approved-projects/ See also the Global Research Alliance on Agricultural Greenhouse Gases online at: https://globalresearchalliance.org/
[22] Quebec, *Quebec in Action: Greener by 2020: 2013-2020 Climate Change Action Plan*, 31. https://www.gov.mb.ca/agriculture/environment/soil-management/soil-management-guide/greenhouse-gases-in-agriculture.html.
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[24] "The Internet of Farming," *CyberTrend* May 2017, 38
[25] A Pape-Salmon, "Canada's Potential Role in the Clean Development Mechanism," (Pembina Institute, 2000) 10, online at: https://www.pembina.org/reports/cdm-canada-role.pdf.
[26] For example, *Nutrient Management Act, 2002*. SO 2002 c4.
[27] http://www.omafra.gov.on.ca/english/engineer/con_energy.htm.
[28] "Saving Energy on Your Farm" online at https://bcagclimateaction.ca/overview/why-mitigation/saving-energy/.
[29] The Canadian Federation of Independent Business reported that 63% of farmers "are investing in equipment, machinery, or vehicles that are more energy-efficient or environmentally-friendly. CFIB, "Realities of Agriculture in Canada," (8 October 2014) online at: https://www.cfib-fcei.ca/sites/default/files/article/documents/5590_0.pdf.
[30] For a survey of US law and policy, see M Nowlin and E Spiegel, "Much ado about methane: intensive animal agriculture and greenhouse gas emissions, ch 9 in MJ Angelo and A Du Plessis, *Research Handbook on Climate Change and Agricultural Law* (Cheltenham, UK: Edward Elgar, 2017. For further examples, see https://www.manuremanager.com/energy/anaerobic-digestion.
[31] http://www.omafra.gov.on.ca/english/engineer/energy.html.
[32] http://www.lethbridgebiogas.ca/ . See also T Kryzanowski, "Canada's largest biogas plant,"
[33] Morgan, Geoffrey, "Shell Canada focuses on green energy", *Edmonton Journal* (7 June 2017), online: <www.pressreader.com/canada/edmonton-journal/20170607/282063391938533>.

[34] *Syncrude Canada v Canada (AG)*, 2016 FCA 160 at paras 64-70.
[35] Strom, Stephanie, "An (Edible) Solution to Extend Produce's Shelf Life", *The New York Times* (13 December 2016), online: <www.nytimes.com> [perma.cc/58B9-M7SC]. See also Hawken, Paul, ed, *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*, (New York, USA: Penguin Books, 2017).
[36] *Pathways: Connecting Canada's Transportation System to the World*, vol 1, ch 6, 88 online at: https://www.tc.gc.ca/eng/ctareview2014/CTAR_Vol1_EN.pdf.
[37] Q-2,r.15 Regulation respecting mandatory reporting of certain emissions of contaminants into the atmosphere.
[38] *Renewable Fuels Regulations*, SOR/2010-189
[39] MacKay and Speer, supra.
[40] Charlebois, Sylvain, "Carbon tax could compromise Canadian food sovereignty", *The Globe and Mail* (19 December 2016), online: <www.theglobeandmail.com> [perma.cc/52HK-M9A6]
[41] "Canadian Renewable & Conservation Expense 'Green' Energy Tax Incentives" (April 2013), online: *Miller Thomson* <www.millerthomson.com/en/publications/communiques-and-updates/tax-notes/april-2013/canadian-renewable-conservation-expense-2/>.
[42] http://www.agr.gc.ca/eng/science-and-innovation/results-of-agricultural-research/holos-software-program/?id=1349181297838.
[43] Agricultural exemptions from otherwise applicable mitigation requirements are not uncommon elsewhere.
[44] Chalifour, Nathalie and Heather C. McLeod-Kilmurray, "The Carrots and Sticks of Sustainable Farming in Canada," (2016) 17 *Vermont Journal of Environmental Law* 303 at 338.