UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Empowering eaters to make climate-friendly choices: A public education initiative

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Scenario 3b:
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ABSTRACT

Agriculture and the food system are responsible for one third of carbon dioxide emissions worldwide (Meleca, 2008). However, climate change public education initiatives rarely focus on food choice as a solution to reducing human impact on climate (Neff, Chan, & Clegg, 2008). Our project aims to increase consumers' awareness of the impact of the food supply chain and personal food choices on climate change. We designed a carbon-friendly food guide with six key recommendations for reducing food-related carbon emissions. The brochure targets Vancouver residents and will be distributed at UBC's farmer's market. We have also created a website which complements the brochure and further elaborates on our recommendations, and a label to indicate which foods at the farmer's market are carbon-friendly. With the brochure, website and label, it is hoped that consumers at the UBC farm will become more conscious of the food system's contribution to climate change. Recognizing that greenhouse gas contributes to global warming and changing personal food choices can significantly decrease food system emissions.

INTRODUCTION

The University of British Columbia's Food System Project (UBCFSP) is an ongoing collaboration between UBC's Faculty of Land and Food Systems and Sustainability office. The project was created in response to recognition that our global, national and local food systems are insecure and unsustainable (Rojas et al., 2007). Since 2002, students have been researching and proposing ways to increase the sustainability of the UBC campus community.

In keeping with this goal, the Centre for Sustainable Food Systems (CSFS) at UBC Farm and the 100-Mile Diet Society are collaborating on the "Changing the Food System to Change the Climate" project. The goal of this two-year project is to highlight how sustainable agricultural techniques can be used to reduce the negative environmental effects of our food system. Five AGSC 450 student groups have been asked to research and develop three educational tools to improve Vancouverites' awareness of the impacts of food choices on climate change. The tools are a Carbon Smart Food Guide, a website to accompany the guide, and a label or sign to be displayed at the UBC Farm Markets.

This report will cover the following: an outline of the impacts of agriculture and food choices on climate change, reflections on the UBCFSP vision statement and our value assumptions, a discussion of our findings and finally, our three education materials based on our findings.

PROBLEM DEFINITION

Climate change has been identified as one of the greatest challenges facing our planet. Greenhouse gases (GHG) like carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) are recognized to be causing these changes that include increasing mean global temperatures, rising sea levels and a higher prevalence of extreme weather (FAO, 2006). Global greenhouse gas (GHG) emissions have increased by 70% since 1970 (IPCC, 2007). Total carbon dioxide emissions have increased by 40% since pre-industrial times, and anthropogenic (human-caused) emissions alone nearly doubled since 1970 (IPCC, 2007). CO_2 accounts for three quarters of anthropogenic emissions, and as such is used as the base for comparison for the global warming potential of other gases (IPCC, 2007).

The agricultural sector has the fourth highest GHG production after power production (~21%), industrial processing (~17%) and transport (~14%) (van Aardenne, Dentener, Olivier, Peters & Ganzeveld, 2000). Agriculture has been estimated to account for 8% to 13.5% of total GHG emissions (Environment Canada, 2007; FAO, 2009; van Aardenne, 2000) but including the entire food system, this number could be as high as 20-30% (Pimentel & Pimentel, 1996). This sector is a significant contributor to all three major GHG as well as ammonia and refrigerants. Food related emissions rose by 27% between 1970 and 1990; growth can be tied to urbanisation, crop intensification, technological changes and worldwide economic growth, among many other factors (IPCC, 2007; FAO 2006).

Only 50% of GHG emissions related to our food systems are from on-farm production – the other half come from transportation, processing, packaging and waste (Heller & Keoleian, 2000). Foods now travel on average 25% further than thirty years ago using more energy-intensive methods of transportation such as airfreight and trucking (FAO, 2006). Consumption of processed foods has risen dramatically since the 1950s and now accounts for 16% of the total energy used in the food system (Heller & Keoleian, 2002). A quarter of all calories produced for human consumption are thrown away, and less than 3% of food waste is composted and used as fertilizer (Heller & Keoleian, 2002). Landfilled waste contributes huge amounts of carbon dioxide and methane.

That an entire half of food system emissions come from off-farm sectors means that consumer choice can have a large effect on emission contribution. Eshel and Martin (2006) demonstrated that personal food choices contribute to GHG emissions on the same order of magnitude as individuals' transportation choices. Neff, Chan and Clegg Smith (2008) followed climate change-related articles in 16

large American newspapers and found that only 2.4% named the food system as a contributor to GHG emissions. Of these, only one-fifth discussed food systems in any detail (Neff et al., 2008). Together, these studies imply that the need for public education about making environmentally conscious food choices is both great and unmet.

To meet this need in Vancouver, the Changing the Food System to Change the Climate project is creating a carbon smart food guide to be distributed at the UBC Farm. A website will accompany the guide, and a sign will be created to identify carbon friendly products at the UBC Farm Markets. For the purposes of these education materials and this paper, we have defined a 'carbon friendly diet' as "a healthy diet that focuses on reducing carbon emissions. This includes the processes in which the food is produced, transported, processed, consumed and disposed."

VISION STATEMENT

As mentioned, our small project is one of many that contribute to the UBCFSP's vision for a sustainable food system at UBC. This vision is made up of seven guiding principles. Of these principles, our project contributes more specifically to increasing awareness among consumers - those who purchase food from the UBC farmer's market – about the effect a carbon-friendly diet can have on reducing emissions and creating a more sustainable food system. Our group was asked to review the vision statement and after much discussion, we decided that we generally agreed with the goals presented, though it inspired several questions and suggestions for additions/extensions.

One of the questions that arose during our discussion was whether or not it was contradictory for the vision statement to suggest that food be locally grown and ethnically diverse. Often, ethnically diverse food must be shipped from other countries. Although we believe it is important to offer as much variety on campus as possible, we think the UBC food system should limit this variety to what can be grown locally.

We also discussed whether or not promoting awareness was enough to change the behaviour of consumers, especially in the case of promoting a carbon-friendly diet. Many nutrition education theories suggest that promoting awareness is only the first step in promoting behaviour change (Contento, 2007). Action usually does not occur unless the educator also provides instructions about how to change and/or modifies the environment to be more conducive to behaviour change (Contento, 2007). In the case of the carbon-friendly diet, we teach the consumer the importance of eating local and then, on our website, offer a map and recommend shopping at farmer's markets or trying community-supported agriculture (CSA) boxes. We suggest the UBCFSP team become more familiar with strategies for behaviour change as the behaviour of both producers and consumers will be a critical part of making a sustainable food system at UBC.

In terms of additions, we believe that organic food production plays an important part in a sustainable food system and should be added to the vision statement. As is explained more fully later in this paper, when the closed system farming techniques used on organic farms are employed, fewer energy-intensive inputs are required for food production. Reducing our reliance on dwindling oil supplies is obviously an important step to increase the sustainability of food production.

Lastly, we suggest that in addition to recycling and composting, waste reduction and material re-use are also clearly stated in the vision statement. Recycling is important, but, the off-site recycling of many packaging materials still requires a great deal of oil-derived energy. Also, many recycling methods can only salvage a percentage of material for re-use, and new material must still be created, often from petroleum (Church, 2005). Re-using materials, reducing consumption and creating less waste can thus contribute to a sustainable food system by reducing dependence on oil-based product and energy.

VALUE ASSUMPTIONS

Our group worked from a weak anthropocentric position. This means that while we focused on the effects of climate change *as they affect humans* we believe that the environment has intrinsic value. However, the educational materials are delivered from a strong anthropocentric stance because we believe that this would make it more accessible to all members of the public. We decided that people who appreciate nature as more than just a means to an end are likely already aware of the impact of their food choices. As such, we chose to target a strongly anthropocentric audience.

As a group, we questioned the UBCFSP's assumption that a local food system is necessarily the most sustainable. While reducing dependence on fossil fuels for transportation, it would require an increase of either processing food, or energy-intensive greenhouse-grown produce. Local food systems could also be more vulnerable to outbreaks of diseases. It is also important to consider how sharply decreasing importations would affect farmers around the globe.

FINDINGS

The subsystem that will be the focus of this research paper is Vancouver since our aim is to educate people of Vancouver about the environmental impacts of different food choices. In order to achieve this goal, we have separated our findings into six key messages. The messages are: eat local and in-season, eat less meat and lower on the food chain, eat organic, reduce waste, eat less processed food, and walk or bike to the grocery store.

1) Eat Local and In-Season

There is a popular movement right now to eat organic foods. Although eating organic is important for reducing carbon emissions, the benefits can be overshadowed by the distance food has travelled. This distance can be reduced by choosing food that is locally produced and in-season. The Canadian Food Inspection Agency considers a food "local" if the item's origin is within 50 kilometres of where it's sold (FarmFolk/CityFolk, 2008). The 100-Mile Diet Society uses a larger radius, which is more realistic for Vancouver, since a wide distribution of agricultural land limits the city's proximity to local food production (100 Mile Diet Society, n.d.). This paper has defined "local" even further, by suggesting that food is produced within 100 miles of where it's sold *and* it is bought from local farmers, not corporations.

Food miles. Choosing local and in-season foods reduces food miles and emissions from transport. According the David Suzuki and Get Local B.C., the average North American meal contains ingredients from five countries and travels an alarming 2,400 kilometers from field to plate (David Suzuki Foundation, 2009; FarmFolk/CityFolk, 2008). Studies have shown that the average household could reduce GHG emissions by a quarter of a tonne if they replaced enough imported foods with those locally grown (FarmFolk/CityFolk, 2008). That is equivalent to the carbon that could fill 25,000 party balloons. Choosing local doesn't just mean skipping the exotic fruits in the produce section. A lot of our food is transported unnecessarily. For example, many countries import and export the same food product in similar quantities. For example, Britain imports 61,400 tonnes of poultry meat a year from the Netherlands and exports 33,100 tonnes to the Netherlands (Church, 2005). Britain also imports 240,000 tonnes of pork and 125,000 tonnes of lamb while exporting 195,000 tonnes of pork and 102,000 tonnes of lamb (Church, 2005). These inefficiencies are characteristic of our current global food system. Choosing local thus also means selecting locally grown foods like potatoes or carrots when they're available. Together, these decisions help to increase the efficiency of the food system as a whole and are an important part of decreasing the travel distance of food and thus the environmental burden associated with transportation.

Methods of transportation. Though the vast majority of food is transported by ship and road, transportation by air is by far the biggest contributor to GHG emissions. Even though only 1% of food is

transported by air it accounts for 11% of all food transport carbon emissions (Garnett, 2008). This is both because air is an energy-intensive mode of transportation and because food shipped by air typically must travel farther to reach its destination. The most energy efficient mode of transportation is by water, followed by rail and road which consume 423, 677, 2890 KJ/tonne-km of energy respectively, compared to 15,839 KJ/tonne-km consumed by air freight (Lang & Heasman, 2004). Per kilometre, airfreight thus contributes six-fold more CO2 emissions than road, 30-fold more than rail, and 40-fold more than water (Lang & Heasman, 2004).

Why local doesn't always mean carbon-friendly. People have come to expect food to be available year-round and have several options for purchasing out-of-season foods. It can be transported from other countries, grown in local greenhouses, or removed from local cold storages. Though there are two local options, in this case, buying local isn't necessarily the most carbon-friendly choice because greenhouses and cold storage are actually quite energy-intensive practices. Thus, imported foods can be less carbon-costly. For example, it was found that in the UK, apples are less GHG-intensive than imports when they are in-season. But, when apples are not in season, apples shipped from the southern hemisphere actually contributed less carbon than the UK apples maintained in cold storage (Garnett, 2008). Another study found that importing Spanish tomatoes to the UK resulted in fewer GHG emissions than those locally grown in greenhouses (Garnett, 2008). The details about greenhouses and refrigeration and their contribution to carbon emissions will be discussed further later in this paper.

Supporting local farms can help decrease emissions. Local farms are more likely to be environmentally responsible because they are usually smaller and more likely to employ closed system farming practices (the benefits of which are explained later in this paper). It has also been suggested that small farmers have more incentive to be environmentally responsible when compared to corporate farmers, because they will personally suffer the consequences of any harm they do to the environment (Harrington, 2008). For example, if soil fertility is damaged because the farmer failed to use crop rotations, he/she will lose a larger portion of his/her income due to unsuccessful crops than a large-scale farmer would.

Transportation is not the only contribution imported and out-of-season foods make to carbon emissions. Local and in-season foods require less processing, packaging, and storage, and, fewer preservatives, all of which require fossil fuels and contribute to carbon emissions. But, a focus on buying locally shouldn't distract from the bigger impacts at other stages in the supply chain. Every Canadian produces about 5 tonnes of greenhouse gas emissions per year (Seeds, 2006). A switch to local foods only reduces personal carbon emission by 5% (Seeds, 2006). As we will discuss further, a more appropriate focus might be on the types of food we choose, for example, plant versus animal, rather than how far our food has traveled.

2) Eat Less Meat

Total GHG emissions from the Canadian Agriculture Sector increased 25% between 1990 and 2006, mainly resulting from the expansion of the beef cattle and swine industry as well as an increase in synthetic nitrogen fertilizer use (Environment Canada, 2006). To have less negative impact on the environment, we could choose to eat meat from grass-fed cattle, eat less red meat overall, or just stop eating meat. Red meat is 150% more carbon intensive than chicken or fish (Weber, 2008). Having one meatless day a week can have the same climate impact as solely buying local foods (Weber, 2008).

Grass-fed and grain-fed cattle. Instead of being fed grass, most cattle today are grain-fed. This is because grain-fed cattle grow faster and are more cost-effective (Walsh, 2005). As a result, the consumer gets cheaper meat (Walsh, 2005). However, a cow's digestive system is not meant to digest grain, and

eating grain causes them to release an excess of gaseous compounds such as methane and carbon dioxide, two potent GHG (Walsh, 2005).

However, having more grass-fed cattle on the market involves increasing deforestation which affects biodiversity, leads to erosion and flooding (Stock & Rochen, 1998). Deforestation also reduces the number of potential trees that can absorb GHG from the air. Additionally, carbon dioxide is released as the trees are cut down and as trees and other plants decompose (Stock & Rochen, 1998).

Grain-fed cattle still have a larger impact on the environment (Stock & Rochen, 1998). Firstly, industrially grown grain limits biodiversity, depletes soils and often involves the use of pesticides (FAO, 2006). Secondly, artificial nitrogen fertilizer is produced through an energy-consuming process that uses great quantities of natural gas and produces huge amounts of CO_2 and N_2O (FAO, 2006). Thirdly, the tractors, slicers and harvesters use diesel for energy and contribute GHG emissions (FAO, 2006). Next, plastic used to bag up harvested grass and corn silage adds to environmental pollution (FAO, 2006). Finally, transporting feed to livestock incurs large energy costs and further increases GHG emissions (FAO, 2006).

Animal by-products. The manure and gas from cattle are the most significant source of GHG emissions from livestock by-products. They produce 9% of human-induced carbon dioxide, 37% of all human-induced methane, and 64% of ammonia, which is tied to acid rain (Environment Canada, 2006). They also generate 65% of human-induced nitrous oxide emissions (N_20), which has 296 times the global warming potential of CO_2 (Environment Canada, 2006). Run-off from improperly managed manure at factory farms can leach into the water supply, causing eutrophication (Oliver, 2008). This is when rivers and streams are starved of oxygen, harming fish and other species (Oliver, 2008). The anaerobic decomposition of sediment that results from eutrophication can lead to increased methane release from lakes (Huttunen et al., 2003). Other by-products that affect the environment are uneaten skin and bones, which are added to the landfill.

Eat foods with a high energy return on input. A food chain is a system that involves primary producers, herbivores, carnivores, omnivores, and decomposers. As energy is being passed through each stage of the food chain, there is less of it available at every stage because energy is used for purposes such as breathing and digesting. This concept is explained by the ecological pyramid, which shows that only 10% or less of energy is transferred from one trophic level to the next (Arcytech, 2000). For example, if there are 10,000 calories at one level, only 1,000 are transferred to the next. Increasing population and economic growth is causing and increase in demand for meat (Li *et al.*, 2006). This means that the food system requires much larger grain consumption through feeding grains to animals and then eating the animals (Li *et al*., 2006). In fact, two-thirds of all grains produced are now used to feed livestock, not humans (FAO, 2006). As discussed earlier, cultivating grain involves the release of massive amounts of greenhouse gas emissions. As omnivores, we have a choice between eating animals and eating plants. By choosing to eat foods that are lower in the food chain, we obtain energy more directly and efficiently, and at the same time reduce GHG emission.

3) Eat Organic

Contrary to conventional growing methods which are based on maximizing outputs and minimizing cost, organic farming supports an environmentally responsible philosophy. It allows for a healthy relationship between the food and the land in which it is grown. Organic agriculture is based on reducing or eliminating reliance on external inputs such as fertilizer, pesticide and irrigation. A true organic farm will have a closed system; that is, external inputs and waste outputs are at a minimum. Self-sufficiency is achieved using careful manure management, compost, crop rotation and other low-impact

farming methods. Biodiversity is also vital in reducing reliance. Manure and compost management are addressed later in this paper; the other aspects are considered below.

The FAO reports that a change from conventional chemical-based agriculture to organic agriculture reduces energy requirements by 25-50% (2009). The same report states that the increase in soil organic matter has an even greater carbon sequestration potential (FAO, 2009). It is believed that if only 10,000 medium-sized farms in the U.S. converted to organic production, they would store so much carbon in the soil that it would be equivalent to taking 1,174,400 cars off the road, or reducing car miles driven by 14.62 billion miles (Sayre, 2003).

Closed System. In organic agriculture, soil fertility is achieved through a closed system approach using composted crop wastes and animal manures (Altieri, Ponti, and Nicholls, 2005). This minimizes both external inputs and waste outputs required. Organic farmers often use manure produced by farm livestock as a natural fertilizer on grassland fields (Altieri et al., 2005). Recycling manure vastly reduces emission of methane, nitrous oxide and ammonia, which occur when manure is discarded (Badgley, Moghtader, Quintero, Zakem, Jahi Chappell, Avilés-Vázquez, Samulon, and Perfecto, 2007). Therefore, integration of livestock and arable production can be useful in reducing the global warming potential of food production.

Crop Rotations. Conventional agriculture relies heavily on the monoculture (the cultivation of the same crop in a field year after year). This crop homogeneity has contributed to the doubling of crop losses due to insect damage over the last sixty years (Pimental *et al*., 1992). In order to mitigate the effects of the conventional farm's ecosystem, harmful agents, such as pesticides and synthetic nitrogen fertilizers are utilized (Meleca, 2008).

Pesticides are used at great environmental and economic cost. Negative impacts traced back to the use of pesticides include contamination of animal products and groundwater, loss of natural pest enemies, pesticide resistance and pollination losses (Pimental et al., 1992). Including human health impacts of pesticide use, costs have been estimated to be 5 to 8 billion dollars per year. The production of fertilizers is energy intensive. It adds between 300 and 600 million tonnes CO_2 per year, representing between 0.6 - 1.2% of the world's total GHGs (Bellarby, 2008). Also, fertilizers are often applied in excess or at suboptimal times and not fully used by the crop plants, so that some of the surplus is lost as N_2O to the atmosphere (Bellarby, 2008). Growing crops in the same site reduces soil fertility and can encourage a build up of pests, diseases and weeds in the soil (Bellarby, 2008).

In organic agriculture, farmers use crop rotations as one of their main tools to control soil fertility. Rotating crops in optimized sequences help break pest cycles and prevent a carry over of pests to the next season. It also ensures that a field always has a crop or cover crop; fields left to lay bare suffer from significant soil erosion (Heller & Keoleian, 2002). A good cropping system allows for a rebuilding phase to restore soil fertility and build organic matter (Bellarby, 2008). A huge amount of carbon is sequestered from the atmosphere when soil is allowed to restore in this manner (FAO, 2009). Additionally, a healthy soil can hold much more water and decreases the need for irrigation (FAO, 2009).

Biodiversity. Genetic diversity is another tool for combating against pests and diseases in organic systems. Planting several different crops or several varieties of one crop decreases susceptibility to disease, pests and environmental conditions (Meleca, 2008). Without biodiversity, options for long-term sustainability and agricultural self-reliance are lost. As the diversity of a system decreases, the risk that a pest or disease will spread throughout an agricultural plant or animal base increases (Meleca, 2008). Diversity in a field significantly reduces the farmer's need for fertilizers and pesticides

Other Farming Methods. In Low Greenhouse Gas Agriculture (2009), the FAO discusses other ways farms can reduce their environmental impacts. Tillage is the disruption of the ground to ready the soil for seeding. Strip or reduced tillage increases carbon sequestration, and require less herbicide and

fertilizer. Selecting varieties and breeds especially fit for local conditions also minimizes input needs, and can improve yields in conventional and organic systems alike. Many organic farmers are using integrated pest mangement (IPM) to replace the role of pesticides in conventional agriculture. Finally, organic waste can be used to partially fuel farm machinery while reducing environmental impact (FAO, 2009).

4) Reduce Waste

Landfills. Organic waste in landfills is eventually decomposed by bacteria found naturally in the waste and surrounding soil (Crawford & Smith, 1985). Bacterial decomposition contributes heavily to landfill gas which includes a mixture of many different gases, mostly methane and carbon dioxide (Crawford & Smith, 1985). In the year 2000, worldwide landfills of municipal solid waste generated over 730 million metric tons of CO_2 equivalents which is equal to 12% of total global methane emissions (Oliver, 2007). This number is expected to escalate by 9% from 2005 to 2020 due to an increasing rate of organic waste deposits (United States Environmental Protection Agency, 2006). If the methane produced by landfills is not collected, it will escape into the atmosphere not only to further pollute our environment but also imparts a lost opportunity to capture and utilize as a source of energy (United States Landfill Methane Outreach Program, 2009).

Waste in food supply chain. One major way to cut down the organic waste going to landfills is to reduce food wastage. About half of the produce throughout the world ends up being discarded along the food supply chain (David Suzuki Foundation, 2009). Much of this waste is due to spoilage, but often, fruit and vegetables are discarded solely due to cosmetic defects such as irregular size and shape. Supermarkets tend to overstock their shelves to compensate for consumers' preference for perfect-looking produce (Garnett, 2008). Thus, to reduce the amount of produce wasted at the supermarket we recommend choosing fruit and vegetables regardless of small blemishes or bruises, especially when buying organic, to reduce the amount of produce wasted at the supermarket.

Personal food waste. North Americans also tend to buy more food than they need. As a result, one in four food purchases end up in the trash (David Suzuki Foundation, 2009). To avoid this reason for food waste, we recommend shopping with a list to avoid impulse buying and bringing Tupperware to pack up leftovers at restaurants.

Carbon emissions due to shopping bags. In the United States, 100 billion plastic shopping bags are produced each year (Ableman, M., Bond, A. B., Gussow, J., Kirschhenmann, F., Landrigan, P., Perera, F., Roberts, J., Walljasper, J., 2008). Plastic bag production is an energy-intensive process requiring a large amount of fossil fuels (Ableman et al., 2008). Paper bags are not a suitable replacement for plastic in terms of carbon emissions. It actually takes four times more energy to produce and ten times more energy to recycle a paper bag (Ableman et al., 2008). Therefore we recommend using a reusable cloth bag to carry home groceries.

Recycling and composting produces fewer GHGs. Although the process of recycling requires energy and produces some GHG emissions, it is still better than throwing recyclable waste into the trash. Landfill waste generates 1.5 lb of GHG emissions compared to 0.5 lb for recycled waste (Harrington, 2008). Therefore, it is wise to recycle and purchase products packaged with recycled materials whenever possible. Composting also produces some GHG emissions because it is decomposed by bacteria, but it is still a better alternative than landfilling. When used as a replacement for fertilizer it reduces the emissions associated with fertilizer's production.

5) Eat Less Processed Foods

Processed food has become increasingly popular in the Canadian diet. In large, developed countries like Canada, food processing is often necessary to prevent spoilage and preserve nutritional

quality during shipping and storage during the winter months. But, a lot of unnecessary processing occurs in Canada and all Western countries. This is due to the fact that competition in the food industry has put pressure on suppliers to "add value" to foods through processing to make their products more appealing at the grocery store (Nestle, 2002). For example, a company makes a larger profit selling potato chips than it would selling potatoes. As a result of the competition and the availability of cheap oil, the number of steps between food production and consumption has steadily increased (Nestle, 2002; Church, 2005). The lengthening of the food supply chain consumes energy and contributes to greenhouse gas emissions in many ways; refrigeration, packaging, thermal processing, food additives, machinery, and transportation are all dependent on fossil fuels (Church, 2005). In this paper, we focus on transportation, refrigeration, and packaging.

Transportation and food processing. As we have already mentioned, transportation is a big contributor to GHG emissions. In food processing, raw materials are often gathered from many different sources, including those in other countries (Church, 2005). Also, food must be shipped between stages of production, and some foods require a surprising number of stages. For example, Swedish ketchup requires more than 52 transport and process stages from farm to final product (Church, 2005). The extension of our food supply chain has become possible in large part due to refrigeration (Garnett, 2008).

The impact of refrigeration. Refrigeration is necessary for food safety to reduce the food spoilage, and also for food storage to make food available year-round. However, compared to sixty years ago, refrigeration has become more and more necessary as the food supply chain has lengthened and included more transportation and storage stages. Now, our food supply chain is refrigerator-dependent and many foods require temperature-control at every stage in the supply chain (Garnett, 2008). The energy required to operate this equipment is enormous and some of the gases used as refrigerants have global warming potentials that are thousands of times greater than CO2 (Garnett, 2008).

Packaging. As mentioned, packaging plays a big role in the production of greenhouse gases. In food processing, materials such as delivery boxes, metal cans, printed-paper labels, plastic trays, cellophane, glass jars, plastic and metal lids (many of which are petroleum-based) are heavily relied on to protectively package and preserve food (Church, 2005). However, a great deal of packaging is used only to ship food products from one stage of processing to the next, resulting in excessive waste that is often not properly recycled or cannot be recycled (The Strategy Unit, 2008).

Choosing local foods that are minimally processed and buying in bulk can help to reduce the carbon emissions associated with the transportation, refrigeration, and packaging involved in the production of many foods.

6) Walk Or Bike To The Grocery Store

Using less personal transportation directly reduces GHG emissions. As we've mentioned, Canada's largest source of GHG gas is transportation (Environment Canada, 2005; Natural Resources Canada, n.d.). In 2006, Transport Canada (2007a) estimated 18.5 million personal vehicles were on the roads in Canada which collectively drove approximately 300 billion kilometres. The GHG emissions from these personal vehicles have grown by 10 percent since 1990, despite a significant increase in fuel efficiency, which indicates that people are driving more often (Transport Canada, 2007a; Transport Canada, 2007b).

We can infer from shopping trends in the UK that one of the reasons people are driving more is for the purpose of picking up groceries (Garnett, 2008; Lang & Heasman, 2004). To reduce the emissions associated with personal transportation we recommend walking or biking to the grocery store. This is reasonable in Vancouver because the city is relatively dense and grocery stores are very accessible by foot (Metro Vancouver, 2007). For those living in areas where walking or bikng is not possible, public transportation is a better mode of transportation. One could also use their personal vehicle but make fewer

trips. If this is the case, then improving fuel effciency by keeping tires inflated and driving below 100 km/hour on the highway, for example, and/or choosing a fuel-efficient vehicle can also help reduce emissions (Environment Canada, 2005).

DISCUSSION

Carbon Friendly Food Guide. We chose to present our Carbon Friendly Food Guide as a tri-folded, 8.5 x 11" pamphlet. We decided to use this format for ease of production, distribution and use. To limit our own carbon footprint, it is printed on recycled paper and will be fully recyclable. The brochure was created to target all audiences. It is eye-catching and simple, but contains more than just basic information. We highlighted simple key phrases like "Save the plant, Eat a Carbon diet", and "Six Steps to a Carbon Friendly Diet" to spark interest. The messages match the website so consumers that choose to further explore the topic will be familiar with the format.

Website. Our website (Appendix B) elaborates on the brochure by providing more in-depth information about carbon emissions for interested individuals. We have provided a carbon calculator to allow them to calculate their emissions. Then we provided links that elaborate on our six key messages, each with further useful links. For example, we gave a list of local foods, recipes, and restaurants that may encourage people to eat more local foods. Finally, we provided links to other useful websites such as the UBC Farm, the 100-Mile Diet, the David Suzuki website, and more. Our website is easy to navigate with a side panel that permits users to go from page to page. We also have a search engine that enables people to search for related information. Though the appearance of the website we created with Microsoft Publisher is not what we would like to see created, the format and content is appropriate.

Sign. To indicate to shoppers at the UBC Farm Markets which foods are Carbon Friendly, we chose to create three small signs (Appendix C). The signs will be approximately 4"x 6" and posted on or near items. We decided to use a sign rather than a label to be put on individual pieces or bags of produce for sustainability reasons. Signs will be laminated and farm staff will use washable markers to check off the criteria that apply to the product. We have chosen three different sets of criteria to lend flexibility to the crop that is being advertised. Our intention is for the farm to have several copies of these three signs so that they can be somewhat tailored to individual crop characteristics.

CONCLUSION

The conventional food industry plays a big part in contributing to global warming because of its dependence on oil in every step of food production. We have learned that, by far, the biggest contributor to carbon emissions in the food supply chain is the meat industry (Garnett, 2008). Therefore, the best advice to give people who want to increase the carbon-friendliness of their diet is to reduce meat consumption and eat lower on the food chain. One could go farther to make a diet carbon-friendly by walking to the grocery store with a reusable bag and choosing whole, organic, local, and in-season foods with minimal packaging. Personal food choices could potentially have a large impact on the food system. For example, if every American skipped one meal of chicken per week and substituted it with a vegetarian meal, it would be equal to the carbon dioxide savings of removing at least half a million cars off the U.S. roads (Eshel & Martin, 2006).

We defined a carbon-friendly diet as a healthy diet that focuses on reducing carbon emissions. This includes the process in which the food is produced, transported, processed, consumed and disposed. The goal of our carbon-friendly food guide and website was to empower consumers to make informed choices about carbon-friendly eating. However, raising awareness is only the first step in stimulating behaviour change according to some theories, such as Contento's transtheoretical model (2007). It suggests that there are several stages of behaviour change. Once consumers are aware of why to make change, they must also

be motivated to take action and taught how to get started (Contento, 2007). There are many theories and strategies which aim to motivate and facilitate behaviour change. One strategy would be to build environmental support that could enable consumers to choose carbon-friendly foods. The sign we designed for the UBC farm is a good example of environmental support because it will help consumers recognize which food is carbon-friendly. We think the UBCFSP team may benefit from becoming familiar with some of the behaviour change theories presented in Contento's textbook (2007) as they could help guide the UBCFSP's next steps in facilitating consumer change.

References:

100 Mile Diet Society. (n.d.). *100 mile diet: Local eating for global change.* Retrieved March 30, 2009 from http://100milediet.org/

Ableman, M., Bond, A. B., Gussow, J., Kirschhenmann, F., Landrigan, P., Perera, F., Roberts, J., Walljasper, J. (2008). *Green Guide: The Complete Reference for Consuming Wisely*. Washington, DC: National Geographic Society.

Altieri, M. A., Ponti, L. and Nicholls, C. (2005): Enhanced pest management through soil health: toward a belowground habitat management strategy. Biodynamics (Summer) pp. 33-40.

Arcytech. (2000). *Interesting facts about food chains.* Retrieved on March 16, 2009 from http://www.arcytech.org/java/population/facts_foodchain.html

Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Jahi Chappell, M., Avilés-Vázquez, K., Samulon, A. and Perfecto, I. (2007): Organic agriculture and the global food supply. Renewable Agriculture and Food Systems: 22(2); 86-108.

Bellarby, Jessica (2008). *Cool farming: Climate impacts of agriculture and mitigation potential*. Amsterdam: Greenpeace International.

Blouin-Gascon, M. (2004). *Why should people recycle?* Retrieved from http://www.ec.gc.ca/EnviroZine/english/issues/46/email_story_e.cfm?Link=/EnviroZine/english/issues/46/any_questions_e.cfm&page=questi

Church, N. (2005). *Why our food is so dependent on oil*. Retrieved February 15, 2009 from http://agbio.ca/DOCs/issues_food_oil.pdf

Contento, I. R. (2007). Nutrition Education: Linking Research, Theory, and Practice. Sudbury, MA: Jones and Bartle Publishers.

Crawford & Smith. (1985). *Landfill Gas Primer – An Overview for Environmental Health Professionals.* Retrieved from http://www.atsdr.cdc.gov/hac/landfill/html/ch2.htm

David Suzuki Foundation. (2009). *Food and climate change.* Retrieved February 4, 2009 from http://www.davidsuzuki.org/Climate_Change/What_You_Can_Do/Food_and_Climate_Change.asp

David Suzuki Foundation. (2009). *David Suzuki's Nature Challenge.* Retrieved March 22, 2009, from http://www.davidsuzuki.org/NatureChallenge/newsletters/sept2008_harvestbounty/page2.asp

Eshel, G., and P.A. Martin, 2006: Diet, Energy, and Global Warming. *Earth Interactions*, 10, 1–17.

Environment Canada. (2005). Lowering Canada's Vehicle Emissions. *EnviroZine: Environment Canada's*

On-line Newsmagazine, 54(2). Retrieved from http://www.ec.gc.ca/EnviroZine/english/issues/54/feature2_e.cfm

Environment Canada. (2006). National inventory report: greenhouse gas sources and sinks in Canada, 1990-2006 (CRF Sector 4). Retrieved from http://www.ec.gc.ca/pdb/ghg/inventory_report/2006_report/s6_eng.cfm#s6_1

Environment Canada, 2007. Canada's 2005 Greenhouse Gas Inventory: A Summary of Trends. Available online at http://www.ec.gc.ca/pdb/ghg/inventory_report/2005/2005summary_e.cfm

FarmFolk/CityFolk Society. (2008). *Get local: Local food is the right choice for our environment.* Retrieved February 28, 2009 from http://getlocalbc.org/en/

Garnett, T. (2008). Cooking up a storm: Food, greenhouse gas emissions, and our changing climate. Retrieved February 15, 2009 from http://www.fcrn.org.uk/frcnPubs/publications/PDFs/CuaS_web.pdf

Harrington, J. (2008). *The climate diet: How you can cut carbon, cut costs, and save the planet.* London: Earthscan.

Heller M.C., and Keoleian G.A., 2002: Assessing the Sustainability of the US Food System: A Life Cycle Perspective. *Agricultural Systems*, 76:3, 1007-1041

Huttunen, J. T., Alm, J., Liikanen, A., Juutinen, S., Larmola, T., Hammar, T., Silvola, J., Martikainen, P. J. (2003). Fluxes of methane, carbon dioxide and nitrous oxide in boreal lakes and potential anthropogenic effects on the aquatic greenhouse gas emissions. *Chemosphere, 52*(3), 609-621. doi:10.1016/j.physletb.2003.10.071

Intergovernmental Panel on Climate Change (IPCC). (2007). "Climate Change 2007: Mitigation of Climate Change". Retrieved 21 November 2007, from HYPERLINK "http://www.ipcc.ch/ipccreports/ar4-wg3.htm

Lang, T., & Heasman, M. (2004). *Food wars: The global battle for mouths, minds and markets.* London: Earthscan.

Li, P., Wang. Y., & Tan X. (2006, April 11). Grain security vs. food security. Message posted to http://www.safea.gov.cn/english/content.php?id=12742763

Meleca, Anthony (2008, 7, 30). The organic answer to climate change. Retrieved March 30, 2009, from Organic Guide Web site: http://www.organicguide.com/community/education/the-organic-answer-to-climate-change/

Metro Vancouver. (2007). Climate Change as a 'Driver' for the Regional Growth Strategy. The Sustainable Region Initiative (Regional Growth Strategy Review Backgrounder #8). Retrieved April 9, 2009 from

http://www.metrovancouver.org/planning/development/strategy/BackgroundPapersReports/RGS_background8_climate_change_Dec2007.pdf

Neff, R., Chan, I.L. Clegg Smith, K. (2008) Yesterday's dinner, tomorrow's weather, today's news? US newspaper coverage of food system contributions to climate change. *Public Health Nutrition*, 11(8), 972-981. doi:10.1017/S1368980008003480

Nestle, M. (2002). Food politics: How the food industry influences nutrition and health. Los Angeles: University of California Press.

Niggli, U., Fließbach, A., Hepperly, P. and Scialabba, N. (2009). Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems. Rome: United Nations Food and Agriculture Organisation.

Oliver, R. (2007). *All about: Landfills.* Retrieved from http://www.cnn.com/2007/WORLD/asiapcf/10/08/eco.about.landfills/#cnnSTCText

Oliver, R. (2008, January 7), Animal waste: Future energy, or just hot air? Message posted to http://edition.cnn.com/2008/WORLD/asiapcf/01/07/eco.about.manure/index.html

Pimentel, D., and M. Pimentel, 1996. Food, Energy, and Society. University Press of Colorado, Niwot, CO.

Pollan, Michael (2006). *The omnivore's dilemma: a natural history of four meals*. New York: Penguin Press.

Rojas, A., Richer, L., Wagner, J. (2007). University of British Columbia Food System Project: Towards Sustainabile and Secure Campus Food Systems. *EcoHealth*, 4, 86-94.

Sayre, Laura (2003). Organic farming combats global warming. Retrieved March 30, 2009, from Rodale Institute Web site: http://www.rodaleinstitute.org/ob_31

Seeds. (2006). *One tonne challenge: Small actions add up to make a tonne of a difference!* Retrieved March 12, 2009 from http://www.seedsfoundation.ca/otc/index.htm

Smith, A. & MacKinnon, J. B. (2007). *The 100 mile diet: A year of local eating.* Vancouver, BC: Random House Canada.

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., de Haan, C. (2006) Livestock's Long Shadow - Environmental Issues and Options. Rome: Food and Agriculture Organization of the United Nations.

Stock, J. & Rochen, A. (1998). *The choice: Doomsday or arbor day.* Retrieved on March 16, 2009 from http://www.umich.edu/~gs265/society/deforestation.htm

The Strategy Unit. (2008). Food Matters: Towards a Strategy for the 21st Century. Retrieved March 15,

2009 from
http://www.cabinetoffice.gov.uk/media/cabinetoffice/strategy/assets/food/food_matters1.pdf

Transport Canada. (2007a). Transportation in Canada: An Overview. Retrieved April 9, 2009 from http://www.tc.gc.ca/policy/Report/anre2007/pdf/overview.pdf

Transport Canada. (2007b). Transportation in Canada: An Overview. Addendum. Retrieved April 9, 2009 from http://www.tc.gc.ca/policy/Report/anre2007/pdf/add2007-e.pdf

United States Environmental Protection Agency. (2009). *Landfill Methane Outreach Program (LMOP).* Retrieved March 22, 2009, from
http://www.epa.gov/lmop/overview.htm

Van Aardenne, J.A., Dentener, F.J., Olivier, J.G.J., Peters, J.A.H.W., Ganzeveld, J.A.H.W. The Emission Database for Global Atmospheric Research 3.2 Fast Track 2000 dataset (Report No. 32FT2000). Retrieved from
http://www.mnp.nl/edgar/Images/Description_of_EDGAR_32FT2000(v8)_tcm32-22222.pdf

Walsh, C.W. (2005, April 6), Grass Fed vs. Grain Fed Beef? Message posted to http://www.luciesfarm.com/artman/publish/article_85.php

Weber, C.L., and Mathews, H.S., 2008. Food-Miles and Relative Climate Impacts of Food Choices in the United States. Environ. Sci. Technol. 42 3508-3513.

APPENDIX A: Brochure

Paper copy to follow

APPENDIX B: Website

Electronic copy to follow.

APPENDIX C: Sign

The following is one version of the sign, designed for produce grown at the UBC farm.