The Debate is Over – Climate Change is Real!

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Welcome to the Chapter on Energy and Climate Change. We're glad that you've taken interest in an issue that will dominate our lives now and into the future. You're probably asking yourself what the supermarket has to do with either of these things. Don't worry. At the beginning, we were asking ourselves the very same thing!

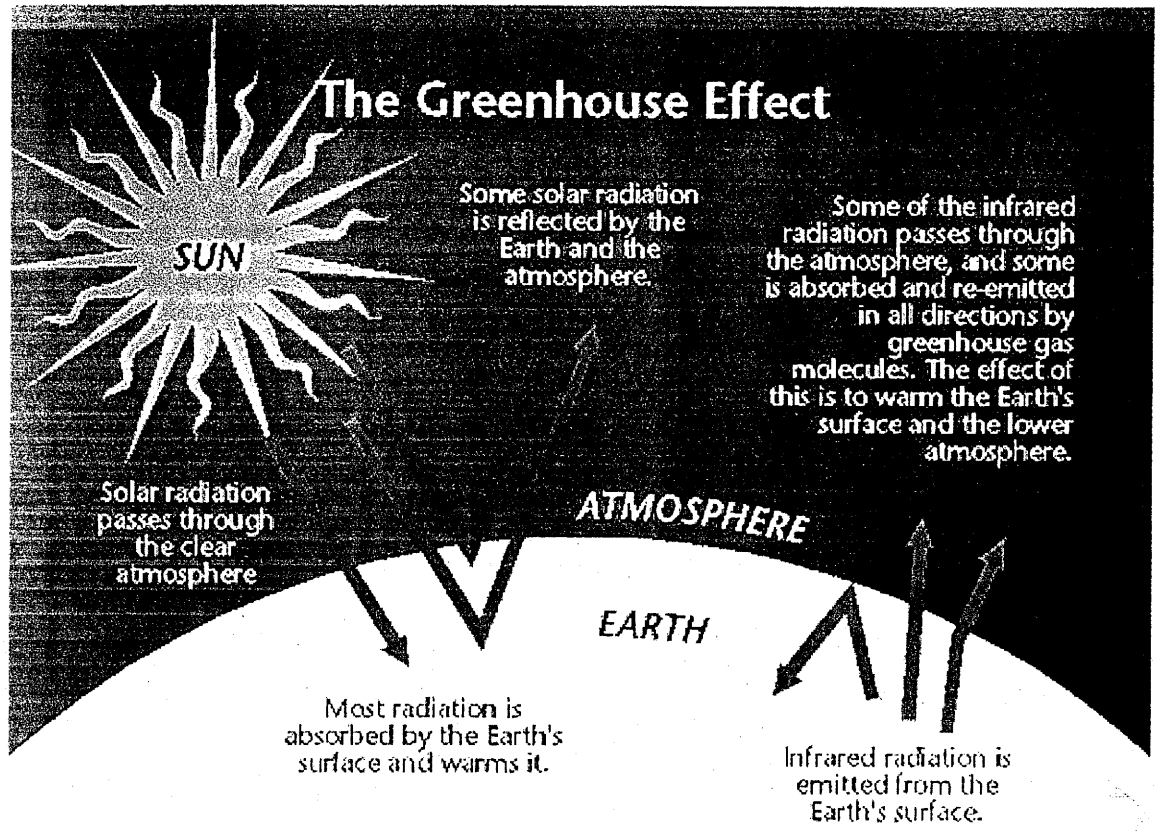
Historically, agriculture was practiced in small areas and produced a variety of foods. Increasing populations and the industrial revolution saw many rural people move to urban centres. This necessitated a uniform and reliable supply of goods to feed the burgeoning urban population who could not provide their own means of food production. Markets, bakeries and butchers were integral components to neighborhoods. As our populations increased further and our hunger for material items increased our cities expanded and required centrally located and sufficiently sized grocery stores to serve our growing needs. Agricultural practices were at the same time forced into instead of providing foods for the consumer; they produced foods rather for the managers of the food industry. These managers shaped our current agriculture system.

Agricultural Systems are very energy intensive meaning that more energy is used in the production and distribution of our food than is actually provided by the food itself. Fossil fuels are used to power equipment, heat buildings and are used excessively in transporting food long distances to the supermarket[1]. Another large user of fossil fuels in the agricultural sector is the production of fertilizers and pesticides. These industrial products are petroleum based. Another concern that has been raised regarding the present agricultural food system is the non-cyclic travel of nutrients and organic matter from rural areas to urban centres. Crops grown in one country and shipped to supermarkets in other countries and there is often no cycle to return nutrients back to the soil. This can result in the degradation of soils leading to lower crop yields and unless nutrients are returned to the soils – they will be rendered useless given time. This could seriously affect our ability to produce sufficient amounts of food for our skyrocketing populations[2]. Under the current mechanized nature of our agriculture system not only are we using excess amounts of fossil fuels, we are enabling the ecosystems to participate in the acceleration of climate change.

In growing with that thought, it is our intention of this chapter to communicate to you, the reader, why our current agricultural practices are unsustainable. We will explore this through agricultures' contribution to climate change and explain how climate change will negatively affect our ability to produce food, therefore jeopardizing food security. While the authors would like to cover every aspect of this issue as it relates to current agricultural practices, it is simply impossible. This issue is incredibly complex and one could devote a significant amount of time to making the linkages between energy, climate change and our current agricultural practices. It is our intention however, to raise important issues surrounding the subject which have led – in part – producers and consumers alike to seek sustainable alternatives.

Climate Change

Climate Change is a phenomenon that is caused by the greenhouse effect. The greenhouse effect is a natural process which allows for heat from the sun (solar radiation) to penetrate through the earth's atmosphere to be absorbed by the earth's surface or reflected back out into space. Overtime the earth gradually re-releases this energy as infrared radiation. Some of this infrared radiation passes through the atmosphere back into space and some is reflected back to the earth by particles in the atmosphere. This process keeps the earth at a livable temperature by maintaining its temperature balance otherwise it would be much too cold.



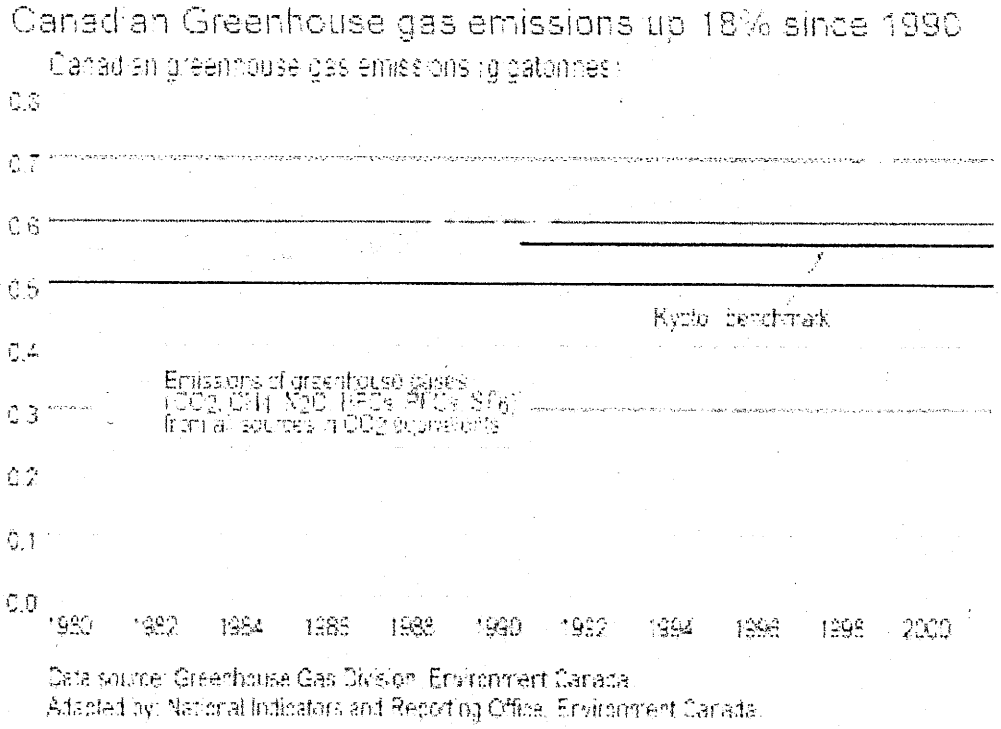
(Figure origin Environment Canada[3])

Certain particles in the atmosphere in particular allow for this process to take place. Those particles are called greenhouse gases. In recent years, **due to human activity, we have been changing the balance of these naturally occurring gases, particularly carbon dioxide (CO_2), methane (CH4), and Nitrous Oxides (NOx) in the atmosphere**[4]. Two other human produced gases contributing to climate change are Chlorofluorocarbons (CFCs) and Sulphur hexafluoride. Human actions have been contributing to an increase of these gases in the atmosphere which through this process has created climate change and global warming. This change to the natural balance in effect is trapping and/or bouncing back more infrared radiation coming from the earth. Similar to glass in a greenhouse, these gases are preventing heat from escaping through the earth's atmosphere. The image above describes this process.

When the earth re-emits this energy it does not release 100 percent of the energy/heat that originally enters the earth's atmospheric system but it returns about 70[5]. 100 percent does not get emitted back because it is consumed when it is absorbed in the processes which give life to our planet such as photosynthesis. Photosynthesis is a process whereby vegetation creates energy for itself through a precise chemical process where oxygen is a by product and carbon dioxide, a greenhouse gas is a building block[6].

So lets take a look at what we are putting into the atmosphere – The Greenhouse Gases

Of the three main gases contributing to climate change, carbon dioxide, nitrous oxides and methane, Carbon Dioxide is having the largest impact. Carbon dioxide makes up approx 73 percent of human caused climate change. The burning of fossil fuels is the main human caused contribution to climate change at 49 percent of all contributions. Carbon dioxide is the main by product of the burning of fossil fuels[7]. Today's atmosphere contains 32 percent more CO_2 than at the start of the industrial era[8]. Methane makes up approx 16 percent of human caused contributions to climate change. Although a smaller percentage, methane absorbs infrared radiation 20 to 30 times faster than carbon dioxide and is currently collecting twice as fast as CO_2 . Nitrous oxides makes up approx 7 percent of human caused



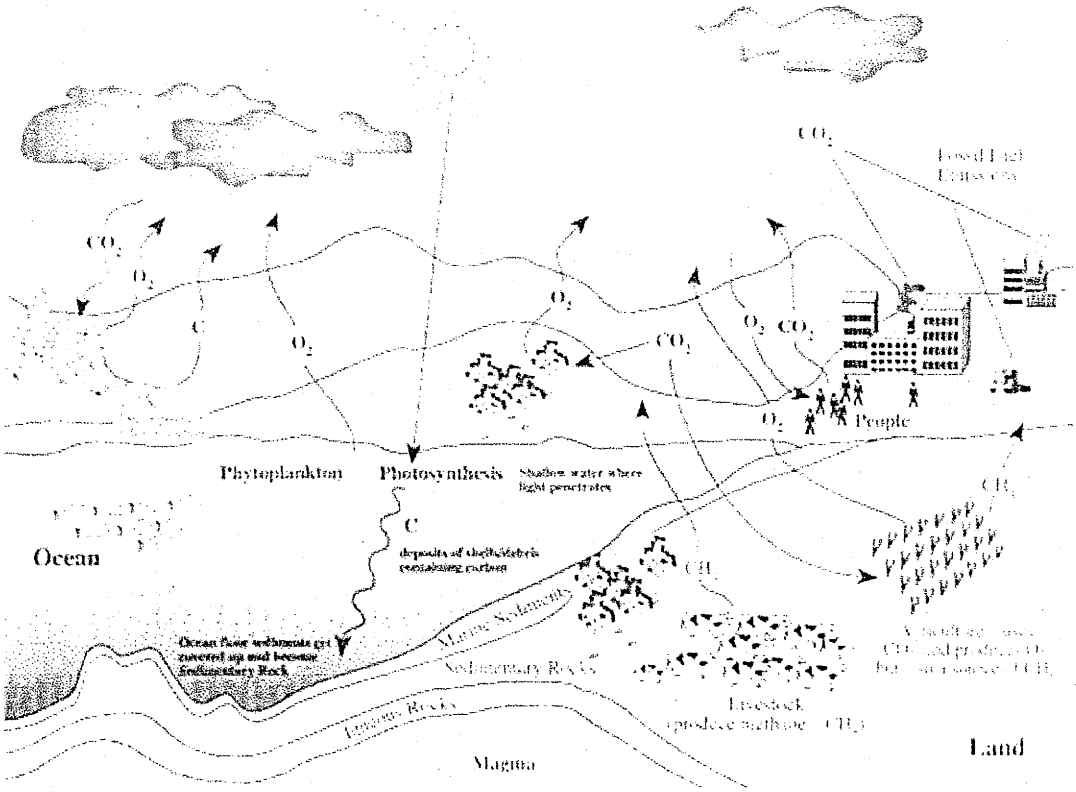
contributions to climate change. It is predicted that as GHG emissions increase so will the global temperature. The figure above displays the Kyoto Protocol's limit for GHG emissions on the middle right of the image. The Kyoto Protocal is an international agreement to work together to try to reduce GHG emissions back to 1990 levels[9]. Above that line representing the aim for Kyoto, is a dotted line displaying Canada's relative greenhouse gas emissions. Since 1990, GHG emissions have increased by 18%. This will lead to a warming effect that will raise global temperatures[10]. (Image origin Environment Canada[11])

Defining Agriculture's Role in Climate Change

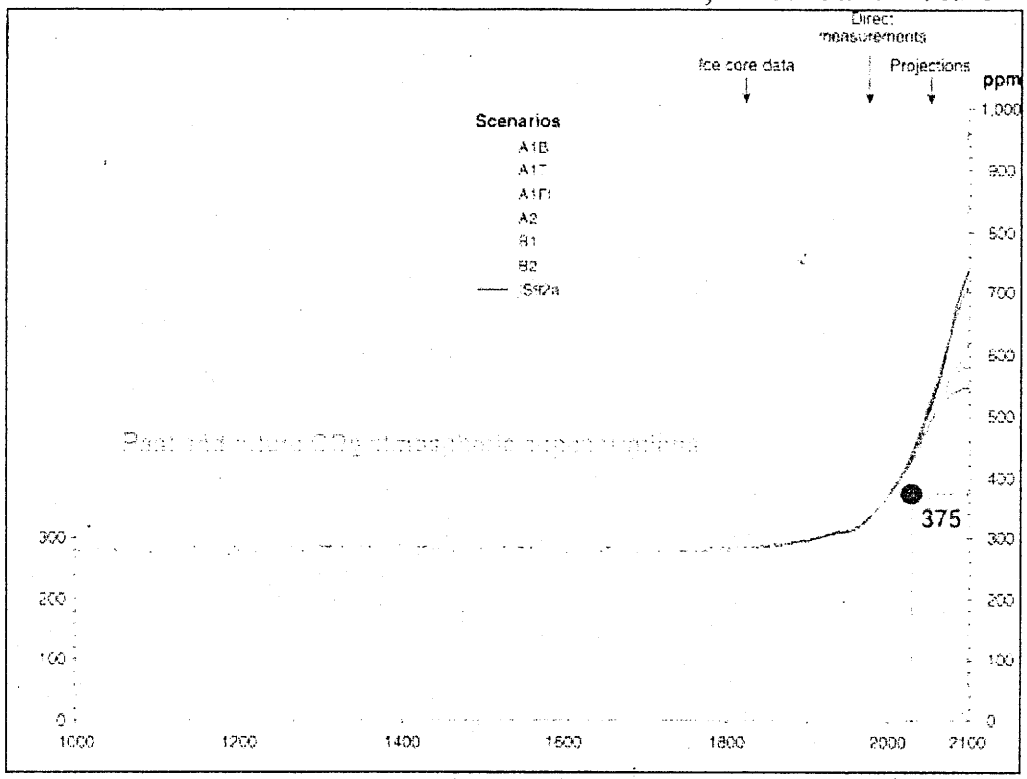
The Food and Agriculture Organization of the United Nations has stated that agriculture is responsible for approximately one-third of climate change. Of the greenhouse gases contributing to climate change is Carbon Dioxide (CO_2). It is estimated that 25% of global CO_2 emissions are a direct result of agricultural practices. This includes not only emission released from the soils as a result of ploughing or tillage, but deforestation and burning practices utilized in developing countries. In their quest to develop self sustaining economies, developing nations are often contracted into growing food for western countries to meet our insatiable appetite. Conventional tilling practices (ploughing) and fertilizer use account for 70% of global nitrous oxide (NOx) emissions. Nearly all of the global Methane (CH4) emissions come directly from domesticated animal production, rice cultivation and forest fires. [12]

The Carbon Cycle

Carbon Dioxide is the single largest greenhouse gas of concern and is used as an indicator when gauging total greenhouse gas emissions. Carbon dioxide is necessary for virtually all life on this planet. Humans and other mammals exhale CO_2 – this is called respiration. Alternatively, plants utilize CO_2 from the atmosphere for use in photosynthesis – a process which produces Oxygen which is necessary for human respiration. Excess amounts of CO_2 are generated from the combustion fossil fuels – coal, oil and natural gas. If Carbon Dioxide is required to support life on earth, then why is it a problem? As you learned in our explanation of climate change - CO_2 among other greenhouse gas emissions are responsible for trapping heat in the earth's atmosphere. (Image Credit: NASA SeaWiFS Project) [13]



Global Carbon Dioxide Concentrations – Past, Present and Future



(Source: Rekacewicz and Bournay – UNEP/GRID)[14]

Since pre-industrial times, the atmospheric concentration of greenhouse gases has grown significantly. The present level of carbon dioxide concentration (approximately 375 parts per million) is the highest for 420,000 years, and probably the highest for the past 20 million years.

Deforestation for Agriculture

Deforestation for agricultures' sake further complicates the issue of rising CO_2 concentrations in the atmosphere. By reducing the abundance (number) of trees, we are effectively reducing the earth's capability to absorb CO_2. Burning biomass for agricultural purposes otherwise known as slash-and-burn, not only reduces the capacity for CO_2 absorption; it emits CO_2 directly into the atmosphere. Trees are often considered to be carbon sinks of the earth.

Brazil

In just one year over 26,000 square kilometers of the Amazon Rainforest was burned or cut down only to be replaced by Soya bean plantations and ranchers. That is over *three times* the size of Algonquin Park here in Ontario. In the same year (2004), Brazil was propelled to a record Soya product trade surplus with most of the Soya products going to China and Europe. In addition to rising popularity of Soya products for direct human consumption, over 90 percent of the 200 million tones of Soya produced around the world per year is used to feed domesticated animals. This has been widely adopted since the onset of the BSE crisis in North American cattle.[15]

The Canadian Context

According to Agriculture and Agri-Food Canada$_2$, total carbon dioxide CO_2 emissions from agricultural practices in Canada are considered to be:

Net Soil Carbon Losses + Direct Fossil Fuel Use + Indirect Fossil Fuel Use

Net Soil Carbon Losses are a result of deep tillage practices and have been discussed earlier in the chapter. *Direct Fossil Fuel Uses* account for emissions as a result of fuels used on the farm for operating machinery and supplying power to buildings and structures. *Indirect Fossil Fuel Uses* account for activities such as: fertilizer manufacturing, transport and application; machinery manufacture and repair; building construction (steel and cement manufacture); pesticide manufacture and electricity generation. [15] A summary of these emissions by Agriculture and Agri-Food Canada can be observed below.

Estimated CO_2 emissions from Canadian agriculture from direct and indirect sources

Direct emissions	1981	1986	1991	1996
	(Million Tonnes CO_2)			
Soils	7.7	7.3	5.1	1.8
Fuel used on farm	9.5	7.7	8.1	9.5
Total direct emissions	17.2	15.0	13.2	11.3
Indirect emissions	13.7	14.7	14.6	16.3
Total emissions attributable to agriculture	30.9	29.7	27.8	27.6

(Desjardins and Coxworth) [16]

What has been discovered as a result of examining this information is that while indirect emissions are increasing, CO_2 emissions from Canadian soils are actually *decreasing* as a result of conservation practices. To further the findings of decreasing CO_2 emissions from Canadian agricultural soils, it is predicted that in the near future the soils will have the potential to *sequester* carbon in the soils. Instead of instead of agricultural soils in Canada being a net emitter of carbon they will effectively act as a carbon sink. This is of particular importance as we are facing unprecedented concentrations of CO_2 in the atmosphere. While not a concrete solution to the problem of climate change, finding sinks to absorb carbon will help to slow the rate of growth of CO2 levels in the atmosphere by removing it.

Other Greenhouse Gas Emissions

Farming practices not only emit Carbon Dioxide, they emit other greenhouse gases as well. Methane (CH4) is emitted from domestic animal production - both from the animals themselves and from the manure that they generate. [17] Nitrous Oxides (NOx) are emitted as a result of agricultural practices in Canada as well. Nitrogen is a constituent of any soil and shares an intricate relationship with Carbon, aiding in the fertility of soil. Once this process is disturbed through deep tillage practices, Nitrogen is emitted into the atmosphere and

binds with Oxygen to create Nitrous Oxides. Other sources of Nitrogen are found in the manures and fertilizers applied to agricultural lands - which are used to restore the essential soil nutrients required for production.

Enteric Fermentation is the release of Methane generated in the digestive process of ruminant (hoofed) animals, such as cattle[18].

This graph is a summary of the greenhouse gases emitted as a result of agricultural practices in Canada. For simplicity, the values in this graph are reported in Mega Tonnes (MT) CO_2 equivalent. As each greenhouse gas has a different warming potential (ability to trap heat in the atmosphere), this measurement allows us to consider the additive effects of these gases and are expressed in CO_2 equivalents.[19]

Linking Climate Change and Food Security

The definition of food security has evolved over the years. Its definition is dynamic and is defined by experiences and needs of those who require it. A suitable definition of food security has been developed by the Food Democracy Network and reads:

Food security as a situation in which everyone has assured access to adequate, appropriate and personally acceptable food in a way that does not damage one's self respect. People are able to earn a living wage by growing, producing, processing, handling, retailing and serving food. The quality of land, air and water are maintained and enhanced for future generations; and food is celebrated as central to community and cultural integrity.[20]

Climate change, most notably raising temperatures and varying hydrological patters will have a direct negative effect on agricultural production across the planet. In other words, climate change will effect food security and have serious social, environmental and economic implications. Following are projected outcomes of climactic change as defined by the Food and Agriculture Organization of the United Nations:

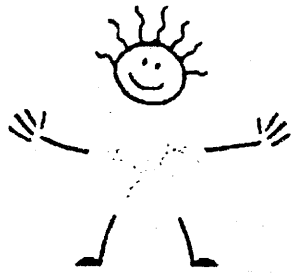
- Climate variability might increase, making fragile farming systems susceptible to loss.
- Climate extremes are suspected to increase, making it difficult for farmers to predict yields.
- Sea-level rises would threaten valuable coastal agricultural land, particularly in low-lying small islands.
- Biological diversity would be reduced in some of the world's most fragile environments, such as mangroves and tropical forests.
- Climatic and agro-ecological zones would shift, forcing farmers to adapt, as well as threatening natural vegetation and fauna.
- Distribution and quantities of fish and seafood could change dramatically, wreaking havoc in established national fishery activities.
- Pests and vector-borne diseases would spread into areas where they were previously unknown.

- Access to water supplies will diminish especially in areas where it is already an issue creating drought, less irrigation and lower yields (40% of developing nations' water supply for agriculture and drinking water comes from the melt water of glaciers[22])

The Prairies - Manitoba, Saskatchewan, Alberta

Forecasts for the Canadian Grain Belt are dismal. Scenarios show increased temperatures and reductions in soil moisture with a doubling of atmospheric carbon dioxide from pre-industrialized levels (see below). Precipitation is suspected to be variable amongst the region - that is, some areas will continue to receive normal rates of precipitation, some will receive more and some areas will see much less. Despite the variability, high rates of evaporation over a longer period of time due to increases in temperatures are predicted to result in diminished soil moisture content.[23] This will have major implications for the livelihood of individual farmers, but more importantly, this will affect regional, national and international food supplies.

Food Distancing



Our food comes a long way to get from the field to our tables. In many cases it is coming from outside our country. This can be measured in something called "Food Miles". **Food miles represent the distance food travels to get from where it is produced to where it is eaten**. Over the past few decades food miles have increased astronomically as a result of globalization, the global economy and global trade. **The average North American meal is said to travel approx. 2,400 km (1,500 miles) from the field to the table[24]. Food Distancing essentially is moving the point of food production further from the market[25]**. Transportation of our food from where it is produced to where it is eaten does not end at the supermarket. It also includes how far citizens have to drive to get from their supermarket to their home. In our suburbanized society the distance from work to the supermarket to home can be quiet large[26].

History of Food Distancing

Our food traveling long distances is not a new phenomenon. This has occurred for hundreds of years. During the Roman Empire, powerful nobles who had an abundance of money could afford food from all across the empire. They could afford it and it was brought to them. This established a class diversion within that society. Locally grown food in Italy was seen as only for the lower class who could not afford imported food. Since then things have changed. Today it is the norm for everyone to eat food that comes from far away regardless of income level. Imported foods are easily accessible in our supermarkets and are difficult to pick out in processed foods as the country ingredients are grown in are not generally listed.

The shift from a locally sourced food system to a global food system can also be attributed to advancements in transportation, such as railways and steamships. It wasn't until the 1860s where transportation of food for the public became possible as a result of the invention of

ice-refrigerated railway cars. This allowed for food to be transported without spoilage. Prior to 1860, people had to use other methods to preserve their food and conserve enough food to last from one harvest to the next. Some of these methods included: canning, preserving, salting, pickling, drying and fermenting. These methods also allowed for transportation, mostly for personal use, after preserving had taken place.[26]

In the 1920s "fast freezing" and "controlled atmospheric storage" technologies were developed which are still used today in some form. Controlled atmospheric storage is most commonly used for apples to preserve them for transport over long distances (Left Image origin David Suzuki Foundation)[27]. They can keep for up to a year's time. Ethylene gas was another invention of the 20s. This allows produce to be picked before ripening and brought to its destination and then sprayed with this gas causing accelerated ripening. In the mid 1900s with the introduction of the refrigerated truck and the falling prices of oil, food shipping began to become a regular practice. During the rationing of World War II, metal was scarce so frozen foods emerged as a viable option. This included processed products such as frozen concentrated orange juice which was originally developed for the military as a way to send oranges and vitamin C to the troops. This trend of frozen foods spilled over into the mainstream food system. Currently, plant breeding and genetic modification are allowing for our food to go farther. By altering a vegetables' genetic makeup it can be made to not rot for an extended period of time. They are also working on toughening up the exterior of produce to withstand mechanized harvesting.

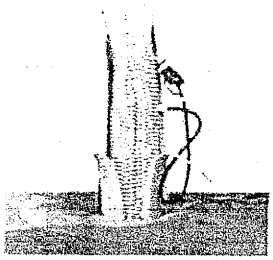
These progressions, although present everyday in our society, are very energy intensive and could be having unforeseen adverse effects on our food. Larger scale technologies needing less human involvement may not be the revolutionary breakthrough they are suggested to be. Larger more efficient forms of transportation are larger points of contribution to climate change. Large ships keep costs down in shipping produce but "efficiency" from a cost perspective does not necessarily mean efficiency from an environmental perspective. For example, when British beef is shipped to Japan it takes a continental route across the United States by primarily rail rather than using the Panama Canal. It is cheaper to use larger ships across the two oceans with all the transfers than it is to simply pack it once on a boat small enough to fit through the canal. Genetic modification besides energy and resource intensive, could pose potential risks and the necessary research has yet to be done[28].

How the Food Distribution System works

Presently, the food distribution system relies on a few main factors to sustain it: technology, packaging, trade and cheap abundant fuel. These 4 factors interact with each other to allow for our present food distribution system to function. One very important thing to note is that our current food system in Canada relies heavily on transportation. The distance or food miles that our food travels would not be possible without technological advancements in agriculture, food processing, and packaging, current global trade and cheap abundant fuel, fossil fuels.

Technological Advancements

New Technologies like GMOs (Genetically Modified Organisms), more efficient storage techniques, mechanized harvesting, and faster, cheap transportation. These technologies are not always cheap or accessible enough to allow local small farms to adopt them which then puts them at a disadvantage when selling their produce as it cannot be sold quite as cheap. Some examples of this are pesticides, fertilizers, and genetically modified seeds. This inevitably removes their share in the market, giving more room for corporate industry to take over. Containerization is an advancement aimed at streamlining the food industry through arranging food in standard-sized containers. This has greatly improved efficiency of food distribution.[29]



Food Packaging

Packaging allows for foods to travel keeping them fresh and prevent spoiling. Creating packaging is an energy intensive practice and because of how far food is traveling you end up using larger amounts of it which in most cases will just end up being discarded upon arrival[30]. Packaging also plays a role in knowing as a consumer what products are sourced locally. In Canada, only 51% of a product's ingredients have to be sourced with in our nation to be deemed a Product of Canada[31]

Packaging Fact: Nitrogen gas is added to pre-packaged lettuce to help reduce browning. The facilities created to clean, chop and package lettuce and the process it goes through is very energy intensive. Producing packaging requires energy consumption. Packaging for pre-cut lettuce is much more substantial than that of normal lettuce consuming more energy just for packaging to be discarded after reaching its destination. Created for convenience but not for Climate Change.

[32]

Global Trade

Trade creates the routes of distribution between countries. It gives a market to producers across the world. Through high exports and high imports there are greater profits. Supermarkets also tend to purchase in massive quantities and will only deal with producers that can provide this. Corporate conglomerates wish to make large purchases to supply their chain stores all across the country with the same products from one purchase. In most cases local farms which produce exactly the same product cannot find a market within their area resulting in export/import of identical products. This is referred to as "food swap". Nations are forced into a certain amount of exports of food by trade agreements Britain is a prime example. Dairy farmers within the nation produce comparable amounts of milk but supermarkets would rather deal with one large producer who will guarantee large amounts of stock, competitive prices and stable quality. Large supermarkets do not want to deal with small farmers because the above factors would vary farmer to farmer. Unless there were an organization for all the farmers to sell their milk to for the same price, who could then sell in larger amounts to supermarkets. Inevitably, this means that food is being stored. Prolonged storage reduces freshness and consumes energy through refrigeration, electricity etc. A direct system of trade from the producers to local supermarkets would cut out the distribution

middleman, give a market to local farmers, and reduce the distance food would travel ultimately reducing the impact the food distribution system has on climate change[33].

Cheap Abundant Fuel

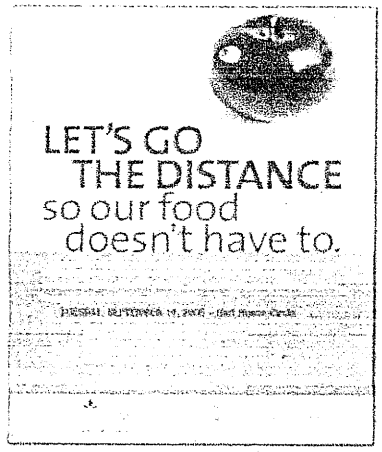
The final factor is cheap abundant fuel. The current distribution system for food is entirely based on cheap abundant fuel and would not be feasible or nearly as profitable without it. When global food trade began this was not as large of an issue but today petroleum costs are constantly going up and expected to peak along with production within 10 years. With a food system based largely on imports for the majority of the year (9 months) our food security depends on an unsustainable resource, Oil[34].

Food Distribution/Distancing and Climate Change

Supermarkets are convenient and sometimes cheaper to buy food from but how much of an impact does that have on climate change? A study was done by Toronto's Food Share comparing food miles of the same products at a farmer's market and a supermarket.

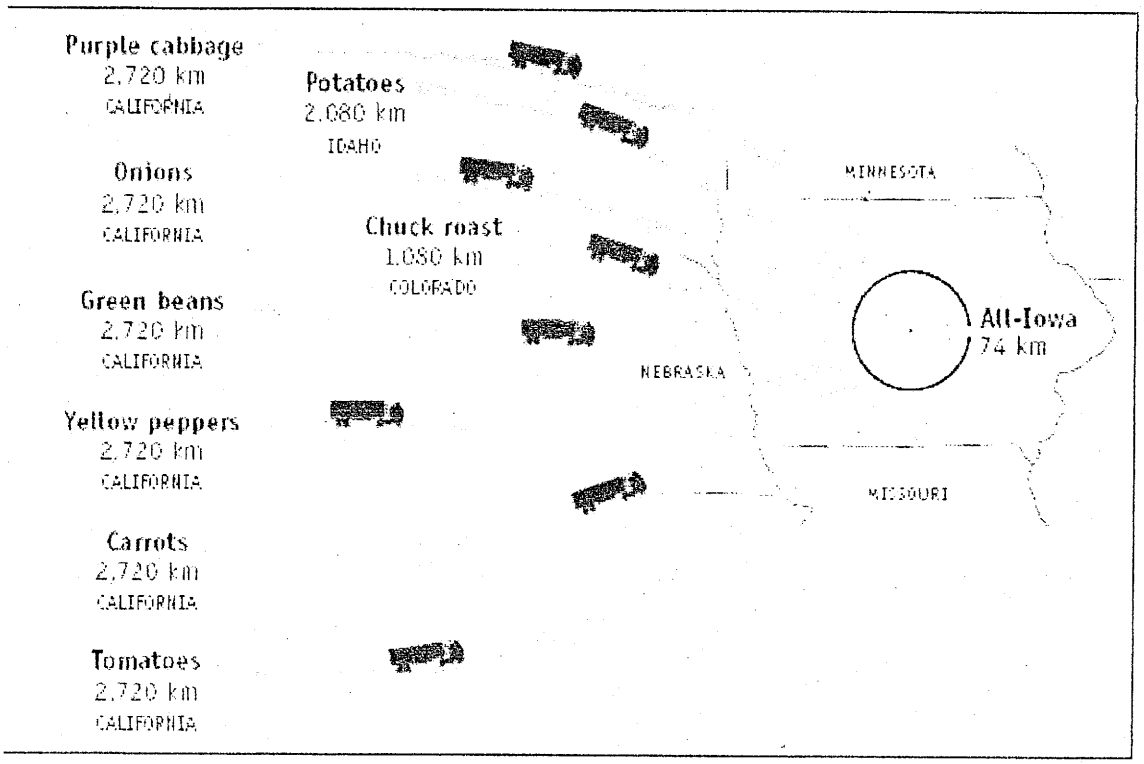
The Results were

- Supermarket foods traveled an average of 81 times farther than local foods.
- A year of consuming local food compared to imported food would reduce greenhouse gas emissions by half a tonne per household[35].
- "Food production and distribution accounts for 10-20 percent of energy consumption in industrialized countries with similar GHG (greenhouse gas) emissions." [36] (Image origin UofT[37])



In Southern Ontario, imported beef to the waterloo region travels an average of 5770 km creating over five times its weight in GHG emissions. **Beef produced within the waterloo area has 667 times fewer GHG emissions.**[38] Food Swap, a result of transport subsidies, centralized buying by supermarkets and food manufacturers and trade agreements forcing nations to export and import the same product to meet quotas on food imports. A prime example of this is Britain. They import the majority of their milk, pork, lamb and other commodities in bulk while the countries' farmers are forced to export the same commodities to find a market. Like the Waterloo region of Ontario, Britain has access to agricultural resources and is not accessing them. Instead they are importing the same products while those within their nation are being exported adding greatly to greenhouse gas emissions. In Britain transportation is the largest growing greenhouse gas emissions contributor[39]. According to A. Carlsson-Kanyama of Stockholm University, **a basic diet comprised of imported vs. local foods can equal 4 times the energy and GHG emissions**[40].

Figure 2-1. Local Versus Imported Ingredients: Iowa



The foods going into an "All-Iowa" meal traveled an average of 74 kilometers to reach their destination, compared with 2,577 kilometers if they had been shipped from the usual distant sources nationwide. Researchers estimated that local and regionally sourced meals entailed 4 to 17 times less petroleum consumption and 5 to 17 times less carbon dioxide emissions than a meal bought from the conventional food chain.

(Halweil, B. 2004.)[41]
Figure 2-1 is a prime example of the implications of a conventional meal compared to a local meal 4 to 17 times less fossil fuel consumption and 5 to 17 times less carbon dioxide. Despite this information being from Iowa, it would be a similar situation elsewhere.

The "ecology of scale" is the idea that there is a loss of productivity between the ecological factors involved in something like agriculture and the end result. For example, the soil is degraded and looses more nutrients through growing a crop with heavy chemical use than the amount of produce that is actually produced. Essentially, ecology of scale refers to a very high energy input into a system to produce something with a significantly lesser outcome than the amount put in. From a logical perspective the ecology of scale suggests that the product that is more environmentally friendly and has been transported efficiently is the better ecological choice and thus the only choice despite other available options[42]. In a nation which has ratified the Kyoto Protocol in 2003, an agreement between a group of nations to reduce GHG (greenhouse gas emissions), it does not seem logical or environmentally sound to import food to consume while producing food for export[43].

Organic food production employs much more environmentally friendly agricultural practices and is said to be healthier for you because of a lack of pesticides, etc. Research conducted through the University of Alberta's Department of Rural Economy suggests that organic food that travels through our food distribution system from a great distance away almost cancels out the environmental benefits of organics because of the generation of GHG emissions through transport. It is not enough to just purchase organic from the supermarket. On average organic food produced using an industrial model with high tillage, similar to the industrial model used for conventionally produced food, equals its contribution in GHG emissions. Health benefits aside, organic produce that is not grown locally has a comparable environmental impact to conventionally grown produce. Buying locally, whether purchasing conventionally grown or organically grown foods, is the key to reducing your greenhouse gas emissions. [44]

Did You Know???

Hot House Tomatoes that are labeled as grown in Canada are still heavy on energy consumption? These tomatoes are grown in greenhouses in Canada in the winter. Some are grown through a process known as hydroponics others are not. This is extremely energy intensive. Even though it is grown in Canada and does not have to travel as far to get to your supermarket, it is still consuming just as much energy if not more than a tomato that is imported from the United States. Also, BC Hot House Tomatoes is just a company name. The stickers on the fruit say BC but the produce is actually grown in Mexico. This produce is consuming double the energy. It is being produced in an inefficient, energy intensive manner and it is being transported from Mexico to here. Make sure you know where and how your tomatoes are being produced.

Alternatives - Moving Towards Sustainable Agriculture

There are alternatives to our current agriculture practices. In an ideal situation, we would all purchase locally grown, organic foods that help to build our local communities. While we wait for our communities to be transformed, we can apply conservation techniques to the current agriculture system that reduces agricultures' contribution to climate change. Remember, agriculture world-wide is estimated to contribute approximately 25% of global concentrations of greenhouse gas emissions. It is for this reason that more sustainable agricultural techniques be adopted.

Conservation Agriculture

Conservation tillage lowers the disturbance to the soils, resulting in a reduction of the soil constituents Carbon and Nitrogen ability to oxidize in the atmosphere creating Carbon

Dioxide and Nitrous Oxides. Applying crop residues to soils help to form a protective layer preventing oxidization of carbon and nitrogen, while returning organic matter to the soil. Soils which have a high organic content are better structured and are better able to retain moisture - which is of particular importance in regions where precipitation is projected to decrease. The use of crop residues can also reduce reliance on fertilizers. Integrated Pest Management can reduce the reliance on pesticide use by using rotational cropping. Rotation cropping involves using different crops each year that make it unfavourable for pests and diseases to colonize which would be a typical scenario under monoculture cropping.[46] Furthermore, conservation agriculture is a requirement of organic certification.

Personal Alternatives

The First Step

- **Food Storage** – stock up on locally grown fruits and vegetables when they're in season – choose produce that will keep longer – potatoes, onions, squash etc.
    - canning, preserving, salting, pickling, drying and fermenting are great ways to preserve food
- **Buy in Season** – when local produce is available from farmers and farmers markets grocery shop there instead of at supermarkets – your family will enjoy it
- **Buy Locally Grown, Organically Produced Products –** buying locally and organic when possible significantly reduces food miles and distancing effect
- **Grow Your Own Garden** – Using organic, local seeds and all natural pesticides/fertilizers you can reduce your impact on climate change and control how your food is produced - Doesn't get any closer to home than your own backyard

Further Steps

- **Join a CSA-** get the majority of your produce from a local, organic source
- **100 Mile Diet** – Try reducing all your food to what is produced within 100 miles of your home and reduce food transportation impacts on climate change
- **Become a Vegan** – consuming no meet or meet related products reduces your impact by **a ton and a half of CO_2** in a year compared to the average N.A. diet
- **Voice your Concern** – Write, email and phone your government representatives to let them know how you feel about these issues – **push for action and change**
- **Get Involved** – join community groups, create citizen initiatives and educate fellow citizens on these issues

"**Industrial agriculture has not produced more food**. It has destroyed sources of food, and it has stolen food from other species to bring larger quantities of specific commodities to the market, **using huge quantities of fossil fuels and water and toxic chemicals in the process**."
- Vandana Shiva a physicist, writer and science policy advocate, who is the Director of The Research Foundation for Science, Technology and Natural Resource Policy from her article discussing the "Hijacking of the Global Food Supply".

47

Endnotes

[1] Pfeiffer, D. A., 2006. Eating Fossil Fuels. Gabriola Island, BC: New Society Publishers Inc.
[2] Halweil, B. 2004. The Transcontinental Lettuce. Eating Here: Reclaiming Homgrown Pleasures in a Global Supermarket. New York: W.W. Norton and Company. pp 23-42, 191-195.
[3] Environment Canada. 2005. Climate Change. [Online] Available http://www.ec.gc.ca/soer-ree/English/Indicator_series/new_issues.cfm
[4] Cartwright, F., Earle, K., Hurlington, K., 2002. On the Threshold: Analysing Canadian and World Issues. Toronto: Gage Learning Corp.
[5] Cunningham, W. P., Cunningham, M. A., Woodworth Saigo, B., Bailey, R., Shrubsole, D., 2005. Environmental Science: A Global Concern. Toronto: McGraw-Hill Ryerson.
[6] Cunningham et al. 44-46
[7] Cunningham et al. 160-166
[8] David Suzuki Foundation. 2007. Solving Global Warming: Science. [Online] Available. http://www.davidsuzuki.org/_pvw370829/Climate_Change/Science/
[9] Environment Canada. 2007. Information on Greenhouse Gas Sources and Sinks : Factsheet 7. [Online] Available http://www.ec.gc.ca/pdb/ghg/
[10] Cunningham et al. 162-166 , Environment Canada. 2005. Climate Change. [Online] Available http://www.ec.gc.ca/soer-ree/English/Indicator_series/new_issues.cfm
[11] Environment Canada 2005.
[12] Food and Agriculture Organization of the United Nations. 2001. Agriculture's role in climate change. [Online] Available http://www.fao.org/AG/magazine/0103sp2. htm
[13] Alder Planetarium. 2005. The Carbon Cycle Carbon In and Out of the Atmosphere [Online] Available http://www.adlerplanetarium.org/cyberspace/planets/earth/ carbon_cycle.html
[14] Bournay, E., Rekacewicz P., 2005. Past and Future CO2 Concentrations – Maps and Graphics ant UNEP/GRID Adrenal. [Online] Available http://maps.grida.no/go/graphic/past_and_future_co2_concentrations
[15] Reynolds, J., 2005. Soya farmers to blame for Amazon forest loss. The Scotsman. Scotland. [Online] Available http://news.scotsman.com/ViewArticle.aspx?articleid=2627988
[16] Agriculture and Agri-Food Canada. 2006. National Land and Water Information Service: Total Emissions. [Online] Available http://www.agr.gc.ca/nlwis-snite/index_e.cfm ?s1=pub &s2=ha_sa&page=26
[17] Desjardins R.L., & Coxworth. E., 2006. Total Emissions. [Online] Available http://www .agr.gc.ca/nlwis-snite/index_e.cfm?s1=pub&s2=ha_sa&page=26
[18] Environment Canada. 2007.
[19] Environment Canada. 2007.
[20] PollutionWatch. 2007. Understanding the Data used on PollutionWatch. [Online] Available http://www.pollutionwatch.org/tools/understandData.jsp
[21] British Columbia Food Systems Network. (n.d.) Food Security. [Online] Available http://www.fooddemocracy.org/security.php
[22] Suzuki, D., The Nature of Things – Climate Change: An Uncertain Future
[23] Ponce-Hernandez, R. 2007. GEO 4 - Chapter 3: Land Resources Assessment and Evaluation – Ask an Expert. [Online] Available http://www.unep.org/experts /default.asp
[24] David Suzuki Foundation. 2007. Food That Needs a Passport. [Online] Available http://www.davidsuzuki.org/NatureChallenge/newsletters/oct2004_buylocal/page3.asp
[25] Halweil 72-76
[26] Pfeiffer 22-25
[27] Halweil 72-75
[28] David Suzuki Foundation. 2007. Think global, eat local?. [Online] Available http://www.davidsuzuki.org/NatureChallenge/newsletters/oct2004_buylocal/page2.asp
[29] Halweil 72-74

[30] Halweil 74-75
[31] Halweil 74
[32] David Suzuki Foundation. 2007. Eat Local?. [Online] Available http://www.davidsuzuki.org/blog/DSF1_10300701.asp
[33] Halweil 74-75
[34] Halweil 76-77
[35] Halweil 76-77
[36] Xuereb, M., 2006. And Miles to Go Before I Eat: Home-Grown Hurrah. in Alternatives Journal 32:3. Waterloo: Faculty of Environmental Science University of Waterloo Press. pp 18-20.
[37] Andree, P., 2006. And Miles to Go Before I Eat: Local Limitations. In Alternatives Journal 32:3. Waterloo: Faculty of Environmental Science University of Waterloo Press. pp 19-21.
[38] UofT. 2007. Sustainable Food Launch. [Online] Available www.provost.utoronto.ca/.../sustainablefood.htm
[39] Xuereb 20
[40] Halweil 76-77
[41] Halweil 76
[42] Halweil 73
[43] Andree 19
[44] Hill, S., Leiss, W., 2006. A Night at the Climate Casino: Canada and the Kyoto Quagmire. In Canadian Environmental Policy, ed. Stephen Hill. Toronto: Canadian Scholars' Press Inc. pp. 187-207.
[45] Betkowski, B., 2007. Transporting organic foods can neutralize environmental benefits. University of Alberta. [Online] Available http://www.afhe.ualberta.ca/Index.asp?page=News&news=976
[46] Ponce-Hernandez, 2007. [Online]
[47] Shiva, V., 2005. The Hijacking of the Global Food Supply. In Human Inequality in Global Perspective, ed. J. Clapp, D. Hall. Peterborough: Trent U Press, article 15.

References

Agriculture and Agri-Food Canada. 2006. National Land and Water Information Service: Total Emissions. [Online] Available http://www.agr.gc.ca/nlwis-snite/index_e.cfm ?s1=pub &s2=ha_sa&page=26

Alder Planetarium. 2005. The Carbon Cycle Carbon In and Out of the Atmosphere [Online] Available http://www.adlerplanetarium.org/cyberspace/planets/earth/carbon_cycle.html

Andree, P., 2006. And Miles to Go Before I Eat: Local Limitations. In Alternatives Journal 32:3. Waterloo: Faculty of Environmental Science University of Waterloo Press. pp 19-21.

Betkowski, B., 2007. Transporting organic foods can neutralize environmental benefits. University of Alberta. [Online] Available http://www.afhe.ualberta.ca/Index.asp?page=News&news=976

Bournay, E., Rekacewicz P., 2005. Past and Future CO2 Concentrations – Maps and Graphics ant UNEP/GRID Adrenal. [Online] Available http://maps.grida.no/go/graphic/past_and_future_co2_concentrations

Botkin, D. B., Keller, E. A., Heathcote, I. W., 2005. Environmental Science: Earth as a Living Planet. Mississauga: John Wiley and Sons Canada, Ltd.

British Columbia Food Systems Network. (n.d.) Food Security. [Online] Available http://www.fooddemocracy.org/security.php

Cartwright, F., Earle, K., Hurlington, K., 2002. On the Threshold: Analysing Canadian and World Issues. Toronto: Gage Learning Corp.

Cunningham, W. P., Cunningham, M. A., Woodworth Saigo, B., Bailey, R., Shrubsole, D., 2005. Environmental Science: A Global Concern. Toronto: McGraw-Hill Ryerson.

David Suzuki Foundation. 2007. Eat Local?. [Online] Available http://www.davidsuzuki.org/blog/DSF1_10300701.asp

David Suzuki Foundation. 2007. Food That Needs a Passport. [Online] Available http://www.davidsuzuki.org/NatureChallenge/newsletters/oct2004_buylocal/page3.asp

David Suzuki Foundation. 2007. Solving Global Warming: Science. [Online] Available. http://www.davidsuzuki.org/_pvw370829/Climate_Change/Science/

David Suzuki Foundation. 2007. Think global, eat local?. [Online] Available http://www.davidsuzuki.org/NatureChallenge/newsletters/oct2004_buylocal/page2.asp

Desjardins R.L., & Coxworth. E., 2006. Total Emissions. [Online] Available http://www.agr.gc.ca/nlwis-snite/index_e.cfm?s1=pub&s2=ha_sa&page=26

Environment Canada. 2005. Climate Change. [Online] Available http://www.ec.gc.ca/soer-ree/English/Indicator_series/new_issues.cfm

Environment Canada. 2007. Information on Greenhouse Gas Sources and Sinks : Factsheet 7. [Online] Available http://www.ec.gc.ca/pdb/ghg/

Food and Agriculture Organization of the United Nations. 2001. Agriculture's role in climate change. [Online] Available http://www.fao.org/AG/magazine/0103sp2.htm

Halweil, B. 2004. The Transcontinental Lettuce. Eating Here: Reclaiming Homgrown Pleasures in a Global Supermarket. New York: W.W. Norton and Company. pp 23-42, 191-195.

Hill, S., Leiss, W., 2006. A Night at the Climate Casino: Canada and the Kyoto Quagmire. In Canadian Environmental Policy, ed. Stephen Hill. Toronto: Canadian Scholars' Press Inc. pp. 187-207.

Pfeiffer, D. A., 2006. Eating Fossil Fuels. Gabriola Island, BC: New Society Publishers Inc.

PollutionWatch. 2007. Understanding the Data used on PollutionWatch. [Online] Available http://www.pollutionwatch.org/tools/understandData.jsp

Ponce-Hernandez, R. 2007. GEO 4 - Chapter 3: Land Resources Assessment and Evaluation – Ask an Expert. [Online] Available http://www.unep.org/experts/default.asp

Regents of the University of California. 2006 Atmospheric Chemistry: The Elements of Global Environmental Issues. [Online] Available http://www.ucsd.tv/moleculesforthemedia/lesson_atmosphere_study.asp

Reynolds, J., 2005. Soya farmers to blame for Amazon forest loss. The Scotsman. Scotland. [Online] Available http://news.scotsman.com/ViewArticle.aspx?articleid=2627988

Robinson, P. J., Sellers-Henderson, A., 1999. Contemporary Climatology. 2nd ed. Toronto: Pearson – Prentice Hall.

Shiva, V., 2005. The Hijacking of the Global Food Supply. In Human Inequality in Global Perspective, ed. J. Clapp, D. Hall. Peterborough: Trent U Press, article 15.

Suzuki, D., The Nature of Things – Climate Change: An Uncertain Future.

UofT. 2007. Sustainable Food Launch. [Online] Available www.provost.utoronto.ca/.../sustainablefood.htm

Xuereb, M., 2006. And Miles to Go Before I Eat: Home-Grown Hurrah. in Alternatives Journal 32:3. Waterloo: Faculty of Environmental Science University of Waterloo Press. pp 18-20.