At the Table
with the Seattle-King County
Acting Food Policy Council
Issue Paper No. 3
January2008

Greenhouse Gas Emissions and the Local Food System

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At the Table with the Acting Food Policy Council: Greenhouse Gas Emissions and the Local Food System

Summary

Most of us know that climate change is associated with human activity, especially the production and use of energy. A significant portion of this stems from a globalized food system. To better understand the climate impact of food in Washington, researchers at the University of Washington assessed and compared greenhouse gas emissions of locally and globally sourced food items. Using the internationally accepted Life Cycle Assessment method, because of its capacity to describe climate impacts in detail, we compared four typical Washington food items sourced regionally and globally. The more locally produced products had less climate impact in every case, though the reasons vary and in this case depended largely on Washington's high agricultural productivity.

This highly specific data is not easily generalized to policy. However, the findings point to the importance of policies that will help strengthen local community food security and agricultural networks as well as walkable, high-quality, livable neighborhoods.

Policy options to reduce the impact the food system has on climate change include:

- Purchase more-locally grown products and develop policies to encourage individuals and institutions to do so.
- Protect local agriculture and support an infrastructure that fosters productivity and sustainability.
- Implement farm-to-institution connections so Washington schools, municipalities, businesses, and emergency food providers are able to easily purchase Washington products.
- Design neighborhoods to include high-quality grocery stores to meet residents' needs, thus reducing the need for driving.
- Educate consumers to ask questions and make informed decisions about their food supply.

Introduction

Global climate change is affecting the Puget Sound region. Researchers from University of Washington's Climate Impacts Group found that winter temperatures in the region have warmed by an average of 2.7 degrees Fahrenheit since 1950, and this heating trend is predicted to bring wetter winters and warmer, drier summers. While experts agree that the recent rise in global temperatures is being driven by human activity, the discussion of what we can do about it has only just begun. World-wide, energy production, industry and motorized transportation are the biggest generators of greenhouse gases (GHGs). In King County, the major source of GHGs is transportation, which is reflected in the strategies that have been proposed by city and county government to slow climate change. Recommendations from the City of Seattle's Climate Report from the Green Ribbon Commission[1] and King County's 2006 Climate Plan[2] emphasize cleaner

[1] http://www.seattle.gov/climate/report.htm

transportation, including improvements in vehicle fuel efficiency and enhancing alternative transportation options. The County's Climate Plan also recognizes the impact of the food system on GHG production. One of the biggest energy using systems in the United States, and thus a major emitter of GHGs, is the system that produces and delivers the food we eat. Therefore, how our food system functions has direct impact on GHG emissions and climate change.

What Is the Food System?

The food system is a concept that describes the people, institutions, and processes that produce and deliver food to consumers including: the production, processing, distribution, wholesaling, retailing, consumption, and disposal of food (Kaufman 2004). Every stage is reliant upon energy, likely in the form of fossil fuel. In the United States, the food system is responsible for almost one fifth of the national energy consumption (Pimentel and Pimentel 1996). Early efforts to assess the climate impact of the food system focused almost exclusively on distribution, specifically transportation of food from the site of production to the consumer. The concept of "food miles" was developed to describe the distances over which food was shipped before it was consumed.

While the concept provided an early and important standardized means of measurement that was relatively easy to understand, it had two key limitations. First, it treated all distances equally regardless of the mode of transportation, for example, miles traveled by train versus freight plane. Second, and perhaps more importantly, it did not include the climate impact of any of the other aspects of the food system. Food has a broader impact on the environment, far beyond transportation. For instance, production and processing of food accounts for nearly one-half of the energy used in the food system (See Table 1).[3]

Table 1. Energy use in the U.S. food system

Food System Process	Sector Average (percent)
Production	17.5
Processing	28.1
Transportation	11
Restaurants	15.8
Home preparation	25

Adapted from (Pirog, Pelt et al. 2001)

From the Field to the Plate

A more complete analysis of the impact of the food system on climate change should include the life-cycle of food—from the field to the plate. This paper describes a research project designed to demonstrate the use of one method- a *Life Cycle Assessment*—in studying the Seattle food system. The approach taken here is to examine the energy use and GHG emissions associated with a simple meal composed of only four foods: salmon, potatoes, asparagus and apples. While all four of these foods are classic Northwest products, they are also globally produced, distributed, and imported into our region. With this in mind, two meals composed of the same four foods were compared: one solely from Northwest sources and one assembled from the global food distribution system.

In this analysis, the locally-produced products were responsible for less GHGs than the imported products, for a variety of reasons.

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[2] http://www.seattle.gov/climate/docs/SeaCAP_plan.pdf

[3] Pirog, R., T. V. Pelt, et al. (2001). Food, Fuel and Freeways: An Iowa Perspective on How Far Food Travels, Fuel Usage, and Greenhouse Gas Emissions. Ames, Iowa State University, Leopold Center for Sustainable Agriculture.

After a description of the methods and assumptions used in this study, the findings are presented in a plate-to-plate comparison. Lastly, we suggest some policy measures based on our findings to reduce the Seattle's climate impacts through the food system.

Methods

Quantifying the impact of the entire food system on climate change would require both extensive assumptions and massive primary data gathering. Instead, the study was focused on comparing the greenhouse gas impact of two similar plates of food by completing a Life Cycle Assessment (LCA) for four items. The LCA is an internationally standardized method of assessing environmental impacts, defined as the "compilation and evaluation of the inputs, outputs and the environmental impacts of a product system throughout its life cycle" (International Standards Organization 1997). An LCA allows identification of the environmental impacts of an item from the acquisition of raw materials, through production, use, and disposal.

The scope was defined in conjunction with the members of Seattle's Food System Enhancement Project (UW-Seattle partnership) in conjunction with the city's Interdepartmental Team on Food Systems and members of the Office of Sustainability and Environment. In this study the LCA framework was used to assess the GHG effects of the cultivation of our selected food items and the effects of transporting them to Seattle. The LCA tracks the food from initial production and harvest through delivery for purchase.

The two plates included the same food items, but the foods on each plate are sourced differently. One plate consisted of items that are produced within Washington State and then transported to Seattle, while the other plate included items that are produced internationally or out of state and then shipped to Seattle. To further explore the GHG impacts of specific farming techniques, organic farming methods were also considered.

Each plate includes four items: apple (0.5 pound), asparagus (0.25 pound), potato (0.5 pound), and salmon fillet (0.5 pound). These items were selected to represent a typical wholesome meal easily available in Seattle. For the locally sourced plate of food, the apple and asparagus came from Yakima, Washington, our state's leading apple and asparagus producing county.[4] The potato came from Benton County, which produces the most potatoes in the nation.[5] The salmon was wild-caught Copper River salmon from south-central Alaska.

For the imported plate of food, the items came from the highest producing region in the country from which the United States imports the most of the specific item. The apple was from Hawkes Bay, New Zealand,[6] the asparagus from Ica, Peru,[7] and the potato from Blackfoot, Idaho because

[4] Anonymous. (2002). "Apples in Washington State- General Production Information." Retrieved February 24, 2007, from http://www.ncw.wsu.edu/treefruit/aplcrop.htm.

5 United States Department of Agriculture (2006). Washington's Potato Estimating Program. N. A. S. S. US Department of Agriculture, Washington Field Office.

6 Patterson, A. (2006). New Zealand Fresh Deciduous Fruit Annual 2006. F. A. S. US Department of Agriculture, Global Agriculture Information Network. GAIN Report Number NZ6026, December 19, 2006.

the US does not import many potatoes and Bingham County, Idaho is the largest potato producing county outside of Washington State.[8] The imported salmon was farm-raised in Norway.[9]

Results from this study should be considered as a benchmark for examining the greenhouse gas impact of cultivating and transporting specific items of food into the city of Seattle. The manner in which food is transported into the city is a complex web of options and in this study, direct shipping routes were selected. However, our assumptions apply to both plates equally, so the differences between these plates are real and significant.

Data Sources

This study used various types of data to estimate energy use and GHG emission caused by food production and distribution. Data were in the form of typical agricultural practices including chemical and fuel use at farms Data were collected from databases, published reports, and other sources. Information was gathered from the United States Department of Agriculture, published journal articles, websites, the United States Environmental Protection Agency, and from the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) database.

This study did not address the greenhouse gas emissions caused by the manufacture of the vehicles, buildings, roads, or any infrastructure. Also excluded were the emissions related to wholesaling, retailing, packaging materials, the consumer's food preparation, or waste treatment. Furthermore, greenhouse gases were the only environmental impact examined in this study. Other environmental impacts associated with farming, such as water use, potential other energy use, runoff of farm effluent, land use, or human labor are beyond its scope.

Impact Assessment – Global Warming Potential

The three main greenhouse gases (carbon dioxide, CO2; methane, CH4; and nitrous oxide N2O) were quantified in this study. However, because these three gases have different climate impacts they were converted to a common scale so that they could be compared. Each of these gases was converted into grams of carbon dioxide equivalents using the standards established by the Intergovernmental Panel on Climate Change. The scaling factor for methane is 23, and the scaling factor for nitrous oxide is 296. This means that one gram of methane is equivalent to 23 grams of carbon dioxide, and 1 gram of nitrous oxide is equivalent to 296 grams of carbon dioxide.

Greenhouse gas emissions were estimated for the various steps in production and distribution of each food item. For the present analysis, GHG emissions were categorized as originating from three sources: *Chemical Production, Fuel Used at Farm/Boat*, and *Fuel Used in Transportation*. Chemical Production includes the production and delivery of fertilizers (nitrogen, phosphate, and potash), herbicides, and insecticides, as well as the emissions from the fields that are emitted

7 United States Department of Agriculture (2005). World Asparagus Situation and Outlook. F. A. S. US Department of Agriculture, World Horticultural Trade & U.S. Export Opportunities.

8 USDA 2006, Ibid

9 Harvey, D. J. (2006). Aquaculture Outlook. E. R. S. United States Department of Agriculture. LDP-AQS-24, October 5, 2006.

after these chemicals are applied. Fuel Used at Farm/Boat includes the burning of diesel, gasoline, and/or propane at the farm to perform farm activities, or on the fishing boat for fishing activities. The specific activities modeled for each farm can be found in the Seattle Food System Enhancement Project report (2007) from which this paper was derived. Included in this category are the emissions associated with extracting the fossil fuels, refining them, delivering them to the gas station pump or to the point-of-use at the farm/boat. Fuel Used in Transportation includes the burning of gasoline, diesel, non-road diesel (for rail transport), and/or bunker fuel (for container ship transport) to deliver the food to Seattle. Included in this category are the emissions attributable to extracting the fossil fuels, refining them, delivering them to the gas station pump or to the point-of-use for the transportation vehicles.

Results

GHG Emissions from the Two Plates of Food

By item, the salmon dominates the analysis. Salmon fishing and farming is the major source of GHG emissions for both plates due to necessary fuel use, and is responsible for emitting 2,013 grams of CO2 equivalent for the local plate (96% of the total, Figure 1) and 2,927 grams for the imported (95% of the total, Figure 1). The total emissions due to the food of the local plate were 2,102 grams; for the imported plate they were 3,083 grams. Examining the other items, for the locally sourced plate the apple production emits 33 grams, that of the asparagus 40 grams, and the potato 16 grams on the local plate, and for the imported plate 70, 46, and 40 grams respectively (Figure 1).

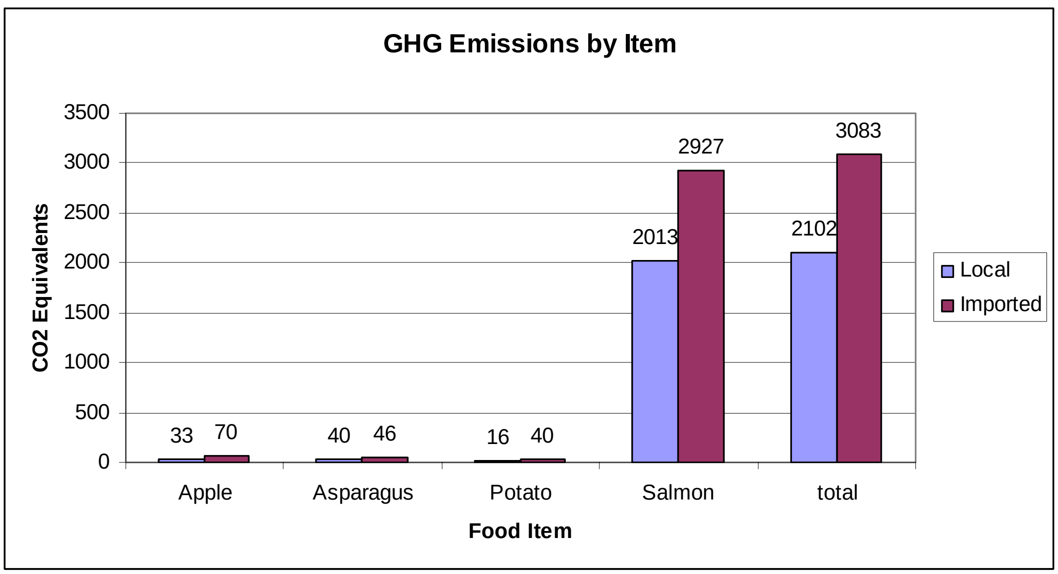


Figure 1. GHG Emissions by Item for Locally Produced and Imported Products.

Examining emissions by source activity, the burning of fuel on the fishing boat and farm is the biggest emitter of greenhouse gases for both plates—due to the fuel consumption for salmon fishing and farming (Figure 2). Transportation was much less significant: for the local plate, transportation adds an additional 35 grams of CO2 equivalent (Figure 2) and for the imported food transportation accounted for 210 grams. Transportation differences become much more apparent when the salmon is factored out (Figure 3) and we compare agricultural products—apples to apples, as it were.

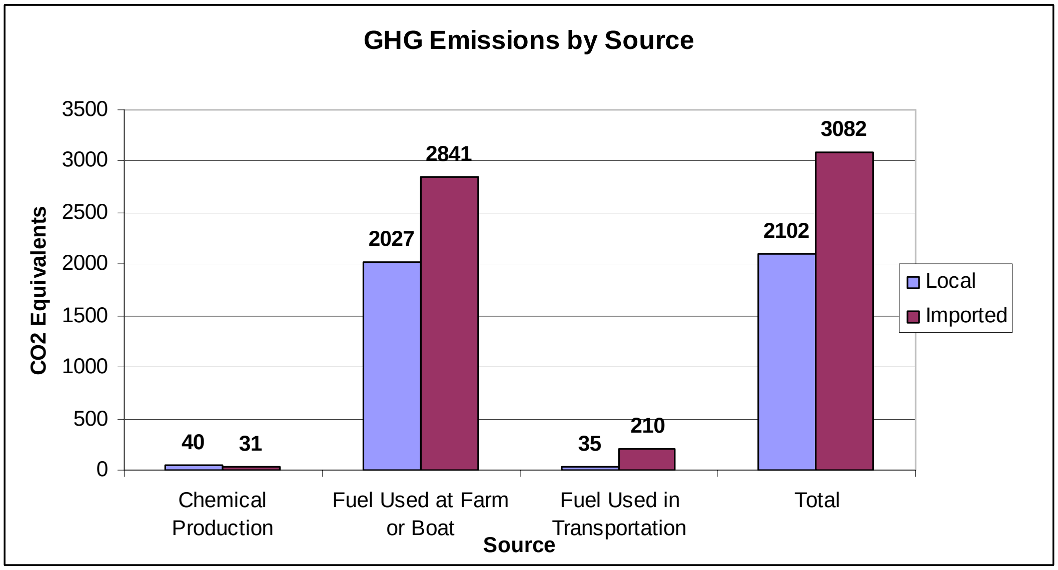


Figure 2. GHG Emissions by Source for Locally Produced and Imported Products.

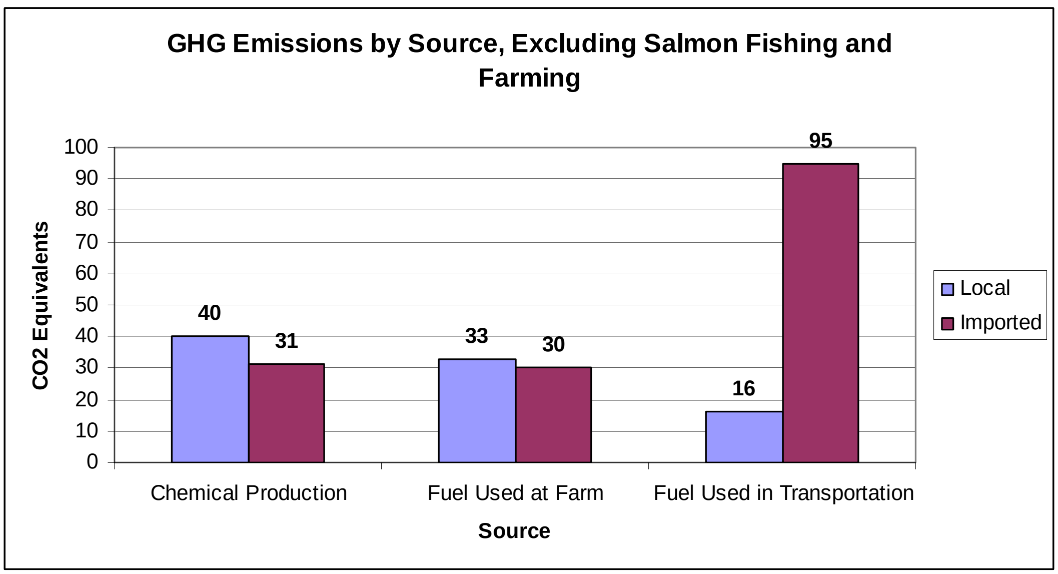


Figure 3. GHG Emissions by Source, Excluding Salmon Fishing and Farming

Comparison of Global Warming Potential of Each Plate

The total greenhouse gas emissions for the local plate are about 33% lower than the total emissions for the imported plate. However, the majority of the total savings comes from the wild-caught salmon. Fuel used on the fishing boats to catch the wild salmon and the emissions from producing, delivering, and administering the fish feed at the fish farm in Norway are between 80-90% of the total emissions for the salmon, and the salmon are over 95% of the emissions for each plate. Thus, the results for Fuel Used at the Farm/Boat are heavily influenced by the salmon (Figure 2).

As Figures 1 and 3 show, however, the agricultural items tell a slightly different story when comparing the local and imported items. For example, the local apple and local potato emit less than half the emissions than the imported ones, while the local asparagus shows only a 20% benefit over the imported asparagus. To demonstrate the variability in product impacts, below we compare the analysis for apples and potatoes, the two products for which the data are strongest.

Apple Life Cycle Assessment Analysis
Production methods, yields, and shipping technologies differentiate the individual products with regard to their global warming potential. This section summarizes the LCA findings by clustering the emissions by product by source for apples and potatoes, which demonstrates differences due mainly to production yield and transportation.

The production of a conventionally grown apple from Washington emits 33 grams of CO2 equivalent. The largest part of this, 19 grams, comes from on-farm fuel use (Figure 4). The imported apple production emits 70 grams of CO2 equivalent, the largest portion being from fuel used in transportation, 40 grams (Figure 5). Production of the organic Washington apple yielded the least GHG emissions, but it was close to the conventional Washington apple emissions, at 29 grams of CO2 equivalent (Figures 6 and 7). This small difference is due to a slightly lower yield and the assumption of a smaller truck for transport, which are less efficient.

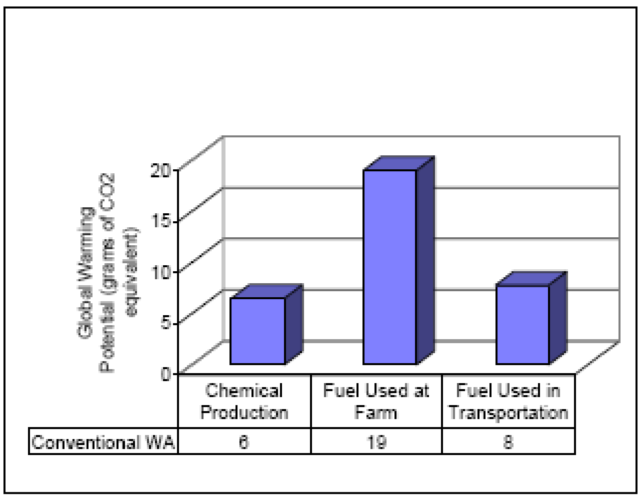


Figure 4. Sources of GHG Emissions from Cultivating and Transporting a Conventional Apple from Yakima to Seattle (via Wenatchee).

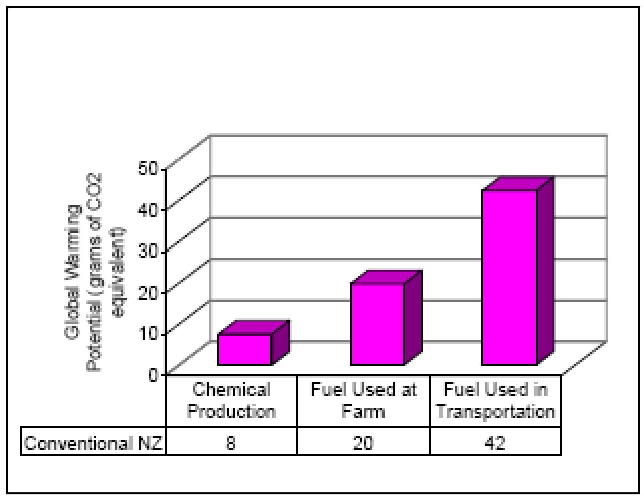


Figure 5. Sources of GHG Emissions from Cultivating and Transporting a Conventional Apple from Hawkes Bay, New Zealand to Seattle (via Auckland).

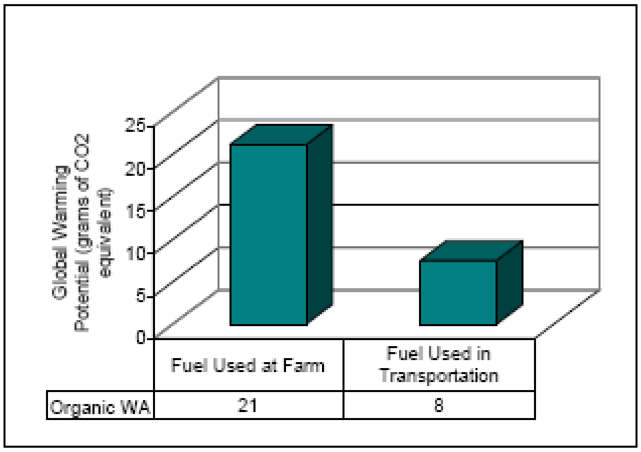


Figure 6. Sources of GHG Emissions from Cultivating and Transporting an Organic Apple from Yakima to Seattle.

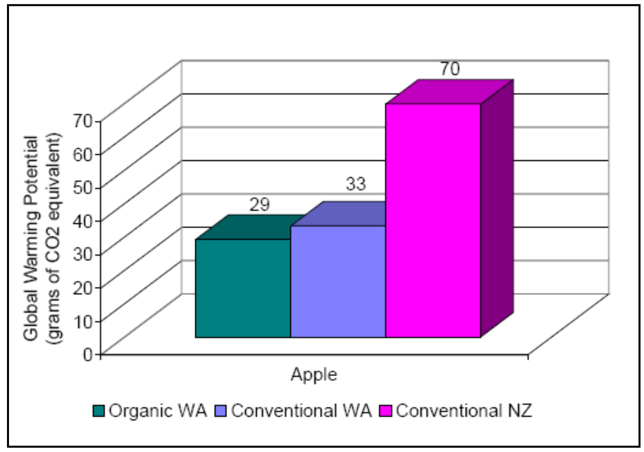


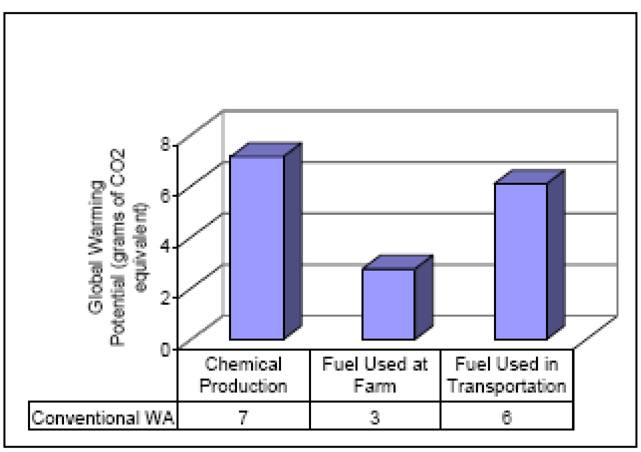
Figure 7. Total Emissions for All Three Apple Sources.

Comparing all three production sources on the same global warming potential scale (Figure 7), the relative effects of location, yield, production, and transportation on GHG emissions are evident. The domestic versus imported difference is largest; domestically, organic production has a slightly lower global warming potential than conventional.

Potato Life Cycle Assessment Analysis

Washington and Idaho potatoes tell a somewhat surprising story. In Washington, the production of conventionally grown potatoes emits 16 grams of CO_2 equivalent. This comes almost equally from chemical production (7 grams) and fuel for transportation (6 grams), and some fuel used on-farm (3 grams) (Figure 8). The imported (Idaho) potato's production emits 40 grams. The largest part of that, 23 grams, is due to transportation (Figure 9).

The difference between the two sources is largely due to a higher yield in Washington than Idaho, and fuel for transportation. The production of the Washington *organic* potato emits 13 grams (Figure 10), the reduction of emissions from chemical production being mostly absorbed by the additional fuel usage due to using less efficient small trucks (an assumption) for transportation.



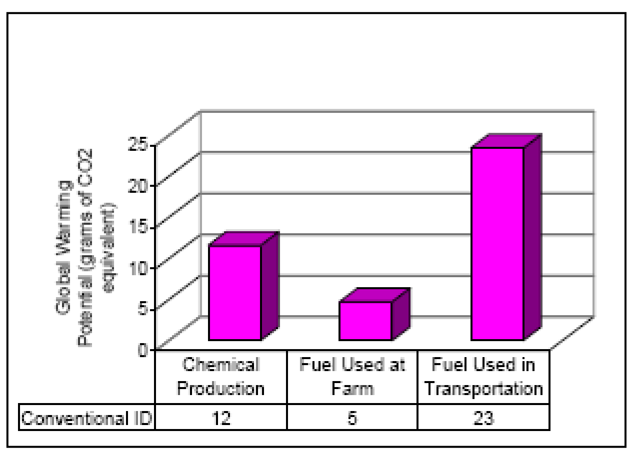


Figure 8. Sources of GHG Emissions from Cultivating and Transporting a Conventional Potato from Prosser, WA to Seattle, WA.

Figure 9. Sources of GHG Emissions from Cultivating and Transporting a Conventional Potato from Blackfoot, ID to Seattle, WA.

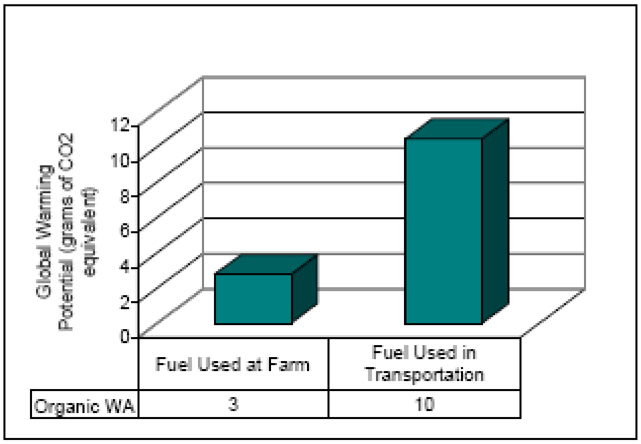


Figure 10. Sources of GHG Emissions from Cultivating and Transporting an Organic Potato from Prosser, WA to Seattle, WA.

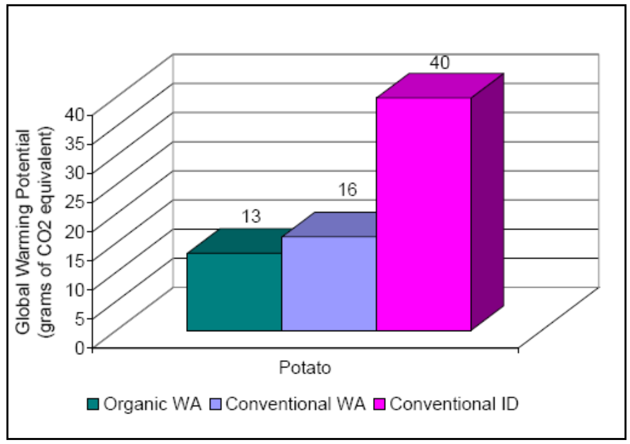


Figure 11. Total Emissions for All Three Potatoes.

Taking all three sources of potatoes into account, it is clear that the production of both organic and conventionally produced Washington potatoes emits less than half (one third for organic) the GHGs than their Idaho counterparts (Figure 11). The reason is twofold. First, the yield of potatoes per acre in Benton County, Washington is nearly twice that for Bingham County, Idaho. Thus, for the same amount of fuel used per acre, and nearly the same amount of fertilizers applied, the greenhouse gas emissions attributable to the Washington potato is about half of that of the Idaho potato. The potatoes in both cases are shipped by semi-truck, but the Idaho potato has nearly four times as far to travel, so the emissions from transporting the Idaho potato are nearly four times greater.

What is so surprising is that, beyond the significant production advantage that Benton County, Washington has for potatoes, the production advantage that Washington has negates the added emissions due to additional shipping, up to about 200 miles. That is, the Washington potato has less climate impact than the Idaho potato, even in much of Idaho.

So if a consumer had a single concern, minimizing or mitigating climate change, they would always buy Washington potatoes over those from Idaho (although the story likely differs in Wisconsin or other potato producing states).

Discussion and Policy Implications

The results of the LCA show that, in this Washington example, locally produced food emits less greenhouse gases for cultivation and delivery to Seattle. Two main reasons for this are that local food has a shorter distance to travel to get to the city and Washington State is a highly productive agricultural region. The results could differ in other places—these findings are not necessarily generalizable. The potato analysis gives a good example of the problems of such generalization.

The distance that food travels to get to the city is a main source of emissions for the food items studied here, but differences in harvest yields and cultivation practices can play an even larger role in the emission of greenhouse gases. Thus, the miles that food travels to get to the city are an inadequate measure of the greenhouse gas impact of food. The LCA analysis performed here shows that harvest yields can greatly affect the total greenhouse gas emissions. Again, considering the Washington potato and the Idaho potato, yields in Washington are almost twice that for Idaho, and yet a similar amount of fertilizers, herbicides, and insecticides are applied to these farms. Thus, it is important to consider every crop individually.

The present findings raise questions for further investigation. Emissions of GHG's due to fruit and vegetable production totaled 89 grams and 159 grams of CO2 equivalent for the local and imported items, respectively. In comparison, burning one gallon of gasoline in a passenger car emits 9,250 grams of CO2 equivalent. Thus, it might be the case that people driving to get their food could be a larger source of greenhouse gases than the emissions created from cultivating and delivering the food to Seattle. This might seem implausible, but the main reason for this is that commercial vehicles (semi-trucks, rail cars, container ships) are much more efficient at moving cargo than passenger cars.

The variation in findings based on detailed information about products makes it difficult to use LCA for suggesting generalizable policies—however, some relevant policy options can be derived. Many of these are consistent with developing characteristics of healthy, livable communities.

Thus, the following are suggestions for urban and metropolitan policy that can reasonably be drawn from the greenhouse gas study. Although other values might be considered—such as water use, labor practices, and nutrition — this analysis focuses only on the impact of GHG emissions.

- Purchase locally grown products and develop policies to encourage individuals and institutions to do so. In general, this should be a lower-impact choice in terms of climate change than imported food purchases. This leads to a second policy suggestion that supports the first.
- Protect local agriculture and support an infrastructure that fosters productivity and sustainability. Washington State and King County have been active in this regard, but should continue to develop further agricultural protections, including farmland preservation, tax relief, and infrastructure improvements to help the state's agricultural economy.
- Implement policies to support farm-to-institution connections, such as the Local Farms-Healthy Kids legislation (HB 2798) so Washington schools, municipalities, businesses, and emergency food providers are able to easily purchase Washington products
- Design neighborhoods to include high-quality grocery stores to meet the needs of neighborhood residents in order to reduce the need for driving.
- Educate consumers to ask questions and make informed decisions about their food supply.

These suggestions are congruent with both Seattle and King County's efforts to create walkable, livable neighborhoods; and the improvement of community food system resources (grocery stores, bodegas, community gardens, hot meal sites, food banks, etc.) will make for a higher quality of life and more resilient city and neighborhoods.

This paper is intended to provide timely, substantive data for an ongoing conversation in which hard comparisons have been lacking, and to stimulate creative thinking about how to minimize GHG emissions generated in the food system. Now is the time for new, creative ideas, such as urban financing of carbon-neutral technology to be used in agricultural regions to reduce the climate impacts of the urban area. An example of this is financing farmers' transition to on-farm biofuel use. The challenge is for everyone. The Acting Food Policy Council looks forward to working with elected officials, the business community, and thoughtful individuals to make the food system, city, county, and state, efficient and environmentally sustainable.

The benefits of supporting a local food system are many. Raising awareness about these issues is important if consumers and decision makers are to help make the changes necessary to realize such a system. The Seattle-King County Acting Food Policy Council is one group working to ensure that all residents have access to nutritious, fresh food that is produced and distributed in a just manner; and that farming, food processing and distribution flourish as part of the local economy and contribute to a healthy environment.

To find out more visit http://king.wsu.edu/foodandfarms/foodpolicycouncil.htm.