Environmental Footprinting for Agriculture in Alberta:

Literature Review and Analysis

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Executive Summary

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All studies and previous research used in this report are listed in the References section of this report.

Executive Summary

The following is a literature review and analysis of environmental footprinting in Alberta, Canada and internationally, which would be appropriate for the development of an environmental accounting framework and measurement index for assessing the environmental impacts of food and agricultural production in Alberta. This literature review and analysis is part of a longer-term, federally funded project on "Environmental Footprinting Opportunities in Agriculture."

The objective of this long-term project is to develop a data baseline for future environmental footprinting, establish a new set of methodologies and tools to evaluate the environmental footprint of Alberta's agricultural industry and help guide and inform policies of Alberta Agriculture and Rural Development. The literature review examines the trends, drivers and studies relevant to the subject of environmental footprinting drawing from research, Life Cycle Assessment studies, grey-literature, industry reporting standards, and expert interviews.

The term **environmental footprinting** is a relative new and generic concept that generally refers to the assessment of energy use, greenhouse gas emissions (CO_2, CH_4 and N_2O), nutrients (fertilizers, manure), pesticide use, land use, (including impacts on biodiversity) and water attributes of agriculture and food production. Life Cycle Assessment (LCA) is one of the tools for conducting environmental footprinting. Lillywhite (2008) used the term, environmental footprint for agriculture, to refer to a hybrid method of incorporating four environmental indicators (pesticides, greenhouse gas emissions, eutrophication, acidification, and water use), drawn from a subset of agricultural LCA data, and presented in a single per hectare metric.

Driving the demand for environmental footprinting and environmental indicator reporting are growing demands for accountability for sustainability accounting and reporting by all sectors: consumers, retailers, industry associations, producers (farmers), and governments. The greatest demand for environmental performance accountability is currently coming from food retailers like Wal-Mart, Marks and Spencer (UK), McDonalds, and Loblaws who have established a set of environmental and social indicators or criterion and performance scorecards for their suppliers that will ultimately extend to the producer and farmer.

Wal-Mart has become the most important leader in demanding environmental and social performance information from their suppliers.

The **Global Reporting Initiative (GRI) guidelines** are the international standard for environmental, social and economic (or sustainability) measurement and reporting used by over 1500 enterprises from all industrial sectors around the world. The GRI guidelines represent the most comprehensive framework for environmental footprinting and have been key to guiding the development of sustainability measurement and reporting by major corporations like Wal-Mart and McDonalds, and their environmental scorecards for their supply chain. More recently GRI produced a set of sustainability reporting guidelines for the food processing industry that is particularly relevant to Alberta's food processing industry, though not directly relevant to farmers. While several major global food producers (farmers) and retailers have used the GRI guidelines to develop CSR and sustainability reports, only a relatively small number of Canadian companies use the GRI guidelines and no Canadian food processor has used the GRI supplement for food processing industries. Unlike other environmental reporting standards like ISO 14000 or certified organic protocols, the use of the GRI guidelines remain voluntary and are not the basis of certification. This makes comparability of GRI-based sustainability indicators and reports difficult. Nor are the GRI guidelines prescriptive in terms of measurement protocols, although GRI has also produced measurement protocols for energy use and water use development that will help standardize reporting on these two key environmental performance variables. These protocols provide detailed and tangible guidelines for how organizations can begin to take a comprehensive life-cycle accounting approach to assessing water use and water discharge impacts.

Notwithstanding these challenges, the GRI guidelines represent a gold-standard for environmental, social and economic sustainability reporting and will likely influence how environmental footprinting and reporting will be conducted in Alberta's and Canada's agricultural and food industries. There is new evidence that companies like Agrium, Loblaws, Wal-Mart, TESCO, Whole Foods Market Inc., and Tyson Foods are beginning to report on some select aspects of environmental and social performance that use the GRI indicator guidelines.

Ecological Footprint (EF) analysis is a biophysical assessment tool that accounts for the environmental impact of consumption. The EF measures how much of nature, expressed in a common unit of bioproductive space (hectares or acres), is used for producing food, energy, transportation needs, housing needs, goods and services, and other materials for a given human population. The estimated EF, expressed as hectares, is compared with the available biocapacity or bioproductive land to a population to assess the sustainability of lifestyles. There have been no studies using the EF methodologies for estimating the biocapacity of Alberta or Alberta agriculture in particular. Ecological Footprint is sometimes mistaken for *environmental footprint*; the EF is a standardized biophysical assessment tool with specific methodological protocols while the *environmental footprint* is a generic term to account for a broad suite of environmental impacts. While the Ecological Footprint Analysis (EFA) can be used to estimate the impact of a given agriculture commodity or class of commodities, there have been few EFA studies focusing specifically on agriculture (e.g. an EF calculation for Israel's grain consumption). While a useful tool for accounting and communicating the overall impact of household consumption on the appropriation of land (for food and materials) and resources (energy), the EF has limitations and is particularly limited for assessing the environmental impacts of agricultural operations.

While water has been traditionally overlooked in the EF biophysical assessments, a number of methods to account for the **water footprint —** defined as the total volume of freshwater that is used to produce the goods and services consumed by a given population — have been under development to illustrate the hidden links between human consumption and water use and between global trade and water resources management.

Life cycle assessment (LCA) is an ISO-standardized analytical framework which evaluates the environmental performance of products, services and activities throughout their entire life history, from "cradle to grave." ISO 14040 and ISO 14044 series, as an example, provides guidance for formal LCA studies including key methodological choices, reporting and application of results). LCA assessments track the flows of matter and energy from the initial extraction of resources, through processing, packaging, transportation and distribution, and finally to the end use of products and disposal or recycling of remaining material. Inputs of resources and outputs of emissions throughout the life cycle are inventoried and translated into contributions to a suite of environmental impact categories of global concern, including global warming, ozone depletion, and energy use. LCA is considered one of the standard quantification tools for assessing environmental impacts and for environmental footprinting and has been used successfully in applications to agriculture and food processing.

Over the past decade, a growing body of research has applied the LCA methodology to products derived from primary agriculture sectors, as well as secondary processing industries producing value-added products. Much of the LCA work on agriculture has been carried out in Europe with a small but growing body of literature examining agricultural production chains in North America. North American LCA studies for grains, beef, dairy, poultry and pork production have focused primarily on energy use and global warming potential from GHG-emissions, and to a lesser degree on acidification potential, eutrophication potential and ozone depletion impacts. LCA has also been employed to compare production practices and model potential benefits of alternative agricultural practices, for example the comparison of organic production methods to conventional methods of agriculture. While there have been a number of proposed methodologies to account for land use impacts and water use impacts, these factors are seldom considered in LCA. The importance of water quality and scarcity and the long-term impacts to soil fertility from land-use practices will require consideration of these factors in future LCA studies of agriculture.

LCA studies that are particularly relevant to Alberta agriculture includes: a) a life cycle assessment of the transition to organic agriculture from conventional production for canola, corn, soy and wheat; b) a life cycle analysis of carbon dioxide equivalents (CO_2e) of Alberta barley, wheat, peas and canola meal used in pork production, slaughter and further processing; c) a life cycle analysis of carbon dioxide equivalents (CO_2e) of Alberta barley, wheat, peas and canola meal used in pork production, slaughter and further processing; d) a life cycle assessment of greenhouse gas emissions from beef production in western Canada; e) environmental performance in the US broiler poultry sector, including life cycle energy use and greenhouse gas, ozone depleting, acidifying and eutrophying emissions, and: f) comparative life cycle environmental impacts of three beef production strategies in the Upper Midwestern United States.

While LCA for agriculture has its strengths for assessing environmental impacts, there are several shortcomings. LCA studies are often difficult to compare across studies, jurisdictions and industries and may not be transferable from one region or country to another jurisdiction. This may be due to differences in methodological assumptions, equivalency factors or coefficients, and the delineation of system boundaries. A critical methodological challenge in agricultural LCAs is the handling of co-product allocation; when a system or process has more than one output, the burden must be allocated among products appropriately without double-counting impacts. There is also a lack of reliable and open-source data and LCA studies can be costly and time consuming. As well, LCA does not typically consider social or economic impacts associated with the system being studied – although there is growing interest in refining the application of LCA-styled tools to these other areas, including life cycle costing (LCC), and social life cycle assessment (S-LCA). Even LCAs of agriculture do not always capture the impacts of the entire life cycle of food products, and often include only those activities up to the "farm gate", and do not consider the potential impacts after the product has changed hands to wholesalers, retailers and consumers.

As a tool for assessing sustainability, LCAs typically do not extend well to aspects of environmental sustainability, such as biodiversity impacts (habitat quality) and land use impacts on soil fertility or health, which are not easily quantified. Examples of land-use impacts not otherwise considered in LCA studies include: degradation of biodiversity; soil erosion; loss of soil fertility; impacts on nutrient cycling; impacts on hydrology; and, one-time habitat loss. Given the importance of soil fertility to long-term food security and agricultural sustainability, measures of soil fertility, even if only qualitative metrics, should be part of a comprehensive environmental footprint assessment framework.

There are important practical issues to consider in agricultural LCA work. According to at least one LCA consultant, most of the data required to conduct agricultural LCAs can be sourced from government agricultural statistics and the publicly available LCA literature. Agricultural LCAs typically run this data through a generic farm model, with coefficients adjusted for variations in operating, soil and growing conditions. However, the generic farm models are assumed to apply to any given agricultural system. Modeling has its limitations, namely that actual farm-level operating statistics are not being collected or used providing a potentially inaccurate accounting of inputs and commensurate environmental impacts.

Other initiatives and tools for assessing the environmental impacts of agriculture and food production were examined including the US-based *Field to Market* **Fieldprint Calculator**. *Field to Market* is the initiative of the Keystone Center, a non-profit organizations dedicated to developing indicators to estimate the environmental, economic, social, and health outcomes of agriculture in the United States. The Calculator allows farmers to better understand how their crop production operations, including land use, water use, energy use, soil loss, as well as climate impact wheat, corn, soybeans, and cotton farming sustainability. The calculator is correlated with national level outcomes used in their environmental indicators report.

The Swiss Federal Office of the Environment has developed the **ecological scarcity method**, a ‘distance to target method’ of life cycle impact assessment, that uses eco-factors, expressed in eco-points per unit of pollutant emission or resource extraction, to rate all Swiss food products. The eco-factors are determined by both the current emissions (to water, air and soils) situation and secondly, by the political targets set by Switzerland or by international policy and supported by Switzerland. The method assesses a number of eco-factors including: CO_2 and energy; air pollutants; heavy metals and arsenic emissions to soil, surface and ground waters; endocrine disruptors in waters; radioactive isotopes in the seas; amount of freshwater consumption impacts of land use on plant biodiversity, and; the assessment of bioreactive landfills. The other factors include the extraction and use of energy resources (non-renewable and renewable), land use, gravel extraction, and freshwater consumption. The selection of these emissions or substances is guided by their ecological and political relevance. The Swiss ecological scarcity method is one of the most rigorous, comprehensive (covering every aspect of emissions to land, water and air, resource use and waste) and pragmatic applications of LCA we reviewed from the literature. The Swiss method shows the potential for using scientifically and politically-based targets (established in law and based on science) as a basis of environmental performance measurement that could be applied to any variety of agricultural products and processes.

Lillywhite (2008), a UK-based academic who has conducted LCA studies in agriculture, proposes the development of the **environmental footprint** index, which incorporates four, weighted environmental indicators (pesticides, greenhouse gas emissions, eutrophication and acidification, and water use) drawn from a subset of agricultural LCA data. Actual environmental data is normalized against a minimum and maximum standard established either from scientific evidence or political/policy targets. The result is a numeric score or index that can be reported on a per hectare basis. Lillywhite suggests that labeling food products with an environmental footprint value is more useful to consumers than simply a carbon footprint value.

Our environmental scan found that major retailers like Wal-Mart, McDonalds, Unilever and Marks & Spencer are leading the demand for environmental and social impact reporting from their suppliers and in turn food producers. Marks & Spencer, for example, wants to become one of the world's most sustainable retailers. According to a recent industry benchmark study of best sustainability practices, Marks and Spencer ranked first ahead of Wal-Mart for innovations that include: a balanced performance scorecard for its suppliers, becoming carbon neutral, sending no waste to landfill, extend sustainable sourcing and a Sustainable Agriculture Program, that will include labeling all of its food items according to food miles giving preference to the 10,000 UK farmers who supply them with fresh meat, dairy and produce. Unilever has made attempts to evaluate its entire value chain from supply through distribution. McDonalds has been using its environmental scorecard to evaluate the environmental performance of its suppliers for several years. Loblaws, Canada's largest retailer, while having adopted some new standards (e.g. sustainable seafood policies) appears to lag these other international retail giants with respect to supply chain environmental monitoring and reporting. Calgary-based Agrium has been working on environmental footprint reduction protocols for farmers and is using their subsidiary called CROP to collect GHG offsets, based on best-management conservation practices, and are developing reporting protocols with industry associations.

Wal-Mart, the world's largest retailer, has emerged as the single-largest driver for environmental and social impact monitoring and reporting. Wal-Mart recently established its own Supplier Sustainability

Assessment Standards for its 60,000 suppliers and a sustainability questionnaire and scorecard for its suppliers. A supplier sustainability index or 'scorecard' considers performance in four key areas: climate and energy, material efficiency, natural resources, and people and community. According to a sustainability and LCA consultant, Wal-Mart is setting the international standard and catalyzing the international market place with what Wal-Mart calls its Productivity Loop or supply chain management expectation of its suppliers. Wal-Mart and other companies are trying to improve the productivity of its supply chain by working directly with producers, manufacturers and distributors to increase the efficiency of the environmental and water footprints of its products. Wal-Mart appears to be motivated by several factors including maintaining its low price competitive advantage; working internally and with other suppliers, Wal-Mart has found cost savings and innovation opportunities by investigating energy use, waste streams and other impacts on natural resources and the community. Wal-Mart sees tremendous potential for driving down costs, reducing environmental impacts of its products, and enhancing quality while helping its suppliers become more sustainable. Another reason is that Wal-Mart is responding to an increasing level of consumer and media consciousness of sustainability issues that include climate change, toxic substances, ethical sourcing and excessive consumption. Some experts believe that Wal-Mart is being strategic by testing the readiness of their suppliers and the market for environmental performance monitoring. Indeed, the list of demands for environmental and social impact reporting of Wal-Mart's suppliers are likely to expand into more challenging areas of measurement, beyond even conventional LCA parameters. One potential area to watch is the growing concern by some retailers of the rising cost of transportation (due to the anticipated rise in fuel costs because of the end of once cheap oil supplies) and thus a potential shift to sourcing food located in closer proximity to retail outlets. As environmental and social reporting begins to mature, indicators will likely become less qualitative and more quantitative.

While there are measurement and reporting challenges faced by Wal-Mart's suppliers, the development and adoption of Wal-Mart's sustainability scorecard and sustainability assessment standards should have significant and lasting impacts in shaping environmental and social indicator measurement and reporting. Environmental reporting pressures on food processors will likely be transferred down the supply-chain to farmers and producers. Wal-Mart may establish its own benchmarks for best environmental performance or best environmental footprint profiles amongst its suppliers. This will likely drive a new kind of competition amongst producers to compete both on price points and most efficient and sustainable environmental and social performance for its products. This will result in new challenges for agricultural producers in meeting these new expectations, both in terms of monitoring and reporting.

A notable benchmark in our literature review was **Nature’s Path Foods**, based in Richmond, B.C. Nature’s Path is a good example of an organic food producer and processor that buys certified organic grains and produce from farmers and produces and sells their organic products in both Canada and the US through retailers like Wal-Mart. Nature’s Path Foods has experienced the challenges of complying with Wal-Marts Sustainability Assessment Standards largely because they source their own grains and inputs to their food production from certified organic producers. Because organically certified products have rigorous environmental standards Natures’ Path products may already represent a ‘gold-standard’ amongst Wal-Mart suppliers. For example, organic products effectively eliminate 100% of pesticide, artificial fertilizers, do not use Genetically Modified Organisms (GMO), and rely only on rainwater for irrigation. Nature’s Path Foods is also unique in that they consider the long-term impacts of their production and supply-chain relationship with organic farmers by considering the implications to soil and ecosystem health over time.

Another notable benchmark for certification of environmental performance in agriculture, in addition to certified organic, is **Local Foods Plus** (LFP) an Ontario-based non-profit organization that helps to support demand for local food producers in Ontario by certifying production that meets its local production and sustainability criterion. LFP screens food producers using a series of sustainability criterion that include sustainable production systems that reduce or eliminate synthetic pesticides and fertilizers, avoid the use of hormones, antibiotics, genetic engineering, and conserve soil and water. Other criterion include: a) safe and fair working conditions for on-farm labour; b) healthy and humane care for livestock; c) enhance wildlife habitat and biodiversity on working farm landscapes, and; d) reduce on-farm energy consumption and greenhouse gas emissions. This is a good example of an industry association driving the standards for environmental footprinting and sustainability reporting. In our opinion, the LFP standards might represent the ‘LEED Certified Platinum’-equivalent standard for agriculture in Canada if they were to also consider the inclusion of energy, water and waste measurement parameters from the GRI guidelines. At least two Alberta organic farmers have been certified by LFP.

In terms of **data sources** for conducting environmental footprinting analysis, agricultural LCAs, GRI environmental and social indicator guidelines and meeting emerging retailer reporting expectations, we have some concerns. We are unable to comment on the capacity of Alberta farmers and food processors to respond to new environmental and social indicator reporting demands from retailers like Wal-Mart. However, Alberta farmers should have the ability to record and provide large amounts of data necessary to conduct LCA of production processes and meet Wal-Mart supplier sustainability standards. Much of the data, however, is in the private rather than public domain. A cursory assessment of known publically available data sources reveals that there are several sources of public data that may complement farm-acquired data. Notwithstanding, there are apparent data gaps that could be filled with farm-level monitoring and reporting, LCA modeling studies, or with the use of coefficients that could convert production statistics to GHG emission equivalents, pesticide impacts related to eutrophication and acidification, as examples.

In conclusion, the demand for environmental and social sustainability performance rating systems are likely going to grow in the 21st century, led by retailers like Wal-Mart. This will mean that real sustainable product innovation by producers and suppliers of agricultural food products will need to demonstrate a deep understanding of the environmental and social attributes of their products, the materials and energy that go into them, the possible human and ecological health impacts of their operations, and a deeper knowledge of the product development processes used to create them. The role of governments in this new field of environmental and social reporting, vis-à-vis agricultural producers, remains to be defined. We believe governments can play a key supporting role in accounting for the macro-natural capital or environmental conditions at the provincial and regional levels and in assisting producers with sustainability reporting and planning.

The following recommendations are provided for consideration by Alberta Agriculture and Rural Development with respect to developing an environmental footprint model and environmental indicator reporting system for Alberta's agriculture and food processing industries:

Recommendation 1: Develop and support an Alberta environmental and social impact data monitoring, impact assessment and reporting system, as well as measurement guidelines or protocols for Alberta's key agricultural products and processes to meet emerging food retail and food processing environmental accountability demands.

Recommendation 2: Develop a data inventory to support certification and participation in supply chain sustainability programs.

Recommendation 3: Research community-based data collection options including implementing an electronic environmental reporting structure and tracking key data as part of annual farm survey.

Recommendation 4: Assess the Alberta's agriculture biocapacity and soil fertility based on eco-zone specific yield factors.

Recommendation 5: Develop and support a made-in-Alberta environmental and social impact indicator performance reporting system and protocols for agriculture.

Recommendation 6: Explore the possibility of expanding the agricultural protocols established as part of Alberta's offset trading program to quantify environmental benefits beyond CO_2 savings. Other possible impact categories to include are: eutrophication and acidification potential, land impact, and water use.

Recommendation 7: Explore the possibility of offering incentives to encourage farmer participation in an environmental reporting framework.

Other considerations for the development of an environmental footprinting model and sustainability indicator and reporting system for Alberta agriculture are offered including: a) A proposed model needs to be based on scientific protocols and relevant local data and be useful to the agricultural community; b) A robust accounting system needs to be populated with good data, cognizant of data availability, data costs, and reliability of data sources, and; c) Assumptions behind the model should be transparent and data sources open, with users having the capacity to change or modify the assumptions to reflect their unique operating situation or provide feedback to adjust models for future updates.