Chasing Fossil Fuels in the Food System

by

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ABSTRACT

A carbon tax has already been introduced in British Columbia, Canada. It is likely that other carbon regulations will come into play across the globe shortly. In all likelihood, with the introduction of a domestic agreement pricing emissions, there will be border tax adjustment or other similar policy response proposed. For example, as the European Union (EU) enters the next development phases for their Emissions Trading System, a border adjustment on GHG emissions, also known as a "Border Carbon Adjustment" (BCA) (Fisher and Fox 2009) is being considered. It may work to displace concerns related to domestic competitiveness and carbon leakage from the trade of outsourced goods (including for example food, clothing and cars). In the absence of an international agreement to account for monitoring, pricing or capping GHG emissions, Canada's response to GHG emissions or Carbon regulations is challenging policy makers. This thesis explores the feasibility of implementing a BCA on a sample of whole foods imported to Canada. It uses numerical industry trade data to create a snapshot of hypothetical Carbon Tariff estimates that reflect GHG emissions from the production and transport of a sample of whole foods imported to Canada. It investigates methods for accounting GHG emissions, trade legalities in the food system and the idealized characteristics of BCA design; it concludes by suggesting a BCA or any other policy tool reliant on GHGe accounting standards could not easily or effectively be implemented as a worthwhile or counteracting response to potential undesirable effects of domestic carbon regulations in any country at this time (2011). Finally, this paper recommends future research in the areas of GHGe accounting standards, food system transparency, product labeling and municipal policy tools as means of reducing GHGe from food production, while avoiding the repercussions of carbon regulations.

PREFACE

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This paper is dedicated not to one, but to all of the porters in the Himalayas of India and Nepal, working to provide sustenance for people both living and traveling in the foothills and hiking circuits of Jiri, Annapurna, Mount Everest and more. Their nobility in hauling, on their backs, over 100 kilograms of everything from Coca Cola and beer to deodorant and Mr. Noodles for 7-28 days of hilly trails to Mount Everest and beyond illuminated and inspired me to consider how goods and foods could be priced as a function of weight and distance traveled (by flip flop at that!). It was the porters in the foothills who I saw provide more encouragement and positive value amongst themselves, strangers, children and trees than any other trekkers I met. Keep on keepin' on good fellows. Hallelujua will meet you at the top.

CHAPTER 1 INTRODUCTION

We have a level of urgency that far surpasses anything that may have boosted previous transitions (Figueres 2011)[1].

Climate change is one of the most important environmental issues of our time, requiring urgent action on the part of all governments and citizens (Environment Canada, 2011).

1.1 Context and Overview

Understanding how climate change and trade policy may affect agriculture and food systems' roles in reducing global greenhouse gas emissions (GHGe) is of utmost concern to policy makers today. Current World Trade Organization (WTO) Doha Round negotiations[2] will set future rules for agricultural trade, likely finishing before 2012 or 2013. Regardless of what happens in the Doha Round negotiations, an increase in trade of agricultural products is projected to occur throughout the following decades (Thompson 2010). A likely future of trade liberalization and population growth is projected to increase demands for food faster than agricultural production can grow; this will affect trade volumes and encourage greater fossil fuel consumption by the transport sector.

Parties to the United Nations Framework Convention on Climate Change and the Kyoto Protocol participated in a series of talks intended to "help shape a climate change regime to follow Kyoto's first commitment period" ending in 2012 (IISD 2008). In Canada, nearly 80 per cent of our population lives in provincial jurisdictions with premiers who support pricing of emissions and cap-and-trade: British Columbia, Manitoba, Ontario and Québec have all expressed interest in collaborating with American states in the Western Climate Initiative cap-and-trade system (Pembina 2011). Domestically in British Columbia (BC), carbon and GHGe regulations are rapidly evolving. In 2007, BC's government passed the *Greenhouse Gas Reduction Targets Act,* legally requiring all

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[1] Christina Figueres, Executive Secretary United Nations Framework Convention on Climate Change in her keynote speech at the International Sustainable Development Research Conference. New York, 10 May 2011

[2] WTO Doha Ministerial Declaration was adopted on November 14 2001 as part of the 4th Ministerial Conference in Doha, Qatar. The declaration states it will work "particularly in the light of the global economic slowdown to maintain the process of reform and liberalization of trade policies" (WTO 2011) in order to promote economic development whilst alleviating poverty; increasing access to multilateral trading systems. The declaration makes reference to 21 subjects working to help governments make decisions on issues with respect to "Agriculture, subsidies, textiles and clothing, technical barriers to trade, trade-related investment measures and rules of origin" (WTO 2011).

public-sector organizations to be carbon neutral by 2010. A “Carbon Tax” has been introduced in the province and BC is aggressively setting and stating GHGe reductions targets (Thompson 2010). In Canada, it is possible that other carbon regulations, inclusive of a cap-and-trade system will come into play within the next five to ten years. Other public sector GHGe reductions schemes are in the works (Government of BC 2011).

While CO2 emission certificates and taxations may internalize the effects of fossil fuel consumption, their effectiveness may be limited if they are only implemented in some countries (Ismer and Neuhoff 2011). Taxing and pricing domestic producers’ GHGe will increase their production costs and could effectively cause them to relocate manufacturing to other jurisdictions not affected by taxes (e.g. China, India, Mexico). Displacing domestic production means goods manufactured in jurisdictions not affected by a tax may be imported at a cheaper cost than they can be produced locally. This creates an outsourcing incentive that could affect domestic producers’ price competitiveness in the global market place. In other words, as emissions regulations raise prices for domestic producers, “the loss of competitive advantage could lead to the displacement of production and thereby emissions abroad” (Fisher and Fox 2009). Additional GHGe could result, from both the production and transport of what were once domestically produced goods, an event also known as emissions or “carbon leakage”.

Carbon leakage[3] and a reduction in domestic producers’ competitiveness in the international marketplace are considered potential undesirable side-effects of introducing domestic carbon regulations. Interest has been growing in policy options and tools that have the potential to combat leakage; a popular tool being considered is a border tax adjustment on products’, services’ or activities’ GHGe, also known as a Border Carbon Adjustment (BCA). A BCA typically “requires importers to pay a tax according to the emissions associated with their products’ production, at the same price faced by domestic producers” (Fischer and Fox 2009). This introductory chapter explores a modest amount of literature related to anthropogenic and food system contributions to GHGe affecting climate change. Definitions, potential challenges and controversies in the design of a

[3] The Canadian Labour Congress defines Carbon Leakage to occur “when there is an increase in greenhouse gas emissions in one country as a result of emissions reductions by a second country with a strict climate policy” (CLC 2011)

BCA on goods imported to Canada are discussed. Methods to account for GHGe from a product or service are outlined and gaps in the ability of current standards to accurately account for the GHGe from a food system or product (be it for the purpose of placing a C-Tariff on them or not) are outlined. The stage is set for future investigation into BCA administrative methodologies; a roadmap of the following two chapters and key points this paper hopes to address follows..

1.2 Frogs in Hot Water – Don't Just Do Something, Sit There

1.2.1 The Climate's Bite on Our Food System

Climate change is a reality. In Canada, our government has identified its effects as "global problem[s] that require *real* solutions" (Environment Canada 2011). Economically, the whiplash of climate change could be "far-reaching, affecting our economy, infrastructure, and health, the landscapes around us, and the wildlife that inhabit them" (Environment Canada 2011). Physical effects and environmental concerns are mounting and include "changing rainfall, winds, clouds and extremes such as droughts, heat waves, severe storms and melting permafrost" (Environment Canada 2011). While all industries, households and individuals are affected one way or another by a changing climate, one sector that is heavily reliant on optimum climate health is our food system.

The International Panel on Climate Change (IPCC), charged with the responsibility of assessing and predicting key impacts of a changing climate on our livelihoods, has outlined concerns and projected changes "in the frequency and severity of extreme climate events to have *significant consequences for food and forestry production*" today (IPCC 2007b). In predicting with medium to high confidence that the world could see an increase in trade of food and forestry products, the IPCC predicts that many developing countries will become more reliant on imports of goods in the near future. In addition to local extinctions of fish species, predictions include complex sufferings for smallholder, subsistence farmers and artisanal fishers, and additional unpredictable consequences that will affect food production cycles of developing countries that supply food to Canada, the USA and other developed nations**.**

Within the last year of this paper's generation, a variety of unpredictable climate events have affected community food producers and suppliers: tsunamis in southeast Asia and Japan, droughts in Australia, extended winter frosts and a series of forest fires combined with heavy wind warnings in the prairies of North America. Recent climate events and turmoil are all real problems, affecting everyone's ability to produce food for the globe's growing population in a sustainable, affordable way. For example, a recent cold winter frost affected tomato production in Florida (winter 2010); per unit costs were raised almost three times the amount consumers and businesses were accustomed to paying (Indiana News 2010). In 2011 the United States Department of Agriculture declared 26 counties in Florida to be in a state *natural disaster* "due to losses caused by frost and freezes in November and December" (Meyer 2011). Many fruits and vegetables were damaged and lost, including Florida's famous crop of oranges that supply ingredients to internationally recognized juice manufacturers (e.g. Tropicana). American farmers found themselves in an interesting position of being eligible for new financing options - available only to those with damaged crops. As a changing and unpredictable climate continues to affect our supply of food however, the intensification of our food system bites back to affect the way our climate is changing.

1.2.2 Our Food System's Bite Out of the Climate

Anthropogenic activities contributing to global GHGe are accounted for, categorized and publicly reported in accordance with guidelines provided by the IPCC. Reports generated by the IPCC suggest that globally, our Energy Supply sector contributes to 25.9% of atmospheric GHGe, with Industry at 19.4%, Forestry at 17.4% (IPCC 2007) and the Agriculture and Transportation sectors accounting for 13.5% and 13.1% of our GHGe total, respectively. All together, anthropogenic activities contribute an estimated 49 Gigatons of CO_2e/year to the atmosphere; the largest amounts (56.6%) of which are generated from fossil fuel consumption (Environment Canada 2009). In Canada, a 2008 annual estimate of our anthropogenic emissions was announced as 734 Megatons of

CO_2e; 82.2% of this total was related to the Energy Supply sector (fossil fuel consumption by the Agricultural sector is included), 6.9% from Industrial Processes, 8.0% from Agricultural Land-Use, 2.9% from Waste and 0.04% from Solvent and other Products used (Environment Canada 2009). While Agriculture's contribution to 8.0% of global sector emissions seems dwarfed by the Energy sector's 82.2%, it is important to recognize that 8.0% in this example equates to approximately 58.72 Megatons of CO_2e (carbon dioxide equivalents). Just what does 58.72 Megatons look like? While standard definitions of size may be hard to come by, 58.72 Megatons of CO_2e seems no small amount of pollution. Just as the food system is affected by our changing climate, our changing climate is affected by our food system.

1.2.3 Canada's Response to Climate Policies

Throughout the history of international climate negotiations, Canada has responded with a series of policies and initiatives, labeled a "Green Plan", a "National Action Program", a "Climate Change Plan for Canada", "Project Green" and other regionally and provincially focused initiatives. Our abilities to reduce emissions as a response to these initiatives have, however, been limited and short reaching. Canadian policies tend to be *voluntary* in nature. Government spending and implemented policies have been inconsistent with federal and provincial GHGe reduction targets (Rivers 2009). As the public sectors focus on designing GHGe target strategies, policy makers struggle to keep up in the design of feasible responses that could affect change at an affordable cost (Rivers 2009). Most Canadian policies have been fragmented between provincial and federal governments, have not covered all sectors of emissions and have lacked a consistently agreed upon standard carbon price.

The governments of BC, Manitoba, Ontario and Quebec have signed on to the Western Climate Initiative (WCI) "a collaboration of independent jurisdictions who commit to work together to identify, evaluate, and implement policies to tackle climate change at a regional level" (WCI 2011). BC has introduced a provincial carbon tax, a tax on GHGe generated by the burning of fossil fuels. Administratively, BC's carbon tax is "collected at the wholesale level in essentially the same way that motor fuel taxes are applied and collected […] minimiz[ing] the cost of administration to government and compliance costs to those collecting the tax on government's behalf" (Ministry of Finance 2011). GHGe tax rates implemented July 1, 2010 were based at $20 per tonne Carbon Dioxide Equivalent[4] (t-CO2e), set to increase by $5/t-CO2e each year until a $30/t-CO2e cap is reached in 2012. The carbon tax's introduction means, for example, that consumption of gas "at the pump" is now taxed 4.45 ¢L and Diesel at 5.11 ¢/L. With the introduction of a domestic carbon tax comes concerns about production costs for producers and impacts on consumers. As domestic producers seek to displace a carbon tax's effect(s) on their production costs, manufacturing in regions without a carbon tax appeals. Outsourcing production means that producers could potentially end up first shipping goods and personnel abroad before *re-transporting* them back to the region affected by the tax, or elsewhere for distribution. The resulting transportation networks could mean more GHGe are released than would have been without a carbon tax; a phenomenon or event better recognized as carbon "leakage".

Leakage is an interesting topic, defined by the IPCC as "[an] increase in emissions outside a country with a decrease in emissions inside a country applying a domestic taxation scheme" (OECD 2009)[5]. A new policy challenge emerges to identify the best options to combat leakage issues. BC and Canada have not yet publicly addressed their response to leakage concerns. The idea of designing and implementing a Border Carbon Adjustment is a policy tool or option being considered as a means to avoid emissions leakage. The potential designs, administration formats and effective ratings of a BCA in Canada are in need of further exploration.

1.2.4 Roadmap of this Paper's Contributions

A Border Tax Adjustment (BTA) is a historically significant policy tool. Concepts related to applications of BTAs date from the formation of the 1957 European Union "and the commitment in the Treaty of Rome to sequenced integration" (Lockwood and

[4] A tonne or unit of carbon dioxide equivalent, CO2e, is a measure "used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP) or impact on the atmosphere […] The conversion factor of GHGe is in terms of GWP is relative to CO2" (OECD 2011).

[5]Carbon Leakage may be defined in other words as "a relocation of carbon-intensive industries from countries with stringent climate change-related rules (such as GHG emission restrictions leading to lower emissions) to countries with less stringent rules or without such rules (leading to increased emissions)" (Yu 2009). Developing countries are suspicious of developed countries' concerns with Leakage, particularly that developed countries' interests may lie in the continued maintenance of their competitive trading edge with respect to "high-value-added and energy-intensive manufactured products" (Yu 2009).

Whalley 2010). Traditionally, a BTA has been seen as a policy tool that could promote harmonization of tax structures, rates and eventually economic and monetary union. Since introduction of the concept, there have been debates around best methods in its application, including whether or not a tax should be applied on a production or consumption basis, issues surrounding its potential to disrupt trade relations and flows, the cost and high budgets involved in its administration, and whether or not it would be effective in protecting domestic producers or even addressing problems of leakage that motivated their applications.

While a Border Carbon Adjustment (BCA) is gaining ground as a potential policy tool that could help combat emissions leakage and encourage the development of a multilateral trading agreement (Fischer and Fox 2009), without any internationally governed or standardized GHGe accounting standards available, the validity of potential Carbon Tariffs (C-Tariffs) to be calculated for a BCA's administration are vulnerable. In addition, most countries are hesitant to implement a BCA without proper understanding of its potential implications to international trade law (Dr. Werner Antweiler, personal communications January, 2011) and impacts on producers supplying goods to the country administering the tax.

As policy makers contemplate the introduction of various carbon regulatory schemes across the globe, complementary policy tools, including Border Carbon Adjustments (a BTA on a goods' or services' GHGe), are being considered. The design of BCAs can be complex, effectively varying according to the region and sector where they are applied. Many economists and policy makers are seemingly unaware of potential complexities in the plethora of data collection activities necessary for their worthwhile application. Determining taxation amounts that could be placed on goods from the implication of a BCA is reliant both on Carbon Footprints of taxable products and a GHGe price. To date, the Carbon Footprints of foods both produced in Canada and imported for our consumption are not identified, implying potential BCA taxation amounts on a good or service are unknown, too.

The **goal of this paper** is to highlight the complexities involved in the potential creation of a Border Carbon Adjustment on products imported to Canada. Three key research questions addressed include 1) "Can GHGe from the production and transport of foods imported to Canada be calculated?" If so: 2) Considering potential characteristics of an Ideal BCA Scheme, "How might C-Tariffs calculated as a function of a food product's GHGe (from production and transport) and a hypothetical 'Carbon Price' vary?" and 3) *Based on results of questions 1 and 2* "What challenges could exist in administering a BCA on Whole Foods Imported to Canada?". To address these research questions, the rest of Chapter 1 completes a modest literature review on definitions of Border Carbon Adjustments and information on GHGe accounting methods and standards pertinent to BCA modeling techniques. Potential Controversies (e.g. WTO Principles, Administrative Issues, Food System Transparency) in BCA applications are discussed. Chapter 2 considers potential characteristics of an ideal BCA model and considers one method to calculate GHGe and C-Tariffs as a function of production and transport GHGe from a random sampling of whole foods imported to Canada. A few key C-Tariff estimates of Whole Foods imported to Canada are highlighted and potential implications of C-Tariff variations are discussed. Recommendations for future research suggest Canada is in need of relocalizing the way we think - about policy. Results of this study are useful in highlighting complexities involved in generating economic and political information reliant both on mathematical and scientific data, not easily transferable across disciplines. They are intended to encourage further in-depth and systems thinking in the design of policy responses to climate change, a heavily scientific-based, yet organic functioning discipline.

1.3 Reviewing the Design of a Border Carbon Adjustment

1.3.1 Defining a Border Tax Adjustment

While a Border Carbon Adjustment is a relatively new concept in climate policy research and negotiations, the term and concept of a "Border Tax Adjustment" (BTA) is not new. "Governments have applied border tax adjustments since the late 18th century" (Biermann and Brohm 2005). Over the past 50 years, BTAs have been more widely used in the context of Value Added Taxes (VAT). In 1968 a working party was established first in Denmark under the chairmanship of Mr. E. Thrane (WorldTradeLaw 2011) to investigate and discuss concerns or implications of BTAs as a policy tool (Biermann and Brohm 2005). Its purpose was to act in accordance with GATT to examine 3 broad areas as related to BTAs: 1) The provisions of the General Agreement relevant to border adjustments 2) The practices of contracting parties in relation to such adjustments and 3) The possible effects of such adjustments on international trade" (WorldTradeLaw 2010). The working party held 12 meetings over 1968-1970 and concluded with a final report to the chair. The report stated that the "Working Party would continue its discussion of the practices of tax adjustments in relation to products of interest to developing countries" (WorldTradeLaw 2010). They recognized that a complete more thorough examination of tax adjustments' relations with trade of industrialized products was necessary and most likely complex. They further agreed that attention on the import side of the trade equation was in need of examination, concluding to state that "current GATT provisions and tax practices are not trade neutral" as pertaining to a BTA. A convergence of other conclusions on a BTAs abilities to accurately and consistently calculate taxation amounts on goods were brought forward.

Concluding the working party's efforts in 1970, the final report noted the term "Border Tax Adjustment" (BTA) as a source of much confusion. Definitions and the nomenclature, term or investigation of the words themselves can lead to confusion. Taken the wrong way, the terminology can imply that a tax adjustment on a good may take place at the border itself. Taxes added to a good under a BTA scheme are added to goods after they cross an importing country's border at the time of sales to a consumer. Also known simply as a "Tax Adjustment", The GATT working Party on Border Tax Adjustments 1970 report defines a Border Tax Adjustment as:

> Any fiscal measures which put into effect, in whole or in part, the destination principle (i.e. which enable exported products to be relieved of some or all of the tax charged in the exporting country in respect of similar domestic products sold to consumers on the home market and which enable imports sold to consumers to

be charged with some or all of the tax charged in the importing country in respect of similar domestic products (WorldTradeLaw 2010, Bierman and Brohm 2005).

This same definition has been adopted by the OECD (Organization for Economic Cooperation and Development) and has also been used in recent World Trade Law negotiations and seems to be widely conceptually accepted. In broader or simpler terms, a BTA applies a charge on imported products corresponding to a tax applied or imposed on domestic products. When domestic products are exported, the tax is exempted or reduced (Ismer and Neuhoff 2011). In the context of environmental taxation and concerns, the rationale behind a BTA is to promote a level playing field in international trade while internalizing potential costs of undesirable impacts, often corresponding to “Dirty” environmental impacts into prices of goods and services (Carbon Tax Center 2011). BTAs are intended to diminish or eliminate potential advantages to firms “that manufacture goods or provide services for world markets, from countries that fail to tax or otherwise price environmental pollutants (e.g. Carbon Emissions) at prevailing world levels” (Carbon Tax Center 2011). This means that in operational practice, the application of a BTA implies that exporters from a country applying a domestic tax on the production of goods will have taxation charges at least partially refunded. For imported goods, the opposite will occur, and they will face a tax payable on entering the country implementing a domestic production tax (Ismer and Neuhoff 2011). What the design of a BTA reflective of Carbon Emissions emitted from goods imported to a region wherein domestic Carbon Certificates or Cap-and-Trade Systems are in effect (e.g. EU ETS) is a modeling topic of discussion today (Peterson and Schleich 2007). The nomenclature used to define what a BTA on goods’ or services’ GHGe might be has been labeled as a “Border Carbon Adjustment” up until and including recent climate dialogues.

1.3.2 Defining a Theoretical Border Carbon Adjustment

> *Border carbon adjustment (BCA) measures are being discussed as a response to concerns over carbon leakage and competitiveness in a number of countries putting in place policies to address climate change* (ICTSD 2010).

The European Union (EU) has recently released domestic policy resulting in its member states to adopt GHGe certificates, also known as CO_2e certificates (Ismer and Neuhoff 2011). As of January 1st 2005, EU based business and production activities that lead to emissions of carbon dioxide (CO_2) have required permits for emissions from their operations (Ismer and Neuhoff 2011). While CO_2e certificates may be useful to internalize effects of fossil fuel consumption, “If they are only implemented in some countries, then their effectiveness is limited […] and production with inefficient technologies in non-participating countries can even be increased” (Ismer and Neuhoff 2011). A Border Tax Adjustment on CO_2e, also known as a Border Carbon Adjustment (BCA) is being considered as a tool that may limit variations and distortions that come about from the implementation of domestic CO_2e certificates.

From this point, this paper adopts the International Institute for Sustainable Development’s (IISD) definition of a Border Carbon Adjustment (BCA) as an “import fee levied by carbon-taxing countries on goods manufactured in non-carbon-taxing countries” (IISD 2008). Upon implementation, BCAs “are intended to address 1) competitiveness concerns and 2) emissions leakage, to help force major developing countries to take on hard commitments in [climate] negotiations” (IISD 2008). As they consider domestic actions to address climate change as part of their obligations to the Kyoto Protocol’s first commitment period (ending in 2012), parties to the United Nations Framework Convention on Climate Change (UNFCCC) are concerned that their domestic industries may end up “at a disadvantage relative to producers in countries that do not take similarly strong actions” (Coseby 2008). BCA’s are being considered as a “trade measure that would try to level the playing field between domestic producers facing costly climate change measures and foreign producers facing very few” (Coseby 2008).

In efforts to level out or counter balance domestic carbon taxations, a BCA would place a charge on imported goods equivalent to the amount of funds they would be charged had the goods been produced locally; it would also potentially provide an equivalent or affiliated rebate to domestic producers looking to export their goods. If a BCA were applied in conjunction with a cap-and-trade scheme, those importing or exporting goods would need to buy emission permits reflective of CO2e capped/traded in production processes equivalent to those faced by domestic producers affected by the cap-and-trade system in effect (Coseby 2008). It seems a BCA could be used as a complementary policy tool to either a C-Taxation or cap-and-trade scheme. How its design could be standardized in a multilateral context is still subject to debate; concerns surrounding methods to calculate C-Taxation amounts and the development of sound administration guidelines are paramount.

1.3.3 Attempts to Calculate Border Carbon Adjustments

Countries have yet to implement a BCA on any goods imported to their region (ICTSD 2010). While theoretical models of BCAs have been determined to make economic sense, translation to a practical application remains a challenge. One notable study completed by Ismer and Neuhoff with the University of Cambridge's Department of Applied Economics proposes a series of Border Tax Adjustment estimates on products' carbon emissions that would correlate to those covered by the EU's current Emissions Trading Scheme. They suggest that due to information constraints, accurate calculations of border tax amounts imposed by an importing country would not be *directly* possible to *practically complete or apply*. Of great challenge in particular, they found that to "identify the appropriate carbon contents embodied in traded goods where exporting countries are unwilling to cooperate in the certification of production methods, accurate calculations would not be possible" (Ismer and Neuhoff 2011). They continue to present scenarios for which potential BCA taxation amounts are estimated as a function of a product's material and electricity inputs.

In the interim, however, Ismer and Neuhoff found that "a system of border tax adjustments for imports with best available technology standards priced at average costs would not fall foul of the General Agreement on Tariffs and Trade" (Ismer and Neuhoff 2011) and could indeed be made compliant with WTO principles. Using food products as an example, they demonstrate how CO_2e products could be estimated using a top-down sector approach or a bottom up economic input-output approach. Both CO_2e estimation approaches seem complex and a variety of discrepancies in calculation results come about, illuminating further controversies and administrative challenges in how a BCA could effectively be applied. One area of concern presented by both of Ismer and Neuhoff's scenarios is how a BCA could accurately take into consideration differentiations in high vs. low intensity manufacturing practices and variations in emission factors for energy production (e.g. coal vs hydro based electricity generation have different emission factors and CO2e values), even in considering a top-down, product "like" ness, or input-output GHGe estimation scheme. In essence, they found that a BCA could be applied in compliance with WTO law, yet accurate estimations of taxation amounts would be challenging to apply. To conclude, they recommend using an input-output model to take a "processed-materials approach where these are in turn evaluated at best available technology whereas, electricity being a homogeneous commodity, should receive a different treatment"(Ismer and Neuhoff 2011). How to extend the theory of such a model to practice however, remains an ambiguity both in terms of the author's understanding of the concept and in terms of methods to accurately communicate information from the modeling in general terms to the public.

1.3.4 Potential BCA Controversies

Controversial in their application, BCAs are at risk of infringing on historically longstanding international agreements (e.g. trade arrangements, supply-chain relationships) and the WTO's principles and priorities while potentially creating costly monitoring and accreditation programs. As a policy tool with the potential to affect trade, the design of a BCA is confronted with many challenges. Principles guiding the trade of goods and services between nations are outlined by the WTO[6]. The introduction of a BCA on goods imported to Canada could be affected, for example, by two of the WTO's principles: the National Treatment Principle (NTP) and the Most Favoured Nation (MFN) Principle. Potential areas of further concern include: the lack of food system supply-chain transparency, inconsistencies and disagreements in GHGe accounting methods, costly administration and accreditation format and implications of the related General Agreement on Tariffs and Trade (GATT), covering international trade of goods as represented by member representatives of the WTO. Questions surrounding the

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[6]WTO principles make reference to "agriculture, textiles and clothing, banking, telecommunications, government purchases, industrial standards and product safety, food sanitation regulations, intellectual property" and other goods and services traded across nations (WTO 2010b).

effectiveness and authenticity of any BCA (i.e. its abilities to conclude or address a multilateral agreement such as the existing Kyoto Protocol[1] and which application format it should take (e.g. Value Added Tax, Customs Tariff, other taxing schemes) are in discussion by world trade leaders today (Dr. Werner Antweiler, in person communications January 2011).

1.3.4.1 Border Carbon Adjustments and the National Treatment Principle (NTP)

The WTO's National Treatment Principle (NTP) requires all "imported goods be treated no less favorably than 'like' domestic products" by a country importing them (Fisher and Fox 2008). In other words, a country may not "discriminate between domestic producers and foreign producers of like products" (WTO 2010b)[1], and both must be treated similarly in the marketplace. Administering a BCA on foods imported to Canada could violate the NTP in one major, if not more ways. Primarily it is interesting to note, that aside from BC's Carbon Tax, Canada does not tax foods produced in our country as a function of their GHGe[7], nor is it participating in a cap-and-trade scheme administered in a way that would have an equal or comparable effect on domestic and imported goods (IISD 2008). As it stands today, since Canada is not taxing all domestic food producers as a function of their GHGe, if it were to place a BCA on foods imported without equally taxing domestic foods produced, it would be in violation of the NTP - discriminating against products imported and taxed for sales in our marketplace.

1.3.4.2 Border Carbon Adjustments and the Most Favored Nation (MFN) Principle

The WTO's Most Favored Nation (MFN) principle "prohibits WTO members from discriminating among trading partners" (Fisher and Fox 2009) while looking to preserve international trade relations. More specifically, as a subject to the MFN principle, Canada may not "discriminate between *like products based on a country of production* and the rules for like imported products should not favour any importing country over another" (WTO 2010b). Introducing a BCA on a food products imported to Canada could violate the MFN principle, similar to the potential violation of the NTP – countries shipping comparable or “like” goods to Canada likely have different GHGe resulting from their production and transport, implying different tariff estimates could be calculated for them; they would be treated differently in the marketplace as a result.

Since products affected both by a domestic carbon regulation and a BCA would be taxed as a function of GHGe, different tariff values on the same goods imported from different countries would be calculated. For example, apples produced in California will most likely have a different GHGe estimate from their production and transport or life cycle as compared to apples produced in China, reflective of differing production and transport preferences chosen by producers and distributors of goods. If a BCA were administered as a function of the GHGe on apples imported to Canada from both California and China, Canada would be taxing the same product – apples, different amounts. This would effectively discriminate between different countries’ apple producers and suppliers and create gaps in marketplace fairness (even if domestic producers were taxed, too).

For a BCA’s design to be compliant with the MFN principle, the same product imported from different countries must be categorized together, treated and taxed the same. Unless for example, standard taxation amounts were labeled for import categories covered by a BCA, consistent taxation amounts on “like” products would not be seen. Confusing in its application and definition, the concept of product “likeness” is not easily understood, especially in reference to trade of goods and services. Explored in the General Agreement on Trade and Tariff’s[8] Article XX of general exceptions, a few challenges related to categorizing “like” foods imported to Canada are discussed next.

1.3.4.3 Understanding GATT and Product “Likeness”

GATT’s Article XX is often seen as an escape clause for environmental concerns to be addressed. The WTO has been more lenient in granting exceptions within it over the past years. An area of international trade law still unsettled is whether or not a Border Carbon

[8] GATT, the General Agreement on Trade and Tariffs is an international organization formed in 1948 and charged with the responsibility of establishing common rules to govern tariffs and eliminate restrictive trade practices. Article XX is a clause within GATT that may allow for exceptions against some rules to occur for some countries.

Adjustment on foods or other goods imported to Canada might be approved under exceptions of Article XX (IISD 2008) (Fisher and Fox 2008) (Dr. Werner Antweiler, personal communications January 2011); how to certify and understand eligibility of a BCA under Article XX's exceptions is challenging.

GATT's general exceptions do permit border tax adjustments of indirect taxes on "like" products yet they prohibit "discrimination between countries where the same conditions prevail, or a disguised restriction on international trade" exists (WTO 2010). Exceptions are not intended to encompass or address "direct taxes, such as income tax or emissions tax, which are imposed on factors of production in the country of origin" (WTO 2010). Understanding exceptions' validities "becomes even foggier when looking at taxes on products' production process"[2] necessary to estimate a tariff on a goods' GHGe. It is interesting to note that while GATT exceptions do not encompass GHGe taxation schemes, they do open up thought to revisions on agreements to prevent the enforcement of measures under the following morale:

> i. Necessary to protect public morals, human, animal or plant life or health;
> ii. Relating to the conservation of exhaustible natural resources (provided such measures also apply to domestic production and consumption);
> iii. Responding to any intergovernmental commodity agreement with conforms to criteria submitted to the contracting parties (WTO 2010c).

Examples of cases that could be made for a BCA to be considered an exception under the above three morale might include: i.) A BCA's intent to protect against air pollution in response to environmental degradation, supporting natural ecosystems essential for human, animal and plant life; ii.) A BCA's potential abilities to conserve exhaustible natural resources by encouraging reductions in fossil fuel and energy consumption; and iii.) A BCA's potential abilities to address Canada's obligations under the Kyoto protocol or other international negotiations pertinent to environmental degradation, air pollution and/or climate change[9].

While it seems an argument could be made to encourage the adoption of a BCA under GATT's Article XX, how food products may be categorized as "like" is still a complex issue. The WTO has ruled that "likeness" may be defined by four criteria or factors related to the nature of the production of a product inclusive of its i. Physical properties, ii. Impacts of its end-use, iii. Consumers' perceptions of the product and iv. Its tariff classification (IISD 2008). While Harmonized System (HS) or tariff category classifications of products imported to Canada could be considered as a method to aggregate "like" products imported under a BCA relative to its physical properties; addressing the other three product likeness criteria could be of significant challenge[10]. Further exploration as to whether or not foods imported to Canada could be categorized under a product likeness scheme for the purpose of a BCA may be a lengthy process not worth the potentially hefty administrative costs necessary to comply to GATT exception(s). Even if characteristics of "like" categories of food products imported to Canada were outlined, understanding how to monitor the legitimacy of product likeness claims is of concern. Question also arise in regards to administration and verification.

1.3.4.4 Accreditation, Verification, Monitoring and Compliance

Legally, to apply a BCA to foods or products imported to Canada, Canada would need "information on methods used to apply the BCA, rationale behind its application and proof of how it is or will be applied" (IISD 2008). Proof of concept on a BCA's application methods would need information on imported products' GHGe activity accounting methodologies and data collected. This suggests an intricate GHGe data accreditation system would be needed. The International Institute for Sustainable

[9] The United Nations Framework Convention on Climate Change (UNFCCC) was born out of the Rio de Janeiro Earth Summit in 1992 with intentions to limit concentrations of GHGs in the atmosphere (UNFCCC 2010b) and ultimately led to the Kyoto Protocol. The Kyoto Protocol is a binding agreement signed in 1997 that set emission limits for 37 industrialized nations. Canada, being a signatory and having ratified the agreement, has committed to reducing emissions to 6% below Canada's 1990 baseline or 558.4Mt of carbon dioxide equivalents (CO_2eq)[9]. Canada's 2008 estimated emissions were 734Mt representing a surplus of 31.5% above the Kyoto commitment (Environment Canada 2010b).

[10] For example, in looking to understand how consumers perceive a product, surveys, questionnaires and both qualitative and quantitative data would be needed to thoroughly understand their opinion. What the formation, administration, distribution, collection, receipt and further dissemination of results of a consumer response feedback process would look like is a complex study in need of detail design.

Development (IISD) suggests rights to establish and reference "Carbon Footprints", or the GHGe from the lifecycle of a product, should lie in the hands of each producer, no simple task for the faint of heart (or will). Having producers accurately collect and compile data on their Carbon Footprints would be an "extremely complex activity to administer, and would involve a plant-by-plant determination of carbon emitted, as well as some sort of accredited verification process" (IISD 2008) to ensure validation of GHGe activity data collected; most likely causing burdens to producers subject to its compliance (ICTSD 2010).

It is not clear how Canada could ask other jurisdictions, especially those in developing countries that lack administrative and government based resources, to provide GHGe activity data on all imported goods. Activity data collection methods may be costly for governments, time consuming for farmers and hardly a direct priority on food security agenda(s). Not only would most products' GHGe activity data be "unavailable for most producers, but it is also unlikely that the national authorities in those countries [could] rush to establish requirements that would make it available for [a BCA's] purpose" (IISD 2008). Errors in GHGe activity data collection for the purpose of a BCA could easily occur, creating many opportunities for "cheat" accounting activities to take place, sabotaging potential taxation design frameworks. Even if data were mandated for collection, how to truly monitor the accuracy, validity and authenticity of any GHGe account from a food product remains extremely challenging. The availability of information on specific activities involved in food production and distribution practices are convoluted with concerns related to exposing "top secret" management practices, 'tricks of the trade', industrial competitiveness and product source locations.

1.3.4.5 Food System Transparency and GHGe Accounting Standards

Our food system in complex. Operations within it are not transparent to consumers today. The industrial nature of supply-distribution chains for the production, manufacture and transport of foods makes it challenging to easily track and monitor any data across a food product's life cycle from production through to waste. Information on how both *farm or food production inputs* (e.g. fertilizers, seeds, machinery, energy supplies), *and food* *products* (e.g. origin and production of ingredients, additives, packaging materials, processing activities, waste generated by food production facilities) are produced and distributed, is required, at a minimum, to make useful estimates of the GHGe, or "Carbon Footprints" from the import of a food product to Canada. This information is not readily available on product labeling or through any publicly available tracking system.

Standards do exist to account for GHGe activities from a nation or region[11], industry[12] or product[13]. To date, however, no international standards for product-specific GHGe accounting activities have been consistently adopted across nations[14]. The European Commission and the International Organization for Standardization (ISO) are in the process of developing methods and standards to account for GHGe from a product's life cycle. Of specific challenge is the design of product GHGe accounting standards for food and food-related products. Food is an organic substance and emissions from its production fluctuate and vary as a function of numerous natural factors (e.g. effects of temperature and climate variations on direct and indirect soils emissions on farms), challenging the ability of a GHGe accounting standard to accurately represent data. Considering the design of current GHGe methodologies, the design and administration of any BCA will face significant on-going challenges related to harmonization of the methodologies into one international standard, and the collection of accurate data. The next section considers what a GHG is and explores various GHGe accounting standards and consumer interests in "Carbon Footprinting"[15] as related to food.

1.3.5 Current Methods to Account for a Product or System's GHGe

Since the design of any successful BCA will be heavily reliant on GHGe accounting methods for any products to be taxed, it is important to understand the measures by which GHGe accounting standards occur.

[11] International Panel on Climate Change National Accounting Standards (IPCC 2006)
[12] World Resources Institute (WRI 2009)
[13] Life Cycle Assessment 14000 series (ISO 2006)
[14] A lack of internationally recognized Product Carbon Footprint or Food Product Carbon Footprint standards is beginning to dilute certification efforts as many businesses and industries attempt to certify products on their own accord.
[15] The carbon footprint of a product is referenced here as the sum of GHGe from activities involved in its manufacture over a specified timeframe.

1.3.5.1 GHGe Accounting Standards: National, Corporate and Product

Three leading GHGe accounting standards are available through the International Panel on Climate Change (IPCC), the World Resources Institute (WRI), and the International Standards Organization (ISO).

The International Panel on Climate Change's (IPCC) Task Force on National Greenhouse Gas Inventories.

The IPCC releases guidelines for *National Greenhouse Gas Inventories* to follow. Five volumes are included for compliance purposes[16]: General Guidance and Reporting, Energy, Industrial Processes and Product Use, Agriculture Forestry and Other Land Use, and Waste. Land-use categories included in each volume relate to Forest Land, Crop Land, Wet Land, Settlement Land, Other Land, N_2O Emissions from Managed Soils, and CO_2 emissions from Lime and Urea Applications, and Harvested Wood Products. Worksheets are provided for each land-use category for GHG inventory managers working for a region or nation to compile information. Data necessary to compile a nation or region's GHG inventory may be collected through national statistics or industry statistics agencies, ministries, provincial or regional authorities. Time consuming in their receipt and synthesis, publications of national inventories are often made one to two years after top-down data are collected and analysed.

The World Resource Institute (WRI) Greenhouse Gas Protocol - A Corporate Accounting and Reporting Standard (CARS).

The WRI's CARS is available as a tool for institutions "*companies and other organizations* [to] identify, calculate, and report on GHGe in outlining a standard for accurate, complete, consistent, relevant and transparent accounting methods"(WRI 2010). The CARS framework guides calculations of GHGe from specific activities (e.g. mobile combustion of fossil fuels) or industry sectors (e.g. cement manufacturing). GHGe reporting values include: Relevancy (meets the appropriateness of an entity's needs), Completeness (includes all sources of GHGe within an outlined boundary), Consistency (to allow for meaningful comparisons), Transparency (a clear audit trail and

[16] Most recent guidelines were released in 2006.

methodology) and Accuracy (uncertainties are recognized and reduced as much as possible)[4].

To follow the WRI CARS, Organizational and Operational Boundaries are set. An Organizational Boundary is set either using the equity share or control approach. Under the equity share approach, “a company accounts for GHGe from operations according to its share of equity in the operation” (WRI 2010), reflecting its economic interests. The control approach considers two types of control through which inventories are taken: financial and/or operational. Under the control approach, “a company accounts for 100 percent of the GHGe from operations over which it has control. It does not account for GHGe from operations in which it owns an interest but has no control”(WRI 2010). Through the financial control approach “the economic substance of the relationship between the company and the operation takes precedence over the legal ownership status”[1]; the operational control approach means if a “company or one of its subsidiaries is the operator of a facility, it will have the full authority to introduce and implement its operating policies”, having the ability to affect policies and decisions made in all operational facilities. Setting an operational boundary involves identifying emissions by “categorizing them as direct and indirect, and choosing the scope of accounting and reporting for indirect emissions”[1]. Direct GHGe are those generated by activities and sources owned or controlled by a company; indirect GHGe are those generated by activities caused by a company's operations, yet occurring at sources owned or controlled by another company or entity.

Data necessary to compile a company’s GHGe inventory is sourced from specific operations, sites, geographic locations, business processes, accountants’ files and owners. GHGe quantified through WRI accounting standards are recommended to be categorized in a “Scope” format. The Scope format is arranged to provide transparency in accounting standards and avoid double counting of emissions. All six of the GHGe types are accounted for as CO_2, SF_6, CH_4, N_2O, HFCs and PFCs. Scope 1 emissions include direct GHGe. Examples of on-site Scope 1 activities include: the generation of electricity, heat or steam, physical or chemical processing, transportation of materials, products, waste and employees and fugitive emissions releases (either intentionally or unintentionally). Scope 2 accounts solely for GHGe both from the generation and purchase of electricity used by a company while Scope 3 GHGe are indirect emissions, optional to report in a company's GHGe inventory. Timeframes (e.g. one year) are set for companies to monitor or track changes in their GHGe inventories by, reflecting changes in operations and management decisions.

Canadian Standards Association (CSA) and ISO 14000 Series Life Cycle Assessment Standards

In August 2009 the Canadian Standards Association (CSA) and the Climate Registry[17] announced a Memorandum of Understanding to align efforts in supporting "consistent GHGe measurement and reporting guidelines in Canada"(CSA 2009). Together, the two organizations decided that a new international standard would be developed by the International Standards Organization (ISO) under the 14000 series entitled "ISO14064" for GHGe inventories and reporting at the organizational and project levels. ISO standards address "the inclusion of environmental aspects in product standards, environmental auditing, environmental assessment of sites and organizations, environmental labels and declarations, environmental performance evaluation and life cycle assessments" (ISO 2006). ISO LCA standards require system boundaries be set for any assessment following their guidelines. To accurately compare any products' or systems' impacts (in terms of either GHG emissions or other impacts), it is first necessary to set consistent system boundaries.

1.3.5.2 Uncertainties in GHGe Accounting for Food Production

While GHGe accounting standards exist for each of the national, corporate and product specific accounting purposes, many uncertainties in organic soils, land-use and other organic processes involved in food production make it a challenge to generate single GHGe estimates for food products. Out of the three standards discussed above, ISO

[17] The Canadian Standards Association is "a leading standards-based solutions organization serving industry, government, consumers and other interested parties in North America and the global marketplace"(CSA 2009). The Climate Registry is a "nonprofit collaboration among North American states, provinces, territories and native sovereign nations that sets consistent and transparent standards to calculate, verify and publicly report greenhouse gas (GHG) emissions into a single registry" (CSA 2009).

14064 and 14065 methodologies are considered today's leading GHGe accounting standards published by the WRI (World Resources Institute)[18] and WBCSB (World Business Council for Sustainable Development). The WRI and ISO standards are those used to guide GHGe data information collected for today's clean development projects, cap-and-trade, and GHGe reduction schemes (e.g. municipal climate action plans). The ISO series, while somewhat ambiguous and flexible in its nature and its ability to account for GHGe, has been used in collaboration with other methods to account for a food product's Carbon Footprint. For example TESCO, a British super market chain introduced a carbon label on some of its foods in 2007, using methods developed by the British Standards Institute standardized within the ISO 14040 and 14044 series (Roos et al 2009) and dictated as Publicly Available Standards 2050 - 2008 (PAS). PAS were made in collaboration with the Carbon Trust[19], the UK's Department of Foreign and Rural Affairs, and the British Standards Institute, intended to measure GHGe of goods and services effective in October 2008.

While the account of GHGe from some Land Use and Land Use changes needed to accurately monitor GHGe from agricultural and food production are included in PAS' GHGe accounting methods, PAS' guidelines do not take account of "changes in the carbon content of soils, either emissions or sequestration, other than those arising from direct land use change" (PAS 2008). PAS states that "while it is recognized that soils play an important part in the carbon cycle, both as a source and sink for carbon, there is considerable uncertainty regarding the impact of different techniques in agricultural systems"[3]on how we account for GHGe. Emissions from livestock, biomass and biofuels are included and accounted for under PAS using the highest tier standards available as provided by the IPCC's guidelines for national inventory reports. While there is consideration of how to include agri-soils emissions in future revisions of PAS' accounting standards, to date the degree of uncertainty in their account makes accurate estimates of food-related GHGe challenging to pinpoint for any label, carbon tariff or other specific measurement purpose.

[18] The WRI also provides the corporate accounting GHG protocol.
[19] The Carbon Trust is a United Kingdom-based "not-for-profit company providing specialist support to help business and the public sector boost business returns by cutting carbon emissions, saving energy and commercializing low carbon technologies" (Carbon Trust 2011).

1.4 This Paper's Contributions to Current Literature

This paper is intended to contribute to topics related to the literature reviewed above and documented information circulating in current policy research networks and institutions in five predominant ways:

1) Illuminating potential complexities in the design of a BCA on food products or other goods reliant on organic processes;
2) Uncovering challenges involved in finding information on product's carbon footprints for the purpose of a taxation scheme;
3) Estimating Default Carbon Footprints and potential areas to focus on for emissions reductions;
4) Presenting Hypothetical Taxation Amounts and potential consumer impacts/useful for economic regressions or other models considering how taxation amounts may affect consumers' willingness to pay for products taxed as a function of their GHGe.
5) Providing Insight into what, if any, form an ideal BCA scheme might take.

Results presented are intended to be useful for policy makers working in or with countries considering Carbon Taxation or cap-and-trade schemes as a response to Kyoto commitments and climate negotiations currently under way. The following chapters are intended to provide more detail into what steps might be necessary in considering the application and design of a BCA on foods imported to Canada. Information, data collection methods and results are preliminary, intended to lay the footwork and encourage future research to occur in areas of carbon accounting, climate regulations and incentives for emissions reductions.

1.5 Information about Collaborators

Information in this section was completed primarily on behalf of the author, with guidance from Drs. Carol McAusland, Werner Antweiler, Rick Barichello, Dan Weary, Joseph Pallant, Stephan Van Eden, Shirlene Cote and other attending members to this thesis' defense.

CHAPTER 2 QUANTITATIVE INCLINATION

This chapter seeks to provide a preliminary investigation into whether or not a model for the design of an ideal Border Carbon Adjustment may exist. To do so, it first provides preliminary insight into potential desirable characteristics for an ideal BCA model's design. Assessing an arbitrary sample of Whole Foods imported to Canada, it prescribes one potential carbon taxation method that reflects the accessibility and availability of food trade data in Canada. It provides a simplistic illustrated example of how GHGe and affiliated carbon tax from and on the import of potatoes from Washington, USA could be calculated. A more thorough explanation of methods used to estimate GHGe from the production and transport of Whole Foods imported to Canada and their affiliated C-Tariff estimates follows with a detailed library of data appendices providing information and data on GHGe and C-Tariff estimates for nine Whole Food categories imported from 43 countries (the top 95% of countries shipping foods to Canada). Implications of using Default Emission Factors to calculate production GHGe from goods imported are discussed, production and transport GHGe from different goods are compared, key contributors to GHGe from the import of Whole Foods to Canada are presented and further model limitations are brought forward. Food System data complexities, issues of accuracy and validation and variations in and between Whole Food Category C-Tariff estimates are listed as potential hurdles to consider in the application of a BCA on foods imported to Canada. Results are intended to provide policy makers an insight into a few details involved in administering a BCA that may not be apparent at first glance.

2.1 Does an Ideal Border Carbon Adjustment Exist?

The effectiveness of a BCA scheme has been described as hard to manage, with narrow or adverse effects, complex administration obligations, and questionable impacts on climate negotiations (Coseby 2011). Even assuming a real comprehensive carbon tax was applied and able to capture all of the production and transport emissions related to any one good, manufacturing sector or other entity in a country, it is this author's opinion that no optimal Border Carbon Adjustment (BCA) scheme can be easily designed. In the end, any BCA framework would have to vary from the ideal in its application, design, and abilities to serve as a worthwhile tool to combat concerns related to emissions reduction, leakage or domestic competitiveness. There are conflicting and inconsistent views amongst the international research community as to whether or not a BCA would be compliant with WTO principles and laws. Many policy researchers say further research and investigation in to the design of BCAs is necessary (Lockwood and Whalley 2010)(Biermann and Brohm)(IISD 2008)(Winchester et al 2011). Nonetheless, if a country or region were to consider applying an "ideal" BCA on goods imported to its jurisdiction, a few preliminary and complementary design traits to consider, at minimum, might include:

a. Understanding the differentiation between the motivation and potential effects of a BCA's implementation;

b. Proactive abilities to align with WTO principles and rules, agreed upon by member parties;

c. Consideration of differing abilities and needs to comply to a BCA by Coalition (i.e. Kyoto signatories) vs. Non-Coalition (i.e. Developing Countries);

d. Sector specificity in GHGe calculations and carbon price assessments;

e. Detailed GHGe input assessments and firm-by-firm data collection to be transferable to taxation amounts;

f. Compliance with an International Accreditation and Reporting Scheme (e.g. the International Accreditation Forum (IAF) Format for Standardization).

While this paper does not attempt to draw out the specifics of an ideal BCA design, a brief explanation of recommended BCA model characteristics is further described next.

2.1.1 Understanding differentiation between the motivation and potential effects of a BCA's implementation

Beginning with understanding and differentiating between the motivation and effect of any BCA, in analyzing its potential impacts, for a BCA to be successful or accepted as a worthwhile policy tool, motivation for its implementation (e.g. desire to displace leakage effects and reduce GHGe) must be seen as independent compared to its actual impacts (Lockwood and Whalley 2010). In assessing the administration and compliance measures involved in its implementation against its abilities to combat leakage or displace emissions, the worthwhile effects of its introduction are most likely to be fickle. It seems any design of a BCA would fail against an analysis framework that judged its abilities to be successful as a function of its cause and effect. As such, for a BCA to be "ideal", its motivation for application versus its potential effects must be viewed as separate components.

2.1.2 Proactive abilities to align with WTO principles and rules, agreed upon by member parties

For a BCA to be legally administered across nations, it must be in alignment with WTO rules (Ismer and Neuhoff 2011) inclusive of those mentioned in the previous section on the Most Favoured Nation and National Treatment Principles. If a BCA model were indeed deemed WTO compliant, the application of "any [BCA] scheme would have to take account of all sorts of foreign policies in considering whether climate change efforts were comparable to domestic efforts" (Cosbey 2008). Other trading agreements (e.g. NAFTA) would need be considered as would the welfare of importing countries potentially affected by its implementation. From a multilateral stance, research and investigation into policies and trade agreements underway by all participating parties must be taken into account. Member parties agreeing to partake in its framework must feel that the design would indeed benefit them in some method or fashion, enhancing their abilities to participate in the global marketplace for trade and GHGe reductions simultaneously.

2.1.3 Consideration of differing abilities and needs to comply with a BCA by Coalition (i.e. Kyoto signatories) vs. Non-Coalition (i.e. Developing Countries)

Many agree that implementing BCAs against developing countries should be avoided since "other policies to address carbon leakage, such as financial and technological assistance, could be used instead" (Biermann and Brohm 2005). Consider coalition countries (those signed on to the Kyoto agreement or other international emissions reductions policies), and non-coalition countries (those who are not - mostly developing countries with limited operational budgets and other national security concerns). A BCA would most likely receive less political resistance if applied only to goods exchanged between coalition countries and if other complementary measures are considered specific to non-coalition countries. Issues pertaining to leakage presenting themselves in developing or non-coalition countries could be addressed by other complementary policy tools supported by coalition parties as part of the same BCA scheme. For example, funding collected from cap-and-trade programs or BCA taxes could in part provide subsidies from coalition parties for technology and/or energy efficiency incentives and activities to occur in developing countries and non-coalition parties supporting "dirty" manufacturing practices or those activities emitting relatively high amounts of GHGe (Winchester et al 2011, McAusland Carol 2011). Allowing a tax-subsidization sidepart to complement the design of a traditional BCA scheme could create the means to reduce GHGe without affecting sensitive welfare measures in those countries already challenged with other issues of national security.

2.1.4 Sector Specificity in GHGe calculations and C-price assessments

For those countries adhering to a cap-and-trade system, carbon tax and/or effectively a BCA scheme, C-Tariffs could be calculated as GHGe (both from direct production inputs and indirect intermediate input emissions)(Winchester et al 2011) multiplied by a carbon price. Here, for a carbon price to be (more) fair, it could be applicable to differing trade flows as a factor of sectors and regions where differentiations are still made between coalition and non-coalition countries, and estimated emissions would be reflective of sector-specific forms of labour and wage rates (Lockwood and Whalley 2010), direct versus indirect emissions. In an ideal situation, a BCA would have the ability to take into account the differences in production practices prevailing amongst individual producers in one way or another. It is simply "unacceptable to set a national baseline of C-intensity of production for all producers from a given sector within a country" (Coseby 2008), as those with "dirty" versus "clean" manufacturing practices would not be given appropriation one way or another to be penalized or rewarded for their operations. To truly take into account differences in production practices in a BCA scheme, it could mean for example, that a firm-by-firm or factory-by-factory calculation of CO2e would be necessary and each producer could have the ability to submit his or her own footprint.

2.1.5 Detailed GHGe input assessments and firm-by-firm data collection to be transferable to taxation amounts

It is beyond the scope of this paper to identify in sufficient detail all activities and data contributing to GHGe from the production, transport and other stages of the life cycle (from "farm to fork") of foods imported to Canada. It seems that to take a 100% complete account of a product's GHGe could be nearly impossible at the best of times. That being said, if a firm-by-firm GHGe assessment were mandated on coalition countries, examples of information categories and data needed to move towards accurate quantification of GHGe released from food products for the purpose of a BCA are listed in Table 1.

Table 1 Food Product GHGe Data Information Template

Information Category	Data Needed
1. Site Specifics	-Timeframe for production; -Area of land under production; -Yield; -Crop Type. -Unit Size (e.g. one pint, one kilogram).
2. Food Production Site	-Direct, Indirect, Pasture Range and Paddock activities; regionally specific soils' emission factors in kt-CO2e/ha. -Amounts and types of energy consumed on the production site (inclusive of storage and any refrigeration facility's consumption); -Emission Factors for each energy type consumed on the production site. -Weight of waste produced on site; -Composition of waste produced (e.g. percent organic vs synthetic); -Emission Factor specific to waste's composition.
3. Manufacture, Transport and Application of Agri-Chemicals	-Agri-chemicals applied on site (name, brand, composition); -Amounts and types of energy consumed in the life cycle of manufacturing agri-chemicals applied on site -Emission Factors for energy types consumed in agri-chemical manufacturing processes -Information on transportation of agri-inputs from manufacturer through distribution to food production site (distance traveled, transport type)
4. Manufacture and Transport of Agri-Machinery[20]	-Information on type and weight of agri-machinery under operation on food production site; -Emission Factors for production of agri-machinery (per piece); -Information on Transport of Agri-Machinery (e.g. distance traveled and transport type chosen); -Machinery operations activity report (e.g. hours spent tilling, discing and other operations; could also be included in the direct and indirect soils' emissions category).
5. Production and Transport of Animal Feed	-Amounts and types of feed consumed on production site; -Production Emission Factor for Feed (inclusive of value added and processing activities); -Information on transport of feed (e.g. distance traveled and shipping method chosen)
6. Packaging and Materials	-Type and weights of packaging and/or other materials used per food type (e.g. mulching materials, clamshells, plastics) -Information on transport of packaging and materials (distance traveled and shipping method chosen).
7. Transportation of Whole Foods	-Information on transport activities from Farm to port for international shipping -Information on transport from international shipping port to Canada (weight, distance traveled, shipping vehicle type or fuel consumption rate) -Energy consumed for cooling, freezing or heating of foods during transport -Information on transport from entry point in Canada to consumer or retail outlet
8. Waste	-Information on amounts and composition of waste produced across a product's life cycle; -Emission Factors specific to waste's composition.

[20] Energy consumed by agri-machinery on food production site included in "Food Production Site" category.

Concerns still exist about accurate GHGe calculation methods, due to difficulties in determining estimates for direct and indirect emissions (Lockwood and Whalley 2010) and with the scientific community's ability to provide accurate GHGe emission factor estimates for organic and other oscillating activities without access and permission to use data necessary to understand a product's production process. Costly scientific measurement tools would be needed to account for changes in GHGe fluctuations related to food production.

2.1.6 Compliance with an International Accreditation and Reporting Scheme (e.g. the International Accreditation Forum (IAF) Format for Standardization)

If data in the above table (and perhaps other data) were to be collected in a meaningful fashion, an international accreditation and compliance scheme would need to be administered to ensure validity and verification of GHGe data. The International Accreditation Forum (IAF) could be considered as a platform. Those firms or organizations operating in countries signing on to a multilateral BCA scheme could become IAF members such that they would then become accredit(ed), certified or registered bodies, eligible to receive certificates attesting that their management, products or personnel comply with a specified GHGe calculation standard as part of a conformity assessment (IAF 2011). The design of the GHGe calculation standard would need be specified, perhaps as part of the emerging ISO LCA series for GHGe accounting assessment currently in place. The IAF may be an excellent platform to administer such a scheme as it is accustomed to administering standards for conformation to "establish mutual recognition arrangements, known as Multilateral Recognition Arrangements (MLA) […] reducing risk to business and its customers by ensuring that an accredited certificate may be relied upon anywhere in the world" (IAF 2011). Allowing the introduction of a GHGe Multilateral Recognition Arrangement through the IAF would encourage the application of a single system to be recognized across countries at the international level, in compliance with the IAF's mandate: "Certified once - accepted everywhere".

If a GHGe accounting standard was agreed upon for food products, those entities looking to be accredited within the context of a BCA system could apply for accreditation membership from the IAF. IAF accreditation could be easily accessible to firms operating in developing countries as it is open and available as an accreditation source on "certification or registration of quality systems, products, services, personnel, environmental management systems of similar programs of conformity assessment" (IAF 2011) which GHGe reporting activities today could certainly fall under.

While the exact design of an "ideal" remains somewhat illusive, certainly elements or traits of an ideal BCA model can be considered. The next section investigates what potential steps could be involved in collecting data on the GHGe from foods imported to Canada for the purpose of an BCA scheme on these foods.

2.2 Investigating Carbon Taxation Accounting Methods

To investigate carbon taxation methods, this section seeks to estimate carbon tariffs on a random sampling of whole foods imported to Canada. Nine Whole Food categories are arbitrarily chosen: Field Grown Vegetables, Greenhouse Grown Vegetables, Fruit, Beef, Pig, Poultry, Lamb/sheep, Eggs and Grains[21]. An estimate of the GHGe from each food category's 1) Production and 2) Transport is made. Data domestic to British Columbia are used to estimate Default Emission Factors (EFs) in kt-CO2e/tonne food produced within each Food Category. Emission Factor estimates are modest in their representation of GHGe from food production activities and include only four key agricultural inputs: i. Agricultural Land Use, ii. Energy consumed by BC's agricultural sector, iii. Agri-Chemicals available to BC's Agricultural sector and iv. Manufacture and Transport of Animal Feed Imported to BC. A transportation formula, weighted average source distance (WASD), is used to estimate GHGe from transport activities. WASD calculates transport GHGe as a function of transport type, distance traveled and weight of goods transported. For each Whole Food category, carbon tariffs are calculated as a function of the food category's production and transport GHGe are multiplied by an assumed carbon

[21] Data on Foods Imported to Canada is sourced from Industry Canada in CAD dollar values and Agriculture Canada as kilograms foods imported; Import data at the Harmonized System (HS) six-digit level is used. A full listing of the sample of whole foods assessed in this paper is available in Appendix 1.

price of 25$/t-CO2e. Two key research questions addressed in this chapter are: “Can GHGe from the production and transport of foods imported to Canada be calculated?” and “How might C-Tariffs calculated as a function of a food product’s GHGe (from production and transport) and a hypothetical ‘Carbon Price’ vary?”. An illustrated example of a potential C-Tariff estimation method is first described. A more detailed description of what is included in methods applied follows with results, with a discussion demonstrating a few limitations in estimating GHGe from the production and transport of foods for the purpose of a BCA scheme.

2.3 Illustrating an Example of C-Tariff Estimates Calculation Methods

To estimate carbon tariffs on the production of Whole Foods imported to Canada, GHGe from their production and transport are first estimated and multiplied by a Hypothetical Carbon Price. This section examines Canada’s import of Potatoes (HS Harmonised System 070190) from Washington (WA), USA to illustrate an example of one potential method to estimate a carbon tariff on a food product imported to Canada.

Primarily, an estimate of the amount of potatoes imported from WA, USA to Canada is obtained both in $CAD (from Industry Canada Trade Online Data) and in weights (From AAFC Agri-Food Canada), averaged over the years 2004-2008. Looking to Industry Trade Data, an average of $68,899,292.00 of potatoes is imported to Canada per year; Agriculture and Agri-Food Canada data for the same HS Category lists 164,045.93 *tonnes* of potatoes imported to Canada per year. Dividing the price of potatoes imported by the weight of potatoes imported provides us with an estimate price of $420.00/tonne or $0.42/kg for potatoes originating in Washington. Next, an estimate of GHGe both from the 1) Production and 2) Transport of Potatoes Imported to Canada is made.

2.3.1 GHGe from the Production of WA Potatoes Imported to Canada

Default emission factors in kt-CO_2e/tonne food are used to estimate GHGe from the production of each of the nine Whole Food Categories imported to Canada, estimated using a provincial top-down assessment approach of data specific to British Columbia, Canada.   Potatoes are categorized in the “Vegetables” Whole Food category and GHGe from their production is calculated as a function of their weight imported (tonnes) and the Default Emission Factor (CO_2e/tonne). The Default Emission Factor for the production of Vegetables is estimated at 0.001kt-CO_2e/tonne.

Default Emission Factors are calculated using a provincially focused top-down input consumption model. Four main agri-inputs are considered as contributors to production emissions contributing to GHGe estimates represented by Default Emission Factors: Agricultural Land Use, Energy Supply-Demand, Agricultural Chemicals and Consumption of Feed. An estimate of BC's agricultural sector's consumption of these four inputs is made[22,23] with corresponding GHGe values listed in kt-CO2e. An estimate of GHGe from the consumption of these four inputs by the Whole Food Production Sector corresponding with the production of the nine Whole Food Categories considered in this paper are listed in Table 2.

Table 2 Agri-Inputs Contributing to Production Emissions for Default Emission Factor Calculations

Production Input	GHG Emissions (kt-CO2e)
Agri-Land Use	2501
Energy Supply-Demand	717
Manufacture and Transport of Agri-Chemicals	824
Animal Feed	69
Total	**4111**

Farm level operations contributing to agricultural production in BC are divided into nine Whole Food category farm types, corresponding with the same Whole Food categories imported to Canada: Field Grown Vegetables, Greenhouse Grown Vegetables, Fruits, Grains, Eggs, Beef, Chicken, Pork and Lamb. For each Whole Food Category produced in BC, its percent consumption of each of the four provincial agri-inputs is estimated to determine how many GHGe the farms within its category have emitted. Provincial agri-

[22] Industry Canada Data is referenced, specific tables used are listed in Appendix 2.
[23] Detailed Calculations and Results on the estimate of GHGe from agricultural production in BC are located in Appendix 2.

input consumption per farm type is allocated as a function of the farm type's CAD$ spent on each input[24] per acre and the number of those farm type's acres operating in BC.

To clarify for example, consider the Agri-Input "Energy Supply-Demand" and the Whole Food Category "Vegetables (Field Grown)" under which potatoes are categorized. The total amount of $CAD spent by the nine Whole Food Category's consumption of energy in BC is $136,916,638.6, corresponding with 717 kt-Co2e released (as listed in Table 2).

Farms corresponding with the Whole Food category "Vegetables (Field Grown)" are estimated to spend $95.00 on energy per acre per year in BC. There is an estimated 25,688.5 acres of Field Vegetables under production in BC. Multiplying ($95.00/acre)(25,688.5acres) results in an estimated $2,440,409.02 spent on energy per year by Field Vegetable producers in BC. Comparing the Field Vegetables dollar figure to the provincial dollar figure, it is estimated that the Field Vegetable's consumption of energy in BC corresponds with two per cent of the provincial total ($136,916,638.6), or 13 kt-CO2e.

An estimated 238,068.4 tonnes of Field Vegetables are produced in BC on annual basis[25]. The amount of GHGe released from Energy Consumed per tonne of vegetables produced is calculated by dividing the Field Vegetable's GHGe estimate from energy consumption by its relative yield: (13 kt-CO2e)/(238,068.4 tonnes) = 0.001 kt-CO2e/tonne. 0.001 kt-CO2e/tonne of Field Vegetables produced is considered the Energy Supply-Demand sector's contribution to Field Vegetable's Default Emission Factor.

Calculations similar to those completed for the energy-supply demand input are made for each of the four provincial agri-inputs consumed in BC. Results are added together to estimate default emission factors for each of the nine Whole Food Categories. To demonstrate how each agri-input contributes to a Whole Food Category's Default Emission Factor, an estimate of each agri-input's contribution to the Whole food

[24] Dollar amounts of each input consumed per acre farm type operating in BC is referenced to different BC Ministry of Agriculture and Lands Planning for Profit Farm Management Sheets. A full listing of these sheets is located in Appendix 4.
[25] Production quantity estimates are obtained by AAFC and StatsCanada Data.

Category “Vegetables” Default Emission Factor is listed in Table 3. A full and detailed listing of calculations and references used to estimate the allocation of provincial inputs to each Whole Food Category is in Appendix 5.

Table 3 Default Emission Factor Estimate for "Vegetables (Field Grown)"

Agri-Input	Contribution to Default Emission Factor (kt-CO2e/tonne)
Energy Supply-Demand	0.0001
Agricultural Chemicals	0.0005
Land-Use	0.0003
Feed	n/a
Total	**~0.001**

To estimate the total amount of GHGe from the import of Washington potatoes to Canada, the amount of potatoes imported is multiplied by their respective emission factor. We know already that an estimated 164,045.93 tonnes of potatoes are imported from Washington, USA to Canada on an annual basis. Applying the “Vegetables (Field Grown)” Default Emission Factor of 0.001 kt-CO2e/tonne,
(0.001 kt-CO2e/tonne) (164045.93tonnes) = **164.05 kt-CO2e** released by the production of Washington Potatoes imported to Canada.

2.3.2 GHGe from the Transport of WA Potatoes Imported to Canada

Transport GHGe estimated in this paper are calculated using the WASD formula explained in Section 2.4 with its affiliated assumption matrix listed in Appendix 3. The WASD formula calculates GHGe in g-CO2e as a function of Transport Distance (km), Weight of Good Transported (tonnes), Transport type (either Truck, Air, Rail or Boat). For potatoes imported from Washington, travel distance is estimated as 342.52 km[26], traveling by Truck[27], whereas Truck has a T-Km, or multiplication factor of 207 (Bentley 2003). For potatoes imported from Washington to Canada, applying the WASD formula takes form as:

(164045.93tonnes)(342.52km)(207 T-km) = 11.65 kt-CO2e

[26] Calculated by Mapquest.com
[27] Transport assumptions are based on information received from representatives of the food production sector and supply-distribution chain.

Once an estimate of GHGe both from the production and transport of potatoes imported from Washington, USA to Canada is made, the two are added together to find the total GHGe estimate to be used for the purpose of calculating a C-Tariff for the category to find:

(164.05+11.65) = 175.68 kt-CO2e are emitted from the production and transport of potatoes imported from WA, USA to Canada on an annual basis between 2004-2008.

To translate GHGe from the import of potatoes to a Carbon Tariff estimate, first for the whole amount of potatoes imported to Canada from Washington, USA a Carbon Price is assumed as 25$/t-CO2e. To estimate the total taxation amount from the import of Potatoes from Washington, USA to Canada, the GHGe from the production and transport of potatoes imported to Canada is multiplied by the assumed carbon price such that:

(175.68kt-CO2e)(1000t/kt-CO2e)(25$/t-CO2e) = $439,200 could be taxed on the import of potatoes from Washington, USA to Canada

To Translate the Whole Food category's taxation estimate to a unit taxation amount of $CAD Tax/$CAD potatoes imported, The Whole Food category's taxation amount is divided by the $CAD Value of Potatoes imported such that:

($439,200 Tax)/($68,899,292) = 0.06 or a 6% C-Tariff per dollar potatoes imported is estimated

Adding an approximated 6% C-Tariff on potatoes imported from Washington, USA means that for each dollar of potatoes imported a 6.37 cent tax increase would occur.

It could be more practical to estimate Carbon Taxation Values on a $CAD per *weight* of a food item imported. For potatoes imported from Washington, USA the unit tax would be calculated as:

($439,200 Tax)(164045.93 tonnes) = $2.67/tonne

To date however, the most accessible data on foods imported is listed by Industry Trade and Customs reports detailed in Canadian Dollars. For the purpose of this paper, C-Tariffs are estimated on a $CAD/$CAD imported basis for each Whole Food Category and its affiliated HS six-digit subcategories, intended to be more pertinent to taxation discussions at the national and international level, wherein economic data is the most predominant method used to value a good. A full listing of results on C-Tariffs are available in Appendix 1, highlights of information are discussed in Results of Section 2.5. A more in depth explanation of what is included in agri-inputs assessed to estimate Default Emission Factors for Whole Food Production of Foods both produced in BC and imported to Canada are discussed next.

2.4 Default Emission Factors for Whole Food Production

There is an inescapable kinship between farming and art, for farming depends as much on character, devotion, imagination, and the sense of structure, as on knowledge. It is a practical art (Wendell Berry, 2007).

To date, "real data" listing GHGe from the production of all foods imported to Canada is not available to the public. Therefore, this paper calculates Default Emission Factors specific to domestic production in BC and extends them to estimate production GHGe from eight Whole Food categories. Included in default emission factor estimates are GHGe source activities of i. Agricultural Land Use, ii. Energy consumed by BC's agricultural sector, iii. Agri-Chemicals available to BC's Agricultural sector and iv. Manufacture and Transport of Animal Feed Imported to BC.

BC Ministry of Agriculture and Lands' Farm Management Budgets (Planning for Profit Sheets) and Statistics Canada data is used to estimate farm level GHGe for eight different types of farms, corresponding with a sample of eight Whole Food Categories both produced in BC and imported to Canada. A provincial estimate of GHGe from agricultural production of foods in BC is made. Four key activities are included as contributing to GHGe from agricultural production in BC: i. Agricultural Land Use, ii. Energy consumed by BC's agricultural sector, iii. Agri-Chemicals available to BC and iv. Manufacture and Transport of Animal Feed Imported to BC. Provincial input estimates are allocated to each of the eight farms types (e.g. fruit orchard, poultry farm, mixed vegetable farm) relative to quantities and types of inputs consumed[28], farm sizes, and yields received over one-year time frames. Emission Factors are presented in kt-CO_2e/tonne food produced for each Whole Food category.

2.4.1 Agricultural Land Use

Environment Canada's (EC's) definition of Agricultural Lands are those lands:

> *Compris[ing of] both cropland and agricultural grassland. Cropland includes all lands in annual crops, summerfallow, and perennial crops (mostly forage, but also including berries, grapes, nursery crops, vegetables, and fruit trees and orchards). Agricultural grassland is defined as "unimproved" pasture or rangeland that is used only for grazing domestic livestock (Environment Canada 2009).*

Agricultural land use GHGe estimates used in this paper are sourced directly from Canada's National Inventory Report (NIR) of GHGe sources and sinks (Environment Canada 2009). Canada's NIR aggregates Agricultural land use emissions into three categories for estimation and accounting purposes: Direct Emissions, Indirect Emissions and Animal Manure on Pasture, Range, and Paddock.

Direct Emissions' sources of GHGe from agricultural soils include primarily N_2O from synthetic nitrogen fertilizers, manure applied as fertilizers, crop residue decomposition, cultivation of organic soils, conservation tillage, summerfallow and irrigation (Environment Canada 2009). Estimates of N_2O GHGe from soils are calculated by taking into consideration eco-district characteristics from the province and nation they are specific to. For direct soils activities such as "crop residue decomposition, soil organic

[28] BC Ministry of Agriculture and Lands' Planning for Profit budgets guidelines[28] are referenced to estimate what percent provincial GHGe released by each of the 8eight farm types correspond with the eight Food Categories.

matter decay, tillage practices, summerfallow, irrigation and cultivation of histosols” a land practice activity report is made to estimate emissions; inclusive of information on which activities are occurring on what percentage of a farm’s land over time. Direct emissions from agricultural practices fluctuate and vary as a function of farm characteristics inclusive of soil type, climate and temperature, agri-chemicals and fertilizers applied, irrigation methods chosen, farmer lifestyle and energy consumption, lifestyle choices, tilling and management preferences, crops farmed, manures applied and crop rotations chosen (Environment Canada 2008). Therefore, a range estimate is often used to present GHGe estimates for direct soils’ emissions. *Indirect emissions* are listed alone as N_2O emissions from runoff and leaching of nitrogen at the eco-district level from the application of synthetic fertilizers, non-volatized manure nitrogen and crop residue nitrogen.□□

Animal Manure on Pasture, Range and Paddock emissions are mostly listed as N_2O from transformations of manure excreted by grazing animals on pasture, range, and paddock.□□For the rearing of animals, main sources of GHGe are enteric fermentation (CH_4) and manure management (N_2O and CH_4) activities. To estimate GHGe released by each animal category or subcategory, animal populations in a region are multiplied by their corresponding emission factors on a per animal head basis (Environment Canada 2009). An example of CH_4 emission factors used to calculate GHGe from the rearing of animals is in Table 4. Similar tables are available to estimate N_2O emissions for each animal type.

Table 4 Emission Factors in CH_4 for Animal Types

Kg CH_4 head/year	**2008 National Inventory Report**	**2009 National Inventory Report**
	kg-CH_4	*kg-CH_4*
Dairy Cow	116-135	105-117
Dairy Heifers	73	77
Bulls	86-94	83-90
Beef Cows	78-88	82-91
Beef Heifers	72-78	67-74
Heifers for Slaughter	58-59	59-66
Steers	55-61	53-58
Calves	48-49	45

GHGe from Direct and Indirect Soils' activities, Animal Manure on Pasture Range and Paddock are all included in the GHGe estimate for Agricultural Land-Use emissions released from the production of Whole Foods considered in this study.

2.4.2 Energy Consumed by BC's Agricultural Sector

Agricultural Industries included as consuming energy in British Columbia's production of Whole Foods are defined and described in the NAICS (North American Industry Classification System) codes 111, 112, 1142, 1151, 1152 as:

- 111: Crop production including oilseed and grain farming (most of which is for feed in BC), vegetable and melon farming, fruit and tree nut farming, greenhouse, nursery and floriculture production;
- 112: Animal production including cattle ranching and farming, hog and pig farming, poultry and egg production, sheep and goat farming, animal aquaculture, and other animal production;
- 1142: Hunting and trapping;
- 1151: Support activities for crop production;
- 1152: Support activities for animal production.

Here, energy consumption estimates made reflect fossil fuels consumed as natural gas, primary electricity, motor gas, kerosene, stove oil, diesel fuel oil, and light fuel oil (StatsCanada 2008) supplied to British Columbia farmlands and establishments primarily engaged in agricultural, hunting and trapping activities. Stationary combustion of fossil fuels from the agricultural sector is quantified as energy consumed for refrigeration and space heating only.

2.4.3 Agri-Chemicals Available to BC's Agricultural Sector

Industry Canada's definition of the NAICS 3253 industry is the manufacture of "Pesticide, Fertilizer, and Other Agricultural Chemicals" (Industry Canada 2009c). Energy types consumed by NAICS3253 include fuel, coal, electricity, heavy fuel oil, distillates, natural gas, petroleum coke and coke from catalytic cracking catalyst, propane, steam and wood: all contributing to GHGe from agri-chemical products' availability to BC.

To estimate GHGe from the production of NAICS3253 *products available* to BC's agricultural sector, a production emission factor in t-CO2e/tonne NAICS3253 produced (relative to energy consumption only) is assumed. Amounts of NAICS3253 products available to BC are estimated by quantifying amounts produced in BC less those exported from BC and adding in those imported[29]. Production emissions are estimated by multiplying the total amount of NAICS3253 products available in BC by the industry's assumed emission factor. Transport GHGe from the import of NAICS3253 products to BC are estimated using the Weighted Average Source Distance (WASD) formula (Bentley et al 2003) outlined and explained in Section 2.4 with corresponding assumptions in Appendix 3.

2.4.4 Manufacture and Transport of Animal Feed Available to BC

GHGe from the manufacture and transport of animal feed products available to BC are estimated in the same way as for the NAICS 3253 Agri-Chemical product industry referenced in this study. Quantities of animal feed available to BC are estimated and production emission factors in kt-CO2e/t-Animal feed produced are assumed[30]. Production emissions for NAICS3253 products available to BC producers are estimated by multiplying the total amount of animal feed products available in BC by the industry's assumed emission factor. Transport GHGe from the import of animal feed products to BC are estimated using the WASD (Weighted Average Source Distance) formula (Bentley et al 2003) outlined and explained in Section 2.4 with corresponding transport assumptions detailed in Appendix 3.

Many activities contributing to the production of Whole Foods in BC are not referenced or included in default Emission Factors calculated in this paper, severely limiting the accuracy of numerical estimates made. Additional assumptions, limitations, and points

[29] 95% of imports are received from the USA, Norway, Switzerland and India. The remaining 5% is assumed in an "other" category of imports shipped.
[30] Greenhouse gas emissions from energy consumption only are included; all other materials and operations generating greenhouse gas emissions from the production of feed are not represented in this estimate.

related to the validity and accuracy of production GHGe estimates made for the Whole Food categories in BC are discussed in results of this chapter.

2.5 Calculating Transport Emissions

A transportation formula known as WASD (introduced above as the weighted average source distance formula)(Bentley et al 2003) is applied to estimate GHGe from transport activities referenced in this paper. The WASD formula takes the format: g-CO_2e = (d)(w)(T-km). To use the WASD formula, the following information is needed: □□

a. How much of a product is being transported (w: weight) □□

b. How far a product is being transported (d: distance between origin of production to consumption point) □□

c. Information on transport vehicle type: boats, planes, trucks and rail. Transport vehicle type emission factors are referenced as “T-km” factors in Table 5.□□

Table 5 T-km Factors Applied in the WASD formula

Transport Vehicle Type	T-Km Factor
Air	1206
Truck	207
Rail	41
Boat	30

Transportation assumptions and limitations that accompany the WASD formula are discussed in Appendix 3.

2.6 Results and Discussion on C-Tariffs

This section lists results of calculations used to estimate hypothetical Default Emission Factors calculated for the production of a sample of nine Whole Food Categories both 1) Produced in BC, Canada and 2) Imported to Canada. Default Emission Factors estimated include GHGe from four key agricultural production activities as specific to BC, Canada: i. Agricultural Land Use, ii. Energy consumed by BC’s agricultural sector, iii. Agri-Chemicals available to BC’s Agricultural sector and iv. Manufacture and Transport of Animal Feed Imported to BC. “Elite Food Travelers” or those food products calculated as having the highest GHGe from their production and transport to Canada (within the arbitrary sample of foods assessed) are highlighted. Carbon Tariff estimates for each Whole Food Category imported from 43 different countries are estimated and discussed. Assumptions, limitations and challenges related to collecting GHGe activity data in the food system and further information on specific data necessary to calculate more accurate emission factors for the production of whole foods imported to Canada follows. Results of this section are intended to demonstrate complexities in food system GHGe accounting standards, highlight key agricultural activities contributing to GHGe from food production in BC, and demonstrate how C-Tariffs estimated on foods imported to Canada may vary.

2.6.1 Default Emission Factors for Whole Foods Produced in BC

Figure 1 presents Default Emission Factor (EF) estimates in t-CO2e/t-food as produced in BC, Canada. Different EF estimates are calculated for a sample of nine Whole Food categories both produced in BC and imported to Canada: Greenhouse Grown Vegetables, Field Grown Vegetables, Fruits, Eggs, Poultry, Beef, Pig, Sheep/Lamp and Grains. Results, while hypothetical only, imply that in a relative sense Beef, Pig, Lamb and Sheep have the highest EF estimates in the livestock rearing categories of BC; Grains and Fruits have the highest EF estimates in the produce categories produced in BC.

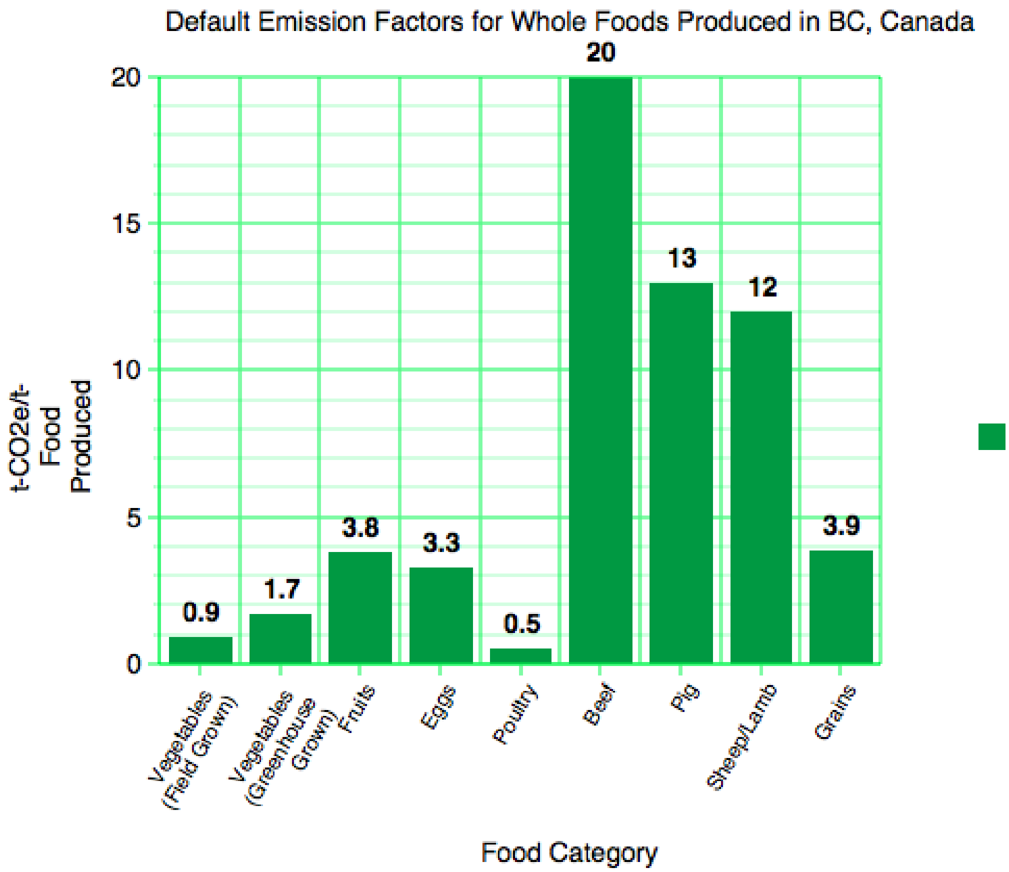

Figure 1 Default Emission Factors for Eight Whole Food Categories Produced in BC, Canada

Beef Pig and Lamb are calculated as having the highest Default EF estimates at 20.8, 13.0 and 12.0 t-CO2e/t-food produced respectively. The strength of their EFs estimated is mostly correlated to GHGe released from land-use activities, manure management and enteric fermentation, followed by smaller amounts of GHGe released by on-site farm energy consumption (e.g. from housing and feeding facilities for animals) and animals' consumption of feed. Land-use emissions from manure management and enteric fermentation contribute to 82% of the Beef Food Category's EF estimate while energy consumption contributes only to 16.5%, feed consumption to 1%. For Pig, land-use emissions from manure management and enteric fermentation contribute to 76.9% of its EF estimate, energy consumption at 21.5%, and feed consumption at 1.5%. For Lamb and Sheep production, land-use emissions contribute to 82.5% of its EF estimate, energy consumption 16.6% and feed consumption 0.1%.

Fruits' and Grains' high consumption of agricultural chemicals means their EF estimate calculated is higher compared to both field grown and greenhouse grown vegetables produced in BC (78.9% of the Fruit category's EF estimate is from the consumption of agricultural chemicals applied on farmlands). The EF estimate for the production of Field Grown Vegetables in BC is 0.9 t-CO_2e/t-food; nearly half that for Greenhouse Grown Vegetables' 1.7 t-CO_2e/t-food, while the Fruit category ends up with an EF of 3.8 t-CO_2e/t-food produced – nearly four times higher in comparison to field grown vegetables.

2.6.2 Comparing Production and Transport GHGe

GHGe estimates from the production and transport of each of the eight Whole Food categories imported to Canada are visualized on a *Food Category* basis (i.e. total amounts of GHGe estimated for the import of each food category imported from all 43 countries to Canada) in Figure 2.

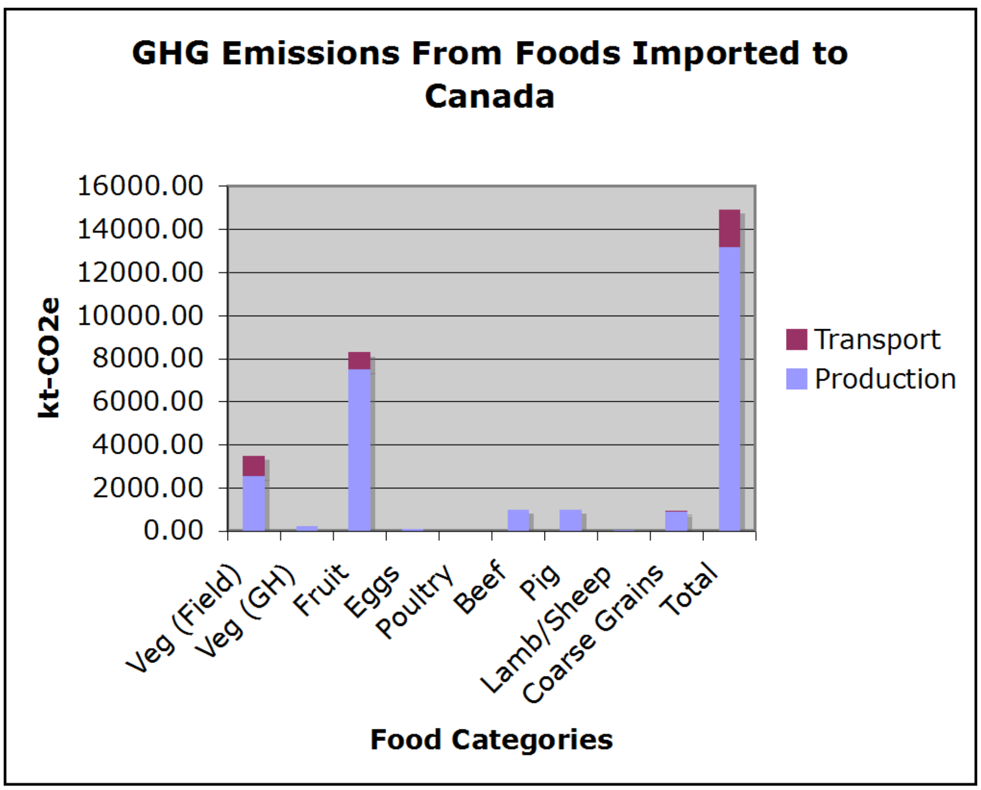

Figure 2 GHG Emissions From the Production and Transport of Food Categories Imported to Canada

Estimates in Figure 2 suggest that relative to GHGe from their transport, production emissions make up a higher percent (between 61-98%, and on average 88%) of each Food Category's GHGe estimate. For Vegetables imported, production emissions are estimated as 73% of their total, for Fruit 91%, Eggs 87%, Poultry 61%, Beef 98%, Pig 98%, Lamb/Sheep 97% and Coarse Grains 95%. Table 6 examines the Whole Food Category "Beef" imported to demonstrate the comparison of Production and Transport GHGe estimated from the top four countries shipping Beef to Canada.

Table 6 Production and Transport GHGe from "Beef" Imported to Canada

Country of Origin	Weight of Food Imported	Production Emissions	Transport Emissions	Production + Transport Emissions
	tonnes	*kt-CO_2e*	*kt-CO_2e*	*kt-CO_2e*
Australia	1982.04	60.25	0.85	61.10
New Zealand	1119.66	34.04	0.39	34.42
Other Countries	1346.23	40.93	0.16	41.08
USA (Denver)	44663.76	1357.78	14.61	1372.39
Total	**49111.72**	**1493.00**	**16.00**	**1509.00**

It is important to note however, that GHGe from production estimated in this study are not representative or reflective of different countries' production practices (as they are assumed Default Emission Factors); and transport GHGe estimated are calculated relative to numerous transport assumptions made for each food category, not reflective of many different transport route options available for the shipment of foods imported to Canada.

2.6.3 Transport Emissions from Whole Foods Imported to Canada

GHGe from the transport of Whole Food Categories imported to Canada are estimated as a function of each Whole Food category's *quantities* shipped, distances traveled and transport methods assumed (i.e. air, truck, rail, boat or a combination)[31]. Canada imports a vast array of fruits and vegetables from the Southern Hemisphere (California, Mexico and Chile) where warm climates permit the growth of many of our favourite foods on a consistent basis. The import of Whole Foods from California, Mexico and Chile

[31] Transport methods assumed are listed in Appendix 3; Assumptions were made based on conversations with industry experts and food procurement officers in business, public institutions, and not-for-profit groups.

contribute the most to transport GHGe from foods imported to Canada, highlighted in Red in Table 7.

Table 7 Transportation Emissions from Foods Imported to Canada

Country	Transport Emissions	Country	Transport Emissions
	kt-CO_2e		*kt-CO_2e*
Australia	2.04	**Other Countries**	32.18
Argentina	20.06	**Peru**	8.71
Brazil	0.01	**Philippines**	0.80
Chile	**92.40**	**South Africa**	16.34
China	28.72	**South Korea**	0.21
Colombia	17.04	**Spain**	3.15
Costa Rica	52.85	**Switzerland**	0.37
Denmark	0.06	**Thailand**	0.97
Ecuador	46.84	**Turkeminstan**	N/A
France	2.38	**UK**	0.19
Germany	1.01	**USA (Atlanta)**	16.26
Greece	0.11	**USA (California)**	**904.62**
Guatemala	29.64	**USA (Des Moines)**	17.31
Honduras	0.38	**USA (Denver)**	14.61
India	1.98	**USA (Honolulu)**	1.94
Italy	1.44	**USA (Illinois)**	41.15
Jamaica	1.03	**USA (Miami)**	42.98
Mexico	**316.32**	**USA (New York)**	2.11
Morocco	10.01	**USA (N Dakota)**	2.11
Netherlands	2.80	**USA (Washington)**	20.70
New Zealand	1.08	**USA (Wisconsin)**	5.80
Norway	0.28		

2.6.4 "Elite Food Travelers" - Banking Air Miles

Within each Whole Food category, "Elite Food Travelers" are identified as the top three foods imported with the highest GHGe from their production and transport. GHGe estimates from the production and transport of Elite Food Travelers' to Canada are visualized in Figure 3.

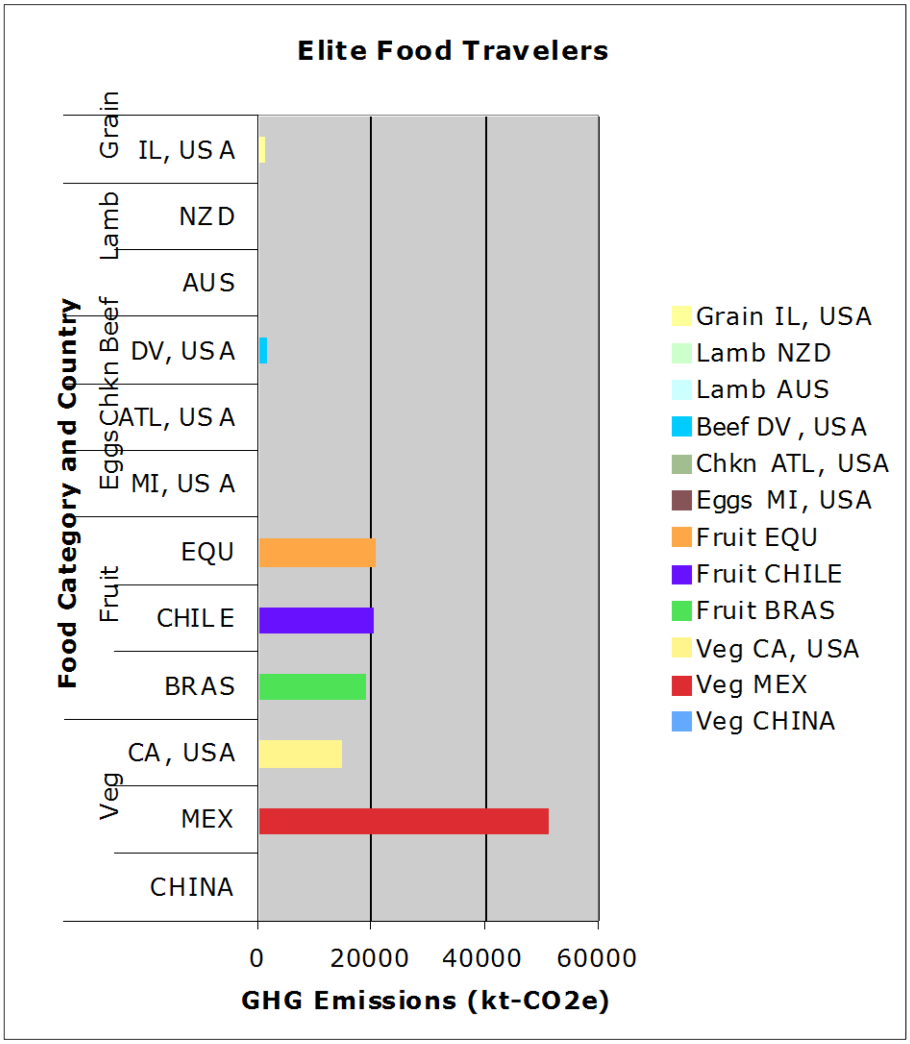

Figure 3 Elite Food Travelers

Vegetables Imported from Mexico. Approximately 23,721,330.44 tonnes of Vegetables (tomatoes, onions, cauliflowers, lettuce, edible root vegetables, cucumbers, peas and beans, asparagus, celery, peppers, spinach and other miscellaneous vegetables) are imported to Canada from Mexico on an annual basis; 51,197.97 kt-CO_2e is estimated as released from their production and transport. Within the category, 42.55% of the GHGe are from the production of *field grown* vegetables, 19.6% from the production of *greenhouse grown* vegetables and 37.7% from *transportation* within the food category.

Fruits imported from Equador, Chile and Brazil. 82,441.32 tons of bananas and 4,576,031.33 tons of tropical fruits are imported to Canada on an annual basis. Fruits imported from Chile are mostly tropical, citrus, tree fruits (e.g. grapes and apples) and berries. Brazil ships “other tropical fruits” as pineapples, guavas, mangosteens, papayas, kiwifruits and durians. While the approximately 5 million tonnes of fruits imported seems dwarfed next to nearly 24 million tonnes of vegetables imported to Canada from abroad, the Fruit Category’s higher Default Emission Factor Estimate means the total GHGe from each of the Fruit category and Vegetables category imported amount to nearly the same.

2.6.5 Food System Complexities, Issues of Accuracy and Validation

Many food system complexities limit the efficacy of GHGe data collection on food products. Not having direct farm level data on activities contributing to GHGe from the production and/or distribution and transport of different foods available to Canadians makes estimating GHGe from their production a challenge. Production and Transportation alone are not the only activities of a food product’s life cycle that contribute to GHGe from its availability. Further activities that could be included in default Emission Factors for food products include but are not limited to: Usage of Agri-Machinery, Other Farming Inputs Available to BC Producers, Domestic Transport of Agri Inputs, Processing Foods, The Manufacture and Transport of Packaging and Materials, Storage Refrigeration and Cooling Activities, Retail Outlets, Warehouses and Food Product Distributors, Transportation of Foods From Retail Outlets to Food Consumption Locations (e.g. Grocery Shopping), and Travel Between International Food Producers and their Domestic Shipping Destinations.

Here, for example, the usage of agri-machinery might include those activities involved in the manufacture and transport of NAICS33311 products to Canada; classified as production of “Agricultural Tractors, Milking Machines, Cabs for Agricultural Machinery, Planting Machines, Cleaning Machines, Plows, Grading and Sorting Machines, Harvesting machinery, Spraying Machinery” (Industry Canada 2009e). Activities involved in the manufacture, transport, application and/or usage of other Farming Inputs Available to BC Food Producers might include: seeds, runners and small plants, smaller animals to raise, bigger animals to breed, casing materials, mulching materials and other farmer lifestyle items (e.g. clothing, gear, food consumed by workers).

A tangled, multi-distribution system of domestic transport of agri-inputs such as agri-chemicals, agri-machinery, workers, seeds, and other food production supplies in BC take countless different transport routes, making it difficult to follow or account for GHGe. Activities involved in the manufacture, transport, storage, distribution and generation of waste from packaging materials and inputs necessary to process and package foods produced and shipped to Canada are vast, hard to follow and may have management protection rights. The long distance transport, storage, refrigeration and cooling of Agri-Inputs and/or foods produced, exported or imported to supply foods imported to Canada means that for many foods, refrigeration is a feature of almost every stage in the supply chain, from the point of harvest or slaughter onwards. Retail Outlets, Warehouses and Food Product Distributors partake in many operational (e.g. in-store food preparation activities, office and business operations) and transport activities (e.g. grocery store deliveries) within and by retail outlets separate from the storage, refrigeration and cooling of agri-inputs and/or whole foods produced in BC. Activities participated in by consumers, caterers, restaurants, individuals and others driving to grocery stores to pick up food (1-10 shopping bags worth) and other transportation activities between retail outlets where people purchase and consume food are by no means easy to follow or collect information on – either locally or internationally. GHGe activities for and travel between international Food producers and their domestic shipping destinations (either by porter, tuk tuk, railroad, yak, truck, van, car, bus or rooftop carrier for example) is often is not tracked – especially in developing countries where inconsistent supply-demand chains occur.

Gathering information on GHGe source activities involved in the production and transport of foods made available to Canada is, for lack of a more descriptive word, *difficult*. For any government or regulatory body to gather adequate data on food system GHGe, many administrative steps and logistics in data collection must be seriously evaluated to determine if the complexities of their application would be worthwhile.

The attempt at partial food product GHGe estimation methods in this paper is intended to provide not only a snapshot of the GHGe that a food product could attract taxes; but also to draw attention to the multitude of steps that may be necessary to account for GHGe from a product imported to Canada. The accuracy and validity of Emission Factors calculated in this paper is extremely limited, unfit for the purpose of any carbon regulation to comply by or consumers to be taxed on – demonstrating that GHGe from the production and transport of foods imported to Canada may not be accurately calculated at this time.

2.6.6 Carbon Tariff Variations

Carbon Tariffs calculated in $CAD/$CAD of each Whole Food Category are estimated as a function of: GHGe from a product's production and transport, an assumed Carbon Price of 25$/t-$CO_2$e, and the values (i.e. $CAD) of each Whole Food category imported from each country. To demonstrate variations in C-Tariffs estimated, C-Tariffs calculated for the Food Category "Vegetables" imported from the top 95% of countries shipping Vegetables to Canada is outlined in Table 8, for Elite Food Travelers in Table 9.

Table 8 C-Tariff Estimates for the Food Category "Vegetables" Imported to Canada

Food Category: Vegetables	C-Tariff Estimate
Country of Origin	*CAD/CAD Imported*
China	0.03
Costa Rica	0.03
Guatemala	0.01
Honduras	0.02
India	0.06
Jamaica	0.03
Mexico	0.04
Netherlands	0.01
Peru	0.02
Philippines	0.02
South Korea	0.02
Spain	0.02
Thailand	0.04
USA (California)	0.06
USA (Miami)	0.02
USA (North Dakota)	0.04
USA (Washington)	0.06

Table 9 **C-Tariff Estimates for "Elite Food Travelers"**

Elite Food Traveler	C-Tariff	C-Tariff
	(%)	*$CAD/$CAD imported*
Garlic from China	1.98	0.02
Onions from Mexico	8.40	0.08
Cauliflower from California, USA	3.50	0.04
Tropical Fruit from Brasil	6.69	0.07
Berries from Chile	4.20	0.04
Tropical Fruit from Equador	7.23	0.07
Eggs from Miami	4.09	0.04
Chicken from Atlanta, USA	0.57	0.06
Beef from Denver, USA	7.14	0.07
Lamb from Australia	3.06	0.03
Lamb from New Zealand	3.03	0.03
Grain from Illinois, USA	14.7	0.15

The highest hypothetical C-Tariff estimates of 15, 8 and 7 cents on the dollar are taxed on imports of Grains from Illinois, Onions from Mexico, and Tropical Fruits from Brazil and Ecuador, tied with those C-Tariffs estimated for Beef Imported from Denver. C-tariff estimates for Grains (15%) and Onions (8%) are higher than other imports' C-Tariff estimates and are relatively high within food categories not only because of production and transport methods chosen, but also because of their relatively *low prices per volume imported* (assumed $0.70/kg and $0.63/kg respectively). C-Tariff estimates can be misleading and challenging to interpret because they are related not only to a product's GHGe that is calculated as a function of its weight, but to the price of a product on a volume basis. For example, while one might expect a high production emission factor for beef to imply a higher C-Tariff on its import compared to tropical fruits - the cheap price of tropical fruit, $1.50/kg compared to Beef's higher price of $7.12/kg means the C-tariff estimated for both categories ends up as approximately the same ($0.07/$CAD).

2.7 Limitations of BCA Calculation Methods Applied

In assessing a potential method to account for GHGe from a sample of Whole Foods imported to Canada, literature reviewed in Chapter 1 and results of Sections 2.1 to 2.7 illuminate the potential for many limitations in Canada's abilities to accurately apply a BCA on foods imported to our nation. Investigating methods to account for the GHGe from the production and transport of foods imported to Canada demonstrates that until food system manufacturing practices are made transparent, any efforts to account for

GHGe from their activities will effectively prove invalid in accurately accounting for GHGe. Applying default Emission Factors means results calculated will be ineffective at distinguishing between “high” and “low” intensities of food product manufacturing practices. Calculating hypothetical C-Tariffs on foods imported to Canada reveals how potential C-Tariff estimates could vary in, of and between different food categories imported from different countries to Canada, creating potential risks for the application of such a C-Tariff to violate the WTO’s Most Favoured Nation and National Treatment Principles discussed in the first chapter of this paper. Implications of a few of these limitations are discussed.

2.7.1 Default Emission Factor Calculation Assumptions

Assuming standard Default Emission Factors for the production of Whole Food Categories imported to Canada creates many limitations to the accuracy of C-Tariff estimations made in this paper. Regional and industry preferences in food production practices are not taken into account and calculation methods chosen rely on government publications. If for example, Canada were to rely on Default Emission Factors to estimate GHGe from the production of imported goods, producers in countries shipping foods to Canada could continue manufacturing practices as normal without being penalized for GHGe intensities from production. Numerical results calculated in this paper are hypothetical only in their application, not to be interpreted as true Emission Factors for the production of Whole Food categories produced in BC.

2.7.2 Not Having Real Data on Food Production Practices could Encourage Producer “Cheat Activities”

C-Tariffs estimated in this paper rely both on government publications, and on assumptions related to percent of each food category produced in Greenhouses vs. on the Field. For fruits and vegetable products, relying on government publications to estimate GHGe source activities for each Whole Food Category both produced in BC and imported to Canada means GHGe estimates do not reflect true farm production practices, technologies, farm sizes, differences between conventional farming, organic farms, alternative farming, integrative farming, free range farm practices, topography and yield variations, climate and temperature changes throughout seasons, animals rearing and feed choices, individual farmers' production preferences, varying input quantities, varieties of foods chosen for production, or other farm variations within Food Categories assessed.

Default Emission Factors for Field Grown and Greenhouse Grown Vegetables are estimated separately: Tomatoes, lettuces, peppers and cucumbers are assumed as produced both in Greenhouses and in the Field. Products grown both in the field and in greenhouses imported from the United States are assumed as 10% Greenhouse Grown and 90% Field Grown (Abate 2006); 8.2% Greenhouse Grown and 91.8% Field Grown from Mexico and S. America (Abate 2006); 93.8% Greenhouse Grown, and 6.2% Field Grown from Europe (namely the Netherlands and Spain). The "Other" category of vegetables imported has been assumed 66% field Grown and 33% Greenhouse Grown (Serecron 2009).

For animal products, assuming Default Emission Factors for Food Categories imported to Canada does not take into account differences in food production practices including, for example, animal rearing preferences, manufacturing and processing differentiations of specialty food prices, weights, manufacturing and processing activities, shipment sizes, weights, brands, specialty and heirloom items or other variations in and of Food Category manufacturing practices. Standardizing Default Emission Factors and unit prices of goods imported to Canada means that, for example, within the Food Category "Vegetables", a fresh potato produced in China will be listed as having the same Default Emission Factor as frozen asparagus produced in Italy (while transport emissions are calculated separately) since both "Potatoes" and "Asparagus" are included in the "Vegetable" Food Category. Variations in production practices and goods imported within each food category are not considered. For animal products, differences in the make or percent fat content of animal foods, variations in animals' physiological status, age, location, any other character specifics of the animal, total feed consumption, buildings and other storage or containment activities, water consumption or any other medical or veterinary treatments necessary for each animal type; or how goods are packaged and/or processed are not considered.

Not having actual data on how and where foods imported to Canada are produced makes estimating worthwhile or accurate C-Tariffs for their import a challenge. The concept of applying Emission Factors to foods produced means Food producers could get away with GHGe intense production practices not represented in C-Tariffs applied to their products imported. Using default Emission Factors to calculate C-Tariffs for the purpose of a BCA limits a BCA's ability to penalize producers with GHGe intense manufacturing practices. This could allowing producers to get away with "Cheat Activities" or those manufacturing practices that contribute relatively high amounts of GHGe to their industry but would not be represented in C-Tariff estimates.

2.7.3 Assuming Standard Pricing for Agri-Inputs Considered as Contributing to GHGe from Whole Food Production

To calculate Default Emission Factors for the production of Whole Food categories in BC, a default price estimate for both agri-chemicals and feed products is assumed in CAD$/kg. Taking a default price estimate does not differentiate between product types, brands, sizes, bulk weights or shipping costs, variations in weights of products, price fluctuations at the retail, wholesale, bulk purchasing prices within industries or differences in production practices between agri-chemical manufacturing plants. Variations in production, processing and manufacturing practices (e.g. milling, packaging, storage, oils, sugars, or other additives used to manufacture feed) or quality, brand, make and pricing variations of feed available to BC are not taken into account. GHGe from agri-chemical and feed product manufacturing are assumed to be directly related to energy consumption alone and are not representative of any other inputs necessary for their manufacture (e.g. packaging materials, machinery). Not taking into account variations in product manufacturing practices or other inputs necessary aside from energy for their production severely limits the ability of Default Emission Factors to present information on GHGe from the consumption of agri-chemicals and feed in BC, Canada. The vast amount of assumptions made in this paper to estimate default production Emission Factors for each food category raises questions as to whether they are worthwhile to calculate. Further research is warranted and necessary on how best to account for GHGe from foods available to consumers.

2.7.4 Full[er] Cost [GHGe] Accounting

As ever, it is in the details where the devil lies.
~IISD, 2009.

Data for scientifically supported Full[er] Cost GHGe Accounting must be solidified before a BCA is Administered. The United Nation's Framework Convention on Climate Change's (UNFCCC) Clean Development Mechanism (CDM) Executive Board is in the process of developing methodologies to account for organic processes related to Land Use (including agricultural production) and Forestry; recent call-outs for methodological advice in the form of guidance from experts was released between February 21st and March 21st of 2011; concluded by their 48th panel on methodologies meeting (UNFCCC 2011a). Reviews of CDM methodologies completed by local carbon project experts (Pallant, Joseph and Rouhaney, Mahbod in person communications April 2011; Black, Andy in person communications April 2011) suggest it may prove challenging to clearly outline how a food product manufacturer may accurately receive credit (either environmentally or economically) as part of a CDM scheme[32]. Ambiguities surrounding a nation's necessity and abilities to validate a GHGe accounting standard for food products available continue in the development of standards today.

The myriad of inputs consumed in the manufacture of foods today indicates that the consideration to what a GHG activity report specific to the food sector and food products is needed. The science behind monitoring GHGe from organic processes involved in agricultural soils, forests and other variable processes in the food system is still in its infancy (Dr. John Gamon, in person communications, May 2011; Dr. Andy Black, in person communications April 2011). Standardized methods and administrative compliance schemes to collect data on GHGe from a product produced outside a region's jurisdiction do not exist; and there are many questions as to how accuracy in GHGe accounting reporting standards could be maintained, monitored and adhered to. Before any BCA can be implemented on products available to any country, serious thought must be put into what the administration of a GHGe accounting data collection process would look like, how it would be adhered to and perhaps most importantly, *who* would be responsible for its administration.

2.7.5 Variations in C-Tariffs Could Infringe on WTO Principles

Variations in products' GHGe from production and transport, differences in dollar values and unit prices of foods imported to Canada mean that the same products imported from different countries will most likely have different C-Tariffs estimated for their import. Thinking back to WTO principles of the Most Favoured Nation Principle and National Treatment Principle in Chapter 1, results of Chapter 2 demonstrate that, if a C-Tariff was applied on foods imported to Canada, we could be at risk of infringing on both of these principles: treating the same good imported from different countries unequally since different carbon taxation amounts would be applied.

2.7.6 GHGe Data Collection Complexities

GHGe data collection activities for a BCA Scheme could be complex and costly: potentially outweighing its abilities to combat leakage and/or reduce GHGe in the atmosphere. Further research into the implementation and administrative logistics of a Border Carbon Adjustment scheme has been deemed necessary[33]. Examining the multitude of data necessary to account for GHGe from a food product imported to Canada suggests many administrative burdens could be associated with accurately collecting data for a BCA scheme. To date, there is no legal entity publicly recognized as an internationally credible dictator of clearly standardized BCA administrative guidelines, or complementary GHGe accounting methods. The multitude of data necessary to accurately account for GHGe from the production and transport of foods imported to Canada suggests that a complex data collection system would be necessary to accurately account for GHGe through the administration of a BCA scheme. How we could monitor the costs involved in collecting data for a BCA relative to its abilities to

[33] (Fisher and Fox 2008)

actually combat emissions leakage or perhaps of more relevance, reduce GHGe in our atmosphere is of significant concern.

2.8 Concluding Note: A BCA may not be the Best

Chapter 2's attempt to estimate C-Tariffs from the production and transport of foods imported to Canada demonstrates how a lack of food system transparency and any method that chooses Default Emission Factors (or emission factors at all) could be limited in its abilities to accurately account for GHGe from food products. Observing estimates of C-tariffs calculated for different foods imported to Canada demonstrates how a BCA could infringe on WTO principles, treating like goods imported from different countries unequally in its application. It is unclear whether it is feasible to design a BCA that addresses domestic competitiveness and emissions leakage concerns that is WTO-legal[1], fair to governments responsible for their administration, and reasonable to producers responsible for supplying information on product manufacturing practices. Potential complexities in a BCA's administrative design for data collection raise concern about its abilities to effectively reduce GHGe and displace emissions leakage as compared to its data collection costs. Many other challenges to administering a BCA most likely exist, and it is not within the scope of this paper to address them all. Results and discussion of this paper suggest a BCA may not be a best policy tool to consider as a balancing tool to carbon regulations currently being developed.

2.9 Information about Collaborators

Research on Default Emission Factors in this section was completed under the guidance of and in collaboration with Marc Lee, Herb Barbolet and Matt Thomson as part of the Canadian Centre for Policy Alternative's Climate Justice Project, 2010. The remainder of this chapter was completed under guidance primarily through conversations with Drs. Werner Antweiler, Sumeet Gulati and Rick Barichello in the Faculty of Land and Food Systems, with consultation at the University of Alberta's bioinformatics network. Contributions made towards fuller cost accounting were retrieved from past works completed with supervision by Dr. Andrew Riseman in the Faculty of Land and Food

Systems, and Terrasphere Systems with Nick Brusatore in Surrey, British Columbia Canada.

CHAPTER 3 SYNTHESIZING MUSINGS

This paper's contributions are most applicable to research fields in 1) GHGe accounting methodologies for food products and 2) Concepts related to Border Carbon Adjustments (BCAs). Research questions explored include 1) How might GHGe from the production and transport of whole foods imported to Canada be accounted for? 2) How might Carbon Tariffs calculated as a function of a Whole Food product's GHGe from production and transport and a hypothetical carbon price vary? and 3) What challenges could exist administering a BCA on Whole Foods imported to Canada? Exploring these three research questions, this paper exposes how very complicated and potentially ineffective it could be to administer a BCA on foods imported to Canada. This chapter continues to suggest *thorough consideration* into both solidifying the design and administration of GHGe accounting standards and understanding WTO regulations is necessary before Canada considers the introduction of a BCA on any product. Recommended areas of future research conclude to encourage a turn towards the re-localization of our political economy as a method to best account for, reduce, and incent the reduction of food system GHGe both domestically in Canada and abroad.

3.1 Contextualizing a Few Historical Logistics

Determining the climate impact caused by a food product is very difficult for consumers to understand as aspects inclusive of product type, production system, packaging, origin, transport, waste and other downstream impacts need to be weighed together
(Roos et al 2010).

We cannot price the CO_2e of a product if we do not know how to account for them. Around 30 years of climate negotiations and protocol developments have helped set the stage for today's emerging climate policy frameworks with complementary GHGe accounting standards developing along the way. Initially, print documentation and talk of climate change's impacts on our environment and health were first taken seriously from a global consensus in 1990 when the International Panel on Climate Change (IPCC) published its first series of Climate Change assessment reports[34]. The United Nations Framework Convention on Climate Changes' (UNFCC)[35] negotiations (between 1992 and 1994) and the 1997 Kyoto Protocol[36] followed. It was not until after the IPCC listed its third assessment report that the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) published an initial *GHGe Protocol For Corporate Accounting Standards* (2001)[37](GHGMI 2011). In 2004, training courses for GHGe verification and accounting were developed under guidance by the ISO's (International Standards Organization)[38] Environmental Management Series Standards Guidelines for the validation and verification of GHGe assessments and in 2007 "a global training and professional institute for GHGe accounting experts" [39] was initiated as part of the Greenhouse Gas Management Institute's design (GHGMI 2011). By 2008 the training program was enhanced in collaboration with the United Nations to generate a GHGe accountant verifiers and accreditors program; encouraging standards' monitoring and validation of activities contributing to a product's Carbon Footprint. Today in the USA, the centralized Regional Greenhouse Gas Initiative (RGGI)[40] is working to "develop accreditation and mandatory training programs for GHGe verifiers to follow (2008)"[2].

[34] The IPCC is an international body working to assess climate change. It was established by the "United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts […] The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change" (IPCC 2011). Globally, Thousands of scientists voluntarily contribute to the work of the IPCC on a consistent basis.

[35] The United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty many countries joined in a collaborative effort to consider options to reduce global warming and potential temperature increases (UNFCCC 2011).

[36] The Kyoto protocol is a treaty that was approved by a number of nations -- having greater abilities and legally binding measures related to the UNFCCC. It is an "international and legally binding agreement to reduce greenhouse gas emissions worldwide, entered into force on 16 February 2005" (UNFCCC 2011). The main difference between the UNFCCC treaty and the Kyoto protocol is that the UNFCCC encourages countries to reduce emissions, while the Kyoto framework binds them to do so; with more emphasis on developed countries responsibilities (as developed countries are assumed to have higher contributors to GHG emissions) (UNFCCC 2011).

[37] The WRI's GHG Protocol is the "most widely used international accounting tool to understand, quantify, and manage greenhouse gas emissions – both by government, industry, and other public/private sectors worldwide" (WRI 2011).

[38] The ISO is an internationally credible organization working to provide a variety of standards and certifications related to social responsibility, risk management, quality management, and environmental management.

[39] E.g. ClimateCHECK, the GHG Experts Network, and GoVIda e-learning, Earth Council Geneva, Swiss Development Cooperation Agency (GHGMI 2011)

[40] The Regional Greenhouse Gas Initiative (RGGI) is an initiative of the North East and Mid Atlantic States of the US. It is the first market-based regulatory program in the United States to reduce greenhouse gas emissions. Ten northeastern and mid-Atlantic states have capped and will reduce CO2 emissions from the power sector by ten percent by 2018.

Most recently, the introduction of training programs pertinent to interpreting information related not only to accounting standards but to international Carbon Markets[41], Clean Development Mechanisms (CDM)[42] and cap-and-trade programs have emerged. Domestically in Canada, it was in March of 2009 that the GHG Management Institute was able to train the "Standards Council of Canada[43] assessors on ISO 14064 and 14065" in areas of GHGe quantification, monitoring, reporting, verification and validation. Standards are available now in both French and English[44] for those wishing to examine in further detail a product's carbon footprint or GHGe from its life cycle.

For food products, defining operational system boundaries and accurately accounting for GHGe from processes with fluctuating emission factors (e.g. GHGe released from organic soils and animal activities reliant on climate, temperature, seasons, humidity, soils classifications, nutrients applied) pose information monitoring and data accounting queries not easily addressed within the WRI, IPCC or ISO's guidelines. Taking a closer look at options to account for the GHGe from food products reveals there may indeed be gaps in accounting standards (most notably related to organic processes) that challenge any nation's ability to accurately account for the GHGe from the import of a food product, or other products of organic nature (Dr. Kent Mullinix Dec. 2010, Dr. Andrew Black Feb 2011, Dr. John Gamon June 2011, in person communications[45]).

It is important to recognize that having *accurate estimates of GHGe* for the pricing of products must be considered before they can have a value-added tax applied to them. Policy makers and government spokespersons need to understand that without a

[41] Carbon Markets trade the reduction of Carbon Emissions in the atmosphere; they can be either voluntary or regulatory/mandatory in scope: "In a voluntary carbon market, an entity (company, individual, or another "emitter") volunteers to offset its carbon emissions by purchasing carbon allowances from a third party, who then takes this money and uses it towards a project that will reduce carbon in the atmosphere […] Compliance carbon markets function under a regulated limit to carbon emissions (a "cap" on emissions), where permits or "allowances" are given or auctioned to carbon emitters who then have to figure out how to conduct their business within this set limit" (RenewableEnergyWorld 2011)

[42] CDMs allow "countries with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO2e, which can be counted towards meeting Kyoto targets" (UNFCCC 2011a).

[43] "The Standards Council of Canada (SCC) facilitates the development and use of national and international standards and accreditation services to enhance Canada's competitiveness and social well-being" (SCC 2011).

[44] (ISO 2011)

[45] Dr. Kent Mullinix is a program developer at the Institute for Sustainable Horticulture of Kwantlen University in Richmond British Columbia; Dr. Andrew Black is a Principal Investigator in the C-Flux laboratories at the University of British Columbia; and Dr. John Gamon is a professor in the department of Biological Studies at the University of Alberta.

scientifically supported standard carbon footprint estimate on which to tax a product, the validity and accuracy of any tax applied to it is certain to be challenged eventually. Scientists working in areas of GHGe measurements and accounting need an opportunity to express their concerns related to validity in GHGe measurements. Economists working to bridge communicative gaps between science and policy need support to relay information between the two fields of research.

3.2 Strengths, Limitations and Where to Think Next

While traditionally, applying a Border Tax Adjustment on GHGe could seem like a practical policy tool to discourage emissions leakage, examining and exploring the availability of data necessary to follow GHGe methodologies and comply with WTO regulations reveals extensive administrative logistics and gaps involved in GHGe accounting regulatory frameworks – potentially challenging the application of any valid or worthwhile Border Carbon Adjustment (BCA) on a product imported to Canada. Concerns with Canada's abilities to comply with the WTO's National Treatment and Most Favoured Nation principles compound issues related to the efficacy of introducing a BCA. Key Strengths, Limitations, Implications of Research Findings, and Directions for Future Research revealed as related to research questions addressed in this paper are discussed in Table 10. Following is a synthesized analysis of directions for future research to consider.

Table 10 Strengths, Limitations, Potential Implications of Findings and Possible Directions for Future Research

Research Question Addressed: **1) Can GHGe from the production and transport of foods imported to Canada be calculated?**			
Strengths of Research	**Limitations of Research**	**Potential Implications of Research**	**Directions for Future Research to Consider**
Raw industry data (rather than empirical data) is used to estimate *quantities of foods* imported to Canada.	Many assumptions on trade values, food prices, and product description categories assessed **limit the accuracy and validity of methods** used to quantify and categorize whole foods imported to Canada.	Attempting to account for trade values of foods imported to Canada is a useful exercise to highlight ambiguities in current food system production and transport networks.	How might transparency in food production and distribution networks supplying Canada (and other developed countries) with food be encouraged?
Traditionally, Emission Factors for food products	Using data specific to BC to estimate production GHGe for products	**GHGe accounting standards available today could be**	What might internationally

Research Question Addressed: **1) Can GHGe from the production and transport of foods imported to Canada be calculated?**			
Strengths of Research	**Limitations of Research**	**Potential Implications of Research**	**Directions for Future Research to Consider**
that take into account regional specifications of a product have not been made available. Here, Default Emission Factors for Whole Food Categories *specific to domestication in BC* are estimated - providing insight for other jurisdictions interested in assessing GHGe from foods produced in their region (s).	imported to Canada does not demonstrate differences in regionally specific production practices of countries shipping foods to Canada. GHGe estimation methods and calculations chosen are **amateur author estimates only** – not entirely useful for much else aside from a hypothetical study.	**misleading** in their attempts to accurately account for Food Product GHGe; especially as related to those GHGe released and sequestered by organic processes (e.g. land-use, soils emissions involved in food production).	standardized methodologies to calculate GHGe from the production and supply of **Food Products** look like?
Inputs aside from "energy consumption" alone are recognized as contributing to food product GHGe; providing a more holistic GHGe estimate on foods assessed as compared to traditional GHGe estimates used for food industry emission factor estimates.	The logistics or administrative details necessary to gather, monitor, report and verify the plethora of data to accurately account for a food product's GHGe from production, transport or other phases of a food product's life cycle are not addressed or mentioned in GHGe accounting standards used in this paper.	The logistics of a GHGe accounting, verification, reporting, and validation scheme appropriate for multilateral administration must be outlined in succinct detail (i.e. who, what, where, when, how and why) **before policy tools reliant on GHGe data are considered**.	**What format would a GHGe data collection, accounting, reporting, monitoring and compliance framework** look like for administration on food products imported to Canada?

Research Question Addressed: **2) Considering design characteristics of a potential ideal BCA, How might C-Tariffs calculated as a function of a food product's GHGe (from production and transport) and a hypothetical "Carbon Price" vary?**			
Strength	**Limitation**	**Potential Implications of Research Findings**	**Potential Directions for Future Research**
Considers design characteristics of an ideal BCA to contextualize research.	No solid characteristic recommendations and concepts are not specific to industry, nation or region.	Until any one country decides to implement a BCA, it is difficult to consider what its actual design would look like, and what potential affects on international trade and WTO legislation it may have.	What a multilateral BCA framework might look like; what potential affects on trade and welfare may result from a country implementing a BCA on goods imported to its region.
Quantitative estimates on potential C-Tariffs are made for a myriad of foods imported to Canada otherwise not available in print format to the general public.	Estimates are **hypothetical only**.	Quantitative data on C-Tariffs does not mean a lot without baseline data for comparisons' sake (i.e. in interpreting the value or potential implications of GHGe estimates made).	What would an inventory of potential GHGe or Carbon Tariffs (C-Tariffs) on other products, activities and industries operating today look like? Who would be responsible for its administration?
Results illuminate which food products imported to Canada could potentially have the highest C-Tariffs (relative to our sample) from import; providing insight to possible impacts on trading relations and WTO agreements, as those	C-Tariffs are calculated as a function of food product's production and transport GHGe alone (guided by numerous assumptions and limitations). It is unclear how data can be assessed to make worthwhile recommendations	Hypothetically speaking, products produced with fewer agri-inputs, traveling shorter distances, choosing lower impact transport choices with higher unit costs will have the lowest C-Tariff values calculated within the sample	Could an equation be developed to make **C-Tariff "trade-off" decisions** related to production practices, transport methods chosen, and unit prices when considering which products to import to Canada?

Research Question Addressed: **2) Considering design characteristics of a potential ideal BCA, How might C-Tariffs calculated as a function of a food product's GHGe (from production and transport) and a hypothetical "Carbon Price" vary?**			
Strength	**Limitation**	**Potential Implications of Research Findings**	**Potential Directions for Future Research**
products with higher C-tariff estimates would likely be more affected in the marketplace.	towards **"Carbon Conscious" purchasing decisions** without including GHGe from a product's full life cycle.	of foods imported to Canada considered in this paper.	

Research Question Addressed: **3) What challenges could exist in administering a BCA on Whole Foods imported to Canada?**			
Strength	**Limitation**	**Potential Implications of Research Findings**	**Possible Directions for Future Research**
Potential WTO concerns that could results from the introduction of a BCA on foods imported to Canada are illuminated.	**WTO and other trade issues are not discussed in thorough enough detail** necessary to create any strong conclusions or research statements related to how the introduction of a BCA may infringe upon them.	Other policy tools must be researched in their effectiveness to balance out domestic Carbon regulations' potential effects on domestic competitiveness and emissions leakage.	What **domestic policy incentives** might reduce GHGe from producers locally to mitigate the effects of a C-Tax on their production costs?
Issues related to the validity of a BCA's *abilities to displace carbon leakage and avoid issues of domestic competitiveness* are addressed.	Many other issues related to the effectiveness of a BCA could occur that are not addressed in this paper.	Concerns related to the potential effects of domestic carbon regulations on emissions leakage and domestic competitiveness of a region are in need of further examination before responsive c-regulatory policy tools be considered.	What are other countries doing to lower GHG emissions from domestic [food] production? Do options to collaborate across nations exist (e.g. with the EU)? If so, how might Canada work with its food system to become a leader in reducing domestic GHG emissions?

3.3 Future Directions for Research

Unless someone like you cares a whole awful lot, nothing is going to get better. It's not. The Lorax (Dr. Seuss).

Investigating options to administer a Border Carbon Adjustment on foods imported to Canada uncovers other carbon policy issues related to transparency of food production and supply, GHGe accounting standards, BCA administration and design frameworks, WTO and GATT principles, emissions leakage and domestic competitiveness.

Synthesizing results from Table 10, this section takes a look at a few key areas of research that should be addressed before Canada considers pricing carbon, implementing carbon regulations or introducing other emissions regulatory devices.

To date, it is not easy to understand where, how and by whom most foods on grocery store shelves are produced and distributed. Before a Border Carbon Adjustment, or any other policy measure reliant on an account of GHGe from a food product can effectively be administered on goods either produced in or imported to Canada, research into how to encourage food system transparency, options to administer consistent GHGe accounting methodologies and methods to reduce GHGe in the political context is necessary. Here, Producers, Consumers, Public Institutions and Policy makers are outlined as key stakeholder groups to pinpoint areas for future food system and carbon policy research.

3.3.1 Producers – Food System Transparency and Product Labeling Opportunities

Food and agri-producers must support of transparency in their own manufacturing practices if data on GHGe activity sources in the food system is to be released. Examples of producer-focused research topics are broken down into Product Labeling and Brand Recognition, Producer Incentives for Data Release, Information on GHGe Released by Organic Processes, GHGe Accounting Standards and Compliance Frameworks and History of Other Environmental Labeling Programs. Questions for each Research Topic to consider are listed:

a. *Product Labeling and Brand Recognition*.
    i. How could a branding, recognition or other product labeling and accreditation system incent (either economically or otherwise) producers and suppliers of foods to make information on production practices available to the public for the purpose of GHGe accounting?
    ii. Who would be responsible for a product labeling and branding system's design and administration and what sorts of social media or technology could be used to communicate information?

iii. What sort of GHGe compliance, monitoring and guidance framework would be necessary for an effective, valid product labeling scheme to be administered on food products available today?
iv. Could Food Producer Friendly GHG accounting toolkits and online-software for GHGe data collection be administered? Why or why not?

b. *Producer Incentives for Data Release*.
   i. How might producers respond if funding were considered as an incentive for them to make information on their production practices transparent to the public?
   ii. What other production values and incentives (aside from finances) might be considered as leverage to persuade producers to provide information on their production practices to the public?
   iii. What sorts of market-based instruments could encourage producers to supply information on their production practices to the public?
   iv. What challenges in areas of food production management might dissuade producers from supplying data on their production practices to the public?

c. *Information on GHGe Released by Organic Processes.*
   i. Can we better understand how variations in organic processes affecting GHGe from the production of foods could be accurately incorporated into GHGe accounting methodologies?
   ii. Can GHGe from organic processes be measured in the context of different bioregions to generate regionally specific Emission Factors for organic food system activities (and what is an affordable cost for such measurements)?

d. *GHGe Accounting Standards and Compliance Frameworks.*
   i. Can food producers account for GHGe from organic processes on their farms in a consistent, standardized format useful for a Carbon Pricing scheme?

ii. How and by whom will data on GHGe source activities in the food system be collected, compiled, verified and monitored for compliance, consistency and validity?
iii. Could food production GHGe data collection mechanisms be a producer-led initiative? Why or Why not?

e. *History of Other Environmental Labeling Programs*.
   i. What other nations, regions, companies, individuals, institutions or other organizations are considering product labeling as a means to gather information on food production practices? Have they been Successful? Why or why not?
   ii. How have producers responded to other environmental labeling schemes either mandated to them or made voluntarily available for their compliance in the past (e.g. Environmental Farm Plans, Organic Certification, Nutritional Labeling Standards)? Does an inventory of Environmental Labeling schemes in effect today exist?

Questions arise related to producers' interests in abiding by any scheme designed to make information available about their food production practices. The relationship between consumers and producers and consumers' abilities to impact producers' management decisions and production practices is of additional interest.

3.3.2 Consumers, Marketing and Communications

Consumers might both demand receipt of information on GHGe from food production practices and impact producers' management decisions. Examples of consumer focused research topics might consider Media and Awareness, Marketing, Communications and Food Consumption Trends and Meaningful Communication Methods. Topics under each research topic might consider:

a. *Media and Awareness*
   i. Could the media be used to provoke public dialogue on the importance of food system transparency?

ii. What new social media tools or strategies could be employed to encourage the demand for information on GHGe from food production and distribution practices?
iii. Which role models, icons, pop figures or other mainstream media might be used to generate awareness and interest surrounding food system transparency and GHGe accounting methodologies?

b. *Marketing, Communications and Food Consumption Trends*
   i. What marketing, promotional incentives and communications tools could be used to disseminate information related to GHGe from food production and distribution practices to consumers?
   ii. Do examples exist of successful marketing campaigns that have shifted consumer demands for products with lower environmental or GHGe impacts?
   iii. How might food consumption trends of different food categories oscillate as a function of information received on GHGe from their production and distribution?

c. *Meaningful Communication Methods*
   i. How can numerical results of GHGe data from a food product be communicated in a meaningful way to consumers (GHGe measured in "t-CO2e' means little to the average joe – or the average carbon accountant, professor, student, farmer, and many others between the ages of 0-99)?
   ii. Can baseline inventories of product GHGe data be constructed to demonstrate just what a "low carbon" versus "high carbon" food or product is? Why or Why not?
   iii. Would it be worthwhile to the average consumer to have GHGe data on products available for consumption?

3.3.3 Public Institutions, Carbon Labeling and Food Procurement

Public institutions (e.g. schools, universities, hospitals and prisons) may play a role in encouraging food system transparency. Examples of research topics might include

Carbon Labeling, Food Procurement Policy, and Joining Food Procurement Policy and Carbon Labeling. Research Questions for each topic might consider:

a. *Carbon Labeling*
    i. What would a step-by-step plan look like for a school, university, hospital, prison or other public institution to provide carbon footprint labels on foods available to its population? Do examples of successful Public Institution based Carbon Labeling schemes exist? Why or Why not?
    ii. How might demographics affect the response of students in different jurisdictions to Carbon Labeling of Food Products in their schools?
    iii. How might schools, food suppliers and distributors engage various student populations (e.g. elementary schools, high schools, universities, colleges) to be interested and aware of their food choices as affecting GHGe and Climate Change?
    iv. Could university students or prison workers (notice the similar level of competency in the task ladder) be enabled and facilitated to assist in the administration and processing of GHGe data collection, monitoring, validation and compliance schemes (e.g. paperwork or other regulatory administrative jobs)? Why or why not?
    v. What would a Carbon Label similar in style to nutritional labels on Canadian foods look like in design?

b. *Food Procurement Policy*
    i. What food procurement policy frameworks could support food product labeling and food system transparency?
    ii. What have other countries (e.g. Europe, Japan, Australia, others) and/or product sectors (e.g. clothing, materials, manufacturing) investigated or tested and found successful in areas of linking carbon labeling, food system transparency and food procurement policy?

c. Joining Food Procurement Policy and Carbon Labeling

iv. Can food procurement policy be used as a tool to incent or mandate the application of a Carbon Label on foods available in and to public institutions? Why or why not?

v. How might a public institution's ethical procurement policy encourage transparency in the food system, carbon labeling or reductions of GHGe from food products?

vi. Is it possible for a public institution to define what a "Low Carbon Food" is for the purpose of a Food Procurement Policy guideline? Why or Why not?

If data on production practices in the food system is made available, policy makers working in areas of the food system, carbon regulations and consumer labeling will be engaged in determining how it can best be used.

3.3.4 Policy Makers, Municipal Governance and Decision Making - Oh My!

Potential unforeseen consequences of introducing a Border Carbon Adjustment (BCA) on foods or other goods imported to Canada make policy makers and administrators nervous in regards to its application and design. Examples of future research topics for policy makers to consider might include a Multilateral BCA Governance Scheme and International Dialogue, Lessons from other Jurisdictions, Industry Collaboration, Decision Making, Trading Guidelines and the Best "Bang for your Buck", Domestic Policy, Innovation and Land-Use Frameworks, Food System Planning and District Energy Management. Research Questions within each topic might consider:

a. Multilateral BCA Governance Scheme(s) and International Dialogues.

i. What characteristics might an ideal Border Carbon Adjustment scheme take?

ii. How could a dialogue addressing concerns related to GHGe data collection and administrative formats of a BCA across key trading nations (e.g. Canada, USA, Mexico, EU, Japan, China India) be encouraged?

iii. Could any of Canada's key trading partners be interested in administering a multilateral BCA scheme, similar in format to the WCI?

b. Lessons from other Jurisdictions.

i. What, if anything, are other jurisdictions considering to displace effects of carbon regulations on their food supply-distribution system?

ii. What sorts of GHGe reduction incentives have been considered by other countries that might best be adopted locally in Canada?

c. *Industry Collaboration.*

i. What estimates of potential GHGe and C-Tariffs from other sectors could be useful to understand also how different industries could be affected by the introduction of a C-tariff?

ii. How could collaboration between industries be encouraged to make data publicly available on GHGe estimates from products' life-cycles?

d. Decision Making, Trading Guidelines and the Best "Bang for your Buck"

i. Does a "trade off" relationship between the five different factors contributing to a product's carbon footprint as assessed in this study exist?[46,47]

e. Domestic Policy.

i. What is Canada doing in the way of domestic reductions of food system GHGe?

ii. What domestic or municipal governance schemes and/or policy directives have been found successful to encourage the reduction of food system GHGe?

f. *Innovation and Land-Use Frameworks.*

i. What elements of design and functionality in upcoming Canadian land-use planning frameworks (e.g. zoning amendments, tax-subsidy relationships, community governance principles, official community plan policies) could be considered to encourage GHGe reductions from food production in municipalities?

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[46] C-Tariffs estimated in this paper are estimated as a function of a product's i. production GHGe estimate, ii. distance traveled between countries of origin and Canada, iii. transport methods (i.e. routes and vehicle type such as air, truck, rail and boat) assumed, iv. weight of goods imported and v. their pricing for the purposes of industry trade.

[47] For example, if I am a Mexican supplier of tomatoes who may be affected by a BCA or Carbon Tariff, I may decide I am interested in changing my production and distribution route to reduce the C-Tariff value on my goods. Assessing the five factors outlined as affecting my C-Tariff, how can I understand where changes must be made in my supply-distribution chain to lower/impact the reduction of a C-Tariff on my goods the most?

g. *Food System Planning and District Energy Management*

i. Could the redesign of how communities give and receive energy be formatted to include a food system planning framework for "Closed Loop Energy Systems"[48]?

ii. How might supporting Closed Loop Energy Systems displace the effects of a Carbon Regulation on a district, region or municipality?

iii. Could offering payment on other Environmental Goods and Services lower GHGe from food producers' operations (and vice versa)?

iv. How could including the Food System in a community's Energy Planning Framework support a municipality's efforts to reduce GHGe?

v. If food producers were integrated into a community's energy design framework, could potential GHGe reductions within the community be accurately monitored and accounted for? Why or Why not?

vi. What sorts of market-based incentives could encourage food producers and other food industries (e.g. waste management, transportation, packaging and materials) to reduce GHGe from their operations and/or participate with municipalities in the design of a Closed Loop Energy System?

vii. What other local (i.e. municipal and local government) policy tools and market-based incentives, such as payment on environmental goods and services could be used to encourage GHGe reductions in the food system?

If Canada is looking to truly see physical changes in reductions of food system GHGe while effectively displacing potential effects of newly introduced carbon regulations on food producers, encouragement for food system transparency combined with research on best practices in Municipal Food System Planning, Local Policy Dialogue and community engagement with policy design and reform are areas of research in need of timely consideration and in-depth thought. On the consumer's side, if we assume that people want to "do good" and lower their environmental impacts from food consumption

[48] While Agriculture plays a role in releasing GHGe to the atmosphere, it also may play a valuable role in sequestering GHGe and providing energy to communities (e.g. biogas carbon capture projects, methane digestion units, energy cogeneration from greenhouses);

(price permitting), "they" (i.e. consumers, food procurement workers, and others) may be interested in knowing how best to make decisions related to food purchasing. Understanding how to order foods in a way that could reduce GHGe from a product's production and/or transport will be of interest to me. Having some sort of "balancing" equation that demonstrates the relationship between factors affecting a product's C-Tariff could prove helpful in demonstrating what production and/or transport activities could lower a product's C-Tariff with the least effort and minimal affiliated costs. Looking to municipal planning frameworks as a means to reduce GHG emissions from food production (rather than tax them), could be a more pro-active area of research to focus policy design, in lieu of a BCA or other national policy tools. Understanding how to best splice activities involved in land-use management, energy system design and food system planning is an emerging topic of research that could both reduce GHGe, displace the effects of potential carbon regulations and avoid slow and complex adoption processes involved in national policy design and administration.

3.4 Concluding Note: Relocalization of our "Policy Economy"?

> *A total economy, operating internationally, necessarily shrinks the powers of state and national governments, not only because those governments have signed over significant powers to an international bureaucracy or because political leaders become the paid hacks of the corporations but also because political processes – and especially democratic processes* ***– are too slow*** *to react to unrestrained economic and technological development on a global scale*[49].

How Canada responds today to current challenges in climate negotiations, natural disasters and emerging climate policy frameworks will ultimately play a role in dictating how we as a nation go down in history in responding to nothing less than a global state of crisis. Administering a BCA on foods or other products imported to Canada will most likely not prove to be a successful mechanism to reduce GHGe or displace concerns raised by the implementation of carbon regulations emerging today. To progressively move forward, it is time for Canada consider how we would like to be *Champion Players in the Climate Change Game*. Today's intricate communication and transport networks allow, encourage and enable policy makers, economists, scientists, academics, and

[49] Wendell Berry in his address "Global Problems, Local Solutions – Relocalization as the Antidote for the Fallacy of Conventional Political Economy" (Berry 2007)

government employees to travel extensively across the globe on a consistent basis. Many of us strive and take pride in presenting research findings and making recommendations for international climate treaties and negotiations, nation-wide and multilateral policy agreements. The higher levels of government are involved in policy dialogue. However, more complicated international regulations, policy administration guidelines, monitoring and compliance schemes result, making it challenging for nations to understand the potential implications of their policy decisions, actions and statements.

Outlining gaps in food system transparency and GHGe accounting standards, complexities in BCA administrative designs and issues related to international trade, this paper suggests that administering an effective Border Carbon Adjustment (BCA) on foods imported to Canada would not be an effective response to C-regulations coming into play today. Examining areas for future research, in lieu of a BCA, or at least before its introduction, Canada may be better off considering what local policy efforts might best reduce GHGe in the food system. Refocusing on policy contexts *locally* at *the municipal level of governance* to reduce emissions, rather than simply taxing them (or taxing others) could put Canada in an excellent position to raise green flags that champion, profile and spotlight our domestic food producers and other manufacturing industries as innovators in the battle against climate change. Supporting GHGe reductions for local producers could provide huge branding and marketing incentives to our food sector both in the local context and as a means to increase the value of our exports as “climate friendly” or “Carbon conscious” products. However, like most problems worth solving, this one might take some time. A call to action is necessary for Canadians to redesign our policy to complement and encourage local merit in administration. There is no time better than the present for Canada to harness our *own communities* as potential drivers to reduce GHG emissions, displace concerns related to carbon leakage and increase domestic producers’ profiles as leaders in the international game of recognition in the Climate Change response network.

3.5 Information about Collaborators

Research in this section was influenced, in part, by involvement with the newly emerging

Institute for Land Use Innovation (ILUI) operating out of the University of Alberta in Edmonton, Alberta. Recommendations for future research are intended to support and guide efforts in aligning research activities the ILUI will partake in over the next 5-10 years, especially in areas of land-use management, payment on environmental goods and services, district energy control and design.

BIBLIOGRAPHY

Agriculture and Agri-Food Canada (2009a) *Industry Webpages Chapter III – North American Fertilizer Prices, Production and Consumption*. Retrieved from http://www4.agr.gc.ca/AAFC/AAC/display-afficher.do?id=11792525332T4&lang=eng

(AAFC 2009b) Internally Circulated documents received in confidence from the Global Analysis department of Agri and Agri-Food Canada, Ontario, Canada. July 2009.

Abate (2006). *The Market for Greenhouse Grown Tomatoes Product Centre*. Retrieved from Michigan State University Website: http://www.productcenter.msu.edu/documents/Working/Hydroponic%20tomatoes%20market.pdf

Agricultural Marketing Resource Centre (2010). *Celery Profile*. Retrieved from: http://www.agmrc.org/commodities__products/vegetables/celery_profile.cfm

Australian Government Department of Climate Change and Energy Efficiency (2010). *National Greenhouse Gas Reporting System*. Retrieved from: http://www.climatechange.gov.au/reporting/publications/pubs/fs-ngers.pdf

BC Hydro (2011) *BC Hydro's Sustainable Communities Research Collaborative*. Retrieved from BC Hydro's Online Resources: http://www.crcresearch.org/files-crcresearch_v2/File/Sustainable%20Communities%20Research%20Collaborative-Ashaw.pdf

BC Hydro (2008) *Greenhouse Industry Report EN (8) Table*, Retrieved from BC Hydro's company information reports webpages: http://www.bchydro.com/about/company_information/reports/gri_index/en8_2__greenhouse.html

British Columbia Agriculture Climate Action (2011). *Climate Action Initiative BC Agriculture and Food. Fact Sheet 8 – Geothermal Energy and Geo-Exchange Systems*. Retrieved from: http://www.bcagclimateaction.ca/wp/wp-content/media/CAI-FactSheet-8.pdf

Bellarby, J, B Foereid, A Hastings and P Smith (2008). *Cool farming: Climate impacts of agriculture and mitigation potential*, Retrieved from Greenpeace International Webpages: http://www.greenpeace.org/international/en/publications/reports/cool-farming-full-report/

Bentley, S and Barker, R. (2003) *Fighting Global Warming at the Farmer's Market* retrieved from the Food Share Network's online resource files: http://www.foodshare.net/resource/files/ACF230.pdf.

Berry, Wendell (2007). *Global Problems, Local Solutions – Relocalization as the Antidote for the Fallacy of Conventional Political Economy.* Retrieved from Nooventures online publications website: http://nooventures.edublogs.org/2007-04-07-global-problems-local-solutions-relocalization-as-the-antidote-for-the-fallacy-of-conventional-political-economy-by-wendell-berry/

Biermann and Brohm (2005). *Implementing the Kyoto Protocol without the USA, the Strategic Role of Energy Taxation at the Border.* Climate Policy 4 (2005) 289-302.

British Columbia Ministry of Agriculture and Lands (1997a) *Planning for Profit Swine Farrow to Finish Spring 1997 Agdex 440-810*. Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/hog/250sows_ok.pdf

British Columbia Ministry of Agriculture and Lands (1998a) *Planning for Profit Broilers (100 000 Birds) Fraser Valley 1996" Agdex 450-810*. Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/poultry/IL31

British Columbia Ministry of Agriculture and Lands (1998b) *Planning for Profit Poultry Broilers.* Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/poultry/fvbroiler.pdf

British Columbia Ministry of Agriculture and Lands (1998c) *Planning for Profit Layers 15000 Birds Fraser Valley Summer 1998 Agdex 450-810*. Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/poultry/fvlayer.pdf

British Columbia Ministry of Agriculture and Lands (1999a) *Planning for Profit "Pear Tree Fruits*. Retrieved from: http://222.agf.gov.bc.ca/busmgmt/budget_pdf/tree_Fruits/99pearfp.pdf

British Columbia Ministry of Agriculture and Lands (1999b) *Planning for Profit Tree Fruits*. Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/tree_fruits/99chyfp.pdf

British Columbia Ministry of Agriculture and Lands (2001a) *Planning for Profit Dairy Farm Summer 2001*. Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/dairy/dair_summer2001.pdf

British Columbia Ministry of Agriculture and Lands (2001b) *Planning for Profit Apple Tree Fruits Summer 2001*. Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/tree_fruits/apples_1742_super_spindle_2001

British Columbia Ministry of Agriculture and Lands (2001c). *Planning For Profit "Tree Fruits Peaches Summer 2001*. Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/tree_fruits/peaches_summer2001.pdf

British Columbia Ministry of Agriculture and Lands (2002a). *Planning For Profit Organic Egg Production 2002.* Retrieved from: http://www.agf.govb.bc.ca/busmgmt/budgets/budget_pdf/poultry/organic_eggs_2002.pdf

British Columbia Ministry of Agriculture and Lands (2007a, b) *Planning for Profit 400 Cow Calf Operation, Kamloops Spring 2007.* Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/beef/2007cow_calf_kamloops.pdf

British Columbia Ministry of Agriculture and Lands (2007c*) Planning for Profit Forage and Hay Production, 2007.* Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/forage/2007/hay_kamloops.pdf

British Columbia Ministry of Agriculture and Lands (2008a) *Planning for Profit 20 Acre Mixed Livestock Operation: Broilers, Layers/Eggs, Sheep, Beef: Full Production.* Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/small_scale/2008mixed%20livestock.pdf

British Columbia Ministry of Agriculture and Lands (2008b) *Planning for Profit 5 acre mixed vegetable operation: Full production Vancouver Island Spring 2008.* Retrieved from: http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/small_scale/2008mixed%20veg.pdf

British Columbia Ministry of Agriculture and Lands (2009a) *Industry Competitiveness*. Retrieved from http://www.agf.gov.bc.ca/indcomp/

Climate Analysis Indicator Tool (CAIT) (2009). *Climate Analysis Indicator Tool*. Retrieved from the World Resources Institute webpages: http://cait.wri.org/cait.php?page=sectors.

Cantliffe et al (2009). *Competitiveness of the Spanish and Dutch Greenhouse Industries with the Florida Fresh Vegetable Industry*. Retrieved from the University of Florida webpages: http://edis.ifas.ufl.edu/cv284

Carbon Tax Centre (2011). *Borders*. Retrieved from the Carbon Tax Centre's Online Webpages: http://www.carbontax.org/issues/border-adjustments/

Carbon Trust (2011). *Default Pages*. Retrieved from the Carbon Trust's online resources webpages: http://www.carbontrust.co.uk/Pages/Default.aspx

Carlsson-Kanyama (1998). *Climate Change and Dietary Choices – How can emissions of greenhouse gasses from food consumption be reduced?* Natural Resources Management, Department of Systems Ecology Stockholm University. *Food Policy,* Vol. 23, No. 3/4, pp. 277–293.

Canadian Centre for Policy Alternatives (2011). *Fair and Effective Carbon Pricing*. Retrieved from: http://www.policyalternatives.ca/sites/default/files/uploads/publications/BC%20Office/2011/02/CCPA-BC_Fair_Effective_Carbon_SUMMARY_0.pdf

Chawla and Wannel (2003). *Perspectives on Labour and Income, the Online Edition "Property Taxes"*. Retrieved from Statistics Canada Publications' Webpages: http://www.statcan.gc.ca/pub/75-001-x/00703/6578-eng.html

Canadian Institute of Planners (CIP) (2010). *Shaping our Communities – Sustaining Canada's Future. "Planning Is…"*. Retrieved from: http://www.cip-icu.ca/web/la/en/pa/3FC2AFA9F72245C4B8D2E709990D58C3/template.asp

City of Richmond (2010). *Development Permit – A guide to obtaining a Development Permit in Richmond"*. Retrieved from the City of Richmond's Shared Assets webpages: http://www.richmond.ca/__shared/assets/da_296186.pdf

Canadian Labour Corporation (CLC) (2011). *Carbon Leakage: What is it? Policy Options for Preventing it*. Retrieved from the Canadian Labour Corporations' News Room Publications: http://www.canadianlabour.ca/news-room/publications/carbon-leakage-what-it-policy-options-preventing-it

Cullinane et al (200x). *Clicks vs. Bricks on Campus: Assessing the Environmental Impact of Online Food Shopping*. Retrieved from Harriot-Watt University Edinburgh's online site resources: http://www.greenlogistics.org/SiteResources/58b76433-8e63-45b7-879c-6f4b23555e24_Clicks%20vs%20Bricks%20on%20Campus%20LRN%20paper%20(Sharon).pdf

Canadian Standards Association (CSA) (2009). *CSA and Climate Registry announce joint support for consistent GHG reporting in Canada*. Retrieved from: http://www.csa.ca/cm/ca/en/search/article/csa-and-climate-registry-support-ghg-reporting

Carbon Tax Centre (2010). *Pricing carbon efficiently and equitably: Border Adjustments.* Retrieved from: http://www.carbontax.org/issues/border-adjustments/

Cosbey, Aaron (2008). *Border Carbon Adjustment.* International institute for Sustainable Development. Results from the Trade and Climate Change Seminary (June 18-20 2008 Copenhagen Denmark).

David Suzuki Foundation (2011). *History of Climate Negotiations*. Retrieved from: http://www.davidsuzuki.org/issues/climate-change/science/international-climate-negotiations/history-of-climate-negotiations/

Department of Environment Foreign and Rural Affairs (2005). *The Validity of Food Miles as an Indicator of Sustainable Development.* Retrieved Sept 25 2009 from: https://statistics.defra.gov.uk/esg/reports/foodmiles/execsumm.pdf

Diglio, A. (200?) *Growth of the Fresh Greenhouse Market in the USA.* Retrieved from the International Society for Horticultural Science's members' webpages: http://www.actahort.org/members/showpdf?booknrarnr=611_15

Duke, Chris (2006). *The Potential for Agricultural Greenhouse Gas Emissions Reduction in the temperate region of Canada through nutrient management planning*. Retrieved from the Soils' resources group webpage: http://www.biocap.ca/rif/report/Wall_G.pdf.

Duke University (2010) *Regression Notes*. Retrieved from Duke University's Online Web Resources: http://www.duke.edu/~rnau/regnotes.htm#tstats

Dunis and Williams (2003). *Applications of Advanced Regression Analysis for Trading and Investment*. Retrieved from Global Risk Guard's Economic Resources Network: http://www.globalriskguard.com/resources/econom/neuralnetwork.pdf

Environment Canada (2010). *A Summary of Trends: 1990-2008*. Retrieved from http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=0590640B-1

Environment Information Administration (2009). *US Carbon Dioxide Emission from Energy Sources 2008 Flash Estimate*. Retrieved from: http://www.eia.doe.gov/oiaf/1605/flash/flash.html

Environment Canada (2011). *Canada's Action on Climate Change*. Retrieved from the Government of Canada's Climate Change Webpages: www.climatechange.gc.ca

Environment Canada (2008) "National Inventory Report: Greenhouse Gas Sources and Sinks in Canada, 2006." Information on Greenhouse Gas Sources and Sinks, http://www.ec.gc.ca/pdb/ghg/inventory_report/2006_report/tdm-toc_eng.cfm, March 22, 2009

Environment Canada (2009) *Environmental Trends in British Columbia 2007*. Retrieved from: http://www.env.gov.bc.ca/soe/et07/01_population_economic/technical_paper/population_economic_activity.pdf

Environment Canada (2010). *A Summary of Trends: 1990-2008*. Retrieved from: http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=0590640B-1

Erera and Tech (2005). *Proceeds from the Institute of Food Technologists' First Annual Food Protection and Defence Research Centre*. Retrieved from: http://www.ift.org/fooddefense/21-Erera.pdf

Food and Agriculture Organization (2010). *Climate Smart Agriculture*. Retrieved from: http://www.fao.org/fileadmin/user_upload/newsroom/docs/the-hague-conference-fao-paper.pdf

Food and Climate Research Network (1999). *Nitrogen Balance from Dairy Farms*. Retrieved from the Food and Climate Research Network Danish Food Database: http://www.lcafood.dk/.

Feenstra et al (2009). *The Low Carbon Diet: Reducing Energy Intensity and Greenhouse Gas Emissions in the Food System using a Life Cycle Assessment Approach*. Retrieved from the University California Davis' Agricultural Sustainability Institute's webpages: http://www.vineyardteam.org/SAE/Feenstra.pdf.

Food and Climate Research Network (2008). *Cooking up a Storm Summary*. Retrieved from: http://www.fcrn.org.uk/fcrnPublications/publications/PDFs/CuaS_Summary_web.pdf

Fisher and Fox (2009). *Comparing Policies to Combat Emissions Leakage. Border Tax Adjustments vs. Rebates*. Retrieved from the Resources for the Futures webpages: http://www.rff.org/documents/RFF-DP-09-02.pdf

Frigon (2007) Gasoline *Prices and the Impact on Demand*. Retrieved from: http://www.parl.gc.ca/information/library/PRBpubs/prb0755-e.htm#prices

Garnett, Tara (2008) *Food and Climate Change, the World on a Plate*. Retrieved from Tara Garnett's webpages: http://www.navigateconferences.com/downloads/CooLogistics%20-%20Tara%20Garnett.pdf

Greenhouse Gas Management Institute (2011*). Online training, networking and professionalizing History*. Retrieved from: http://ghginstitute.org/who-we-are/history/

Gifis, Steven H. (1984). *Law Dictionary* (Barron's), p. 471 (2d ed. 1984). Retrieved from: http://en.wikipedia.org/wiki/Property_tax#cite_note-0

Government of British Columbia 2011. *Climate Change Targets and Plans*. Retrieved from: http://www.gov.bc.ca/yourbc/climate_change/cp_planet.html?src=/planet/cp_planet.html

Global Trade Analysis Project (2010). *Merchandise Tariff Data*. Retrieved from: https://www.gtap.agecon.purdue.edu/resources/download/857.pdf

Health Canada (2011). *Food Labeling*. Retrieved from: http://www.hc-sc.gc.ca/fn-an/label-etiquet/index-eng.php

Harmonized System Coding Organization (hscode.org) (2011). *HS Code Search: All Country HS Code: Harmonized System Code*. Retrieved from: http://hscode.org/

Institute for Agriculture and Trade Policy (2009). *Identifying our Climate Footprint - Assessing and Reducing the Global Warming Impacts of Food and Agriculture in the U.S.* Retrieved from: http://www.iatp.org/iatp/publications.cfm?refid=105667

International Centre for Trade and Sustainable Development (ICTSD) (2010). *Practical aspects of border carbon adjustments: Assessing costs from a trade facilitation perspective*. Retrieved from: http://ictsd.org/i/news/bioresreview/97116/

International Institute for Sustainable Development (2009) *Bali to Copenhagen Series Options for Policy Makers: Addressing Competitiveness, Leakage and Climate Change*. Retrieved from: http://www.iisd.org/pdf/2009/bali_2_copenhagen_bcas.pdf

International Institute for Sustainable Development (2008) *Border Carbon Adjustment*. Retrieved from: http://www.iisd.org/pdf/2008/cph_trade_climate_border_carbon.pdf

Indian and Northern Affairs Canada (2011). *Environment and Conservation Division Renewable Resources and Environment*. Retrieved from: http://www.ainc-inac.gc.ca/ai/scr/nt/ntr/pubs/EC-eng.asp

Indiana News (2010). *Florida Frost Heats Up Midwest Produce Prices*. Retrieved from: http://www.theindychannel.com/news/22777593/detail.html

Industry Canada (2009a, 2009b) *Trade Data Online*. Retrieved from: http://www.ic.gc.ca/eic/site/tdo-dcd.nsf/eng/Home

Industry Canada (2009c) *Definition Processed Food Manufacturing*. Retrieved From: http://www.ic.gc.ca/cis-sic/cis-sic.nsf/IDE/cis311cste.html

Industry Canada (2009d). *Definition Beverage and Tobacco Product Manufacturing*. Retrieved from: http://www.ic.gc.ca/cis-sic/cis-sic.nsf/IDE/cis312defe.html

International Accreditation Forum (IAF) (2011). *IAF – Certified Once, Accepted Everywhere.* Online Webpages Retrieved from: http://www.iaf.nu/

International Organization for Standardization (2011). *ISO 14064-1:2006. "Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*. Retrieved from: http://www.iso.org/iso/catalogue_detail?csnumber=38381

Intergovernmental Panel on Climate Change (IPCC) (2011). *Online Resources. Organization*. Retrieved from: http://www.ipcc.ch/organization/organization.shtml

International Panel on Climate Change (IPCC) (2006). *IPCC Working Documents Volume 4- Agriculture, Forestry and Other Land Use*. Retrieved from: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_01_Ch1_Introduction.pdf

International Panel on Climate Change (IPCC) (2007). *IPCC Working Documents IPCC Fourth Assessment Report: Climate Change 2007*. Retrieved from: http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

International Panel on Climate Change (IPCC) (2007a). *IPCC Working Documents Chapter 8 Assessment Report*. Retrieved from: http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter8.pdf

International Panel on Climate Change (IPCC) (2007b). *IPCC Publications and Data Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability.* Retrieved from: http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch5s5-es.html

International Panel on Climate Change (IPCC) (2008). *IPCC Working Documents Annex 1 Use Guide and Access to More Information*. Retrieved from: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_appendix.pdf

International Standards Organization (ISO) (2006). *New ISO 14064 standards provide tools for assessing and supporting greenhouse gas reduction and emissions trading.* Retrieved from: http://www.iso.org/iso/pressrelease.htm?refid=Ref994

Islands Trust (2010). *Density Transfer and Amenity Zoning in the Mudge Island Planning Area*. Retrieved from: http://www.islandstrust.bc.ca/ltc/gb/pdf/gbrptdensittranseramenityzonaug052006mudocpmtg.pdf

Ismer and Neuhoff (2011). *Border Tax Adjustments: A Feasible Way to address non-participation in Emissions Trading.* Retrieved from: http://www.dspace.cam.ac.uk/bitstream/1810/388/1/EP36.pdf

Kairos et al. (2008). *Guide to Calculating GHG Emissions by Hand*. Retrieved from: http://www.re-energize.org/En/docs/Kairos_GHG_calculator_by_hand.pdf

Konshaug (1998). "Energy Consumption and Greenhouse Gases in Fertilizer Production". Retrieved from the International Fertilizer Organization's Webpages: http://www.fertilizer.org/ifa/Home-Page/LIBRARY/Publications.html/Energy-Consumption-and-Greenhouse-Gas-Emissions-in-Fertilizer-Production.html

KRAV (2011). *Certified by KRAV. KRAV Standards 2004.* Retrieved from: http://arkiv.krav.se/arkiv/regler/Standards2004EditionJuly.pdf

LiveSmart BC (2009). *BC's Greenhouse Gas Emissions*. Retrieved September 30 2009 from: http://www.livesmartbc.ca/learn/emissions.html

McCallum (1995). *National Borders Matter Canada-US Regional Trade Patterns*. The American Economic Review, Vol. 85, No. 3, (Jun., 1995), pp. 615-623 Published by: American Economic Association

Martinez-Zarzoso (2003). *Gravity Model: An Application to Trade between Regional Blocs*. Retrieved January 26 2011 from the International Atlantic Economic Society's Webpages: http://www.iaes.org/journal/aej/june_03/martinez.pdf

Meyer (2011) *Florida Frost Disaster Declaration*. Retrieved from the Brownfield Agricultural News Bulletin: http://brownfieldagnews.com/2011/01/27/florida-frost-disaster-declaration/

Ministry of Finance (2011). *How the Carbon Tax Works*. Retrieved online from the Government of BC's webpages: http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm

National Resources Canada (2008). *Emission Factors Appendix*. Retrieved from: http://oee.nrcan.gc.ca/industrial/technical-info/benchmarking/ctwp/appendix-a.cfm?attr=8

National Roundtable on the Environment and Economy (2009). *Achieving 2050: A Carbon Pricing Policy for Canada*. Retrieved from: http://www.nrtee-trnee.com/eng/publications/carbon-pricing/carbon-pricing-advisory-note/carbon-pricing-advisory-note-eng.pdf#page=112

Wooders et al (2009). *Border Carbon Adjustment and Free Allowances: Responding to Competitiveness and Leakage Concerns*. Retrieved from the Organization for Economic Cooperation and Development Roundtable on Sustainable Development's webpages: http://www.oecd.org/dataoecd/33/34/43954465.pdf.

Organization for Economic Cooperation and Development (OECD) (2010). *Trade and Agriculture Directorate: Treatment of Agriculture in Selected Regional Trade Agreements*. Internally Circulated Document as received from Cameron Short.

Organization for Economic Cooperation and Development (OECD 2011). *Glossary of Statistical Terms OECD Information Portal*. Retrieved from OECD's statistics webpages: http://stats.oecd.org/glossary/detail.asp?ID=285

Ontario Ministry of Municipal Affairs and Housing (2011). *Citizen's Guide to Land Use Planning*. Retrieved from the Government of Ontario's Webpages: http://www.mah.gov.on.ca/Page338.aspx

Pacific Carbon Trust (2010). *Pacific Carbon Trust Growing BC's Green Economy*. Retrieved from: http://www.pacificcarbontrust.com/LinkClick.aspx?fileticket=Pl5rkzkaOiI%3D&tabid=124&mid=573

Peterson and Schleich (2007). *Economic and Environmental Effects of Border Tax Adjustments.* Working Paper Sustainability and Innovation Retrieved from: ww.isi.fraunhofer.de/isi-de/e/...and... /BTA_Peterson_Schleich_final.pdf

Rattray, David WT (2011). *Municipal System and Municipal Financial Control in Canada*. Retrieved via Parlcent's Parliamentary Centre Online resources: http://www.parlcent.ca/easterneurope/docs/PC%20Article%20on%20Municipal%20Control.pdf

Publicly Available Standards (2008). *PAS 2050:2008 – Specification for the assessment of the life cycle greenhouse gas emissions of goods and services*. Retrieved from: http://www.bsigroup.com/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050

Pembina (2011) *Cap and Trade – Canadian Affair after All?* Retrieved from Pembina's webpages: http://www.pembina.org/blog/523

Powel et al (2002) *Agricultural influences on Carbon Emissions and Sequestration*. Retrieved from the Department of Biological Sciences and Centre for Environment and Society - University of Essex's webpages: http://www.organic.aber.ac.uk/library/Carbon%20emissions%20and%20sequestration.pdf

Princeton University (2010) Princeton University *Interpreting Regression Output Data and Statistical Services*. Retrieved from: http://dss.princeton.edu/online_help/analysis/interpreting_regression.htm

Raloff (2010). Science News Direct. *AAAS of Dining. Climate Friendly Meats*. Retrieved from Science News Direct Webpages: http://www.sciencenews.org/view/generic/id/40934/title/AAAS_Climate-friendly_dining_%E2%80%A6_meats

Central Kootenay Regional District (CKRD) (2011). *Official Community Planning and Zoning Amendments*". Retrieved from: http://www.rdck.bc.ca/development/planning/forms/ocp.html

Renewable Energy World (2011). *The Carbon Market*. Retrieved From: http://www.renewableenergyworld.com/rea/news/article/2008/05/the-u-s-carbon-market-52451

Ritchie and Smith (2009). *Technical Memorandum to the City of Vancouver*. Retrieved from: http://vancouver.ca/engsvcs/solidwaste/landfill/pdf/greenhouse%20Emmissions.pdf

Rivers, Nic (2011). *Federal and Provincial Climate Change Policy in Canada: Lessons from Canada's Climate Change History*. Retrieved From:

www.sustainableprosperity.ca/dl136

Roos et al (2010). *Uncertainties in the Carbon Footprint of Food Products: A Case Study on Table Potatoes*. International Journal of Life Cycle Assessment (2010) Issue 15 pp 478–488

Standards Council of Canada (2011). *Welcome Pages*. Retrieved from: http://www.scc.ca/en/home

Smith et al. (2007). *Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Retrieved from the IPCC's website publications and resources webpages: http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter8.pdf

Statistics Canada (StatsCan) (2011). *Census Counts 49 431 Farms in Alberta*. Retrieved from: http://www.statcan.gc.ca/ca-ra2006/analysis-analyses/alberta-eng.htm

Statistics Canada (StatsCan) (2009a). *Report on Energy Supply-Demand in Canada Catalogue 57003-x*. Retrieved from: http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=57-003-X&lang=eng

Statistics Canada (StatsCan) (2009b). *Report on Energy Supply-Demand in Canada "Tables"*. Retrieved from: http://www.statcan.gc.ca/pub/57-003-x/2007000/tablesectlist-listetableauxsect-eng.htm

Statistics Canada (StatsCan) (2009c). *Energy Fuel Consumption of the Manufacturing Sector by Subsector*. Retrieved from: http://www40.statcan.gc.ca/l01/cst01/prim73-eng.htm?sdi=manufacturing%20food

Statistics Canada (2009d). *Human Activity and the Environment: Food in Canada*. Retrieved from: http://www.statcan.gc.ca/daily-quotidien/090609/dq090609a-eng.htm

Statistics Canada (StatsCan) (2009e) *Population Statistics*. Retrieved from http://www.bcstats.gov.bc.ca/

Statistics Canada (StatsCan) (2009f) *Energy Consumption by the Food Manufacturing Industry*". CANSIM Summary Table 128-0006. Retrieved From: http://www40.statcan.gc.ca/l01/cst01/prim73-eng.htm?sdi=manufacturing%20food

Statistics Canada (StatsCan) (2009g) *Table 1: Total Nitrogen and Phosphorous Content of Manure by Livestock Type, 2006*. Retrieved from: http://www.statcan.gc.ca/pub/16-002-x/2009001/tbl/prod/tbl001-eng.htm

Statistics Canada (StatsCan) (2008). *2006 Census of Agriculture*. Retrieved from: http://www.statcan.gc.ca/pub/95-629-x/2007000/4182411-eng.htm

Sykes (1988). *An Introduction to Regression Analysis*. Retrieved from the University of Chicago's Education Files Webpages: http://www.law.uchicago.edu/files/files/20.Sykes_.Regression.pdf

United States Senate (2011). *U.S. Senate Committee on Energy and Natural Resources the Low Carbon Economy Act.* Retrieved from: http://energy.senate.gov/public/index.cfm?FuseAction=IssueItems.View&IssueItem_ID=e6a0eeb8-4fda-437c-8ce3-f8b77d28d32e

United Nations' Framework Convention on Climate Change (UNFCCC) (2011). *Essential Background*. Retrieved from: http://unfccc.int/essential_background/items/2877.php

United Nations' Framework Convention on Climate Change (UNFCCC) (2011a*). Clean Development Mechanism*. Retrieved from: http://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php

Western Climate Initiative (2011). *About the WCI*. Retrieved from: http://www.westernclimateinitiative.org/organization

Webers and Matthews (2008). *Food-Miles and the Relative Climate Impacts of Food Choices in the United States*. Retrieved from the Department of Civil and Environmental Engineering and Department of Engineering and Public Policy. Carnegie Mellon University, Pittsburgh, Pennsylvania's online food science files: http://psufoodscience.typepad.com/psu_food_science/files/es702969f.pdf

Wightman, Julia (2009). *Production and Mitigation of Greenhouse Gases in Agriculture Cornell University Fact Sheet*. Retrieved from the Climate and Farming Organization's Online Publications: http://www.climateandfarming.org/additional_resources.php.

Winchester et al. (2011). *Will Border Carbon Adjustments Work?* Berkeley Electronic Press, 2011. The B.E. Journal of Economic Analysis and Policy, Vol. 11 [2011]. Iss. 1 (topics) Art. 7

Wood and Cowie (2004). *GHG Emissions from Fertilizer Production.* Retrieved from the IEA Bioenergy Publications Website: http://www.ieabioenergy-task38.org/publications/GHG_Emission_Fertilizer%20Production_July2004.pdf

DeWeerdt, Sarah (2009). *Is Local Food Better*? Retrieved from the World Watch Institute Organization's Webpages: http://www.worldwatch.org/node/6064

World Bank (2010). *Data Catalogue*. Retrieved from: http://data.worldbank.org/data-catalog

World Trade Law (2010). *Border Tax Adjustments. Report of the Working Party Adopted Dec. 02 1970*. Retrieved from: http://www.worldtradelaw.net/reports/gattpanels/bordertax.pdf

World Information Trade System (WITS) (2010). *WITS Presentation Data.* Retrieved from: http://192.86.102.134/WITS//Presentation.html

World Resource Institute (WRI) (2010) *GHG Protocol "Corporate Accounting and Reporting Standards"*. Retrieved from: http://www.ghgprotocol.org/files/ghg-protocol-revised.pdf

World Trade Organization (WTO) (2010). *Tariffs.* Retrieved from: http://www.wto.org/english/tratop_e/tariffs_e/tariffs_e.htm

World Trade Organization (2010a). *Understanding the WTO – the basics*. Retrieved from: http://www.wto.org/english/thewto_e/whatis_e/tif_e/fact2_e.htm

World Trade Organization (2010b) *Doha Round Explained*. Retrieved from: http://www.wto.org/english/tratop_e/dda_e/dohaexplained_e.htm

World Trade Organization (2010c) *Legal Texts: GATT 1947 "The General Agreement on Tariffs and Trade (GATT 1947 Article XVIII – XXXVIII*)". Retrieved from: http://www.wto.org/english/docs_e/legal_e/gatt47_02_e.htm#articleXX

World Trade Organization (2011). *The Doha Declaration explained*. Retrieved from: http://www.wto.org/english/tratop_e/dda_e/dohaexplained_e.htm

Yu (2009). *Competitiveness, Trade and Climate Change Linkages: Developing Countries' Perspectives*. Retrieved from the South Centre Organization online news: http://www.southcentre.org/index.php?option=com_content&task=view&id=1085&Itemid=279

Zenghong et al. (2009). *Climate Change: Global Risks, Challenges and Decisions: Mitigating greenhouse gas emissions through local land use planning*. Retrieved from the University of Nebraska, Community and Regional Planning Program's webpages: http://iopscience.iop.org/1755-1315/6/50/502021/pdf/ees9_6_502021.pdf

APPENDICES

Appendix 1 Whole Foods Imported to Canada

TABLE A1. 1 VEGETABLES IMPORTED TO CANADA

1.1 HS Category and Description: 70190 Potatoes, Fresh or Chilled Except Seed

Point of Origin	Dollars Imported	Weight Imported[50]	Production Emissions[51]	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
WA, USA	68899292	164045.93	164.05	342.52	207.00	11.63	175.68	6.37
Other	10694492.80	25463.08	25.46	3905.79	30.00	2.98	28.45	6.65
Total	**79593784.80**	**189509.01**	**189.51**	**4248.31**		**14.61**	**204.12**	**6.41**

1.2 HS Category and Description: 70200 Tomatoes, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[52]	Production Emissions (Field)[2]	Production Emissions (Greenhouse)	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
CA, USA	154749721.20	106723.95	96.05	55.50	1735.00	207	38.33	189.88	3.06
Mexico	103498086.00	71377.99	65.52	30.44	3941.00	207	58.23	154.19	3.72
Netherlands	3855777.40	2659.16	0.16	12.97	5514.85	30	0.44	13.58	8.80
Other	6838620.40	4716.29	3.11	8.09	3905.79	30	0.55	11.76	4.29

[50] Price Assumed $0.42/kg (AAFC 2009b).
[51] Default emission factor calculated for "Vegetables" is assumed as 0.001 kt-CO2e/ton.
[52] Price Assumed $1.45/kg (AAFC 2009b).

Point of Origin	Dollars Imported	Weight Imported[52]	Production Emissions (Field)[2]	Production Emissions (Greenhouse)	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
Total	**268942205.00**	**185477.38**	**164.85**	**107.00**	**15096.64**	**--**	**97.55**	**369.40**	**3.43**

1.3 HS Category and Description: 70310 Onions and Shallots, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[53]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C- Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
WA, USA	69112006.20	127985.20	127.99	342.42	207	9.07	137.06	4.96
Mexico	25332012.80	46911.13	46.91	3941.00	207	38.27	85.18	8.41
Peru	1837445.60	3402.68	3.40	6758.05	30, 207[54]	0.69, 1.22	5.31	7.23
Other	4843048.80	8968.61	8.97	1735.00	207	1.05	10.02	5.17
Total	101124513.40	187267.62	187.27	3905.79		50.30	237.57	5.87

1.4 HS Category and Description: 70320 Garlic, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[55]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
China	4989041.61	3079.66	3.08	9418.35	30	0.87	3.95	1.98
CA, USA	3535824.00	2182.61	2.18	1735.00	30	0.78	2.97	2.10
Thailand	649514.40	400.93	0.40	14631.65	30	0.18	0.58	2.22
S Korea	568009.00	350.62	0.35	19567.45	30	0.21	0.56	2.45
Turkmenistan	976163.40	602.57		Not Avail	30		Not Incl	Not Incl
Philippines	3908787.00	2412.83	2.41	11053.75	30	0.80	3.21	2.05
Other	1536134.40	948.23	0.95	3905.79	30	0.11	1.06	1.72
Total	16163473.80	9977.45	9.98	60311.99	30	2.95	12.92	2.00

[53] Price assumed $0.54/kg (AAFC 2009b).
[54] Products are assumed to travel first by boat from Peru to LA, California USA and second by truck from LA, California USA to Vancouver, BC, Canada.
[55] Price assumed $1.62/kg (AAFC 2009b).

1.5 HS Category and Description: 070410, 070490, 070511 Cauliflowers, Broccolis and Other Brassicas, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[56]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C- Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
CA, USA	270093827.40	281247.74	281.35	1735.00	207	101.04	382.39	3.54
Mexico	16921059.20	17626.10	17.63	3941.09	207	14.38	32.01	4.73
China[57]	1232854.40	1284.22	1.28	9418.35	30	0.36	1.65	3.34
Other	603543.80	628.69	0.63	3905.79	30	0.07	0.70	2.91
Total	288851284.80	300886.76	300.89	19000.23		115.86	416.75	3.61

1.6 HS Category and Description: 70519 Lettuce, Chilled or Cooled

Point of Origin	Dollars Imported	Weight Imported[58]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km			Kt-CO_2e	%
CA, USA	235937428.60	144746.89	130.27	1735.00	207	51.99	257.53	2.73
Mexico	872147.80	535.06	0.49	3941.09	207	0.44	1.16	3.31
Other	399711.20	245.22	0.16	3905.79	30	0.03	0.61	3.82
Total	237209287.60	145527.17	130.93	9581.88		52.45	259.29	2.73

1.7 HS Category and Description: 070610, 070690 Edible Roots (Carrots, Turnips, Salad Beets), Fresh or Cooled

Point of Origin	Dollars Imported	Weight Imported[59]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
CA, USA	120841146.40	131349.07	131.35	1735.00	207	47.17	178.52	3.69
Mexico	4188585.40	4552.81	4.55	3941.09	207	3.71	8.27	4.93
China	2927322.20	3181.87	3.18	9418.35	30	0.90	4.08	3.49

[56] Price assumed \$0.96/kg (AAFC 2009b).
[57] Distance calculated as between Shanghai, China and Vancouver, BC Canada.
[58] Price assumed \$1.63/kg (AAFC 2009b).
[59] Price assumed \$0.92/kg (AAFC 2009b).

Other	873079.40	949.00	0.95	3905.79	30	0.11	1.06	3.04
Total	1288301.33	140032.75	140.03	19000.23		51.90	191.93	3.72

1.8 HS Category and Description: 70700 Cucumbers and Gherkins, Fresh or Cooled

Point of Origin	**Dollars Imported**	**Weight Imported[60]**	**Production Emissions (Field)**	**Production Emissions (Greenhouse)**	**Distance Traveled**	**T-km**	**Transport Emissions**	**Total Emissions**	**C-Tariff Estimate**
	CAD	**Tons**	**Kt-CO_2e**	**Kt-CO_2e**	**Km**			**Kt-CO_2e**	**%**
Mexico	30293516.40	23483.35	21.56	10.01	3941.09	207	19.16	31.57	2.61
FL, USA[61]	13645834.60	10578.17	9.52	5.50	2394.67	207	5.24	15.02	2.75
Honduras	1913457.80	1483.30	1.36	0.63	8565.50	30	0.38	1.99	2.61
Other	3035778.20	2353.32	1.55	4.03	3905.79	30	0.28	5.59	4.60
Total	48888587.00	37898.13	33.99	20.18	18807.05	--	25.06	54.18	2.77

1.9 HS Category and Description: 70810, 70820 Peas and Beans, Shelled or Unshelled, Fresh or Chilled

Point of Origin	**Dollars Imported**	**Weight Imported[62]**	**Production Emissions**	**Distance Traveled**	**T-km**	**Transport Emissions**	**Total Emissions**	**C- Tariff Estimate**
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
CA, USA	48852687.80	21809.24	21.81	1735.00	207	7.83	29.64	1.52
Mexico	8899714.20	3973.09	3.97	3941.09	207	3.24	7.21	2.03
China[63]	8920720.00	3982.46	3.98	9418.35	30	1.13	5.11	1.43
Guatemala[64]	5170635.00	2308.32	2.31	8652.45	30	0.60	2.91	1.41
Other	2810242.40	1254.57	1.25	3905.79	30	0.15	1.40	1.25
Total	74653999.40	33327.68	33.33	27652.68	--	12.95	46.27	1.55

[60] Price assumed $1.29/kg (AAFC 2009b).
[61] Products assumed to travel from Miami, Florida USA to Toronto, ON Canada.
[62] Price assumed $2.24/kg (AAFC 2009b).
[63] Distance calculated as between Shanghai, China and Vancouver, BC Canada.
[64] Distance calculated as between Puerto Barrios, Guatemala and Southampton, ON, Canada.

1.10 HS Category and Description: 070920, 0709030 Asparagus or Aubergine, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[65]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	Carbon Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
Peru	26067597.00	10262.83	10.26	8493.05	30,207[66]	5.77	16.03	1.54
Mexico	25893237.80	10194.19	10.19	3941.09	207	8.32	18.51	1.79
CA, USA	23809530.00	9373.83	9.37	1735.00	207	3.37	12.74	1.34
Other	4222335.00	1662.34	1.66	3905.79	30	0.19	1.86	1.10
Total	79992699.80	31493.19	31.49	18074.93	--	17.64	49.14	1.54

1.11 HS Category and Description: 70940 Celery, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[67]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**			**Kt-CO_2e**	**%**
CA, USA	50250242.60	67013.66	67.01	1735.00	207	24.07	91.08	4.53
Mexico	1109268.40	22185.37	22.19	3941.09	207	18.10	40.28	9.07
Other	63132.20	1262.64	1.26	3905.79	30	0.15	1.41	5.59
Total	51432643.20	1028652.86	1028.65	9581.88		42.31	1070.97	5.21

1.12 HS Category and Description: 70960 Peppers, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[68]	Production Emissions (Field)	Production Emissions (Greenhouse)	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO2e**	**Kt-CO2e**	**Km**			**Kt-CO2e**	**%**

[65] Price assumed \$2.54/kg (AAFC 2009b).
[66] Products assumed to travel first by boat from Peru to Los Angeles, CA USA and second by truck from Los Angeles to Vancouver, BC Canada.
[67] Price assumed \$0.75/kg (AgMRC 2010).
[68] Price assumed \$1.75/kg (AAFC 2009b).

Point of Origin	Dollars Imported	Weight Imported[68]	Production Emissions (Field)	Production Emissions (Greenhouse)	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
FL, USA[69]	85691188.40	48966.39	44.07	25.46	2555.67	207	25.90	95.44	2.78
Mexico	62074513.00	35471.15	32.56	15.12	3941.09	207	28.94	76.63	3.09
Netherlands[70]	19583028.40	11190.30	10.50	3.61	5514.85	30	1.85	15.96	2.04
Spain[71]	12173358.00	6956.20	6.52	2.24	1776.00	30	0.37	9.14	1.88
Other	7059070.00	4033.75	2.66	6.92	3905.79	30	0.47	10.06	3.56
Total	186581157.80	106617.80	96.32	53.36	17693.40	--	57.54	207.22	2.78

1.13 HS Category and Description: 70970 Spinach, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[72]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
CA, USA	42514695.40	17568.06	17.57	1735.00	207	6.31	23.88	1.40
Mexico	119748.60	49.48	0.05	3941.009	207	0.04	0.09	1.88
Other	1451842.60	599.93	0.60	3905.79	30	0.07	0.67	1.15
Total	44086286.60	18217.47	18.22	9581.88	--	6.42	24.64	1.40

69 Distance calculated as between Miami, Florida USA and Toronto, ON Canada.
70 Distance calculated as between Rotterdam, Netherlands and St Johns, NS Canada.
71 Distance calculated as between Port of Spain, Spain and St Johns, NS Canada.
72 Price assumed \$2.42/kg (AAFC 2009b).

1.14 HS Category and Description: 70990 Miscellaneous Other Vegetables, Fresh or Chilled.

Point of Origin	Dollars Imported	Weight Imported[73]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
CA, USA	84706242.00	78431.71	24.83	1735.00	207	28.17	53.00	1.5
Mexico	27116663.20	25108.02	25.11	3941.09	207	20.48	45.59	4.20
Costa Rica[74]	1537142.80	1423.28	1.42	9409.10	30	0.40	1.83	2.97
Other	10619640.40	9833.00	9.83	3905.79	30	1.15	10.99	2.59
Total	123979688.40	114796.01	114.80	18990.98	--	50.21	165.00	3.33

1.15 HS Category and Description: 071320, 07131, 071332, 071333, 071339, 071340, 071350, 071390 Beans and Leguminous Vegetables, Fresh or Chilled.

Point of Origin	Dollars Imported	Weight Imported[75]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
ND, USA[76]	46042726.20	74262.46	74.26	354.89	207	5.46	79.72	4.33
China[77]	3372935.40	5440.22	6.98	9418.35	30	1.54	6.98	5.17
Thailand[78]	1121449.80	1808.79	2.60	14631.65	30	0.79	2.60	5.80
Peru[79]	1142628.00	1842.95	2.88	8493.05	30,207	0.37	2.88	6.30
India[80]	2558127.00	4126.01	6.11	16011.75	30	0.66	6.11	5.97
Other	4736401.80	7639.36	8.53	3905.79	30	1.98	8.53	4.50
Total	58974268.20	95119.79	106.82	52815.48	--	0.90	106.82	4.53

[73] Price assumed $1.08/kg (AAFC 2009b).
[74] Distance calculated as between Puntarenas, Costa Rica and Southampton, ON.
[75] Price assumed $0.62/kg (AAFC 2009b).
[76] Distance calculated as between North Dakota USA and Winnipeg, MB Canada.
[77] Distance calculated as between Shanghai, China and Vancouver, BC Canada.
[78] Distance calculated as between Bangkok, Thailand and Vancouver, BC Canada.
[79] Products are assumed to travel first by boat from Callao Peru to Los Angeles, California USA and second by truck from Los Angeles, CA to Vancouver BC, Canada.
[80] Distance calculated as between Chennai, India and Vancouver, BC Canada.

1.16 HS Category and Description: 071410, 071420, 071490 Manioc Sweet Potatoes or Arrowroot, Fresh, Chilled Frozen or Dried

Point of Origin	Dollars Imported	Weight Imported[81]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
CA, USA	22842441.00	24828.74	24.83	1735.00	207	8.92	33.75	3.69
China[82]	4195462.80	4560.29	4.56	9418.35	30	1.29	5.85	3.49
Jamaica[83]	3699817.00	4021.54	4.02	8569.20	30	1.03	5.06	3.42
Costa Rica[84]	2483324.00	2699.27	2.70	9409.10	30	0.76	3.46	3.48
Other	4391517.80	4773.39	4.77	3905.79	30	0.56	5.33	3.04
Total	37612562.60	40883.22	40.88	33037.44	--	12.56	53.44	3.55

[81] Price assumed $0.92/kg (AAFC 2009b).
[82] Distance calculated as between Shanghai, China and Vancouver, BC Canada.
[83] Distance calculated as between Kingstown, Jamaica and Vancouver BC Canada.
[84] Distance calculated as between Puntarenas, Costa Rica and Southampton, ON Canada.

TABLE A1. 2 FRUITS IMPORTED TO CANADA

2.1 HS Category and Description: 80300 Bananas Including Plantains, Fresh or Dried

Point of Origin	Dollars Imported	Weight Imported[85]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km			Kt-CO_2e	%
Ecuador[86]	49464792.80	82441.32	313.28	7704.95	30, 207	44.38	357.65	18.08
Costa Rica[87]	61023584.40	101705.97	386.48	9409.10	30	28.71	415.19	17.01
Columbia[88]	79433554.60	132389.26	503.08	4290.00	30	17.04	520.12	16.37
Guatemala	46259369.00	77098.95	292.98	8652.45	30	20.01	312.99	16.91
Other	28119464.80	46865.77	178.09	3905.79	30	5.49	183.58	16.32
Total	264300765.60	440501.28	1673.90	33962.29	30	115.63	1789.53	16.93

2.2 HS Category and Description: 080430, 080450, 080720, 081050, 081060 Other Tropical Fruits including Pineapples, Guavas, Mangosteens, Papayas, Kiwifruit and Durian, Fresh or Cooled

Point of Origin	Dollars Imported	Weight Imported[89]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
Costa Rica[90]	78732565.00	52488.38	199.46	9409.10	30	14.82	214.27	6.80
Mexico	29506558.20	19671.04	74.75	3941.09	207	16.05	90.80	7.69
USA[91]	21734516.20	14489.68	55.06	4473.30	30	1.94	57.01	6.56
New Zealand	8586433.00	5724.29	21.75	11468.30	30	1.97	23.72	6.91

[85] Price Assumed \$0.60/kg (AAFC 2009b).
[86] Products are assumed to travel first by boat from Guayaquil to LA and second by truck from LA to Vancouver, BC, Canada.
[87] Distance calculated as between Puntarenas, Costa Rica and Southampton, ON, Canada.
[88] Distance calculated as between Baranquilla, Columbia and Southampton, ON, Canada.
[89] Price assumed \$1.50/kg (AAFC 2009b).
[90] Distance calculated as between Puntarenas Costa Rica and Southampton, ON, Canada.
[91] Distance calculated as between Honolulu, Hawaii and Vancouver, BC, Canada.

Point of Origin	Dollars Imported	Weight Imported[89]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
Italy	8486433.00	5657.98	21.50	8289.85	30	1.41	22.91	6.75
Brasil[92]	6903985.00	4602.66	17.49	7192.80	30	0.99	18.48	6.69
Ecuador[93]	6864047.00	4576.03	17.39	7704.95	30, 207	2.64	19.85	7.23
Belize	6773572.00	4515.71	17.16	4716.37	207	4.41	21.57	7.96
Chile[94]	6545659.00	4363.77	16.58	9934.20	30, 207	2.64	19.22	7.34
Peru[95]	4125025.00	2750.02	10.45	8493.05	30	1.55	12.00	7.27
Thailand	4438957.00	2959.30	11.25	14631.65	30	1.30	12.54	7.06
Other	15443831.20	10295.89	39.12	3905.79	30	1.21	40.33	6.53
Total	198142120.60	134844.76	512.41	94160.45		50.74	563.15	7.11

2.3 HS Category and Description: 080510, 080520, 080540, 080550, 080590 Citrus Fruits, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[96]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C- Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
CA, USA	185726246.80	226495.42	860.68	1735.00	207	81.34	942.03	12.68
Morocco[97]	67529484.20	82353.03	312.94	4051.50	30	10.01	322.95	11.96
South Africa[98]	40267274.60	49106.43	186.60	11088.90	30	16.34	202.94	12.60
China[99]	28162804.00	34344.88	130.51	9418.35	30	9.70	140.21	12.45
Mexico	15456611.00	18849.53	71.63	3941.09	207	15.38	87.01	14.07
Argentina	12744904.00	15542.57	59.06	15441.95	30	7.20	66.26	13.00

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[92] Distance calculated as between Sao Luis and Southampton, ON, Canada.
[93] Products are assumed to travel first by boat from Guayaquil, Ecuador to Los Angeles, CA USA and second by truck from Los Angeles, CA to Vancouver, BC Canada.
[94] Products are assumed to travel first by boat from Antofagasta, Chile to Los Angeles, CA USA and second by truck from Los Angeles, CA to Vancouver, BC Canada.
[95] Products are assumed to travel first by boat from Callao, Peru to Los Angeles, CA USA and second by truck from Los Angeles, CA to Vancouver, BC Canada.
[96] Price Assumed $0.82/kg (AAFC 2009b).
[97] Distance calculated as between Agadir, Morocco and Southampton, ON Canada.
[98] Distance assumed as between Cape Town, S Africa and Southampton, ON Canada.
[99] Distance assumed as between Shanghai, China and Vancouver, BC Canada.

Point of Origin	Dollars Imported	Weight Imported[96]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C- Tariff Estimate
Chile[100]	9658741.30	11778.95	44.76	9934.20	30,207	7.13	51.89	13.43
Spain[101]	14019138.00	17096.51	64.76	1776.00	30	0.91	65.88	11.75
Other	38923644.10	47467.86	180.38	3905.79	30	5.56	185.94	11.94
Total	412488848.00	503035.18	1911.53	61292.78	--	153.57	1065.11	12.52

2.4 HS Category and Description: 080610, 080910, 080920, 080930, 080940 Tree/Vine Fruits (Soft) including: Grapes, Apricots, Cherries, Peaches, Nectarines, Plums and Sloes, Fresh or Chilled.

Point of Origin	Dollars Imported	Weight Imported[102]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
CA, USA	356339997.60	159793.72	607.22	1735.00	207	57.39	664.61	4.66
Chile[103]	176652961.60	79216.57	301.02	9934.20	30,207	47.94	348.96	4.94
Mexico	37537825.00	16833.11	63.97	3941.09	207	13.73	77.70	5.17
Other	25301865.80	11346.13	43.12	3905.79	30	1.33	44.44	4.39
Total	595832650.00	267189.53	1015.32	19516.08	--	120.39	1135.71	4.76

2.5 HS Category and Description: 080810 Tree/Vine Fruits (hard) including Apples, Pears and Quinces, Fresh or Chilled.

Point of Origin	Dollars Imported	Weight Imported[104]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
WA, USA	171723466.00	318006.42	1208.42	342.42	207	22.54	1230.96	17.92
Chile[2]	25992615.40	48134.47	182.91	9934.20	30, 207	29.13	212.04	20.39
China	17198076.80	31848.29	121.02	10697.15	30	10.22	131.24	19.07

[100] Products are assumed to travel first by boat from Antofagasta, Chile to Los Angeles, CA USA and second by truck from Los Angeles, CA USA to Vancouver, BC Canada.
[101] Distance assumed as between Port of Spain, Spain to St John, New Brunswick Canada.
[102] Price assumed $2.23/kg (AAFC 2009b)
[103] Products are assumed to travel first by boat from Antofagasta, Chile to Los Angeles, CA USA and second by truck from Los Angeles, CA USA to Vancouver, BC Canada.
[104] Price assumed $0.54/kg (AAFC 2009b)

Point of Origin	Dollars Imported	Weight Imported[104]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
Argentina	14812020.00	27429.67	104.23	15441.95	30	12.71	116.94	19.73
New Zealand	12095548.00	22399.16	85.12	114668.15	30	77.05	162.17	33.41
Other	15241873.20	28225.69	107.26	3905.79	30	3.31	110.56	18.13
Total	257063599.40	476043.70	1808.97	154989.66	--	154.96	1963.92	19.09

2.6 HS Category and Description: 080711, 080719 Watermelons, Melons, Fresh or Chilled.

Point of Origin	Dollars Imported	Weight Imported[105106]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
CA, USA	**101783376.00**	**188487.73**	**716.25**	**1735.00**	**207**	**67.69**	**783.95**	**19.26**
Mexico	**31183864.80**	**57747.90**	**219.44**	**3941.09**	**207**	**47.11**	**266.55**	**21.37**
Guatemala[107]	**20036336.80**	**37104.33**	**141.00**	**8652.45**	**30**	**9.63**	**150.63**	**18.79**
Costa Rica	**15610287.00**	**28907.94**	**109.85**	**9409.10**	**30**	**8.16**	**118.01**	**18.90**
Other	**12795555.00**	**23695.47**	**90.04**	**3905.79**	**30**	**2.78**	**92.82**	**18.14**
Total	**181409419.60**	**334943.37**	**1276.58**	**27643.43**	**--**	**135.37**	**1411.96**	**19.46**

2.7 HS Category and Description: 081010, 081020, 081030, 081040 Berries (Strawberries, Raspberries, Blackberries, Mulberries, Loganberries, Red Currants, Gooseberries, Cranberries, Blueberries, and Others), Fresh, Chilled or Steamed

Point of Origin	Dollars Imported	Weight Imported[108109]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	**Tons**	**Kt-CO_2e**	**Km**		**Kt-CO_2e**	**Kt-CO_2e**	**%**
CA, USA	**314451711.40**	**120479.58**	**457.82**	**1735.00**	**207**	**43.27**	**501.09**	**3.98**

[105] Price assumed \$0.54/kg (AAFC 2009b).
[106] Price assumed \$2.54/kg (AAFC 2009b).
[107] Distance assumed as between Puerto Barrios, Guatemala and Southampton, ON Canada.
[108] Price assumed \$2.61/kg (AAFC 2009b).
[109] Price assumed \$2.54/kg (AAFC 2009b).

Point of Origin	Dollars Imported	Weight Imported[108109]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
Mexico	34390685.80	13176.51	50.07	3941.09	207	10.75	60.82	4.42
Chile	23999387.80	9195.17	34.94	9934.20	30,207	5.56	40.51	4.22
Other	11505337.80	4408.18	16.75	3905.79	30	0.52	17.27	3.75
Total	384347122.80	147259.43	559.59	19516.08		60.10	619.69	4.03

TABLE A1. 3 ANIMAL PRODUCTS IMPORTED TO CANADA

3.1 HS Category and Description: 020110, 020120, 020130 Bovine Cuts Beef Various, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[110]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
USA[111]	318005967.40	44663.76	893.28	1580.22	207	14.61	907.88	7.14
Australia	14112106.80	1982.04	39.64	14298.65	30	0.85	40.49	7.17
New Zealand	7972013.60	1119.66	22.39	11468.15	30	0.39	22.78	7.14
Other	9585176.60	1346.23	26.92	3905.79	30	0.16	27.08	7.06
Total	349675264.40	49111.69	982.23	31252.81	--	16.00	998.24	7.14

3.2 HS Category and Description: 020312, 020319 Ham and Swine, Fresh and Chilled.

Point of Origin	Dollars Imported	Weight Imported[112]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
USA[113]	290478471.20	77254.91	1004.31	1081.63	207	17.30	1021.61	8.79
Other	41735.40	11.10	0.14	3905.79	30	0.00	0.14	8.72
Total	290520206.60	77266.01	1004.46	4987.42	--	17.30	1021.76	8.79

3.3 HS Category and Description: 020422, 020423 Sheep, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[114]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
Australia[115]	20632861.60	2028.80	24.35	14298.65	30	0.87	25.21	3.06

[110] Price assumed \$7.12/kg (AAFC 2009b).
[111] Distance calculated as between Denver, CO USA and Regina, SK Canada.
[112] Price assumed \$3.76/kg (AAFC 2009b).
[113] Distance calculated as between Des Moines, IA USA and Winnipeg, MB Canada.
[114] Price assumed \$10.17/kg (AAFC 2009b).

Point of Origin	Dollars Imported	Weight Imported[114]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
New Zealand[116]	20509234.40	2016.64	24.20	11468.15	30	0.69	24.89	3.03
USA[117]	700442.80	68.87	0.83	1081.63	207	0.02	0.84	3.00
Other	13797.20	1.36	0.02	3905.79	30	0.00	0.016	2.98
Total	41856336.00	4115.67	49.39	30754.22	--	1.58	50.96	3.04

3.4 HS Category and Description: Chicken Whole or Parts, Fresh or Chilled

Point of Origin	Dollars Imported	Weight Imported[118]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
USA[119]	182216806.00	51041.12	25.52	1538.68	207	16.26	41.78	0.06
Brasil[120]	113077.80	31.67	0.02	7192.80	30	0.01	0.02	0.05
Other	72.20	0.02	0.00	3905.79	30	0.00	0.00	0.04
Total	182329956.00	51072.82	25.54	12637.27	--	16.26	41.80	0.06

3.5 HS Category and Description: Eggs From Birds, Fresh, Preserved or Cooked

Point of Origin	Dollars Imported	Weight Imported[121]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
USA[122]	55393953.40	23876.70	78.79	2394.67	207	11.84	90.63	4.09
China[123]	1965742.80	847.30	2.80	9418.35	30	0.24	3.04	3.86

[115] Distance calculated as between Adelaide, Aus and Vancouver BC Canada.
[116] Distance calculated as between Auckland, NZ and Vancouver BC Canada.
[117] Distance calculated as between Des Moines, IA USA and Winnipeg, MB Canada.
[118] Price assumed $3.57/kg (AAFC 2009b).
[119] Distance calculated as between Atlanta, Georgia USA and Toronto ON Canada.
[120] Distance calculated as between Sao Louis Brazil and Southampton, ON Canada.
[121] Price assumed $2.32/kg (AAFC 2009b).
[122] Distance calculated as between Miami, Florida USA and Toronto, ON Canada.
[123] Distance calculated as between Shanghai, China and Vancouver BC Canada.

Point of Origin	Dollars Imported	Weight Imported[121]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
Other	266490.60	114.87	0.38	3905.79	30	0.01	0.39	3.68
Total	57626186.80	24838.87	81.97	15718.81	--	12.09	94.06	4.08

3.6 **HS Category and Description: Grains, Mostly Animal Feed**

Point of Origin	Dollars Imported	Weight Imported[124]	Production Emissions	Distance Traveled	T-km	Transport Emissions	Total Emissions	C-Tariff Estimate
	CAD	Tons	Kt-CO_2e	Km		Kt-CO_2e	Kt-CO_2e	%
USA [125]	130625831.20	186608.33	727.77	1065.30	207	41.15	768.92	14.71
France[126]	6338561.40	9055.09	35.31	5163.35	30	1.40	36.72	14.48
China	6121065.00	8744.38	34.10	9418.35	30	2.47	36.57	14.93
Germany[127]	3564541.00	5092.20	19.86	6005.10	30	0.92	20.78	14.57
Other	1445057.20	20651.51	80.54	3905.79	30	2.42	82.96	14.34
Total	161106055.80	230151.51	897.59	25557.89	--	48.36	945.95	14.67

[124] Price assumed $0.70/kg (AAFC 2009b).
[125] Distance calculated as between Chicago, IL USA and Toronto, ON Canada.
[126] Distance calculated as between Le Havre, France and St John, NB Canada.
[127] Distance calculated as between Hamburg, Germany and Saint John, NB Canada.

Appendix 2 GHG Emissions from Whole Food Production in BC, Canada

TABLE A2. 1 TOTAL GHG EMISSIONS

Production Input	GHG Emissions	Percent Provincial Total
	Kt-CO2e	%
1a,b Enteric Fermentation and Manure	**1613**	**39.23**
1c Agricultural Soils	**888**	**21.6**
2. Energy Supply-Demand	**717**	**17.44**
3.4 NAICS3253 Manufacture	**610**	**14.84**
3.5 NAICS3253 Transport	**214**	**5.20**
4.0 Animal Feed/Grains	**69**	**1.7**
5.0 TOTAL	**4111**	**100.00**

Appendix 3 Transport Assumptions

1) Distances Traveled.

a. Distances traveled between “other” countries and Vancouver are estimated at 3905.79kms[128] and assumed to travel by boat.
b. Distances traveled between USA and Canada are assumed as between the capital of the top exporting American state shipping goods to Canada and the capital city of the closest Canadian provincial capital.
c. Distances traveled between international countries (aside from the USA) and Canada are assumed as between the capital or largest city of the international country and the closest Canadian provincial capital city.
d. Land and Road Transport Distances are estimated by mapquest.com
e. Air Transport Distances are estimated by mapcrow.com.
f. Sea Distances traveled are estimated by marinetimechain.com.
g. GHG emissions from transfer shipments, multiple trips or shipments of goods occurring before the last shipment received by Canada’s customs agency are not included in transport GHGe estimates.

2) Transport Vehicle T-Km factor assumptions.
Non-Perishable Goods

a. Distances between cities on the Western side of N. America and Canada are assumed to travel by truck to Vancouver, BC.
b. Distances between Mexico and Canada are assumed to travel by truck.
c. Distances between Western Central and S. American countries or those countries with primary shipping ports on the Western coast of the Americas are assumed to travel first by boat to Los Angeles California, USA and second by truck from Los Angeles to Vancouver, BC Canada.
d. Distances between Eastern Central and S. American countries or those countries with primary shipping ports on the Eastern coast of the Americas are assumed to travel by boat to the closest Eastern province of Canada (shipping ports accessible imply more frequent shipments to S Hampton, Ontario and Saint Johns, New Brunswick).
e. Distances between Costa Rica and Canada are assumed to travel by boat from Puntarenas to Vancouver, BC Canada.
f. Distances between coastal European countries and Canada are assumed to travel by boat to Saint Johns, New Brunswick or South Hampton, Ontario.
g. Distances between inland European countries and Canada are assumed to travel by boat from the most accessible nearby UK shipping port (often Boston) to Saint Johns, New Brunswick or South Hampton, ON.
h. Distances between the Asias and Canada are assumed to travel by boat from the most accessible shipping ports (sometimes most accessible ports are not located in the same country shipping goods) to Vancouver, BC Canada.

[128] Estimated based on weighted average distance between countries shipping foods to Canada and Canada

i. Distances between Western African countries and Canada are assumed to travel by boat from most accessible shipping ports (sometimes most accessible ports are not located in the same country shipping goods) to Saint Johns, NB Canada.

j. Distances between Eastern African countries and Canada are assumed to travel by boat from most accessible shipping ports to Vancouver.

k. Distances between Australia or New Zealand and Canada are assumed to travel by boat to Vancouver.

Perishable and Delicate Goods:

l. All perishable goods received from outside of North America are assumed to travel by air.

m. Perishable goods received from within North America are assumed to travel by truck.

3) Transport assumptions specific to imports of NAICS3253 products to BC:

a. Distances traveled between the USA and BC are assumed to travel to travel by truck to Vancouver, BC Canada.

b. Distances traveled between Europe and BC are assumed to travel first by boat to Halifax, Nova Scotia (NS) Canada and second by truck from Halifax to Vancouver, BC Canada.

c. Distances traveled between India and Canada are assumed to travel by boat from Chennai to Vancouver, BC, Canada.

d. Domestic transport of NAICS3253 products available to BC are assumed as an arbitrary 300 km only, traveling by truck within the province.

4) Limitations of T-km factors used in WASD formula

a. T-km factors used in our study do not take into account changes or differences in or of technology, energy consumption rates or types (e.g. alternative energy fuels, biofuels, diesel, natural gas, electric), year, make or model of various transportation vehicles within transport vehicle categories. Not taking account differences within transport type categories means for example the energy consumed by a small family-owned truck vs. an eighteen-wheel semi truck are estimated using the same T-km Factor, 207.

b. Any GHG emissions resulting from refrigeration or cooling activities from shipping vehicles are not included in T-km factor estimates.

5) Other Transport Assumptions and Limitations

a. Alternate shipping routes traveled by foods imported to Canada are highly possible and not referenced or included in this study.

Appendix 4 British Columbia Ministry of Agriculture and Lands Planning For Profit Sheets Referenced

BCMAL Planning for Profit budgets guiding default Emission Factor estimates for food production in BC, Canada. The following publications have been referenced:

a. Field Grown Vegetables produced on a 5 acre mixed vegetable (22 vegetables averaged) operation on Vancouver Island in the spring of 2008 (BCMAL 2008b);
b. Greenhouse Grown Vegetables produced on Vancouver Island in a 6000ft2 greenhouse (BCMAL 2008b); □
c. Hard Tree Fruit produced from 1742 apple trees per acre in the Okanagan Valley in 2001 (BCMAL 2001b) and 389 pear trees per acre in 1999 (BCMAL 1999a);
d. Soft Tree Fruit produced from 311 peach trees per acre in the Okanagan valley in 2001 (BCMAL 2001c) and 574 cherry trees per acre in summer of 1999 (BCMAL 1999b); □
e. Pig produced on a 250 sow farm in the Okanagan valley (BCMAL 1997a); □□
f. Sheep produced as 7 animals or 549 lbs. reared on a mixed animal farm (BCMAL 2008a); □□
g. Beef reared on an average 200 cow calf operation in Williams Lake and 400 cow calf operation in Kamloops during the spring of 2007 (BCMAL 2007a and BCMAL 2007b); □
h. Grains for feed produced as Barley and Alfalfa on a 300 acre farm in Kamloops during spring of 2007 (BCMAL 2007c); □□
i. Poultry produced on a 100 000 bird (BCMAL1998a) and 50 000 broiler bird (BCMAL 1998ab) operation in the Fraser Valley during summer of 1998; □
j. Dairy produced on an average 100 cow operation in the Fraser Valley during the summer of 2001 (BCMAL 2001a); □
k. Eggs produced by 15 000 birds: 300 eggs per hen per year in summer of 1998 (BCMAL 1998c) and organic eggs; 285 eggs per her per year (BCMAL 2002a).

Appendix 5 Default Emission Factor Estimate Calculations.

TABLE A5. 1 AGRI-INPUTS' CONTRIBUTIONS TO DEFAULT EMISSION FACTORS ESTIMATES

A5.1.1 Energy

	Energy Supply and Demand						
Food Category	Energy Consumption (1)	Area Under Production in BC (2)	Energy Consumption in BC	Percent Provincial Agri-Setor Consumption	Provincial GHG's (5)	Yield (2)	Contribution to Default Emission Factor
	$/acre/year	*acres*	*$CAD*	*percent*	*kt-CO2e*	*tons*	*kt-CO2e/ton*
Vegetables (field)	95	25688.516	2440409.02	0.02	13	238068.4	0.0001
Vegetables (greenhouse)	45000	623.58	28061100	0.20	147	100940.88	0.0015
Fruit	82.67	48980.162	4049189.993	0.03	21	222172	0.0001
	$/animal/year	*# animals in BC*	*$CAD*			*tons*	
Dairy (12)	105	72,756	7639380	0.06	40	639647	0.0001
Eggs (3) (4)	0.125	181,959,350	22744918.8	0.17	119	49473	0.0024
Poultry	0.125	14,942,613	1867826.625	0.01	10	216,712	0.0000
Beef	60	728,099	43685940	0.32	229	69,321	0.0033
Pig	70	135,826	9507820	0.07	50	17,900	0.0028
Lamb, Sheep	7.7	61,033	469954.1	0.00	2	1,218	0.0020
	$/acre/year		*$CAD*				
Coarse Grains	81.05	202962.37	16450100.09	0.12	86	192,024	0.0004
Total	45501.67	n/a	136916638.6	1.00	717	1,747,476	n/a

A5.1.2 Agricultural Chemicals

	Ag Chemicals					
Food Category	Ag Chemical Consumption	Area Under Production n BC	Ag Chemical Consumption in BC	Percent Provincial Agri-Sector Consumption	Provincial GHG's	Contribution to Default Emission Factor
	$/acre/year	*acres*	*$CAD*	*percent*	*tons*	*kt-CO2e/ton*
Vegetables (Field)	208	25688.516	5,343,211	0.15	125	0.0005
Vegetables (Greenhouse)	1990	623.58	1,240,924	0.04	29	0.0003
Fruit	573.13	48980.162	28,072,000	0.81	657	0.0030
Dairy	n/a	n/a	n/a	n/a	n/a	n/a
Eggs	n/a	n/a	n/a	n/a	n/a	n/a
Poultry	n/a	n/a	n/a	n/a	n/a	n/a
Beef	n/a	n/a	n/a	n/a	n/a	n/a
Pig	n/a	n/a	n/a	n/a	n/a	n/a
Lamb, Sheep	n/a	n/a	n/a	n/a	n/a	n/a
	$/acre/year					
Coarse Grains	45.21	202962.37	202,962	0.01	5	0.0000
Total	2816.34		34859098.15		816	

A5.1.3 Land-Use

Food Category	Land Use Percent Provincial Land Use Consumption (7)	Provincial GHG's	Contribution to Default Emission Factor
	percent	*kt-CO2e*	*kt-CO2e/ton*
Vegetables (Field)	0.09	82.09	0.0003
Vegetables (Greenhouse)	n/a	n/a	n/a
Fruit	0.18	156.57	0.0007
	Manure (5) (6)		
	percent	*kt-CO2e*	*kt-CO2e/ton*
Dairy	0.10	159	0.0002
Eggs	0.02	32	0.0007
Poultry	0.06	96	0.0004
Beef	0.70	1136	0.0164
Pig	0.11	178	0.0100
Lamb, Sheep	0.01	12	0.0099
	Land Use GHGs		
	percent total		
Coarse Grains	0.73	649	0.0034
Total		*kt-CO2e*	
	Total Manure GHGS (5)	1613	
	Total Land Use GHGS (5)	888	
		2500	

A5.1.4 Feed

Food Category	FEED Feed Consumption (11)	Production in BC	Food Category Consumption	Percent Agri-Sector Feed Consumption	Provincial GHGs	Contribution to Default Emission Factor
	$/animal/year (1)	*# animals (2)*	*$CAD*	*percent*	*kt-CO2e*	*kt-CO2e/ton*
Vegetables (Field)	n/a	n/a	n/a	n/a	n/a	n/a
Vegetables (Greenhouse)	n/a	n/a	n/a	n/a	n/a	n/a
Fruit	n/a	n/a	n/a	n/a	n/a	n/a
Dairy	1922	72,756	#########	0.0413	2.8903	0.0000
Eggs	11.36	181,959,350	2.067E+09	0.6101	42.7241	0.0009
		-				
Poultry	1.33	14,942,613	19873675	0.0059	0.4108	0.0000
Beef	1305	728,099	950169195	0.2804	19.6391	0.0003
Pig	1550	135,826	210530300	0.0621	4.3515	0.0002
Lamb, Sheep	13.5	61,033	823945.5	0.0002	0.0170	0.0000
Coarse Grains	n/a	n/a	n/a	n/a	n/a	n/a
Total	4803.19	197899677.4	3.388E+09	1	70.03	

Appendix 2 Box 2	Production GHGs (	Production yield	Production GHGs Total	Exports	Less Export produc	Plus Import GHGS	Total
	kt-CO2e/tonne	*tonnes*	*kt-CO2e*	*tonnes*	*kt-CO2e*	*kt-CO2e*	*kt-CO2e*
COARSE GRAINS	0.003852	290.20	1.12	63.65687214	0.245214595	69.16	70.03

TABLE A5. 2 SUMMARY OF RESULTS AND DEFAULT EMISSION FACTOR ESTIMATES

A5.2.1 Consumption of Energy and Agricultural Chemicals

Appendix 2 Box 3				
SUMMARY TABLE				
	Energy Supply	Default EF contribution	Ag Chemicals	Default EF contribution
Food Category	*kt-CO2e*	*kt-CO2e/ton*	*kt-CO2e*	*kt-CO2e/ton*
Vegetables (field)	12.79	0.0001	125.10	0.0005
Vegetables (greenhouse)	147.02	0.0015	29.05	0.0003
Fruit	21.21	0.0001	657.25	0.0030
Dairy (8,10)	40.03	0.0001	n/a	n/a
Eggs	119.17	0.0024	n/a	n/a
Poultry	9.79	0.0000	n/a	n/a
Beef	228.88	0.0033	n/a	n/a
Pig	49.81	0.0028	n/a	n/a
Lamb, Sheep	2.46	0.0020	n/a	n/a
Coarse Grains (mostly fo	86.19	0.0004	4.75	0.0000
Total (14)	717.35	n/a	816.16	n/a

A5.2.2 Consumption of Land-Use and Feed

Food Category	Land Use	Default EF contribution	Feed	Default EF contribution
	kt-CO2e	*kt-CO2e/ton*	*kt-CO2e*	*kt-CO2e/ton*
Vegetables (Field)				
Vegetables (Greenhouse)	82.09	0.0003	n/a	n/a
Fruit	n/a	n/a	n/a	n/a
	156.57	0.0007	n/a	n/a
Dairy	158.83	0.0002	2.8903	0.0000
Eggs	32.25	0.0007	42.7241	0.0009
	0.00	0.0000		
Poultry	95.94	0.0004	0.4108	0.0000
Beef	1136.01	0.0164	19.6391	0.0003
Pig	178.18	0.0100	4.3515	0.0002
Lamb, Sheep	12.09	0.0099	0.0170	0.0000
Coarse Grains	648.76	0.0034	n/a	n/a
Total	2500.74		70.03	

A5.2.3 Default Emission Factor Estimates and Percent Total

Food Category	TOTAL (9)	Default EF contribution	Relative Percent Total
	kt-CO2e	*kt-CO2e/ton*	
Vegetables (Field)			
Vegetables (Greenh	219.98	0.0009	0.05
Fruit	176.07	0.0017	0.04
	835.04	0.0038	0.20
Dairy	207.73	0.0003	0.05
Eggs	161.89	0.0033	0.04
Poultry	106.14	0.0005	0.03
Beef	1384.53	0.0200	0.34
Pig	232.35	0.0130	0.06
Lamb, Sheep	14.57	0.0120	0.0036
Coarase Grains	739.70	0.0039	0.18
Total	4078.00		1

A5.2.4 Calculation Notes

(1) Consumption estimates are retrieved from BCMAL Planning For Profit (PFP) sheets (BCMAL 2008b).
(2) 2006 Agriculture census yields have been converted from hectares to acres (Serecron 2009).
(3) Poultry produced to provide eggs for consumption are assumed to consume the same amounts of energy as poultry produced for to provide meat for consumption.
(4) Birds have been assumed as producing 25 dozen eggs per year. 1 tonne of eggs is estimated as 1462 dozen eggs. Therefore, annual egg production in BC is estimated at: 3111480 tons or 4548983760 eggs. Assuming 25 dozen eggs are produced per bird, the number of birds producing in BC is calculated as181959350.4
(5) Data has been referenced from author's estimates as sourced from Appendix 1.
(6) Emission Factors are estimated relative to Canada's national nitrogen and phosphorous percent composition (Stats Canada 2009g)
(7) Land use emissions per food category have been estimated and assumed as equal on a per acre basis for food categories of field vegetables, fruit trees and coarse grains.
(8) Data and numbers include an industry energy consumption estimate for NAICS 311511 "Fluid Milk Manufacturing" also.
(9) Calculation totals may not add up 100% correctly due to rounding in estimation methods.
(10) Data here is included for comparison totals and calculation purposes only.
(11) Quantities of Feed Available to BC are calculated and referenced in author's Appendix 2.
(12) Data presented here is included for comparison estimates only.

Appendix 6 Carbon Tariff Estimates Categorized on a per Country Basis.

TABLE A6. 1 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF VEGETABLES IMPORTED TO CANADA BY COUNTRY

	Vegetables				
	Production Emissions (Field)	Production Emissions (Greenhouse)	Transport Emissions	Total Emissions	C-Tariff per $CAD HS (
Countries of Origin	*kt-CO2e*		*kt-CO2e*	*kt-CO2e*	*$CAD*
Australia	xx	xx	xx	xx	xx
Argentina	xx	xx	xx	xx	xx
Brasil	xx	xx	xx	xx	xx
Chile	xx	xx	xx	xx	xx
China	21.53	xx	6.08	27.61	0.03
Colombia	xx	xx	xx	xx	xx
Costa Rica	4.12	xx	1.16	5.29	0.03
Denmark	xx	xx	xx	xx	xx
Ecuador	xx	xx	xx	xx	xx
France	xx	xx	xx	xx	xx
Germany	xx	xx	xx	xx	xx
Greece	xx	xx	xx	xx	xx
Guatemala	2.31	xx	0.60	2.91	0.01
Honduras	1.36	0.63	0.38	1.74	0.02
India	4.13	xx	1.98	6.11	0.06
Italy	xx	xx	xx	xx	xx
Jamaica	4.02	xx	1.03	5.06	0.03
Mexico	250.74	55.80	213.30	519.84	0.04
Morocco	xx	xx	xx	xx	xx
Netherlands	10.66	16.58	2.29	12.95	0.01
New Zealand	xx	xx	xx	xx	xx
Norway	xx	xx	xx	xx	xx
Other Countries	71.47	19.47	8.83	80.30	NA
Peru	15.51	xx	8.71	24.22	0.02
Philippines	2.41	xx	0.80	3.21	0.02
South Africa	xx	xx	xx	xx	xx
South Korea	0.35	xx	0.21	0.56	0.02
Spain	0.37	6.52	2.24	9.14	0.02
Switzerland	xx	xx	xx	xx	xx
Thailand	2.21	xx	0.97	3.18	0.04
Turkmenistan**no shipping port avail.					xx
UK	xx	xx	xx	xx	xx
USA (Atlanta)	xx	xx	xx	xx	xx
USA (California)	1744.82	130.76	654.92	2399.74	0.06
USA (Des Moines)	xx	xx	xx	xx	xx
USA (Denver)	xx	xx	xx	xx	xx
USA (Honolulu)	xx	xx	xx	xx	xx
USA (Illionois)	xx	xx	xx	xx	xx
USA (Miami)	53.59	30.96	31.15	84.74	0.02
USA (New York)	xx	xx	xx	xx	xx
USA (North Dakota)	74.26	xx	5.46	79.72	0.04
USA (Washington)	292.03	xx	20.70	312.73	0.06
USA (Wisconsin)	xx	xx	xx	xx	xx
Total for Food Group	**2555.89**	**237.64**	**960.83**	**3579.05**	**0.56**

TABLE A6. 2 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF FRUITS IMPORTED TO CANADA BY COUNTRY

Fruits				
Country of Origin	Production	Transport Emissions	Total Emissions	C-Tariff per $CAD HS (
	kt-CO2e	kt-CO2e	kt-CO2e	$CAD
Australia	xx	xx	xx	
Argentina	163.29	19.91	183.20	0.17
Brasil	17.49	0.99	18.48	0.07
Chile	580.22	92.40	672.61	0.07
China	251.53	19.92	271.46	0.15
Colombia	503.08	17.04	520.12	0.16
Costa Rica	695.79	51.68	747.47	0.12
Denmark	xx	xx	xx	xx
Ecuador	330.67	46.84	377.50	0.17
France	xx	xx	xx	xx
Germany	xx	xx	xx	xx
Greece	xx	xx	xx	xx
Guatemala	433.97	29.64	463.62	0.17
Honduras	xx	xx	xx	xx
India	xx	xx	xx	xx
Italy	21.50	1.41	22.91	0.07
Jamaica	xx	xx	xx	xx
Mexico	479.86	103.02	582.88	0.10
Morocco	312.94	10.01	322.95	0.12
Netherlands	xx	xx	xx	xx
New Zealand	106.87	79.02	1.97	0.00
Norway	xx	xx	xx	xx
Other Countries	654.76	20.19	674.95	N/A
Peru	10.45	1.55	12.00	0.07
Philippines	xx	xx	xx	xx
South Africa	186.60	16.34	202.94	0.13
South Korea	xx	xx	xx	xx
Spain	64.97	0.91	65.88	0.12
Switzerland	xx	xx	xx	xx
Thailand	11.25	1.30	12.54	0.07
Turkmenistan	xx	xx	xx	xx
UK	xx	xx	xx	xx
USA (Atlanta)	xx	xx	xx	xx
USA (California)	2641.97	249.70	2891.67	0.08
USA (Des Moines)	xx	xx	xx	xx
USA (Denver)	xx	xx	xx	xx
USA (Honolulu)	55.06	1.94	57.01	0.07
USA (Illionois)	xx	xx	xx	xx
USA (Miami)	xx	xx	xx	xx
USA (New York)	xx	xx	xx	xx
USA (North Dakota)	xx	xx	xx	xx
USA (Washington)	xx	xx	xx	xx
USA (Wisconsin)	xx	xx	xx	xx
	7522.27	763.81	8102.15	1.90

TABLE A6. 3 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF EGGS IMPORTED TO CANADA BY COUNTRY

Eggs				
Country of Origin	Production Emissions	Transport Emissions	Total Emissions	C-Tariff per $CAD HS
	kt-CO2e	*kt-CO2e*	*kt-CO2e*	*$CAD*
Australia	xx	xx	xx	xx
Argentina	xx	xx	xx	xx
Brasil	xx	xx	xx	xx
Chile	xx	xx	xx	xx
China	2.80	0.24	3.04	0.04
Colombia	xx	xx	xx	xx
Costa Rica	xx	xx	xx	xx
Denmark	xx	xx	xx	xx
Ecuador	xx	xx	xx	xx
France	xx	xx	xx	xx
Germany	xx	xx	xx	xx
Greece	xx	xx	xx	xx
Guatemala	xx	xx	xx	xx
Honduras	xx	xx	xx	xx
India	xx	xx	xx	xx
Italy	xx	xx	xx	xx
Jamaica	xx	xx	xx	xx
Mexico	xx	xx	xx	xx
Morocco	xx	xx	xx	xx
Netherlands	xx	xx	xx	xx
New Zealand	xx	xx	xx	xx
Norway	xx	xx	xx	xx
Other Countries	0.38	0.01	0.39	NA
Peru	xx	xx	xx	xx
Philippines	xx	xx	xx	xx
South Africa	xx	xx	xx	xx
South Korea	xx	xx	xx	xx
Spain	xx	xx	xx	xx
Switerland	xx	xx	xx	xx
Thailand	xx	xx	xx	xx
Turkmenistan	xx	xx	xx	xx
UK	xx	xx	xx	xx
USA (Atlanta)	xx	xx	xx	xx
USA (California)	xx	xx	xx	xx
USA (Des Moines)	xx	xx	xx	xx
USA (Denver)	xx	xx	xx	xx
USA (Honolulu)	xx	xx	xx	xx
USA (Illionois)	xx	xx	xx	xx
USA (Miami)	78.79	11.84	90.63	0.04
USA (New York)	xx	xx	xx	xx
USA (North Dakota)	xx	xx	xx	xx
USA (Washington)	xx	xx	xx	xx
USA (Wisconsin)	xx	xx	xx	xx
	81.97	12.09	94.06	0.08

TABLE A6. 4 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF POULTRY IMPORTED TO CANADA BY COUNTRY

Poultry				
Country of Origin	Production Emissions	Transport Emissions	Total Emissions	C-Tariff per $CAD HS
	kt-CO2e	kt-CO2e	kt-CO2e	$CAD
Australia	xx	xx	xx	xx
Argentina	xx	xx	xx	xx
Brasil	0.02	0.01	0.02	0.0050
Chile	xx	xx	xx	xx
China	xx	xx	xx	xx
Colombia	xx	xx	xx	xx
Costa Rica	xx	xx	xx	xx
Denmark	xx	xx	xx	xx
Ecuador	xx	xx	xx	xx
France	xx	xx	xx	xx
Germany	xx	xx	xx	xx
Greece	xx	xx	xx	xx
Guatemala	xx	xx	xx	xx
Honduras	xx	xx	xx	xx
India	xx	xx	xx	xx
Italy	xx	xx	xx	xx
Jamaica	xx	xx	xx	xx
Mexico	xx	xx	xx	xx
Morocco	xx	xx	xx	xx
Netherlands	xx	xx	xx	xx
New Zealand	xx	xx	xx	xx
Norway	xx	xx	xx	xx
Other Countries	0.00	0.00	0.00	0
Peru	xx	xx	xx	xx
Philippines	xx	xx	xx	xx
South Africa	xx	xx	xx	xx
South Korea	xx	xx	xx	xx
Spain	xx	xx	xx	xx
Switerland	xx	xx	xx	xx
Thailand	xx	xx	xx	xx
Turkmenistan	xx	xx	xx	xx
UK	xx	xx	xx	xx
USA (Atlanta)	25.52	16.26	41.78	0.01
USA (California)	xx	xx	xx	xx
USA (Des Moines)	xx	xx	xx	xx
USA (Denver)	xx	xx	xx	xx
USA (Honolulu)	xx	xx	xx	xx
USA (Illionois)	xx	xx	xx	xx
USA (Miami)	xx	xx	xx	xx
USA (New York)	xx	xx	xx	xx
USA (North Dakota)	xx	xx	xx	xx
USA (Washington)	xx	xx	xx	xx
USA (Wisconsin)	xx	xx	xx	xx
	25.54	16.26	41.80	0.01

TABLE A6. 5 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF BEEF IMPORTED TO CANADA BY COUNTRY

Beef				
Contry of Origin	Production Emissions	Transport Emissions	Total Emissions	C-Tariff per $CAD HS
	kt-CO2e	*kt-CO2e*	*kt-CO2e*	*$CAD*
Australia	39.64	0.85	40.49	0.07
Argentina	xx	xx	xx	xx
Brasil	xx	xx	xx	xx
Chile	xx	xx	xx	xx
China	xx	xx	xx	xx
Colombia	xx	xx	xx	xx
Costa Rica	xx	xx	xx	xx
Denmark	xx	xx	xx	xx
Ecuador	xx	xx	xx	xx
France	xx	xx	xx	xx
Germany	xx	xx	xx	xx
Greece	xx	xx	xx	xx
Guatemala	xx	xx	xx	xx
Honduras	xx	xx	xx	xx
India	xx	xx	xx	xx
Italy	xx	xx	xx	xx
Jamaica	xx	xx	xx	xx
Mexico	xx	xx	xx	xx
Morocco	xx	xx	xx	xx
Netherlands	xx	xx	xx	xx
New Zealand	22.39	0.39	22.78	0.07
Norway	xx	xx	xx	xx
Other Countries	26.92	0.16	27.08	NA
Peru	xx	xx	xx	xx
Philippines	xx	xx	xx	xx
South Africa	xx	xx	xx	xx
South Korea	xx	xx	xx	xx
Spain	xx	xx	xx	xx
Switzerland	xx	xx	xx	xx
Thailand	xx	xx	xx	xx
Turkmenistan	xx	xx	xx	xx
UK	xx	xx	xx	xx
USA (Atlanta)	xx	xx	xx	xx
USA (California)	xx	xx	xx	xx
USA (Des Moines)	xx	xx	xx	xx
USA (Denver)	893.28	14.61	907.88	0.07
USA (Honolulu)	xx	xx	xx	xx
USA (Illionois)	xx	xx	xx	xx
USA (Miami)	xx	xx	xx	xx
USA (New York)	xx	xx	xx	xx
USA (North Dakota)	xx	xx	xx	xx
USA (Washington)	xx	xx	xx	xx
USA (Wisconsin)	xx	xx	xx	xx
	982.23	16.00	998.24	0.21

TABLE A6. 6 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF PIG IMPORTED TO CANADA BY COUNTRY

Pig				
Country of Origin	Production Emissions	Transport Emissions	Total Emissions	C-Tariff per $CAD HS
	kt-CO2e	*kt-CO2e*	*kt-CO2e*	*$CAD*
Australia	xx	xx	xx	xx
Argentina	xx	xx	xx	xx
Brasil	xx	xx	xx	xx
Chile	xx	xx	xx	xx
China	xx	xx	xx	xx
Colombia	xx	xx	xx	xx
Costa Rica	xx	xx	xx	xx
Denmark	xx	xx	xx	xx
Ecuador	xx	xx	xx	xx
France	xx	xx	xx	xx
Germany	xx	xx	xx	xx
Greece	xx	xx	xx	xx
Guatemala	xx	xx	xx	xx
Honduras	xx	xx	xx	xx
India	xx	xx	xx	xx
Italy	xx	xx	xx	xx
Jamaica	xx	xx	xx	xx
Mexico	xx	xx	xx	xx
Morocco	xx	xx	xx	xx
Netherlands	xx	xx	xx	xx
New Zealand	xx	xx	xx	xx
Norway	xx	xx	xx	xx
Other Countries	0.14	0.00	0.15	NA
Peru	xx	xx	xx	xx
Philippines	xx	xx	xx	xx
South Africa	xx	xx	xx	xx
South Korea	xx	xx	xx	xx
Spain	xx	xx	xx	xx
Switzerland	xx	xx	xx	xx
Thailand	xx	xx	xx	xx
Turkmenistan	xx	xx	xx	xx
UK	xx	xx	xx	xx
USA (Atlanta)	xx	xx	xx	xx
USA (California)	xx	xx	xx	xx
USA (Des Moines)	1004.31	17.30	1021.61	0.09
USA (Denver)	xx	xx	xx	xx
USA (Honolulu)	xx	xx	xx	xx
USA (Illionois)	xx	xx	xx	xx
USA (Miami)	xx	xx	xx	xx
USA (New York)	xx	xx	xx	xx
USA (North Dakota)	xx	xx	xx	xx
USA (Washington)	xx	xx	xx	xx
USA (Wisconsin)	xx	xx	xx	xx
	1004.46	17.30	1021.76	0.09

TABLE A6. 7 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF LAMB AND SHEEP IMPORTED TO CANADA BY COUNTRY

Lamb, Sheep				
Country of Origin	Production Emissions	Transport Emissions	Total Emissions	C-Tariff per $CAD HS
	kt-CO2e	*kt-CO2e*	*kt-CO2e*	*$CAD*
Australia	24.35	0.87	25.22	0.03
Argentina	xx	xx	xx	xx
Brasil	xx	xx	xx	xx
Chile	xx	xx	xx	xx
China	xx	xx	xx	xx
Colombia	xx	xx	xx	xx
Costa Rica	xx	xx	xx	xx
Denmark	xx	xx	xx	xx
Ecuador	xx	xx	xx	xx
France	xx	xx	xx	xx
Germany	xx	xx	xx	xx
Greece	xx	xx	xx	xx
Guatemala	xx	xx	xx	xx
Honduras	xx	xx	xx	xx
India	xx	xx	xx	xx
Italy	xx	xx	xx	xx
Jamaica	xx	xx	xx	xx
Mexico	xx	xx	xx	xx
Morocco	xx	xx	xx	xx
Netherlands	xx	xx	xx	xx
New Zealand	24.20	0.69	24.89	0.03
Norway	xx	xx	xx	xx
Other Countries	0.02	0.00	0.02	NA
Peru	xx	xx	xx	xx
Philippines	xx	xx	xx	xx
South Africa	xx	xx	xx	xx
South Korea	xx	xx	xx	xx
Spain	xx	xx	xx	xx
Switzerland	xx	xx	xx	xx
Thailand	xx	xx	xx	xx
Turkmenistan	xx	xx	xx	xx
UK	xx	xx	xx	xx
USA (Atlanta)	xx	xx	xx	xx
USA (California)	xx	xx	xx	xx
USA (Des Moines)	0.83	0.02	0.84	0.03
USA (Denver)	xx	xx	xx	xx
USA (Honolulu)	xx	xx	xx	xx
USA (Illionois)	xx	xx	xx	xx
USA (Miami)	xx	xx	xx	xx
USA (New York)	xx	xx	xx	xx
USA (North Dakota	xx	xx	xx	xx
USA (Washington)	xx	xx	xx	xx
USA (Wisconsin)	xx	xx	xx	xx
	49.39	1.58	50.97	0.09

TABLE A6. 8 GHG EMISSIONS AND C-TARIFF ESTIMATES FOR THE PRODUCTION AND TRANSPORT OF COARSE GRAINS IMPORTED TO CANADA BY COUNTRY

Coarse Grains				
Country of Origin	Production Emissions	Transport Emissions	Total Emissions	C-Tariff per $CAD HS
	kt-CO2e	*kt-CO2e*	*kt-CO2e*	*$CAD*
Australia	xx	xx	xx	xx
Argentina	xx	xx	xx	xx
Brasil	xx	xx	xx	xx
Chile	xx	xx	xx	xx
China	34.10	2.47	36.57	0.15
Colombia	xx	xx	xx	xx
Costa Rica	xx	xx	xx	xx
Denmark	xx	xx	xx	xx
Ecuador	xx	xx	xx	xx
France	35.31	1.40	36.72	0.14
Germany	19.86	0.92	20.78	0.15
Greece	xx	xx	xx	xx
Guatemala	xx	xx	xx	xx
Honduras	xx	xx	xx	xx
India	xx	xx	xx	xx
Italy	xx	xx	xx	xx
Jamaica	xx	xx	xx	xx
Mexico	xx	xx	xx	xx
Morocco	xx	xx	xx	xx
Netherlands	xx	xx	xx	xx
New Zealand	xx	xx	xx	xx
Norway	xx	xx	xx	xx
Other Countries	80.54	2.42	82.96	NA
Peru	xx	xx	xx	xx
Philippines	xx	xx	xx	xx
South Africa	xx	xx	xx	xx
South Korea	xx	xx	xx	xx
Spain	xx	xx	xx	xx
Switzerland	xx	xx	xx	xx
Thailand	xx	xx	xx	xx
Turkmenistan	xx	xx	xx	xx
UK	xx	xx	xx	xx
USA (Atlanta)	xx	xx	xx	xx
USA (California)	xx	xx	xx	xx
USA (Des Moines)	xx	xx	xx	xx
USA (Denver)	xx	xx	xx	xx
USA (Honolulu)	xx	xx	xx	xx
USA (Illionois)	727.77	41.15	768.92	0.15
USA (Miami)	xx	xx	xx	xx
USA (New York)	xx	xx	xx	xx
USA (North Dakota)	xx	xx	xx	xx
USA (Washington)	xx	xx	xx	xx
USA (Wisconsin)	xx	xx	xx	xx
	897.59	48.36	945.95	xx

TABLE A6. 9 GHG EMISSIONS FROM THE PRODUCTION AND TRANSPORT OF WHOLE FOOD CATEGORIES IMPORTED TO CANADA BY COUNTRY

Total GHG Emissions from all Food Categories Imported to Canada				
Country of Origin	Production Emissions (Field)	Production Emissions (Greenhouse)	Transport Emissions	Total Emissions
	kt-CO2e	kt-CO2e	kt-CO2e	kt-CO2e
Australia	66.23	xx	2.04	68.27
Argentina	164.25	xx	20.06	184.31
Brasil	0.02	xx	0.01	0.02
Chile	580.22	xx	92.40	672.61
China	309.96	xx	28.72	338.68
Colombia	503.08	xx	17.04	520.12
Costa Rica	699.91	xx	52.85	752.76
Denmark	3.87	xx	0.06	3.93
Ecuador	330.67	xx	46.84	377.50
France	54.20	xx	2.38	56.58
Germany	21.91	xx	1.01	22.92
Greece	2.05	xx	0.11	2.16
Guatemala	433.97	xx	29.64	463.62
Honduras	1.36	0.63	0.38	1.74
India	4.13	xx	1.98	6.11
Italy	17.32	xx	1.44	18.76
Jamaica	4.02	xx	1.03	5.06
Mexico	730.59	55.80	316.32	1046.92
Morocco	312.94	xx	10.01	322.95
Netherlands	19.95	16.58	2.80	22.76
New Zealand	46.59	xx	1.08	47.67
Norway	5.16	xx	0.28	5.44
Other Countries	848.79	19.47	32.18	880.97
Peru	15.51	xx	8.71	24.22
Philippines	2.41	xx	0.80	3.21
South Africa	186.60	xx	16.34	202.94
South Korea	0.35	xx	0.21	0.56
Spain	65.34	6.52	3.15	75.02
Switzerland	7.10	xx	0.37	7.47
Thailand	2.21	xx	0.97	3.18
Turkmenistan	??	??	??	??
UK	3.62	xx	0.19	3.82
USA (Atlanta)	25.52	xx	16.26	41.78
USA (California)	4386.79	130.76	904.62	5291.41
USA (Des Moines)	1005.14	xx	17.31	1022.45
USA (Denver)	893.28	xx	14.61	907.88
USA (Honolulu)	55.06	xx	1.94	57.01
USA (Illionois)	727.77	xx	41.15	768.92
USA (Miami)	132.38	30.96	42.98	175.37
USA (New York)	51.43	xx	2.11	53.53
USA (North Dakota	74.26	xx	5.46	79.72
USA (Washington)	292.03	xx	20.70	312.73
USA (Wisconsin)	72.83	xx	5.80	78.63
	13160.84	254.21	1764.34	14931.70