An Evaluation of Food Security in Manitoba: An Issue of Sustainable Supply

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Abstract

The discipline of Sociology has been quiet regarding the production of food by industrial agriculture. However, there are issues that potentially undermine the ability of industrial agriculture to continue to produce food at the same rate. These issues include: global climate change, aquifer depletion, soil erosion and exhaustion, the increase in global production of meat, the ever expanding global population and peak oil. This thesis considers how these issues will affect Manitoba's agriculture, Manitoba's ability to adapt to a period of change and its ability to continue to feed its population. Unstructured interviews with expert informants allowed for the collection of data that are not readily available. These data are combined with pre-existing data to assemble an agricultural profile. There are two competing theories within the current dialogue: limits-to-growth and ecological modernization. Ultimately, the food procurement practices will be assessed with reference to the limits-to-growth theory and recommendations will be made.

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Chapter 1: Introduction - Environmental Crisis and Food Security

This chapter serves to highlight the environmental crises that affect the production and food procurement practices currently being practiced in Canada. It also serves to outline the direction of the thesis as a whole.

Environmental crises such as peak oil, climate change, aquifer depletion, soil erosion, salination and depletion, and the global increases of both humans and livestock, all bring into question the future of our society. One major issue facing the human population is that in the face of this environmental turmoil, how are we going to continue to produce enough food to sustain the population? This thesis is a preliminary study to explore how these issues are likely to affect Manitoba's agriculture, Manitoba's ability to adapt to a period of rapid change and its ongoing ability to continue to feed its population. In order to evaluate Manitoba's current situation, there are many "smaller" questions that have to be addressed.

Manitoba's food procurement practices are dictated at least partially by the climate. Manitoba's climate is such that the growing season is short. An agricultural profile is developed for Manitoba in Chapter 5. The profile will assist in understanding if and how Manitoba agriculture will need to address and meet many of these environmental constraints.

Given the scale of the disruptions that will be precipitated by climate change and peak oil, it is important to know how dependent Manitoba is on food produced outside of its own borders. Long distance transport may no longer remain feasible due to shortages in fossil fuels. If Manitoba is unable to rely upon a steady source of food from outside the province, the question becomes: what is the capability of Manitoba to produce all of its own food from within its own borders? If production is able to keep up with the demand, the short growing season means that the food will require storage, which relies on infrastructure and energy. On the other hand, if Manitoba is unable to achieve a production level adequate for sustaining the current population, what is the appropriate number of people that could live in Manitoba? How many people can be sustained on a per acre basis? Does the frequency of extreme weather events affect the types of crops that can be grown in Manitoba? Are there better ways to deal with these extreme weather events?

It is not just fossil fuels used in transportation that are important to consider. Fossil fuels are used extensively throughout all aspects of the process. On farm, fossil fuels are used by equipment during seeding, maintaining, harvesting, transporting and storage of the food produced. Virtually every chemical used on farm to fertilize crops and control pests has been produced by and/or from fossil fuels.

Alternatives such as organic agriculture, permaculture, polyculture and vertical agriculture will be discussed to assess each of their capabilities. Ultimately, the question of social change is of utmost importance. Understanding how these issues will affect Manitoba will be of little value if change cannot be implemented. Where does the change start and who is responsible for carrying it out?

These questions were posed to a number of individuals and organizations who have an intimate knowledge of Manitoba agriculture practices and capabilities. The study requested participation from all types of organizations; government, non-governmental and private sector businesses that work in the area. Those who were willing to participate provided important data. Given the variation in the kind of information sought from each organization, it was gathered by using qualitative interview methods. Each interview was conducted with a topic guideline and remained as unstructured as possible.

Sociology and the Environment

The discipline of Sociology has been exceptionally quiet regarding the issues at hand. Sociology has traditionally excluded the realm of the environment. The conditions into which Sociology was born and matured, were conditions where the

environment could be ignored and counted as being extraneous to the social space (Catton and Dunlap, 1978). The world population and consumption levels were small enough to have little effect on the environment. Numerous localized areas have experienced mass human extinctions due to population size and resource extraction. Since then, population levels have increased enormously and the consumption of natural resources has been increasing alongside. Sociology as a discipline no longer has a choice but to include the environment within its scope if it hopes to contribute to the social change that will be necessary to meet these coming challenges.

Two theoretical camps have been vying with each other over how to best tackle the environmental issues at hand; limits-to-growth and ecological modernization. Limits-to-growth resulted from a study that was released in 1970 by a group called the Club of Rome. The study argued that the continued growth of the human population would lead eventually to a scenario where the human population became unsustainably large. The idea is that as the population grows, pollution, production and consumption grow as well. If growth continues, all things being equal, the supply of non-renewable resources dwindles and is no longer sufficient to supply the population; as well, the renewable resources are used at increasing pace so that they cannot renew themselves quickly enough. This is the basis of neo-Malthusian ideas about the "global consequences of exponential growth in

population, industrial production, and material consumption" (Harper, 2008: 208). The resulting scenario is known as an outbreak-crash scenario. The outbreak portion of the scenario occurs when the initial growth of the population is still small enough that the amount of resources used are not cutting into the environmental capital, but rather they are surviving on the interest. Ecological overshoot occurs after the demand levels have increased sufficiently that the interest is no longer sufficient, and it becomes necessary to draw down the initial capital. It is at this point, where even maintaining this level of demand becomes unsustainable that "ecological debt" begins to accumulate. The crash scenario occurs after the point where the remaining resources are no longer able to sustain the demands made upon the ecosystem and it collapses. It is at this point where the population enters into a massive die-off.

The second theory, ecological modernization, began by arguing exactly the opposite. Here, it is argued that society can carry on largely as it has been simply by instituting measures that counteract the environmental issues. Ecological modernization theory (EMT) argues that economic development is the necessary fix. Proponents of this theory argue that increasing affluence allows better organization of citizens to pressure the government. It is the government's responsibility to institute policies which aid in the reformation of business to more environmentally conscious practices. There have been significant improvements of society's practices, such as the implementation of recycling. The major problem with this

approach is that even with the technological improvements, the level of consumption has historically increased to such an extent that it has completely negated any positives that were gained with the change in the policy and practices (Harper, 2008: 216).

More recently, ecological modernization theorists have changed the point of their argument. Initial criticism of this theory was its reliance on technology to increase the natural boundaries of nature. The theorists attempted to separate themselves from the technological criticism by tying their theory to other theories. These theories have included Ulrich Beck's risk society theory[1] (Mol and Spargaaren, 21). They have now admitted production and consumption would simply continue under different relations of production. The only reason that capitalism is the dominant mode of production is because it is the only one that has survived (Mol and Spargaaren, 22). The affiliation with risk society theory does not change the fact that innovation (technological, policy or organizational) remains the vehicle to address environmental limits. The fatal flaw with ecological modernization is that it fails to recognize that continued growth is not possible

[1] Risk society theory argues that the welfare state had been successful enough that division along class lines was no longer a big issue (Cohen, 1997). Beck argued that the division within society was occurring around the division of technological risks (Cohen, 1997). According to Cohen, ecological modernization and risk society were not two theories opposed to each other but rather two theories that discussed a societies potential course in decision making (Cohen, 1997).

although innovation may increase the length of time it takes for overshoot to be reached. Therefore, human beings will be forced to live within the limits of nature and technological innovation will not overcome excessive population and consumption pressure**.**

Chapter 2: A History of Food Security and a Discussion of Theory

This chapter serves to outline the historical discussion around the idea of food security. Also, I will point out and discuss a number of local organizations and people working on the issue of food security in Manitoba. Limits-to-growth and ecological modernization both have merits and drawbacks. A deeper discussion and comparison between these two theories is necessary to evaluate which is better able to address the ecological crises that we face. At the end of the chapter, I will make a case for what I consider to be the theory that is most appropriate to guide the direction of change in our society.

Food Security

Food security was first discussed during the United Nations announcement of the Universal Declaration of Human Rights in 1948. Article 25 of this declaration states:

> everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, *including food*, clothing, housing and medical care and necessary social services, and the *right to security* in the event of unemployment, sickness, disability, widowhood, old age, or other lack of livelihood in circumstances beyond his control (United Nations , 4, emphasis added).

This article in the declaration extends to all individuals the right to food throughout their life, regardless of situation. As pointed out by the Manitoba Food Charter, this is not a law, but rather it is something that all signatory countries should strive to achieve (Manitoba Food Charter, 2008). It is important to note that Canada signed this agreement.

In 1976, the member countries of the United Nations ratified the Covenant on Economic, Social and Cultural Rights which addressed many topics, one of which was food. This document further defined what was previously stated by the Universal Declaration of Human Rights. Article 11 of this document states that those who ratify it, recognize the right of everyone to not only have adequate food but also to continue to attempt to improve the supply of food and to implement specific programs formulated to deal with the problem of hunger in the world (United Nations, 4). It also addressed the issue of reforming current agrarian systems and developing new ones, "to achieve the most efficient development and utilization of natural resources" (ibid., 4). Perhaps the most important of the statements was that the problems need to be solved, taking into account, the issues faced by both importing and exporting countries (ibid., 4). Canada signed this agreement as well.

The Food and Agriculture Organization of the United Nations began tracking the world's hungry in 1969-1971 using a revised analysis tool. Yet it was not until

1996, that the United Nations officially planned an event, which had as its sole purpose to address this problem. It was called the World Food Summit and it took place in Rome, Italy, over the period of five days. The meetings resulted in the publication of a report that outlined both the problem of hunger and also a plan of action designed to help eliminate it. The meetings produced an agreed upon and achievable goal of reducing the number of hungry in the world by no less than half (Food and Agriculture Organization, 1). It was at this time that the United Nations made its first attempt to define the term "food security". They argued that it exists when "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (ibid., 4). They viewed poverty as the main reason for the existence of food insecurity. Indeed, the authors of the Rome Declaration pointed out, that on average, the food available per capita had increased by fifteen percent in the period between 1976 and 1996 (ibid., 4). Further, they argued that eliminating poverty would eliminate food insecurity. It was accepted that food security is not an issue of supply; rather, it is a lack of access that is the main problem.

The Food and Agriculture Organization produced another report marking progress of the Rome Declaration after five years. It is noted that the elimination of hunger had been much slower than had been hoped for. The number of hungry

people in the world was only diminishing at a rate of 8 million per year, not fast enough to meet the goal they set out in 1996 (ibid., 81).

It appears that the optimistic goal of reducing the number of hungry people in the world by half failed to take into consideration the continued population growth of the world. According to the United Nations, in 1995 there were about 5.7 billion people in the world; by the year 2000 the population had grown to 6.1 billion. In 2005, it was 6.5 billion or about 800 million more people than 1995 (United Nations, 2007). This is also roughly equivalent to the number of people that the UN was originally attempting to help. Furthermore, it has been estimated that by 2050, the world population will reach between 7.8 billion and 10.7 billion (ibid., 2007). The food supply necessarily needs to increase in order to feed not only those who are already alive but to feed all of the people that are continuously being added. Even now, if food were distributed equally, there would be approximately 2786 calories per capita, per day (Evans, 1998: 184 and Badgley et al., 2003: 92).

The United Nations is not alone in its concern about food security. Indeed, it is the body responsible for discussing this at the world level but there are people who are concerned with food security on a much smaller scale; individual countries, provinces and even communities. There are Manitobans who are not just concerned for Manitoba in general, but are focused on those who live in rural, urban and

northern areas of the province. There is also a growing body of academic work on the subject of food security in Manitoba (cites include: Thompson, 2008; Thompson et al, 2011). The main group responsible for this discussion within the province is the Manitoba Food Charter, now called, Food Matters Manitoba.

According to its web site, the Manitoba Food Charter is both an organization as well as a document (Manitoba Food Charter, 2008). The Manitoba Food Charter unofficially began in 1992 after a paper titled "An Action Plan For Food Security For Manitobans" was released by the group known as The Nutrition and Food Security Network of Manitoba (ibid, 2008). However, it was not until 2006 that a steering committee was formed to develop a document representing stakeholders across Manitoba (ibid, 2008). This document became known as the Manitoba Food Charter. It represents opinions from 70 groups of people and stakeholders from "across the province – 22% in rural communities, 17% in Manitoba's north, 33% from urban and 28% from consultations involving mixed regions" (ibid, 2008). This document represents the single vision of all those that took part in its development. This vision is summarized as follows: "a just and sustainable food system in Manitoba is rooted in healthy communities, where no one is hungry and everyone has access to nutritious food. It is an economically viable, diverse and ecologically sustainable system to grow, harvest, process, transport, and distribute food while minimizing

waste" (ibid, 2008). This vision acts also as the group's definition of the term food security.

A just and sustainable food system is a very broad statement, and as such, the Manitoba Food Charter defines the term by way of examples. The Peoples' Summary of the Food Charter is where these examples can be found. It begins by stating, a just system is one where all communities are healthy; northern, rural, and urban. This means that no one is hungry including everyone from single mothers to disabled persons and those in remote communities. Finally, a just system occurs when "everyone has access to nutritious food" (Manitoba Food Charter, 2008). A sustainable system contains the following characteristics; it is economically viable and provides a good living for all those involved in the food system. It is diverse and contains large farms as well as community gardens and is ecologically sustainable (ibid, 2008).

The Charter also discusses the idea of Aboriginal Peoples' rights to sustainable hunting, fishing, trapping and gathering practices in Manitoba and asserts that we must uphold this right. It discusses the idea of maintaining healthy community relationships, a balance between international trade and locally produced foods that will provide a variety of healthy and nutritious food as well as the provision of pertinent information that allows consumers to learn whether or not the

food they are eating is indeed, healthy (ibid, 2008). This balance between the locally and internationally sourced foods, would create local income generation through an increase of local labour needed to produce consumer goods. The increase of locally produced goods that are purchased locally, means that the monies that are already available circulate within the local economy. On the other hand, monies that are used to purchase goods from interprovincial and international locales are immediately removed from the local community and the overall amount of capital left is reduced.

Food security is most often conceptualized as being a problem of access. Studying both poverty and famines, Amartya Sen showed very clearly that famines are not necessarily a direct consequence of a reduction in the availability of food per person (Sen, 1981:161). He points to a series of famines where this was precisely the case; the Irish famine that occurred in the 1840s is a good example and more recently the Bengal famine in 1943 (Sen, 2009:26). During the Irish potato famine, Ireland continued to export large quantities of food to England, even while many people were dying of starvation (Sen, 1981:161). Sen shows that there is a set of rules governing a person's entitlement to food. In a market based society, the distribution of all goods, including food, is not based on needs, biological or otherwise. Goods are distributed to those that have the proper entitlement characteristics. In a market based society that means whoever has the necessary currency to purchase the goods.

This occurs regardless of the needs of others. Starvation results from "a failure to be entitled to a [commodity] bundle with enough food" (Sen, 1981:45). The point is that to achieve food security one must have access to food.

Food Security Theories

Until now, the issue of access to food has primarily been the main concern for food security theorists. This paper attempts to understand and explain issues surrounding the availability of food to the world's population. Theories that discuss food security and agriculture have primarily come from more broad development based theories. Manfred Schulz (1999) argues there are six different development theories that discuss agriculture; Modernization, Dependency, Basic Needs, Neo-Liberalism, Post-modernism and Sustainable Development. However, all six are arguably variations on two: limits-to-growth and ecological modernization.

Limits-to-Growth

If limits-to-growth posits that growth at any rate is unsustainable, than the idea of growth must be explained. Ecological marxism as put forth by Joel Kovel explains the problems with growth. Kovel argues that capitalism must continuously expand in order to survive (Kovel, 2002: 38). Expansion is expressed in value terms

(though it requires material and energy inputs), and it takes place through the circuit of capital. Karl Marx defines accumulation, as the returning of surplus-value realized through a market exchange, back to the production process (Marx, 543). This action allows for a greater purchase of labour power, raw materials, and machinery with the goal of increasing the production quality/value, which would obtain more surplus-value during the next market exchange. This is known as the Money-Commodity-Money' cycle (M-C-M') that continues with M' becoming M at the start of the next cycle.

It is not just growth that capitalism is striving for. It also makes every attempt to increase the speed of the cycle (Kovel, 59). A commodity that is left on the market never to be exchanged is a problem for capitalists. The exchange-value must be released from the commodity so that the cycle can begin again. This was realized by Victor Lebow in 1955,

> Our enormously productive economy demands that we make consumption a way of life, that we convert the buying and use of goods into rituals, that we seek our spiritual satisfaction, our ego satisfaction, in consumption. We need things consumed, burned up, replaced, and discarded at an ever-increasing rate (Lebow, 1955).

Capitalists often attempt to reduce the amount of time it takes in the production of its commodities through increasing the efficiency of the division of labour and technology. Allan Schnaiberg understood this process as leading to a "treadmill of

production" (Gould, Pellow and Schnaiberg, 297). Schnaiberg argued that the increase in the use of technology in production constitutes a reduction in the amount of labour from which companies could profit. Marx considered technology a form of constant capital from which profit could not be made (Marx, 202). Schnaiberg argued that the increased reliance on technology is the reason production increased; technology is able to sustain higher levels of productivity (Gould et al., 297).

The "treadmill of production" can be seen all throughout capitalist societies but it will be considered in the context of modern agriculture. Farmers involved in modern agriculture are forced by capitalist economies to increase the amount of food that they produce. The problem is that as farmers produce more food, more food becomes available for the general public, making each unit less valuable (Magdoff, Foster and Buttel, 12). This forces the farmers into a position where they are required to produce more to make the same amount as before, but by producing more they in effect further reduce the price for their product. As such they are forced to buy more land, bigger equipment to achieve the same profits year after year. When applied to agriculture it drives the intensification of agriculture. By receiving lower prices for agricultural products, farmers have been forced into using innovative techniques to force the land to produce more food. The food becomes produced at a rate that degrades the soil, forces larger scale monoculture cropping, results in increased use of pesticides/insecticides, and is unsustainable in the long term. This

efficiency has been pushed by a drive to increase profit. This efficiency can be measured roughly by the types of inputs compared to the outputs (Porritt, 2004: 5).

According to this group, growth and associated consumption increases must stop or face the consequences of a large-scale crash of the human population. Mathis Wackernagel developed the most widely known evidence supporting the limits-to-growth argument (Harper, 210). Wackernagel calculated the "ecological footprint" (ibid, 210), which represents the "the biologically productive land and water required to produce the resources consumed and to assimilate the wastes generated by a given human population" (ibid, 210). The calculation yielded a total of 2.1 global hectares available per person, not including any other life form, in 1995. As population continues to increase, the amount of land available per person must decrease. Indeed, the same calculation showed that in 2007 the land available per capita had decreased to 1.8 global hectares, even while we were requiring on average 2.7 hectares per person (Global Footrint Network, 2012). Further, as consumption increases with population, available non-renewable resources must permanently decrease. Essentially, limits-to-growth proponents argue that current practices are wholly unsustainable. They argue that a drastic decrease in consumption brought about partially by a decrease in population is the only way to ensure that humans can ensure survival over the long run (Pimentel and Pimentel, 1995). The outbreak-crash scenario calculations are based on unrefined indicators and rough measurements and

so, while we know that the overshoot process has been underway since the mid 1980s, we have no way to chart exactly where we are in the scenario. There are underlying assumptions that are based on aspects about our society that we are not capable of calculating, like population growth and decline, or on our best estimates on the amount of resources that are left, such as oil and natural gas. Unfortunately, it appears that we will never know exactly where we are until the population crash begins. Harper argues that we are currently in the 'overshoot' portion (ibid, 209).

Overshoot is where the renewable resources are being consumed faster than the recharge rate. It appears that the limits-to-growth theory regards ecological problems as having ecological solutions. These solutions might take the form of a Malthusian type die-off, or according to the Global Footprint Network run by Wackernagel we can choose to start living in a way that allows us to remain within the ecological limits of the earth (Global Footprint Network, 2010). Limits-to-growth theorists argue that the significant changes need to be implemented immediately in order to prevent these ecological crises from turning into ecological catastrophes. Angus and Butler argue that fossil fuel use has to be replaced with ecologically sound sources such as, wind, solar and geothermal (Angus and Butler, 2011). Current agriculture practices have to immediately be converted to ecological agriculture (ibid.). Production and consumption practices have to be changed completely. In short, Angus and Butler call for nothing short of an 'ecological

revolution' requiring a massive cultural shift (ibid.). There is another group of theorists that put forth a differing argument. Ecological modernization theorists argue that any environmental problem has solutions that originate from societies' capacity for reflexivity, including their capacity for innovating within existing social relations and institutions.

Ecological Modernization

Ecological modernization theorists acknowledge that environmental problems have become significant issues. However, they argue that further economic development would solve these problems (Harper, 2008, 212). As production continues and people become more affluent, they are better able to organize and make environmental concerns known to government (ibid, 212). It is this pressure, which creates change through policy implementation, and government incentives, which make "green production" by business more appealing. Ecological modernization goes by many names including; eco-efficiency, clean production, industrial ecology, natural capitalism as well as others listed by Harper (ibid, 212).

Policy changes can force business to change how they produce, but more often governments institute what is known as incentive based shifting mechanisms (ibid, 212). These usually consist of tax shifting that is revenue neutral. Harper

points towards European countries that have lowered income tax and property taxes while increasing taxes on carbon based fuels and pesticides (ibid, 212).

There are multiple ways that production itself could become more environmentally considerate. Biomimicry and cogeneration feed into another mode of change known as a service and flow economy (ibid, 212). Biomimicry is the attempt to mimic an ecosystem by building into the production process as many recycling features and feedback loops as possible. Cogeneration, however, attempts to use wastes in such a way as to produce another commodity. Harper explains that one could use the "waste" heat energy created by a factory and convert it to electricity (ibid, 212). This occurs when corporations are forced to become responsible for all aspects of the commodities that they produce, including the recycling, disposal or remanufacturing. Manufacturers of consumer goods have become conscious of the amount of raw materials that are needed to produce commodities. This is being facilitated by the rising costs associated with manufacturing. Since the 1970s, these manufacturers have decreased the overall amount of materials used in producing individual goods. However, it should be noted that the level of consumption has increased, and as a consequence, the overall usage of materials has not diminished (ibid, 212). This is understandable considering the growth imperative of capitalism.

The principles followed are based on technological advances that allow capitalist economies to function without change (Harper, 2008: 213). This includes the use of technology in agriculture that promotes the increased production of food. From this theoretical perspective, the use of agricultural technology is essential to feeding the world's population. Included within this definition of technology is; farm equipment, irrigation pumps, fossil fuel based chemicals, as well as, genetically modified seeds and foods. It is the use of technology that has created the vast increases in food production. Without technology, food production would have peaked when all the available arable land was in production. Moreover, it is clear that all of the arable land is currently in production or covered by concrete. In the last forty-nine years, most of the increase in arable land occurred between 1965-70 and was due to the reduction of fodder land (Evans, 1998: 136). According to Evans, there have been small increases in the amount of land under till in South America, Africa and Asia since then. However, this has always been "offset by reduction in the more developed countries" (ibid, 1998:151).

The ecological modernization theory openly admits that environmental problems have been created due to the growth in population and consumption of goods. However, where the limits-to-growth theorists argue that this growth must cease, ecological modernization argues that way we produce and consume needs to change, but that the issue of growth is not of concern (Mol and Spaargaren, 2011:

262). They argue that the market will provide many of the solutions. A clean environment is a privilege to be obtained by affluent societies. An adequate level of income is required to achieve the ability to influence government policies by forming pressure groups and non-governmental organizations (Harper, 2008: 212). Once this occurs, the market seizes the opportunity to become more environmentally friendly.

Recently, more nuanced versions of ecological modernization have been explored. Schnaiberg and Kovel among others argue any change "failing to attack the fundamentals of capitalist world order will result in superficial and cosmetic environmental reforms" (Mol and Spaargaren, 22). However, ecological modernization theorists have changed their argument. They now understand sustainability to be separate from any form of production. They argue that sustainable production and consumption are achievable under different 'relations of production' but that capitalism has proven the most resilient of such relations in the modern era, and so is the most likely set under which ecological modernization will unfold (ibid, 22-23). They attempt to shift the debate away from the economic system and the limits in nature towards the idea of social change. Mol and Spaargaren point to the differences between radical ecologism and ecological modernization. They argue that radical ecologism ties environmental change to social change and that "reforms of society's culture and structure not only contribute to, but are a prerequisite for, these desired goals" (ibid, 35). Ecological

modernization retorts that environmental concerns should not be placed in a primary position when compared to other goals of the society and radical change is not necessary as environmental improvement can take place without it (ibid, 35).

Ecological modernization theorists have attempted to separate themselves from the technological criticism by acknowledging that technology alone will not be enough to stop or reduce environmental destruction. Arthur Mol and Gert Spaargaren argue that most recently the theory fits under the umbrella of reflexive modernization along with risk society theory (Mol and Spaargaren, 21). Previously, Joseph Huber used the Schumpeterian model to explain environmental change. Regardless of which model of change they select to rely on, fundamentally the mode does not change, innovation is the vehicle to carry environmental reform.

The fatal error that ecological modernization has embedded within is that it fails to acknowledge the problem with growth. A clear example of this failure is shown by Gonzalez's discussion on the ecological modernization of the automobile. The state of California leads the way in the control of automobile emission standards. George Gonzalez argues that this ecological modernization of the automobile occurred largely because activists were allowed to be a part of the discussion with the provision that they removed from their dialogue any conditions surrounding growth (Gonzalez 210). He argues that even with the stricter emissions standards

California's air quality is getting worse. Gonzalez attempts to argue that it is not the idea of growth that is the problem, rather it is that California is not allowing a proper democracy to be carried out. He argues that the inclusion of the activists is merely symbolic (Gonzalez, 209). He argues that the primary reasons California has the worst air quality in the US are because of "population growth, growing economic activity and an increase in the number of automobiles (with internal combustion engines) as well as in the average number of miles driven" (Gonzalez, 208). Gonzalez has but little choice to argue that it is failed democracy that is to blame for creating this situation, since "at the core of ecological modernization is the idea that environmental protection and economic growth are complementary goals" (ibid, 208). California has not failed as a democracy, the state, like Gonzalez, has simply failed to recognize that continued growth is impossible in a world where resources are finite. This is the primary difference between limits-to-growth and ecological modernization. In their seminal work, The Ecological Modernization Reader: Environmental Reform in Theory and Practice, the editors, Mol, Sonnenfeld and Spaargaren offer only what amounts to academic name calling as criticisms against limits-to-growth. They argue that this perspective "diverge(s) significantly from ecological modernization theory in the sense that the former are highly abstract rather than richly particular, are structurally deterministic rather than reflexive and change-oriented and are profoundly pessimistic rather than opening up windows to

institutional and cultural environmental change" (Spaargaren, Mol and Sonnenfeld, 510-511).

Ecological modernization also points to water usage as an example of positive change within agriculture. In the United States, the total yearly amount of water used to irrigate crops has not increased since the 1970s, however, the number of acres that are irrigated has increased by twenty percent (ibid, 2008:215). They celebrate this efficiency as a victory, and yet, they miss the point. Fossil water is still being consumed at a rate far quicker than can be replenished (ibid, 2008: 49-50) which will lead to massive failure once aquifers are depleted within the next 50 years. At least ecological modernization theorists recognize the problem of water usage, which is more than can be said about modern agriculture's dependency on fossil fuels. Fossil fuels are the backbone of industrial agriculture. They are used in every aspect of production, transportation, refrigeration and the cooking of food. Fossil fuels, like water, are also finite resources. The difference between the two is that water has the ability to renew itself; fossil fuels on the other hand recharge at a rate that is so slow that once they are consumed, humans will not be able to use them again. In the next chapter, it will become clear that ecological modernization fails to adequately address the issues surrounding industrial agriculture and because of this ecological modernization should be discredited as a valid theory and should not be used when attempting the explain how we should go about organizing our society. In

what follows, it will also become clear that we are on the threshold of a whole new dimension of food procurement and production practices.

Chapter 3: Threats to and Problems with Modern Industrial Agriculture

Industrial agriculture was developed in the early 20th Century. It has been used ever since. It is able to achieve much higher yields than other forms of agriculture; for example, maize production has increased by about four fold per hectare: about 8 000 kg compared to 1 998 kg (Pimentel, Pimentel and Karpenstein-Machan, 8). The increased reliance of fossil fuels on the farm has reduced the amount of labour per hectare to about ten hours (ibid, 7). This is down from approximately 1 444 hours for a hectare of maize grown and harvested using strictly hand tools (ibid, 25). It is not hard to understand why agriculture practices began to rely on fossil fuels; "a small gasoline engine will convert 20% of the energy input of one gallon of fuel into power. That is, the 38,000 kcal in one gallon of gasoline can be transformed into 8.8 KWh, which is equivalent to 3 weeks of human work" (Giampietro and Pimentel, 3).

The earliest form of agricultural societies relied on human labour as the sole input of energy, and maintained a higher efficiency when compared to industrial agriculture. The first type of agriculture that humans practiced became known as slash-and-burn agriculture. This method of growing required large tracts of land (two hectares per person) and a lot of human labour (1144 hours annually, or approximately 60 percent of the total labour output for one adult) in order to support

one family of five (Pimentel, Pimentel and Karpenstein-Machan, 4). However, when evaluating the energy efficiency of slash-and-burn agriculture, it is the most efficient. Energy efficiency is measured by comparing the amount of energy as an output of food energy compared to energy inputs. Slash-and-burn agriculture has a ratio of 8.4:1 (ibid, 4).

Draft animal agriculture was the second type of agriculture practiced by humans. The significant difference was that the amount of land required to support an individual was reduced to about 0.8 hectares. More importantly, the amount of human labour was reduced as the animal took responsibility for some of it. In total human labour was reduced from 1144 hours per hectare to 380 hours per hectare. The energy input becomes greater when compared to slash-and-burn agriculture as now the animal requires food energy to be able to work. This system results in an output to input ratio that is halved when compared to slash-and-burn system, at about 4.1:1 (ibid, 6).

Industrial agriculture has increased the overall output per hectare, while reducing the amount of labour to ten hours per hectare (ibid, 8). The problem has become that even with the four fold increase in output, the input has become so great, that the output to input ratio has again been reduced. Currently the ratio is about 2.8:1 (Pimentel, Pimentel and Karpenstein-Machan, 8). A recent study by Piero

Conforti and Mario Giampietro found a similar ratio, albeit slightly smaller, for Canada at 2.52:1 (Conforti and Giampietro, 235). It should be noted that these ratios are attempting to account for only the energy that is used on the farm itself, and does not account for transportation, refrigeration, packaging, selling and cooking. This leads one to understand that the amount of energy used by industrial agriculture is massive. On-farm energy use for industrial agriculture can be easily accounted for in the use of fossil fuel based inputs such as fertilizers, pesticides, fuel for tractors and trucks and irrigation; each of which is required for continued output (Pimentel, Hurd, Belloti, Forster, Oka, Scholes and Witman, 443).

Industrial agriculture has been encouraged not only by corporations but also by governments. In 1944, the Bretton Woods meetings were held between leaders of the western capitalist countries. Ideas that proliferated from these discussions were based on growing the world economy. Three supranational institutions were created to achieve this goal. The World Bank has generally been responsible for providing funds for infrastructure projects to facilitate a global trade, such as, energy plants, long-distance transport networks and communications systems (Patel, 2007). The International Monetary Fund has been responsible for creating financial systems that have at their very center, unbridled growth (ibid). Furthermore, the International Monetary Fund has been able to institute and enforce strict structural adjustment polices on countries that are unable to finance development autonomously or service

their debt to the North (ibid). The problem is that these countries were set up to fail. The plan that was created for them usually included huge infrastructure projects that would enable the country to increase its economy. When the economy did not increase, the countries were unable to pay the debt. As a consequence, the International Monetary Fund refused to refinance the loan unless the country agreed to certain restrictions; reduced spending on social services and planting cash crops for export are among some. This resulted in the replacement of political colonization with a form of economic colonization (ibid.). The third institution, the General Agreement on Tariffs and Trade, or GATT has been attempting to remove all barriers to international trade, such as tariffs (ibid). In 1995, GATT was changed to the World Trade Organization. It was this transformation that allowed new domains for regulation, among these were agriculture. The United States and the European Union negotiated into the agreement the allowance of agricultural subsidies for them, but the rest of the countries that signed were disallowed from paying subsidies (ibid.). The removal of trade barriers in combination with the generous subsidies, have created a system where the food produced in the US and the EU is less expensive then that what can be produced in the Global South. This effectively enables the US and the EU to produce as much food as they can. They will always have a market to sell to, since they will always out compete the Global South on prices, even in the South's own markets. This has encouraged western farmers to produce as much as they can.

Vandana Shiva argues, "the imposition of the mechanical-industrial paradigm for production and distribution of food… in the South was initially carried out by the World Bank and IMF through 'development' aid. It is now imposed through World Bank/IMF structural adjustment programs (SAPs)" (Shiva, 2008:15). The structural adjustment policies are placed on countries that are unable to pay for the loans they were convinced to take. These policies include, "forcing countries to dismantle their local food economies, export what they produce and import what they need" (Shiva, 2008:105).

States have played a role in the global intensification of agriculture. Subsidies paid out have been significantly more beneficial to farmers with large tracts of land. The more land a farmer manages, the greater the subsidies received. In the United States, "the largest 10 percent of farms received nearly two-thirds of the federal subsidies handed out in 2000." The situation is the same in Europe, where "80 percent of UK farm subsidies are given to the 20 percent of farmers with the largest holdings" (Norberg-Hodge et. al., 2002: 8). The subsidies allow large-scale farmers to sell their commodities for less than it takes to produce. This forces smaller farmers to do the same, with one difference: the small-scale farmers do not receive as much in subsidies and as such, they often lose money year after year (ibid, 2002: 8). As these farmers leave the land in search for other jobs, the overall number

of farmers is reduced. The land becomes concentrated in the hands of the largest few. There are many reasons why this practice creates instability with the food system. Larger tracts of land being managed by fewer farmers requires the use of techniques that make each farm easier to manage; bigger equipment using more fossil fuel, and less biodiversity requiring higher applications of fossil fuel based chemicals. It is not just the farms that are increasingly being concentrated; everything in relation to food production is becoming concentrated as well. This means that fewer individuals are increasingly responsible for the production, sale and distribution of the food. In Canada, the number of farms has been steadily declining. In 1986, Statistics Canada reported 293 089 farms, whereas in 2006 there were only 229 373 farms, a total decrease of twenty-two percent (Statistics Canada, 2008). Manitoba has experienced a similar decline in numbers. In 1986, there were 27 336 and in 2006 there were only 19 054 farms left (Statistics Canada, 2008).

Methods of Agricultural Intensification: Feeding More With Less

Nutrient depletion of the soil has always been a problem with agriculture. Nitrogen is especially quick to become depleted (Heinberg, 66). Previous systems attempted to correct this by implementing leguminous trees onto the land or using crop rotations that included the growth of legumes. However, this was not always sufficient at restoring enough nitrogen to the soil. During the 1850s, the application

of Guano, or bird feces, from Chile and Peru, became an easy way to restore productivity to the soil because it contained high levels of nitrogen. These supplies were not inexhaustible, and within twenty years, they had run out (ibid, 66). In 1909, Fritz Haber and Carl Bosch vaulted themselves to eternal fame, when they discovered how to turn ambient nitrogen into Ammonia (Heinberg, 66 and Shah, 18). This process now known as the Haber-Bosch process made possible an extreme population growth. This process first relied on the electrolysis of water to produce the hydrogen atoms required to bond with the nitrogen, later it used coal, and then natural gas, to create the inorganic fertilizer (Heinberg, 66)[2]. The energy required to manufacture, transport, and spread nitrogen based fertilizer, accounts for between thirty percent and seventy percent of all on farm energy use (Swanton, Murphy, Hume, and Clements, 403). This energy variance is due to the differing needs of crops. Swanton et. al., were comparing corn and soy beans.

There are other problems associated with the use of fertilizers. First, nitrogen based fertilizer increases "yields at first, but over time, farmers have had to apply more and more in order to sustain the incredible bounty of the first harvests" (Shah, 42). Furthermore, the increased use of fertilizers has created both environmental and

[2] According to the International Fertilizer Association (IFA), natural gas has the highest hydrogen content of any existing energy source. The IFA does not supply the statistics for greenhouse gas emissions but they state that using coal to produce ammonia releases 2.4 times more carbon dioxide than using natural gas (IFA, 2009).

health problems. Nitrogen based fertilizers are volatile and transform into water-soluble nitrates that leak into the water system (Evans, 168). Nitrates in the water are known to cause algae blooms in the Gulf of Mexico.

Giampietro and Pimentel show that nearly half of the corn from the United States is produced as a permanent monoculture (Giampietro and Pimentel, 8). The result has been a drastic increase in both crop losses to pests and application of pesticides. The longer that a single crop is planted in the same space over consecutive years, the longer the different pest species that feed on the crop have to invade, establish themselves and reproduce. Essentially this creates a haven for those organisms and they thrive.

Pesticides have to be applied to these crops in an attempt to maintain levels of output. For corn, the amount of pesticides that are applied each year have increased nearly 33-fold since 1945 (Pimentel and Pimentel, 9). The increased use of pesticide for other crops has seen an increase of thirty three fold, and even so, crop loss due to pests have increased nearly four fold (Giampietro and Pimentel, 8). Despite this increased use, pesticides account for between 7.6 and 25 percent of on-farm energy use (Swanton et al., 403). Humans have created technology that attempts to reduce the amount of chemicals that are applied to farmland each year. We have also attempted to produce products and seeds that make the spraying of

chemicals more effective. The effect to the soil however, still remains the same, the application of chemicals to the soil destroys the organisms that are the source of soil fertility. Shiva argues,

> the millions of organisms found in soil are the source of its fertility. The greatest biomass in soil consists of microorganisms, fungi in particular. Soil microorganisms maintain soil structure, contribute to the biodegradation of dead plants and animals, and fix nitrogen. They are the key to soil fertility. Their destruction by chemicals threaten our survival and our food security (Shiva, 2008: 101)

Charles Darwin was among the first to deliberately create hybrids for maize (Evans, 121). This process began the study of breeding maize to produce higher yielding varieties. Three trends emerged that allowed hybrid maize to establish itself among farmers. First, breeding companies started producing hybrids. Moreover, the hybrids themselves grew in such a way so as to allow for mechanized harvesting. Lastly, fertilizer application increased as a result (Ibid, 122). As hybrids became more developed, their yields increased further. When compared to the 1930's, "the average yield of maize is now four times higher" (Ibid, 123). This allows a higher production of food quantity, without increasing acreage. The process of creating hybrid seed could potentially require many generations before the desired characteristics are achieved. It has been argued but not yet demonstrated that genetic modification has the ability to create the desired characteristics much quicker.

There are three categories of genetic modification that must be distinguished. The largest of these categories, genetically modified organisms, include all types of genetic modification including those that are achieved naturally through breeding (GMO) much like the hybrids that Darwin created. Genetic engineering (GEO) on the other hand involves entities that have been "modified using techniques that permit the direct transfer of genes to that organism; collectively these techniques are called recombinant DNA technology" (Natural Resources Canada, 2007). Essentially, these techniques recombine or remove DNA that is already available within the organism. Transgenic organisms are completely different and are created by combining DNA from species that are not able to reproduce (e.g. fish genes implanted in tomatoes).

GEOs represent the possibility of creating new organisms that have desirable traits, such as virus resistance, higher yields, resistance to herbicides, as well as many others. All of these characteristics could generate a larger net yield due to fewer losses as a result of weeds, pests and drought. Again, this allows the population to grow without increasing arable land size. The consequences of introducing new organisms to the environment are not known. This has created a necessity for developing large seed banks to preserve the natural diversity. Further, the insecticidal properties of the seeds will eventually diminish and the need to apply pesticides will resume.

Machinery is essential to industrial agriculture and it is the main reason for the decreased amount of labour required per hectare. When machinery was first introduced, the net effect was the elimination of draft animals from the farm. Each animal removed from the farm freed up roughly a hectare, that was previously committed to animal feed, to further tilling for food for humans (Evans, 117). This allowed the world's population to grow without increasing the amount of arable land (Evans, 119). A recent study included no less than 17 different types of machinery in use for conventional agriculture (Hoeppner, Entz, McConkey, Zentner and Nagy, 62). The list includes; a fertilizer spreader, water truck, disk drill, tandem disk, combine and baler, among many others. Machinery accounts for roughly twenty to forty percent of energy usage on a Canadian farm (Swanton et al., 403).

Irrigation of farmland is extremely valuable. It allows farmers to plant crops closer together producing greater yields per hectare. It also helps to alleviate any damages that could be caused due to drought or dry spells. Furthermore, the use of irrigation allows land that does not have sufficient water to be brought into production. The water used for agriculture is pumped from underground aquifers or other water sources nearby, such as streams, rivers or lakes. The pumps used to complete this work are fossil fuel driven. According to a study cited by Dale Allen Pfeiffer in a paper that predates his book of the same title, *Eating Fossil Fuels,*

irrigation accounts for around thirteen percent of on farm energy use (Pfeiffer, 2). Irrigation provides a security for farmers when the weather does not cooperate. The problem with modern irrigation is that it is using water sources upwards of 160% of the aquifer's natural recharge rate (ibid, 5). It is only a matter of time before these aquifers are unable to produce the amount of water necessary to continue with this type of production.

Wherever agriculture is practiced, soil erosion is a problem to be solved. As the landscape is transformed by human crops, the soil is left bare and uncovered. Soil is unprotected and open to the elements. It can be blown away by winds, or washed away by water. The end result is top soil that is continuously being diminished. Although there have been techniques put in place to help reduce soil erosion, soil is eroding approximately sixteen times faster than it can form (Harper, 47). It is estimated "that five pounds of topsoil are lost for every pound of grain harvested in Iowa; in eastern Washington each pound of grain costs twenty pounds of topsoil" (Norgberg-Hodge, Merrifield and Gorelick, 2002:42). Indeed, "about one third of the world's soil that ever existed has been lost" (Southwick in Harper, 47).

Industrial agriculture is extremely energy intensive. When calculating the total on-farm energy use approximately "3 kcal of fossil energy are being spent to produce just 1 kcal of food" (Pimentel and Pimentel, 5). Energy use on the farm,

while significant, does not account for the majority of energy used in industrial agriculture. Indeed, according to Michael Pollen "between seven and ten calories of fossil fuel are used to deliver one calorie of food energy to an American food plate" (Pollan, 183). Giampietro and Pimentel argue for the upper limit of this range (Giampietro and Pimentel, 3). This means, that between four and seven calories of energy are spent by our food system after the harvest for every calorie of food. That roughly equates to between fifty-seven and seventy percent of the total energy used. These calories are used up in processing, storing, packaging, refrigeration and transportation.

One study completed compared the amount of energy that one-455 gram can of corn contains to the amount of energy that was embodied from farm to consumer. They found that a can of corn gives the consumer about 375 kcal of energy. They also found that it took 3065 kcal of energy to produce the can of corn; production - 450 kcal, processing - 316 kcal, packaging - 1006 kcal, transportation - 158 kcal, distribution - 340 kcal, shopping - 311 kcal, and home preparation - 457 kcal (Heller and Keoleian, 30). Leaving out the home preparation and production leaves a total of 2 158 kcal of energy, almost six times the amount that is provided by the corn. Breakfast cereals are no better, as the comparison reveals that they on average provide approximately 3 600 kcal of food energy per kilogram and they take about 15 675 kcal to process and prepare, most of it being required to produce the

cardboard packaging (ibid, 29). Diet soft drinks are the worst by far, "a 12-ounce can of diet soda requires a total of 2200 kcal to produce (over 70% goes toward the aluminum can) and may provide only 1 kcal of food energy" (ibid, 29).

Refrigeration and freezing of food products requires a large amount of energy. The average food retail building requires about 214 British Thermal Units (BTU) of energy per square foot to keep everything cold, whereas, the average industrial building requires approximately 90.5 BTU per square foot of energy (ibid, 29). A food retail outlet requires about 2.5 times the amount of energy than the average industrial building. This of course, does not discuss refrigeration in transport or at the home of the consumer.

As noted above the increased mechanization has resulted in higher energy usage on farm. It has also had other effects on the farm as well. The increased mechanization of our agricultural system has resulted in a large decrease in the number of farmers. There has been a concomitant loss of farming expertise with the reduction in the number of farmers as well as their increased reliance on industrial tools of the trade rather than an understanding of the needs of ecosystems working in polycultural harmony. The decrease in the need for farm labour has led to an influx of people to urban areas looking for work. The farmers still attached to the land feed these large urban areas. The large supply of abundant fossil fuel energy has

increased "the capacity of far-away production and cheap long range transportation" (Gunther, 8). The supply chain became extended beyond regions or countries but included the entire world as a possible source for food products. Most of Canada's food chain has never been studied, save for only four places; three in Ontario and one in British Colombia. Manitoba's food chain has never been studied until now. However, "given the volatile nature of current energy prices, transportation and distribution are extremely vulnerable sectors of the current food system" making them important to study (Heller and Keoleian, 41).

There are two issues that need to be explored in any discussion of food security; the increase of meat production and global climate change. The past few decades have seen a global rise in the consumption of meat. A growing middle class in China and India have become wealthy enough to start emulating the western lifestyle and incorporating more meat into their diet. Indeed, if the rate of increase continues, by the year 2050, livestock will be consuming as much grain as 4 billion people (Porritt, 2004: 5). If one were to combine the UN estimate of world population and the estimated amount of feed that cattle require, there may be the equivalent of 11-15 billion people requiring nutrition.

Consumption of modern meat products is done at the expense of food, water, and the environment. As previously stated, efficiency in agriculture has become of

primary importance and yet meat still continues to grow in popularity. Modern agriculture produces meat by way of intensive agriculture, keeping the cattle, chickens and pigs in confined areas for their entire lives. The livestock are fed grain products through intensive feeding regimes designed to grow them at the optimal pace. Exactly how much grain is fed to livestock has been debated considerably. Differing modes of calculation have produced differing numbers. This difference is not only noticeable within countries but between countries. The US Cattleman's Beef Association may have different reasons for completing its calculations than the US Department of Agriculture Economic Research Service. Indeed, Gold reports that to produce one kilogram of beef, the former argues it only takes 4.5 kg of grain, as opposed to the latter which argues16 kg of grain is required (Gold, 2004: 23). Also, less developed countries will produce a ratio that is much lower than more developed countries. In India, poultry requires between 1.2 and 1.6 kg of grain to produce one kilogram poultry, whereas in the U.S. one kilogram of poultry requires 2.1-3 kg of grain (Patnaik, 2008: 4 and Gold, 2004: 23). There are important choices to be made in the production of animal protein. As size of the animal becomes larger, more grain is necessary to feed them. That is, chickens require less grain per pound than cattle.

The above ratios are assumed to be nutritionally equivalent, that is, one kilogram of grain is equal to one kilogram of the assorted livestock meat. Patnaik

argues that by looking at the ratio in a slightly different way the picture becomes more clear. Patnaik shows that there are large differences in the nutritional characteristics of the grain required to produce meat, if consumed directly, compared to those provided by consuming the meat. Poultry requires 1.2 kilograms of grain (Patnaik, 2008: 15). A kilogram of poultry provides 1090 calories and about 259 grams of protein. The grain itself however, is much more energy dense and provides 4140 calories and 118 grams of protein. Beef requires about 8 kg of grain product. One kilogram of beef provides 1140 calories and 226 grams of protein, the grain alone would provide 27600 calories and 784 grams of protein (Patnaik, 2008:15).

The intensive production of meat uses other natural resources. Feedlots and slaughterhouses require large amounts of energy to operate. Michael Pollan calculated how much energy was required to feed a single cow from birth to slaughter. Disregarding everything else, the cow ingests the equivalent of about 35 gallons or approximately 133 litres of oil to reach its final weight of 1200 pounds. This is not inclusive of the energy used to heat the feedlot, transport the meat upon slaughtering and butchering, this is only the amount that the cow has ingested through corn and soy products (Pollan, 2006: 83-84). There is a substantial difference between the water required for plant products relative to meat. According to Pimentel, between 500-2000 liters of water are required per acre to grow the majority of food and forage crops, whereas it takes about 100,000 liters of water to

produce one kilogram of beef (Pimentel and Pimentel, 2003: 602s). This calculation takes into account both the amount of water used by the cow directly as well as that which is embodied in the grain.

Livestock also produce a large amount of gas. Methane and nitrous oxide are two of these gasses and both are known greenhouse gasses. These gasses trap heat in the atmosphere, essentially acting as insulation for the planet. Livestock produce both of these gasses and are responsible for "15-20 per cent of annual methane emission, 7 per cent of nitrous oxide, and 10 per cent of total green house gasses" worldwide (Gold, 2004:38).

The heavy use of fossil fuels in all aspects of life has affected the environment of the world in such a way that an average overall increase of between three and five degrees Celsius is expected in the next fifty years (Shiva, 2008: 1). Burning fossil fuels releases carbon dioxide, also a green house gas, which increases the temperature. The more carbon dioxide in the atmosphere the hotter the planet becomes. Some scientists have come to expect that the entire Earth's atmosphere will gradually increase in temperature without any further thermal inputs. This increase will not be uniformly distributed as the increases in world temperature are not occurring equally, with temperature rising more at the North and South Poles (Gore, 2006:149). As temperature rises the ice caps are melting. This opens more

water that is absorbing the sun's rays instead of reflecting them, causing the melting to increase at an exponential rate (positive feedback loop). If, for example, the Greenland ice sheet were to melt completely this would mean a global rise in sea levels of about seven meters (Shiva, 2008: 10). This will result in the flooding of coastal cities everywhere causing a mass exodus from those areas and an overall concentration of people on the greatly reduced amount of remaining arable land.

Farmers surrounding glaciers have often used the runoff during the summer to irrigate crops. During the winter months, the glaciers had a chance to build up again; until now the freezing and thawing have been approximately equal. As a direct result of global warming, these glaciers have been melting more in the summer and have not been building up during the winters. The permanent retreat of these glaciers will eventually create intense water availability issues for the communities that depend on this water supply (Shiva, 2008:10). Glaciers are melting all over the world. Lester R. Brown argues that of all the glaciers that are melting, the Himalayas are of utmost importance. About seventy percent of the water flow in the Ganges River during the dry season is from glaciers, and by 2035 it could be a seasonal river (Brown, 2009: 66-67). In China, both the Yellow and the Yangtze Rivers are fed by the Himalayas glacial runoff. There are over half a billion people in China that are reliant on this water (ibid, 2009:66-67).

The term "global warming" is actually a misnomer. In reality, what is being experienced has been described as "climatic chaos" with regions facing different weather patterns than have previously existed (Shiva, 2008: 10-11). This intensification of weather patterns is becoming noticeable for example, hurricanes and tornadoes are becoming stronger and more numerous. Rain falls are much heavier in shorter periods of time causing flash flooding. Droughts are lasting longer and are much more severe (ibid, 2008: 10-11). The effect on monocultural agriculture will be disastrous, with entire regions losing crops due to storms in any given year, while other regions are being lost permanently for agriculture. The IPCC research points towards significant decreases in cereal crop production at lower latitudes (Easterling *et al.* 2007:274).

These are some of the issues surrounding the future of agriculture. Any one of these issues is sufficient to cause concern. These issues seem to be heading towards a convergence, which will create a large-scale disaster for people around the world. Even if they do not all peak at the same time and are staggered, the overall effect will still precipitate the need for fundamental changes in human food procurement practices. Furthermore, it is possible that the predicted severity of each issue may not be as bad as anticipated, but their arrival within a proximate time frame may lead significant negative interactive effects.

Both limits-to-growth and ecological modernization addresses these issues and provides possible solutions. The solutions offered by limits-to-growth address them in a more convincing manner. Ecological modernization offers solutions that lead one to believe that they are not ecologically informed in any meaningful way. Perhaps, ecological modernization's 'business as usual' techniques are but apologetics, wishful thinking, or obfuscating ideology.

At this point, if all of the previous forecasts are not enough cause for concern, it can be argued that the whole of industrial agriculture food production is but a house of cards about to lose its key underpinning resource, fossil fuel.

Peak Oil

> "There are many reasons why we might worry about our reliance on crude. After all, we use the stuff 100,000 times faster than it can accumulate underground" (Shah, viii).

The term peak oil has become fairly well known over the last several years. Richard Heinberg has described it as the "moment in time when the world will achieve its maximum possible rate of oil extraction; from then on, for reasons having mostly to do with geology, the amount of petroleum available to society on a daily or yearly basis will begin to dwindle" (Heinberg, 1). This has become known as

"Hubbert's Peak", after the first person who forecast this coming event, M. King Hubbert. His paper titled *Nuclear Energy and the Fossil Fuels,* was presented to the American Petroleum Institute in 1956 in Houston, Texas. In it, he described the methodology he employed to estimate the United States' oil reserves, production and ultimately, the timing of the peak oil in the US. His genius was realizing the problem with compound growth. He understood that there was no way that production of oil could continue to rise indefinitely. He states, "no finite resource can sustain for longer than a brief period such a rate of growth of production (ibid, 7-8)". Hubbert understood that the production of a finite resource will have two known points on a graph. The first is at point zero, when production has yet to begin; and point infinity where production must also be zero, as the resource has been exhausted (ibid, 9). Ultimately, this means that, at whatever rate oil is extracted it must ultimately return to zero. Production of oil follows what has come to be known as a bell curve.

Based on this knowledge, he was able to chart what the production curve would look like for the United States. He noticed that the production of oil would peak sometime between 1965-70 depending on the total reserve volume of oil. Hubbert's predictions were true for the United States. However, in 2010, the United States oil production rose 3 percent over 2009 (U.S. Energy Information Administration, 2011). The U.S. Energy Administration argues that this was

primarily due technological advances, like horizontal drilling (U.S. Energy Information Administration, 2011). Other researchers began to study the world's oil reserves. As researchers initially studied this area both the predictions made and methods used were diverse. One trend that became noticeable for all oil producing nations was that the period of peak discovery of new oil reserves was followed by approximately thirty years before the production peaked for that country. There have been has been essentially no new oil reserves found since the 1960s (Heinberg, 109). However, if one were to look at the average estimated peak year for global oil production, calculated from published reports after 1995 it is 2010 (Hughes, 2004:25). Indeed, all except outlying predictions converge between the years 2005-2012 (ibid, 2004:25). One report recently published argues that peak oil could occur between the years 2008-2023 (Carlson, 2011) the author argues that it would be wise to act as if the date of peak oil production is in the later stages of the decade 2010-2020 (Carlson, 2011:186). Regardless of when the date of peak oil occurs, now or 30 years from now, the changes that are necessary are so large that we need to begin to implement them immediately.

The entire agricultural system needs to be redesigned to focus on less fossil fuel use. Vandana Shiva argues that the modern understanding of development is problematic as it is understood in terms of economics. Development is always of the economic variety that leads to the definition of, "self-organizing, self-regulating

systems as ‘undeveloped’ and ‘underdeveloped’ and suggests that they should be made dependent of external inputs-external resources, energy, and money. Living systems, living societies, living cultures are thus transformed into mechanical systems” (Shiva, 2008: 14). These types of systems she argues are allopoietic, and continue to run on exosomatic energy (ibid, 2008:14). These systems are ultimately unsustainable. This is the way our current agricultural system is setup. It is this reliance on economic development that has created the “triple threat” of peak oil, global climate change and the potential food crisis that we face today. Shiva recommends that we replace the allopoietic system with a system that relies primarily on human energy an endosomatic system. Shiva calls this type an autopoietic system (ibid, 2008:14). The answer is to do exactly the opposite of what modern, industrial agriculture does (ibid, 2008:14). Machinery has to be replaced with human labour. Food needs to stop being unnecessarily exported. Food needs to be produced for local consumption. The application of poisonous chemical inputs to fields has to be arrested and organic agriculture must become the dominant mode of food production. The way North Americans select food has to change, by obtaining their proteins from sources other than livestock.

Machinery vs. Human Labour Power

One major problem that industrial societies are going to face as we return to sustainable agriculture will be the dearth of both farmers and farming knowledge. Heinberg understands that the only reason so few people can produce so much is due to fossil fuels. As peak oil hits and the production of oil declines, it will be necessary to have large numbers of people return to the land. In the United States, he estimates that there are currently about 3-4 million farmers (Heinberg, 2007: 61). Each farmer is feeding approximately 100 people.

There has been one successful transition caused by an artificial peak oil scenario caused by extraneous social factors. Cuba faced an artificially steep decline in fossil fuel use. It had to quickly implement policies and programs to increase food production without the help of fossil fuel. Cuba found it necessary to implement an education program with experts from Australia to help teach them methods of organic farming and soil rebuilding. Cuba now requires approximately 15-25 percent of its population to produce food. If the United States were to need the same percent then about 40-50 million farmers would be necessary (ibid).

Global vs. Local

Agricultural products are available to the consumer anywhere in the world. The logistics behind it are astounding. Foods imported are often the same as those that are exported. In 1996, Britain imported an estimated 114 000 tons of milk. In the same year it exported 119 000 tons of milk (Norberg-Hodge et. al., 2002: 18). Norberg-Hodge et. al. argue that similar types of statistics can be found for many other countries and they go on to question why this is occurring. The answer is that, "proponents of free trade argue that fleets of cargo ships, trucks and planes carrying the same commodities in opposite directions somehow leads to economic efficiency" (ibid, 2002: 19). To some extent this is true. The massive exchange of these commodities helps to increase profits of both large agribusiness and speculators who can take advantage of "government subsidies, exchange rate swings and price differentials" (ibid, 2002: 19). There are many benefits to having a local agriculture system. A local system would use less energy in transportation and refrigeration (Shiva, 2008:97). Consumers in local systems often have the ability to connect with those growing their food. This creates a social experience whereby the consumer has the ability to ask about the methods employed for growing or making the food being bought. There are many ways that individuals can begin to rely more heavily on the production of home grown food products and will be discussed in more depth later.

Modern Industrial vs. Organic Agriculture

Modern industrial agriculture continues to be based on oil. The use of oil on farm will become much more expensive and ultimately prohibitive. The modern industrial farm can only function because of the continued use of oil. As noted earlier, chemicals make up to twenty-five percent of on-farm energy use. A kilogram of nitrogen based fertilizer requires two and a half litres of diesel to make and apply, while a kilogram of phosphorous requires approximately half a litre (Shiva, 2008: 101).

The use of poisonous inputs needs to stop. Many chemicals used on industrial farms have become known to be health hazards for humans and the environment. Pesticides, like dichloro-diphenyl-trichloroethane (DDT), have been used to help ensure a bountiful crop each year. The problem is that they are extremely harmful. DDT initially was used as an insecticide and was used globally. The Stockholm Convention on Persistent Organic Pollutants was established and there are over 151 signatory countries that have banned the use of DDT (Stockholm Convention, 2011). Pesticides are responsible for having killed all of the fish from fifteen tributaries along the Tennessee River in Alabama (Carson in Cook, 2004: 162). In humans, pesticides are known to cause disruptions to "neurological and reproductive systems and contribute to cancer (Cook, 2004: 165-166). These

chemicals, applied to crops, make their way into the ground and eventually into the water system. Ninety-five out of one hundred wells tested in California contained detectable levels of chemicals; nearly half exceeded safe consumption levels (Cook, 2004:165-166). Pesticides should only be used when absolutely necessary because they kill everything, including the organisms living in the soil (Evans, 1998: 160). Indeed, organic farming is based on the idea of living soils that are fed to increase soil fertility (Shiva, 2008: 112). The two largest carbon sinks have been degraded because industrial agriculture has failed to return organic matter back to the soil (ibid, 2008: 113).

Overcoming Industrial Agriculture: A Discussion on the Options Available

The major environmental crises, global climate change, peak oil, chemical usage, aquifer depletion, soil erosion, salination and degradation, as well as meat consumption and a growing global population, all have an effect on the global output of food. All of these issues affect how much food can be produced globally. There is a finite amount of land from which we are able to grow the food required to sustain the population. In light of these issues it seems unlikely that food production will keep pace. The current predictions for climate change patterns show that lower latitudes will experience a reduction in crop output with as little as a one to three degree change in global temperatures. The increases in temperatures also change

water patterns. The timing and quantity of precipitation will be affected; there will also be an increase in the frequency of drought (Warren, et al., 2004).

If production of oil falters quickly, the impact could potentially shut down the majority of agricultural operations. However, if the production of oil decreases slowly we might have the chance to adapt over the course of several years. Regardless, the price of oil is going to continually increase, causing a proportional change in the price of food. At some point the cost of production and shipping will create a situation where local, organic foods are the only ones available and/or affordable.

Water and soil are two of the most important things to consider when growing food. If either is insufficient in quantity or quality, then the plants are not going to grow. Rainfall patterns are currently changing and are becoming much less predictable (Byrne, Kienzle, Sauchyn, 64-65). This change requires that farmers have access to water for irrigation. However, the aquifers that they normally call on are becoming depleted through over-use. Water insufficiency will certainly cause regional failures of crops. Fields that are left to summer fallow are also left prone to soil erosion caused by wind. The use of chemicals also affects soil quality. The chemicals kill off all microorganisms and thus leave plants prone to disease and

insects. Chemicals are also extremely energy intense to produce, distribute and apply. Chemicals will be more expensive to use as oil prices climb.

The global population continues to grow. Each individual requires a certain amount of space to live, thereby taking away precious agricultural land. However, more importantly, as the population keeps growing, the agricultural industry must continue to feed each new mouth.

There are many understudied and underutilized ways that allow farmers to adapt to some of the environmental issues. Some of these include, urban agriculture, community supported agriculture, vertical agriculture, making uses of polycultures, biodynamic agriculture and permaculture. Each of these types can address some or all of the environmental issues in meaningful ways. As each are described and explained, the benefits and drawbacks will be pointed out. Generally speaking, they all have the ability to reduce the consumption of oil, by using virtually no chemicals, reducing transportation distance and making use of smaller machinery, if any at all. Organic methods employed by all of these alternatives allow the soil to rejuvenate and use less water for irrigation. Global population growth and meat consumption are the two issues that these alternatives might have trouble addressing.

Practicing more urban agriculture is one way that individuals can achieve a 100-mile diet. Consuming a diet that was produced close to home, reduce the amount of oil that is used in shipping, and prevent the release of greenhouse gases that would have been released. Urban agriculture can be roughly defined as "the growing of plants and the raising of animals for food and other uses within and around cities and towns" (van Veenhuizen, 2006: 2). This definition includes all types of agricultural endeavors as long as they remain close to or within a city's boundaries and ranges from subsistence farming in backyards to commercial for profit agriculture.

There are growing numbers of people in urban areas. This population is made up of a significant number of poor who have inconsistent access to food. If these people were located in rural areas they might have the ability to grow their own food, instead of being forced to buy it (ibid, 2006: 3). About seventy-five percent of the world's poor live rurally (World Resources Institute, 2005: 5). Most of these people rely heavily on access to natural resources, including the ability to farm in order to survive (World Resources Institute, 2005: 6). Urban agriculture helps to ensure that those needing food are able to obtain it. It is already a significant movement. "Conservative estimates suggest that, in 1993 between 15 and 20% of the world's food was produced in urban areas" (Armar-Klemesu, 1999: 103). This type of agriculture allows urban dwellers to supplement their diets with food produced by

themselves or by others who live close by. Urban agriculture has the ability to create conditions where food security is vastly improved. There is a portion of land currently dedicated to growing ornamental grasses. This land is often located in public areas such as parks and in private areas like front and back yards. Ornamental grasses, like Kentucky Blue Grass, require large amounts of resources to maintain. The actual quantity of this space currently being utilized for this is unknown. With the number of urban dwellings in Winnipeg alone, the size of arable land being wasted is significant. Urban agriculture improves access to food for urban dwellers. More importantly, it creates a buffer zone between crop failures from rural farms and starvation by urban dwellers. The use of urban agriculture creates a supply chain that has built in safety mechanisms to help prevent human suffering.

The benefits of urban agriculture are not only limited to an increase in food availability. As access to fresh food increases, the level of health increases (van Veenhuizen, 2006: 3). Local economic development increases as well when household expenditure on food decreases as the amount of food produced increases. It also has the ability to create community, which would enhance social inclusion and allow people to build a network of people around them (Norberg-Hodge, et al., 24).

There are concerns with urban agriculture. Among them are: the contamination of produce with heavy metals from improperly treated waste water,

auto exhaust fallout, spread of disease from the activities of scavenger animals attracted to agricultural activities and also, the spread of diseases that can be obtained from livestock (ibid, 2006: 3). All of these are valid concerns. Rene van Veenhuizen argues that just like every other industry that produces commodities, there must be policies implemented that reduce or eliminates the risks associated with urban agriculture. Ultimately there are also limits to the amount of land that is suitable for urban agriculture. Large buildings within the downtown sections of cities cast shade on large tracts of ground and, in these circumstances, the only viable space is on flat roofs of buildings that are able to support the extra weight of roof top gardening. However, as communities are forced to abandon the use of cars, parking lots, many roadways, lawns and boulevards can be converted to food production. An increase in the land available for agriculture allows more people to take up the job of growing food in the city. This helps to increase the number of farmers but also increases the overall amount of farm knowledge.

Community supported agriculture is also an interesting way to re-localize the food system. This type of agriculture relies on a community base to support a farmer. Each person in the community pays up front for shares in the harvest for the year. The farmer in turn provides each person with quantity of food equal to the share that was purchased. Paying for the share at the beginning of the season allows farmers to stay free of debt, whereas what normally occurs is that farmers cannot

afford the initial capital required to plant seeds every spring. They take out bank loans and then pay them back after the harvest. If the harvest is below average then they may not earn enough to support themselves for the rest of the year or at worst cannot pay off the loan in its entirety. CSAs create a food system that shares the risks of farming (i.e. flood, drought, insects, etc.) with the community; this allows the farmer to survive even in periods of turmoil. There are many benefits and very few drawbacks to this type of organization. In general each consumer pays substantially less for a season of fresh produce and the farmer has a stable market in which to sell the produce (Norberg-Hodge, Merrifield and Gorelick, 2002: 23-24). Furthermore, the consumer can feel safe knowing where the food was produced, by whom and by what methods. It reconnects the farmer and consumer, especially in the common case where the farmer welcomes the consumer onto the farm, sometimes to help complete some of the tasks (ibid). It is in this way that some can build up "sweat equity" whereby individuals work on farm and are paid with food.

CSAs tend to be small-scale, one farm family growing food for some specified number of people. If CSAs grow all of the food using organic methods, then the soil they cultivate increases in fertility every year. Planted with enough space between each plant the farm could easily rely on rain-water for irrigation, especially if there were a rain-water storage system installed. Each year that organic methods are employed, the soil has the ability to capture and retain four tons of

carbon dioxide per hectare (Shiva, 2008:98). CSAs significantly decrease the amount of oil being used especially in transportation and storage. The farm would almost certainly be within 100-miles of the consumer's house. This prevents unnecessary imports.

A more indirect mode of community supported agriculture occurs at the local farmers' market. A study that was produced by Toronto's Food Share recently calculated the distance travelled by local produce to the Dufferin Grove farmers market and found that the average distance was only 101 kilometers, well within the 100-mile radius that several groups recommend (Bentley and Barker, 2005: 7). The benefits of shopping at a farmers market are much the same as buying a share with an individual farmer. All of the profit obtained this way is collected by the farmer and not by distributors. A farmers' market farmer does not have the connection to the community that keeps them free from loans. These farmers still require the capital every year to grow the produce. Also, individuals who become regulars to the farmers market would get to know the farmers that are selling the produce. It may take a longer time to foster relationships with the producers this way, but it is still possible to do so.

In theory, vertical agriculture appears to be one solution to the impending food crisis. Vertical agriculture has yet to be employed as a technique and the

proceeding discussion is speculative at this point. Vertical farming employs technology to build multi story buildings designed to grow produce all year round. At the present moment one building with "an architectural footprint of one square city block and rising up to 30 stories (approximately 3 million square feet) could provide enough nutrition (2000 calories/day/person) to comfortably accommodate the needs of 10,000 people" (Despommier, 2008a). It is estimated that one acre of vertical farmland is roughly equivalent to ten to twenty acres, depending on the crop that is grown (ibid, 2008a). Each floor of a vertical agriculture building would be designed to achieve the maximum output per crop. The setup allows for a much more intensive growing scheme than conventional growing allows. The most immediate benefit for the environment is that by building upwards, instead of outwards, farmland located in rural areas is no longer required to support the population can be reverted to natural habitat for local wildlife.

There are many benefits to vertical agriculture. Vertical farming has the ability to produce food year-round. The produce is grown in controlled climate conditions, allowing for the selection of the peak conditions for the crop that is being grown (ibid). In Manitoba, the electricity needed for lighting and controlling the temperature in the building can be generated from the hydro stations in the province. There could potentially be situations where electrical resources are unable to fulfill the need of a city. One solution that Despommier has pointed towards is using a

certain waste management system that has the ability to dispose of effluent in more effective ways as well as generate enough electricity to support a vertical agriculture building. Organic matter makes up a portion of any city's waste. This organic waste could be used in methane production to supply these farms with energy. Also, vertical farms have the ability to recycle liquid waste. Indeed, Despommier argues that if these buildings are designed correctly they will be able to restore black and gray water to near potable quality. Furthermore, initial costs of constructing a building of this sort would be eventually offset completely, by the ever rising costs of transportation and refrigeration of food originating at a distance. These costs would be offset more quickly if older buildings were converted.

The problem is that because a vertical agricultural building has yet to be constructed nobody knows exactly how much it will cost initially. However, a company called Plantagon has just broken ground on the first vertical agriculture building. Within several years the data that is currently missing to form an adequate decision on the effectiveness on these buildings will be available for dissemination. Despommier estimates that each vertical farm would cost between $20-30 million to build a prototype and "hundreds of millions to build" one of the thirty story buildings he recommends (Venkataraman, 2008). Despommier bases the estimate on technology that has not been invented. That is probably why the estimate is quite vague to say the least. Regardless of how well the building is designed and manages

to sustain itself with any more significant inputs, the building itself has to be built using massive amounts of energy and resources, all during a time when these resources are becoming scarce and expensive. However, any discussion on the building of a vertical agriculture building is preliminary. Just as growing the same crops every year in the same spot outside has created pest control problems, there is a strong likelihood that a vertical agriculture building would have pest problems.

Vertical farming has social impacts as well as environmental ones. There is an obvious reduction in fossil fuel use due to the fact that most traditional field machinery is unnecessary. Human labour has to replace machinary, which has the side benefit of creating jobs in the food industry, at least in the short run. It is probable that machines could eventually be developed to take care of the majority of the work. Furthermore, as long as the food grown remains where it is grown, fossil fuel use is reduced even further by the lack of transport. If done properly, Manitobans could eat fresh, organic produce all year long without relying on California, British Columbia, Mexico or any of the other numerous places that currently supply our produce. However, the energy and resources required to construct a new vertical agriculture building or even that which would be required to retrofit an already existing building, are exorbitant and restrict the usefulness of this option. Given the risks of building an untested technology this option would be a high-risk venture. It will be interesting to see how well Plantagon fairs.

Polyculture or biodiverse farming techniques plant many different types of crop within the same field. Vandana Shiva's farm, Navdanya, practices three variations of this method of farming. They plant fields of seven, nine and twelve different types of grains. The use of polyculture cropping techniques has proved to be more resilient under many conditions than monocultures. Furthermore, they have found that by using biodiverse techniques the farmers produced more food, and also made more money than the farmers that practiced monoculture systems (ibid, 2008: 117). The Navdanya website offers statistics on the amount of food that is produced by polyculture techniques compared to monoculture cropping systems. The ratio that is produced is called the land equivalent ratio (LER). In all cases, the polyculture acre produced more food than the equivalent monoculture acre (Shiva, 2002).

Another movement towards sustainable agriculture has been the biodynamic agriculture movement. It is the oldest non-chemical farming initiative since the beginning of industrial agriculture and predates the organic movement by approximately twenty years (Biodynamic Gardening and Farming Association, 2008). Having been developed without the use of chemicals, biodynamics is situated to address at least some of the environmental concerns listed above, like soil health, water usage issues, especially if the ground was mulched and it at least partially halts the consumption of oil.

This movement began in the 1920s by a group of people that were concerned with the course that agricultural practices were taking. Dr. Rudolf Steiner developed a unified approach to agriculture, which blended "the ecology of the earth-organism to that of the entire cosmos" (ibid). Biodynamics is the only western science-based approach that explicitly blends spirituality with agriculture. The blending of spirituality and agriculture makes biodynamic agriculture different from permaculture.

Permaculture is another mode of food production and cannot be considered a form of agriculture. It was started in the 1970s by Bill Mollison and David Holmgren. Permaculture developed directly as a result of the realization that there is a deteriorating natural resource base as well as the knowledge that current energy use levels were temporary and future food production could not depend on fossil fuel based fertilizers and chemicals (Holmgren, 2002: xvi-xvii). The name itself is a reflection of these ideas and combines the two words, permanent and agriculture. Permaculture is defined as "consciously designed landscapes which mimic the patterns and relationships found in nature while yielding an abundance of food, fibre and energy for provision of local needs" (ibid, 2002: xix). As soon as permaculture moved from theory to practice it was no longer only permanent agriculture but rather it became "permanence in culture" (ibid, 2002: xix). It was no longer just a way to grow enough to eat; it became a way to organize living arrangements to obtain the

best possible design. Holmgren understands permaculture as the "relationships with, and the design and redesign of, natural resource management systems, so that they may support the health and well-being of all present and future generations" (ibid, 2002: v).

Permaculture currently works mainly at the individual level. However, according to David Holmgren, intentional communities often use permaculture as a way to sustain themselves. He goes on to say that intentional communities actually played a significant role in the development of permaculture (Holmgren, 175). Village Homes, a subdivision of Davis, California, is one of these communities. Village Homes built 225 residences on 70 acres of land (Village Homes, 2008). Instead of constructing the homes to emphasize individual privacy, they were built to emphasize community. They have very little space devoted to streets and a lot devoted to green space (23 acres are devoted to community gardens, orchards and parks). Indeed, they produce such a variety of food that there is something ripe and ready to eat nearly every month of the year. Almonds for example, are produced at a rate that far exceeds the local consumption and they sell off the rest to commercial producers (Village Homes, 2008). Front yards of many of the homes are devoted to additional food production. The houses themselves are built with living roofs, and most use a passive solar design. Embodied within this community are the core values on which permaculture is based.

The design of a permaculture garden attempts to reproduce relationships that are often found in nature. It eliminates the need for fossil fuel inputs. It is a designed system which encourages fertilization through manure (attracting wildlife as well as keeping livestock) as well as by planting deep-rooted plants and legumes. It also reduces the amount lost due to pests, by way of incorporating complementary planting (i.e. green beans repel the potato beetle). Permaculture defends against loss by planting in multiple areas that separates the produce of a specific type so that if one plant is lost, others will thrive. This type of strategy does not lend itself to industrial agriculture, as it does not allow for a quick harvest. Furthermore, there are no machinery or transport trucks using fossil fuel. The garden is too diverse to match the abilities of machines. Permaculture is useful for increasing food security for individuals. Although permaculture does not give any firm statistics on the yields per acre, yields produced will be reflective of the design. A permaculture garden that is set up to maximize fibre or wood production, will not produce as much food as one that prioritizes food. The beauty of permaculture is that no matter what the priority for the individual it can be achieved. Smarter planting achieves a garden that does not require nearly as much labour to maintain as other types of food production. Labour is actively designed out of the process. This allows the gardeners to spend more time on other activities.

The purpose of the preceding is not to champion one method over another. Rather, it is to show that there are many ways that individuals and small groups of people can actively institute change within the society that they live. Regardless of the method of stewardship that one selects, the general trends are the same. Fossil fuels are essentially eliminated from the production process through organic methods of growing and crop rotations. Human and animal labour replaces the machinery that currently tills, seeds and harvests. More people become responsible for growing a share of the food, including those that live in urban areas.

To overcome industrial agriculture, changes in the overall system have to be achieved. Social change can begin in one of two directions. It can be led from the bottom by grass roots organizations, who gain enough public support that states begin to become pressured to institute change. Alternatively, the state can institute policies that require citizens to participate.

The literature has been fairly explicit about the global consequences that we could be facing if these environmental crises are not adequately addressed. There is not much literature surrounding how these issues will affect Manitoba. The next chapter will explain why the goal of the research and how that goal has been achieved.

Chapter 4: Qualitative Interview Methods Using the Criterion Selection Method

There are many factors that determine whether the current food system will be able to meet future demands. Ultimately the goal of this research is to make recommendations so that Manitoba and its citizens are best able to adequately feed themselves during a period of major change. A critical evaluation of Manitoba's agricultural practices has never been completed. Manitoba is practicing agriculture without deliberately contemplating the consequences to the environment and its people. The question that this thesis is attempting to address is whether or not Manitoba is well situated to address and react to potential problems with the food supply caused by decreasing supplies of oil, climate change, as well as the other issues discussed above. The type of research that is best suited to studying this type of problem is evaluation research.

Evaluation research is often used as a tool to aid in policy-making decisions. Each of these decisions entails six steps:

> (1) identification of a problem that requires amelioration; (2) policy planning - the consideration of alternative intervention strategies for addressing the problem; (3) development of a specific policy action or program; (4) implementation of the policy or program; (5) analysis of the program's impact; and (6) feedback on the problem and policy and administrative action (Singleton and Straits, 2005: 415).

Singleton and Straits argue that even though most evaluation research is carried out at the fifth stage, social scientists can have an impact on all stages (ibid). It is clear that this thesis will not be responsible for identifying the problems, associated with modern industrial agriculture, nevertheless, it is located in "step one" as I will explore the nature and extent of the food security issue as it applies to Manitoba. Although, according to Singleton and Straits, investigative journalists among others are generally responsible for identifying social problems, there is clearly a role for social science research into the prospects for Manitoba to weather the coming series of dislocations and to begin to conceptualize a community based response to the looming problems.

Singleton and Straits argue that social scientists' role begins with initial conceptualization and analysis. Social scientists complete research to determine what is known, what remains unknown and document the extent of the problem (ibid, 2005: 417). One purpose of this research is to determine if there is a problem with modern industrial agriculture in Manitoba. If there is a problem, the research must determine what is already known concerning the potential magnitude of the problem. The second purpose is to evaluate multiple potential approaches to correct the problem. The third and final purpose of this research is to develop specific solutions designed to address the problem in an appropriate local fashion. Given its

exploratory and preliminary purpose, this thesis will be engaging in the first three steps of Singleton and Straits' evaluation research.

The Process of Selecting Interview Candidates

There are many people who have been striving to bring the potential problems of industrial agriculture to the forefront. Many of those people have banded together and formed non-governmental organizations. These are the people that could provide the most insight into addressing the research questions mentioned above. Each organization provided insight to the current state of food security in Manitoba. They were selected by the "criterion selection method" (McDavid and Hawthorn, 2006: 183). This method of sampling selects participants by way of measuring against some criterion, in this study those selected are considered expert informants, and were contacted using recruitment letters (Appendix A). Manitoba is the unit of analysis and consequently is also the case that is being studied.

The first task of this thesis is to estimate the current level of food consumption and compare it to the amount of food grown in Manitoba as well as the amount of food imported from outside Manitoba. Once it has been determined how much food the current system imports, we can then estimate, with some assumptions, what effect peak oil is likely to have on food productive capacity in Manitoba.

Estimating the effect of peak oil on Manitoba will allow us also to make estimates regarding a time frame when oil will become too expensive to continue with food procurement at a distance. The ultimate goal for Manitoba should be that each of its communities becomes food self-reliant within the 100-mile radius. To achieve this goal, will Manitoba need to reduce its population? If so, what is an appropriate population range for Manitoba?

To answer these questions, an agricultural profile for Manitoba was prepared. This profile includes a discussion of food miles in Manitoba, fertilizer use, irrigation and tillage practices. The profile also includes the amount of fossil fuels used for food production and estimates the potential effects of climate change on the prairie provinces and what types of crops will still be viable. How many of these potential problems does Manitoba have embedded in its agricultural system? What effect will these unsustainable current practices have?

It is justified to work from the limits-to-growth framework, which operates on the understanding that current industrial agriculture is wholly unsustainable. The question becomes what are appropriate solutions to these conditions? These solutions would not only take into account each of the issues above in isolation, but also must consider the interplay between each as well. Will farm productivity remain at current levels, or will they increase or decrease with a change in the

system? How many people can be fed per acre of arable land? These questions need to be answered to arrive at an estimation of population that can be considered appropriate for Manitoba.

At first glance, Manitoba does not appear to be any different from other provinces in Canada or for that matter any different from other industrialized nations. This means that our agricultural system is one that is based on growing produce for export and is immensely reliant on petrochemicals to fertilize and control pests. Like other industrialized systems, Manitoba employs a decreasing number of farmers, producing food on ever larger tracts of land relying on large machinery to complete the necessary tasks.

There were valuable data that would be missed if I only interviewed the non-governmental organizations. In order to access these kinds of data, government departments and food distribution companies were also included in the study. Governmental departments that are responsible for keeping track of Manitoba agriculture and were expected to have access to data necessary to complete an agricultural profile were included. It was assumed that food supply companies would be able to provide data on the amount of food imported and exported from the province. These groups of individuals would be the best source of concrete statistics regarding Manitoba's food system.

Due to the variation of information sought from each organization, interviews were conducted following qualitative interview methods. Each interview was conducted with a topic guideline and remained as unstructured as possible. The interview schedule can be found listed as Appendix B. When commenting on the use of unstructured interviews, Singleton and Straits argue, "the interviewer is free to adapt the interview to capitalize on the special knowledge, experience, or insights of respondents" (Singleton and Straits, 2005: 222). The information obtained through these interviews was not coded and analyzed like other types of interviews. The purpose was not to compare the data to each other or make any quantifiable claims. Rather, the information is likely to produce insight and richness of data not found in quantitative methods. These data were used to complement the information that is currently known about Manitoba agriculture. Furthermore, the interviews provided viewpoints that are not widely available and allowed for a broader as well as a more in-depth study into the agricultural system.

In all, ten interviews were conducted. They included individuals associated with retail stores, government departments, and non-governmental organizations. All but one retail organization declined to be a part of the study. Two-thirds of those who could speak on behalf of the government organizations agreed to be interviewed. All but one non-governmental organization agreed to participate and be

interviewed. It is not surprising that the retail organizations refused to be interviewed they have a vested interest in continuing with a business as usual approach and may not wish to share their inventory, sales volume, suppliers, and other commercial information. It was expected that most of the non-governmental organizations would participate. For the most part they did. NGOs have a vested interest in participating in as many community events as possible. They are always attempting to reach as many people as possible. Even though the number of interviews was not as high and the distribution was skewed, this was still an extremely informative research project. It was decided that it was important to continue the research project even though participation was skewed because research on this issue had yet to be undertaken in Manitoba. The data collected provides a beginning for other research, which will undoubtedly follow when the forces at play make the current system increasingly unworkable.

Chapter 5: The Spectrum of Food Procurement Practices in Manitoba

This analysis of food procurement practices in Manitoba involved interviews that took place over the span of ten months. What follows is an analysis of the data that were collected from each of the respondents on the issues discussed above. There were three main topic areas to be explored. The first was Manitoba's food procurement practices, which includes Manitoba's practices on production, consumption, importing and exporting. The second section was reserved for environmental concerns and possible solutions. The final section attempted to open up a discussion regarding change and what is required to implement these possible solutions.

In terms of form and flow, the analysis has been set up to discuss each of the questions or topics separately. This was easy in some instances, for example, social change and Manitoba's capability to produce food. There are numerous issues, that are going to be discussed later, that are intimately connected with each other, for example irrigation and nutrient loading. These issues are interrelated to such an extent that to speak of one is to speak of the other.

Manitoba Agriculture and Food Practices

Every single respondent went through the same thought process when asked the question, "If Manitobans were to eat only food produced within Manitoba, what types of food would Manitobans be eating in each of the four seasons?" The response was always along the lines of, "We could do our protein no problem, we have got dairies, and produce, fruit and vegetables, and a diversity of grains, yeah we grow things from all of the food groups. So theoretically, nutritionally we could do it." This was normally followed by a moment or two of silence and reflection and was followed up with, "We have more eaters than the diversity of growers. We may have the volume of crops but it is probably flax and wheat and forage crops and things grown for feed. We would have to eat a lot of pork. We grow a lot of a few things but not a lot of things. It would have to change, what people are growing would have to change." At this point the responses began to diverge from each other. Some started to think about what it was like in the past, how their own families spent a significant amount of time in the garden, canning and preserving their own produce. Another replied that his family spend a lot of time in the garden during the summers, specifically to get back to a more local diet. One respondent joked, I guess a Manitoban diet would be "strictly buffalo, pemmican and some fish". They all seemed to converge again and say that to make it possible would take a lot of work

and a massive cultural shift. One respondent went on to say, that it was not a lack of desire or ingenuity on the farmers' part, it was not being able to compete with California on price.

The second question that was asked was, "How much food is brought in from outside of Manitoba during the various seasons?" Only two respondents were able to answer this question, although both respondents had similar answers. The first said seventy-five percent while the second said it was about eighty percent. The other respondents were not willing to speculate; often times simply saying, "I don't know" or "Most of what we eat". I followed up with the question, "How much of that is necessary?" Again, the answers came back very limited. However, one respondent came back with, "What is necessary is, I suspect, closely correlated with what is enough? And in our culture, it does seem like we know what the answer to it is. More is simply our answer, we want more choice, more options, more taste, more flavour." This respondent had previously taken part in this exercise on his own accord, determining which foods that his family could not do without, he carried on, "What can we do without, has traditionally been understood as a sacrifice, with negative connotations, you're going to give up your imported beer? How could you?" And yet, "The re-orienting of those desires for my family has been liberating. It has been liberating in a way that I have not anticipated." Another respondent began reflecting, "I come from a time when Manitobans ate Manitoban food, we did

not suffer from not having green bananas and tomatoes in January. Indeed, if you look at the tomato that you get in January, that's GMO and picked green and injected with a gas to turn it red and you don't really have a January tomato. You have a very poor substitute. I don't see this [eating Manitoban food] as a hardship, I see it as an asset." In fact Manitoba Agriculture, Food and Rural Initiatives commissioned a study to find out how vulnerable Manitoba's food supply would be in the event of a pandemic. The study found that as long as trade ceased, Manitoba is able to provide more than enough nutrients to provide all of its citizens with a healthy diet (Hickson, *et al*, 2008).

A study of Manitoba's "food miles" shows that on average food consumed in Manitoba is shipped long distances (Appendix E). Grain products in Manitoba are shipped on average 405 kms. Meat, dairy and fish products travel on average 1 060 kms. Fruits, vegetables and nut products travel from the farthest being shipped on average 1 936 kms.

Three of the respondents stated that significant portions of Manitoba winter produce could easily be supplied by greenhouses. They all noted that it might cost more to supply that produce, but that it could be done. One noted that in their experience, farmers are willing to grow what consumers want. Another noted that greenhouses would only be practical if they were heated using sustainable sources of

heat, such as biomass, geothermal, wind or solar (with thermal mass to hold the heat).

The next question asked was, "What capacity does Manitoba have to develop or enhance its food storage capacity in the event that we must increasingly rely on local food production?" Essentially, all answers from all respondents were the same; the response was we have the capacity to increase storage facilities. A couple of respondents argued that increasing the province's capabilities for storage is a key issue for local food supplies. Another respondent argued that the type of storage obtained from glass jars was all that is needed. One respondent stated, "People think it's either doing all of the work yourself or buy it from California. Of course, there's a middle ground. A company like Peak of the Market could easily have fresh frozen produce available year round."

Another respondent replied that it is possible to increase food storage in Manitoba, but it would more than likely increase the price of food. He was skeptical that it was possible since the province has cheap food policies in place. The respondent was referring to the federal/provincial agreement on agriculture. This agreement between the two levels of government sets out rules for subsidy payouts. The respondent argued that these rules support large scale, conventional production of food that mostly ends up on the export market. The respondent stated that the

subsidies are paid out according to a business risk model. Manitoba produces a significant amount of pork. The rate of return decreases as the amount of pork products increase, subsidies are paid out to the pork producers that artificially lower the consumer price, which increases the amount of product that consumers will purchase. Since these subsidies are paid out to conventional farmers, organic farmers do not enjoy the same cost reduction. Furthermore, since more pork is produced than can be consumed locally, it ends up on the export market. The respondent argued this creates a situation that has become known as 'dumping'. Manitoba's exports of relatively cheap pork products enter the export market and create a situation where other pork producers in other provinces/countries cannot produce pork for the same price. Those producers are forced to produce something else. The respondent went on to argue that our pork producers undermine the ability of other regions to produce pork. This of course occurs in reverse as well, this partly explains why Manitoba produces a lot of canola and pork.

There were several questions asked on the production capabilities and practices of Manitoba agriculture. The first of these questions was, "Do you know how many people can be fed by the cultivated acreage of Manitoba farmlands?" The answers came back a resounding, "I don't know". Two of the respondents carried through the chain of thought. The first replied that there are "13 000 000 acres of arable farm land and just over a million population. It is quite possible that we could

support that population and it is possible we could support more. The question is support at what level. If we are going to support at the middle-income class of living, then no, they are too consumptive." The second answered that "If suddenly the rest of the world stopped, Manitoba would not starve. But, there would be expectation dissatisfaction." The respondent carried on saying that there would be people unimpressed at not being able to order a Caesar salad from Boston Pizza.

Two questions were aimed at chemical usage on Manitoba farms. The first was, "How have herbicides, pesticides and fertilizers affected food in Manitoba?" As well as the second question that asked, "Is there any estimate on the amount of chemicals used per acre?" The first question produced some rather interesting responses, which will be discussed later. For now however, it was agreed that the use of chemicals generally increases the amount that is produced on a given acre of land. The latter question was generally answered with, "I do not know, but I think it is a lot."

Environmental Issues Faced by Manitoba

There were four environmental issues that were discussed during the interviews that have impacts both at the local level but also at the global level. These four issues are: peak oil, climate change, population increases, as well as increased

consumption of meat. The effects and the solutions to these issues are global in scope. The rest of the environmental issues, aquifer depletion, soil erosion and exhaustion, as well as chemical use have effects and solutions that can be achieved locally.

The first question that dealt with a specific environmental issue was, "Have you thought about peak oil and the ramifications of expensive fossil fuel inputs, such as: chemical fertilizer, insecticides/herbicides/fungicides, machinery, transportation, processing, refrigeration, cooking?" This was followed up with, "If fossil fuel production declines and input costs increase dramatically, what effects will this have on food production and what alternatives may be possible?" These questions produced an overwhelmingly unified response. Every single respondent commented that peak oil is the biggest issue that has to be addressed by food producers around the world. As one respondent argued; "It's the elephant in the room." Each followed a different mental pathway towards the consequences of more expensive fuel. Each pathway that the individual respondents traveled concluded at the same point; the food we eat would be significantly more expensive and that we would need to rely on a more locally based food production/distribution system. One respondent stated,

> Quite frankly I would rather that oil was $900 a barrel. Suddenly, my local product is worth more money, because no one can compete. Mine is here right now, if you want to buy something from Germany, go ahead but it will cost 40 times as much. Quite honestly, a great big oil crisis would solve a lot of problems. That

> also makes the more damaging forms of agriculture more expensive. Suddenly, spraying everything with petro-chemicals doesn't look so good.

Another responded, "My shift to thinking about organic [food], in the past ten years, is totally towards peak fuel. It drives home why a smaller, organic farm is more important. It reduces the amount of fuel used. Agriculture uses such a large portion of fossil fuels. It has to be one of the areas that we cut back." Another respondent argued, "Large [acreage] farmers can't see a way to reduce the oil they use because of the large tracts of land they need the big tractors and such. But by reducing the amount of chemicals they use they reduce their costs. Regardless, farmers are starting to move towards organic farming whether on purpose or not, simply because they want to reduce costs." Overall, the respondents highlighted the different aspects of a situation where oil becomes more expensive. In the end, every part of Manitoba's food production and procurement practices become more expensive. This all leads to a situation where ultimately the increased costs of production manifest in the increase of food prices.

If it is understood that prices are going to increase because of the price of oil, then we must simply find ways in which decrease the amount of income necessary to purchase the food necessary to survive. The Victory Garden model that is was used during World War Two in the United States might be able to offset, at least partially

the amount of money spent on food. This would help consumers secure the produce they need while still being able to afford the additional costs.

As noted by one respondent, the rising cost of food might better situate Manitoba's farmers to take advantage of the local market. If costs continue to escalate, especially for oil, Manitoba produce becomes less expensive in comparison to the honey from Germany, or the cucumber from Mexico. In other words, the transition to a local food system would be assisted by the increasing price of oil.

What was interesting was that there were two respondents who had experiences that made them think further into the problem. One stated, "What is more sustainable? The cucumber that is organically produced in California, or the cucumber that is grown locally in a greenhouse in February? I don't know." This respondent carried on, "When I was completing a 100-mile diet, we talked about it and we were all traveling all over the place on daily basis to try and acquire local produce. I wondered how much fossil fuels we were burning in comparison to how much would be burned if we all just went to one store and shopped there." Interestingly, the second respondent had a similar thought process, "I do not think that the simple localization of the food system is going to be the panacea to that [peak oil]. There are all kinds of energy costs that are associated to localizing the food system. We were selling at the St. Norbert's Farmer's Market last year, and

there is a traffic jam there every single Saturday. The question became, is this sustainable? We have consumers driving fairly long distances to purchase their groceries." One respondent argued,

> "The contention that science and technology will get us out of this, I think it is faith [that] is poorly placed. There is no magic in the growing of food. Food needs three things: it needs a land base of course, within that land base it needs nutrients, water and solar energy. We have been extracting stored solar energy and applying it to the equation. When that stored solar energy comes in short supply, we go back to the annual rate of photosynthesis, and it does not support 6 billion people, or the nine billion people I suspect will be there by the time of the final realization."

The farmer's market as it stands now is not wholly sustainable. North American cities have been designed around the use of cars. The consumer is still required to drive to, and in some instances, drive longer to a farmer's market then to the local supermarket. At some point, the idea of what is sustainable will be required to change to the distance that can be covered under human power (walking or cycling). Locally sourced food that is distributed from a stationary point still requires food miles to retrieve it, however, food purchased virtually and delivered alleviates a portion of the food miles. Setting up food delivery systems comes at the cost of not meeting other like-minded individuals.

The literature reflects the respondent's comments. Dale Allen Pfeiffer argues that prices will rise out of control by the end of the decade (Pfeiffer, 42). When peak

oil causes a rise in the prices in all aspects of the food production and distribution process, then there needs to be a discussion on how to control the costs of production. Ultimately, there is a significant need to remove as much of the oil from the equation. As noted earlier, chemical use accounts for a significant amount of on-farm energy use, and a switch to organic production would reduce overall energy use the most. Three calories of fossil fuel energy are spent on farm for the production of one calorie of food; the removal of chemicals from the farm would change that ratio to two to one. Even with the ratio at two to one, there is still too much energy spent producing food. Two calories of fossil fuel to one calorie of food is still not sustainable. Besides, an extra five to seven calories are spent after the harvest, during processing, transportation and storage. There is little doubt that as fossil fuel prices increase, the price of food is going to increase to the point where it will not be affordable for even more of the population than is currently the case.

As stated previously, there were numerous types of responses to the question, "How have fertilizers, herbicides, pesticides and fertilizers affected food in Manitoba?" The unified response was that it is generally known that the application of chemicals increases food output. After that was stated, there were numerous respondents who went on about the consequences of applying chemicals. The most often noted consequence of applying chemicals is that the chemicals require significant amounts of fossil fuel to be created. However, they also require fossil

fuel to transport from the factory to the store, then from the store to the farmer, and finally for the farmer to apply to the fields.

The second issue that was raised during the interviews was of nutrient loading in the soil. Three respondents recognized this to be a significant issue. Fertilizers are applied in such a manner that plants cannot successfully absorb it all. This causes it to build up in the soil and eventually end up in the ground water and river systems. Two of the three respondents pointed towards the application of chemical fertilizers, while the third specifically stated that the spreading of manure was to blame. He stated that if he were to grow a cereal grain, he knows that he would have to replace about 25 pounds of phosphorous per acre to maintain the soil fertility. The Manitoba Pork Council believes they are under some of the most stringent environmental regulations in Manitoba. One respondent argued, management practices allow up to 840 pounds of phosphorous per acre, so "When I saw this, I knew it wasn't waste [manure] management. It was waste disposal." He argued that the market has concentrated large numbers of animals into very small amounts of space and the surrounding land cannot adequately absorb the manure these animals are producing. The Manitoba Pork Council argues that the manure that is produced by their livestock is only enough to fertilize "… 15% of the total crop land in Manitoba" (Manitoba Pork Council, 2011). Clearly, they could fertilize more land if they spread the appropriate amount of nutrients on any given piece of land.

Whether caused by artificial or natural fertilizers, eventually this degrades the groundwater to the point where it is not potable. The situation is worse for river systems. The excess nutrients cause algae to bloom in the lakes. As it dies off at the end of summer, it begins to decompose and the algae consume all of the available oxygen in the water. This destroys the life sustaining abilities of that body of water. Agriculture is not the only reason for nutrient loading, but it does play a significant part. One respondent noted that at least a third of the nutrients that end up in Lake Winnipeg that cause algal blooms, are caused by agricultural runoff.

There were three questions that were designed to address the issue of climate change. They were, "What about the effects of climate change? What might we anticipate as the consequences for local food production and for distant food supply sources currently being used?" and "Increased frequency of extreme weather events?" The responses came back extremely varied. A few of the responses were rather apocalyptic, while others were hopeful. One respondent in particular was more baffled about the situation, while the rest did not make any statements regarding their views of the future. One thing is certain, each of the respondents either directly or indirectly bound the issue of climate change to that of oil use; one respondent argued, "I sort of see them as twin threats".

Those that took the apocalyptic view argued, "The evidence points towards a catastrophic event…agriculture is a huge climate change offender… There are huge sums of natural gas used in the production of fertilizer. There are huge amounts of fossil fuel used in unnecessary transport… It needs to be changed." While another argued, "Peak oil and climate change are two huge issues, we will see how it will all play out. We don't know, but I believe the predictions are going to come true. It is a pretty frightening aspect for agriculture and so it's pretty frightening for all 6.7 billion of us." The hopeful response was more cautious than anything, claiming "We have our work cut out for us". The one response that came back baffled stated,

> We think about it a lot. Actually addressing [it], I think we are in the same position as the rest of the world. We would really like to do something about it but, geez we're not sure what that would be. Let's face it, we don't truck our produce from California and we have measures in place to guarantee that. We have on farm inspections to make sure that our growers produce what they sell. At the same time we know that the majority of our clientele drive out from the green belt of the city, the Wolseley and the River Heights. [They] Drive all the way down Pembina Highway to come shop at the St. Norbert Market. I worry late at night whether we haven't just undermined everything that we are trying to do.

The rest of the respondents were willing to discuss the facts. Two pointed out that agriculture is responsible for between 17 and 30 percent of global greenhouse gas emissions. Another pointed out that cattle produce more emissions than any other animal.

Three respondents specifically noted that water was the biggest issue with climate change. They broke the issue into two separate issues. One argued that with an increased mean temperature, there is going to be an equal increase in the amount of evapo-transpiration that each plant experiences. This will increase the amount of water that each plant will require to survive. The second issue is that there will be a change is seasonal rainfall. The respondents argued that the change is not necessarily going to be more or less, although it might be. They argue the data suggests that precipitation is going to occur in fewer but more extreme events. They argue that this might lead not only to more instances of flash floods but also more instances of drought. Drought may be averted or at least lessened in severity by the use of irrigation. However, because of the change in rainfall patterns, they argue that it is possible that the water table will be affected to the point where irrigation may not be a viable solution.

According to the Intergovernmental Panel on Climate Change (IPCC) the most important issue with agriculture on the Great Plains is the availability and distribution of rainfall and water. The IPCC argue that the Great Plains region actually stand to see agriculture yields increase as the temperature increases. However, they argue that these increases quickly turn to decreases in a situation where global temperatures rise more than three degrees Celsius (Field, C.B. et al. 2007:631). Any increase in temperature means that both crops and livestock will

require additional water. Irrigation will be the key to making up any water deficit that is created by climate change. Water storage capabilities should also be increased so as to make better use of the water that is available through snow or rain. It should be noted that permaculture has been vocal in their support of setting up swales, to harvest, store and even transport water, as it is available. Permaculture also argues that applying a thick layer of mulch has the ability to absorb and store water to distribute as necessary. Mulching around plants also reduces the need for water as the mulch keeps the roots cool.

The literature review pointed towards moving away from a meat based diet and relying increasingly on a plant based diet. There were two questions used to open the conversation on meat consumption; "What are your thoughts on the impact of the meat-based diet?" As well, "Is increased reliance on a plant-based diet a likely requirement in response to anticipated disruption of current food production practices?" This particular discussion took a very unexpected turn and also produced a high number of uniform responses. The respondents were quite sure that meat production as practiced by industrial agriculture is environmentally unsustainable. A number of respondents noted there were also ethical issues around raising animals for meat. These issues are outside the scope of this thesis and will not be dealt with. Seven of the ten respondents stated that meat consumption in North America was far

too high and should definitly be cut back. Eight respondents noted that it was not simply about consuming meat, it was about how the meat was produced in the first place.

Three respondents noted that a significant portion of meat was grazed on lands that were unable to grow anything else; "Most apprehensions here is that, although meat production is very inefficient at turning grain into protein, it is an efficient way of turning marginal land into protein. At least in Canada, most of the meat production is at least partially done on land that wouldn't grow grain."

Two respondents noted that in Manitoba, it is the hog industry that is responsible for the majority of the issues surrounding meat production. One noted that there are not many feedlots for cattle but there certainly are a great number of hog barns. Another added that there is a good reason why hog barns became popular in Manitoba. The problem is that the 'crow rate' was suspended. The 'crow rate' or the Crow's Nest Pass Agreement, was a subsidy that was used to help pay for freight costs of Canadian grain farmers, to ship the grain throughout the world. It was started in 1897 and was an agreement between the Canadian Pacific Railway and the Canadian Government. The agreement was designed to help ensure that CPR would continue to send trains across Canada with full loads. The agreement was to subsidize the shipping of grain in the amount of 3.3 million dollars a year, in

perpetuity (Regehr, TD and Ken Norrie, 2011). There were numerous warnings that this subsidization policy contravened some the rules in NAFTA and as such in 1993 the 'crow rate' was cancelled (ibid, 2011). This is one reason why the hog industry is so big in Manitoba. The grain farmers could no longer afford to ship grain long distances. So they decided to start feeding it to local animals."

Three respondents argued that an increase in plant consumption is necessary to help prevent the environmental issues surrounded by meat production. However, two noted that eating a balanced vegetarian diet requires the destruction of natural landscapes. "I went to a dinner once with quite a few vegetarians and I was one of few who ate meat. I was taking a lot of barbs from them, all in good fun mind you. I listened to it all and I said 'you know people, as much as I have enjoyed this meal there is something that bothers me about it.' They replied, 'what's that?' and I said, 'everything on this table was made available because some natural habitat was changed to provide it.' And it got very quiet." Another respondent argued, "so the environmental cost is not grain versus meat but rather, natural habitat versus meat."

Raising animals and the consumption of meat is not necessarily a bad thing as long as it is carried out with appropriate means of production. Livestock produce some greenhouse gas and the waste they produce can cause problems as they build in the ecosystem. It is important to note that these issues usually only manifest

themselves when the animals are concentrated to such a point that wastes they produce cannot be adequately absorbed by the surrounding land. They key to raising livestock is the size and scope. The purpose is to maximize the benefits and minimize the drawbacks. Livestock provide an extra source of security to a small-scale farmer. They provide an extra source of protein, if needed. Indeed, the keeping of animals is necessary for smaller farms to remain productive without relying on natural gas based chemical inputs. It was argued by one interviewee that even though it does not appear that a meat based diet can be as sustainable as a plant based diet, "There is a lot of thought out there that argues that it is impossible to have a closed-loop system without animals. The animals supply the manure to maintain soil fertility. Since time began, animals have always been a part of the ecosystem." The literature indicated that livestock was terribly inefficient at turning grain into protein. However, in Manitoba, cattle are raised predominantly on land that would not support anything else. The energy required to raise a cow is solely the amount of solar energy that is required to grow the grass. This applies to all sizes of farms, right down to the backyard permaculturist who raises chickens to help control pests, increase soil fertility and produce eggs.

The next issue that agriculture is going to have to address is the constant increase in global population. To address this topic, the question became: "World

population is continuing to grow, what does this mean for food security?" In four of the interviews, the respondents answered immediately, "We are not able to feed all of the people that are hungry now." At the moment a segment of the world's population is not currently being fed properly. As shown earlier, the problem is one of access, not one of supply. Three of them noted that approximately one billion of the world's population are overfed while another one billion are undernourished. One respondent noted that there is a very distinct interplay between governments and corporations. Another relayed that developing countries should focus on food first subsistence agriculture instead of the export oriented agriculture that the World Bank is attempting to impose.

Numerous people responded by evaluating whether food production could increase to satisfy the world's needs. The first respondent argued that there was lots of potential to grow food production, while one claimed that food production is not keeping up with population increases as it is. Another respondent argued that we might be able to succeed in increasing food production but we would have to "Simply not to waste it, eating less meat, stop feeding grains to animals, and simply put a moratorium on creating fuel from grain." The rest stated that there was no way to know whether it will keep up. According to Angus and Butler, there are four ways to ensure that food production keeps up with population growth: (1) Food is transported to places where people can afford to purchase it. (2) Grain is converted

into beef (3) Food is converted to biofuel (4) Food is destroyed, spoiled or thrown away (Angus and Butler, 2011). These authors go on to argue that, "blaming food shortages on overpopulation downplays the fact that the existing global food system is grossly inequitable, wasteful, and inefficient" (Angus and Butler, 2011).

Therefore the "Question is whether, combined with the other issues, agriculture can keep up with population growth. We are standing on a knife-edge in terms of our food supply in general and we are just going to be tilting that much closer to the edge." Catherine Badgley and her team of researchers argue that organic agriculture would have no problem feeding all those new individuals (Badgley *et al.,* 2006). The overall issue of overpopulation tends to be blown out of proportion. For many years, the birth rate has been dropping off. In many of the highly developed countries the birth rate is below the replacement level (Angus and Butler, 2011). The global south is where the highest percent increase of population is occurring and they are not the ones responsible for any of these environmental issues (Angus and Butler, 2011).

The final two respondents took a completely different approach to the topic. The first argued that while the question of population was an interesting one, the issue of consumption is more important. The second argued, "What I worry about is that if we really do start running out of food, that might make bulk production

economically sustainable again." The respondent was making reference to what might occur if food prices rose so dramatically that producers were no longer worried about the price of fossil fuel based inputs and transportation at a distance. As noted earlier, if food prices rise dramatically, it will be because of a rise in the cost of oil. However, if the price of food increases because of something else, the issue will still be an issue of access. Richard Heinberg argues that "global food production approximately tripled during the 20th century, just keeping pace with population growth" (Heinberg, 193). He goes onto argue that the end of increased food productivity is already occurring, "global food per-capita food production has been falling for the past several years. Grain surpluses in the exporting countries (Canada, the US, Argentina, and the European Union) relative to global demand have disappeared, and farmers are finding it hard to maintain production rates" due to a long list of issues (Heinberg, 195).

The issue of water was discussed throughout the interviews as it related to climate change and chemical usage. Water usage was another issue that was discussed. The question asked was, "Have you thought about issues around water depletion?" One respondent was quite critical of both water usage and water policies. First, this respondent noted that farmers,

> are growing a crop that is highly dependent on water, but the biggest crop loss factor is flooding. So now you have a crop that is serviced by pivot irrigation to prevent drought, but also is serviced

> by tile drainage to prevent flooding… when the rain comes the water immediately leaves the field and into the public drainage system. I don't begrudge the tile drainage, but it should be serviced by a catch basin that uses it within normal rainfall patterns. That's not what happens. It is taken away and ends up in Lake Manitoba. Then when the weather turns the other way, we burn huge volumes of fossil fuel to pump water from the Assiniboine River or from the aquifer. That's not water management, that's intellectual impairment. But it is market driven and that's the cheapest thing to do. The environment is a public resource. If I can gain profit from moving my drainage system to the public system then I will because it benefits my economic well-being.

The respondent noted that the fault for this situation does not lie with just farmers. It was noted that there was one particular instance that stood out.

> The province wanted to divert a significant amount of water from the Assiniboine River to help service other communities. Instead of using monthly flows, and using the numbers from the highest demand months, July and August, they took the total amount of water that flows every year and divided it by 12. The average number created was higher than the amount of water available to consume in the months of July and August. There is a system of water management and it's called the magic wand system of water management.

Another respondent argued the reasoning for this irrational behavior. In "Japan it is pretty obvious there is no surprise stash of…water…Here we have the mentality that Manitoba water is never going to end." Water conservation practices have to be developed to reduce the amount of water used during production. Less intensive agriculture, with plants spaced farther apart would require less water. Mulching practices and cover crops, require less water. System's like the "three sisters" practiced in South America use a polyculture scheme that uses companion plants.

Rainfall storage systems would allow the collection of rain to be used later when it is needed, this would prevent or at least reduce the need to use underground aquifers.

This discussion was immediately followed up with simply, "Soil erosion? Soil exhaustion?" It is not possible to discuss agriculture without discussing the issues surrounding soil. This particular area produced a small amount of information. All of it however could be used as a sound bite. One respondent argued the prairies are so flat and wide open that the soil is vulnerable. Another respondent reminisced to one particular windstorm. "I looked outside and thought there must be a fire somewhere but it was top soil and so much of it that it filled in all the ditches." Two of the respondents noted that there was a great measure taken to plant shelterbelts to combat erosion, which helped significantly. The increasing size of mechanized equipment required to farm the land, has led to the shelterbelts becoming obstacles that need to be removed. One respondent noted that both the installation and the removal of these shelterbelts are being done at the public's expense. The other respondent stated that the reduction of summer fallow and the practice of no-till agriculture have helped retain soil. Permaculture and other forms of organic agriculture have the ability to significantly reduce the amount of soil erosion. Organic agriculture often uses mulch between the rows of plants. They also make use of cover crops.

The second issue that was raised was a reduction in the quality of soil. One respondent argued, "Soil health has to be rebuilt. Conventional farming sucks all of the nutrients from the land and organic matter has to be built back up, to be more resistant and yield producing." Another respondent added to that line of thought, "A century of production has depleted the productive capacity of this land base, and we have depleted it substantially. What we have been able to do is replace that depletion with other inputs, connected to fossil fuel. We have been able to artificially replace what we have lost." However, these "nutrients…might not be able to be replaced due to things like peak phosphorous and peak oil." The use of nitrogen fixing crops like, legumes, will have to be used as part of a rotational planting. Some of these are extremely deep rooted and can mine phosphorous from great depths that are not achievable using other crops.

Ecological modernization and limits-to-growth both agree that modern industrial agriculture is wholly unsustainable. Joseph Huber argues agriculture "relies on heavy machinery, artificial fertilisers, pesticides that do more harm than good, and soil and groundwater degradation" (Huber, 46). Pfeiffer offers similar arguments, "we have appropriated all of the prime agricultural land… biological diversity – the underpinning of life on this planet – has been diminished… soils and fresh water resources have been degraded and depleted… our land and water resources, and even our food, are also highly tainted with toxins we have over-

applied in an effort to protect our food crops from pests… our farmlands have been concentrated into agribusiness dedicated to maximizing short-term profit (Pfeiffer, 39). The difference between the two is their ideas regarding solutions and social change.

Solutions and Social Change

The last grouping of questions surrounded the idea of social change. There really is no point in discussing the above environmental issues without discussing the possibility that we might also be able to pursue different avenues to correct them. The first set of questions deals with alternative food production practices that may be able to counteract some of the issues with current practices. The second grouping asks about the mode in which to affect desired change.

The first two questions that were used were, "What kind of yield is possible with organic agriculture?" And, "How does this compare with industrial agricultural practices?" The respondents chose to answer both questions at once, with comparative statements. Two people responded that it is possible to achieve production that was equal to or greater than industrial agriculture using organic methods. Another three respondents offered that it was possible to achieve slightly less than equal levels of production. One study produced in 2006 compared global

yields from both organic and conventional or low-intensive agriculture from across the globe. It found that in developed countries that make use of conventional agriculture, organic agriculture produces ninety-two percent of the yields currently seen by conventional agriculture. However, in developing countries organic agriculture produces 180 percent of the yield when compared to low-intensive agriculture that is predominantly used (Badgley et al., 2006: 91). This study went on to argue that if the world switched en masse to organic agriculture the potential yield would be somewhere between 2641 and 4381 kcal per capita per day (ibid, 2006: 92). One interviewee argued that the problem is that the majority of academic studies completed have nothing to do with organic agriculture, indeed they have to do with increasing efficiency in industrial agriculture.

Aside from the fact that you can achieve similar production with organic agriculture, there are a great many environmental benefits from using organic agriculture. For example, one respondent claimed that, "Zero-till and organic systems have the ability to increase carbon sequestration." In terms of meat production they argued, "rotating grazing systems, instead of conventional systems. We are trying to treat the land the same way the bison did. They would hit an area very hard and then leave it for a long time to re-grow." Another respondent said that even if we were to consume only organic food from the same sources, the amount of fossil fuel would be decreased because the amount of inputs would have dropped significantly. Two

respondents argued that using organic agriculture would help mitigate the effects of climate change. They argued that there was no way that plants would be able to survive an extreme flood or drought, however organic agriculture is significantly better at surviving moderate events of flooding and drought. Organic agriculture has more organic matter in the soil than industrial agriculture. The organic matter in the soil acts to protect the root systems in the event of a flood and retains moisture in the event of a drought. One respondent stated that an industrial farmer who made use of cover crops might fair the same as an organic farmer. This respondent explained that there is a spectrum that farmers fall into; some purely organic, some purely industrial, though most employ methods from each. This was echoed by another respondent who argued that organic may not be the entire answer; "Not necessarily organic but, definitely lower input. I think there are areas where inputs are necessary." This respondent was referring to the case where due to some malady, a farmer would lose all or the majority of the crop. However, if the farmer used a chemical input, the crop could be saved or the damage alleviated.

A shift to organic agriculture is riddled with the problem that the majority of farmers no longer have the knowledge to switch to organic farming. The problem at the moment with organic agriculture is that, "Chemical inputs are a substitution for traditional knowledge and we pay for them. Farmers no longer understand how to

farm without those inputs, the knowledge is gone." Another respondent went on to say that, "Not only do they not have the skill but I'm probably the last generation that has any of that knowledge at all. I haven't been able to pass it anywhere." There is a very urgent need to have this knowledge recorded, to be distributed when it is needed later. Knowledge preservation, transfer and re-skilling are going to be very important. The huge question is whether or not there is enough of this type of knowledge left that we might stand a chance in the event that mobilization has to occur quickly.

There is hope however, as one respondent who started a community garden reflected, "I have found it interesting watching the knowledge pathways begin to emerge. You hear conversations like, I was on the phone last night talking to my grandmother about pickling recipes." The knowledge can still be accessed but there have to be people who want to access it. These respondents are talking about the use of knowledge that is available locally. The respondents understand that there are fewer people locally who understand traditional farming practices. It is important that we understand the difference between extirpation and extinction. Manitoba can look to many other countries that still rely on traditional farming methods if there is not adequate local knowledge.

The shift to organic agriculture ideally should be started immediately. To some extent the shift to organics has begun. Every year the number of certified organic farms increases across Canada. The number of certified organic farms in Canada has increased from approximately 1200 in 1992 to just over 3900 in 2009, (Macey, 2010: 2). There was an additional 201 organic farms from 2008 to 2009, this represents a 5.4 percent increase (ibid, 2010: 2). Even though the increase is promising, organic farms only make up 1.7 percent of the total number of farms in Canada (ibid, 2010: 2). Industrial agricultural practices have ruined the ability of the soil to take care of itself. One respondent argued that, "You take away the soil's ability to fight off all of the pests and disease has been reduced from all of the chemicals in it. It's like a drug addict getting cut off from their fix. Until the soil has the ability to take care of itself there will be a reduced yield."

Micheal Pollan argues that for the entire period of time that industrial agriculture has been the predominant form of agriculture, the alternative has always been called organic. Organic has always implied "nature rather than machine" (Pollan, 2006: 131). Two different types of organic agriculture have developed over the years; industrial agriculture and small-scale, local and labour intensive organic agriculture. Pollan argues that a lot of the organic food is produced by the former,

> When I think about organic farming, I think family farm, I think small scale, I think hedgerows and compost piles and battered pickup trucks.

> I don't think migrant laborers, combines, thousands of acres of broccoli reaching clear to the horizon. To the eye, these farms look exactly like any other industrial farm in California -- and in fact the biggest organic operations in the state today are owned and operated by conventional mega-farms (Pollan, 2001:158).

All of these farms are essentially no different then their industrial counterparts. Pollan traced a number of industrial organic products back to the farm. What he found was that, some organic milk comes from farms that do not allow the cows to see grass. He also found that one farm produces eighty percent of the organic lettuce grown in the US, and that the only difference between organic poultry and industrial, was the feed (Pollan, 2006: 138-140). If this is organic, then we might be able to buy ourselves some time, simply from the reduction of chemical use, but that is about all. The original notion of organic and what it implies is how we might be able to survive the oncoming environmental crises.

Both polyculture and permaculture have been used as sustainable agriculture models in other countries. The question that was asked regarding these activities was, "What about polyculture and permaculture as ways of increasing yields?" Polyculture was unknown by the majority of respondents. One respondent asked if I was specifically talking about the "three sisters" example that was used in South and Central America. Three sisters system was used a lot by aboriginal tribes. They realized that if you were to plant corn, beans and squash in the same field the

production for that field increased. The three plants used form a symbiotic relationship. The beans grow on the corn stalks and fertilize the squash and corn by fixing nitrogen, while the squash acts as a cover crop and shades the roots of the corn and beans. The respondent went on to emphasize that there is huge potential for using this system to increase the resilience of farms. Their thought was, "Way in the future we might be able to have a perennial polyculture, mixing all kinds of grains in the same field. I wouldn't call it a near term solution, but it has potential. We need more research and development." Another respondent offered, "For organic certification you have to fill out forms. One of the questions on that form is how many acres of X are you growing. Well on any given acre of land we are growing fifteen to twenty different species. If that is a polyculture then the policy work has to change. They assume you are growing one thing on a big piece of land." However, after explaining to the respondents that had not heard of polyculture and how it had been utilized in India, the response came back something to the effect, "Canada simply does not have enough labour to adequately employ this technique." Canada probably does not have enough labour to employ this technique. However, as the global population growth tapers off and begins to decline, Canada might be in a situation where they can begin utilizing immigrants from the south to help diminish the shortage of labour that would be faced in all industries.

Labour was also an issue for permaculture, however, it is not an ongoing one. "Starting a permaculture system is labour intensive but as time progresses it becomes more efficient." The respondents noted that permaculture techniques always attempt to "mimic natural systems." It is this mimicking that makes permaculture so efficient. It was also mentioned that permaculture tends to be "urban in scope" or at least occurring on smaller plots of land. Even given the fact that permaculture began in New Zealand, it was noted that it wouldn't be that hard to adapt the concept to Canada's climate. Canadians might have to begin using plants that have been forgotten about. Potentially, permaculture "Completely shifts the focus of our entire system. I think permaculture is something that we should be spending time on as academics, as governments, as producers. It is very appropriate way to address some of the ecological as well as social aspects." The concept was explained to one respondent who had not heard of permaculture, and the response was, "No form of agriculture can be permanent unless you take less than you give back."

Another type of agriculture that might be employed to help mitigate some turmoil caused by the environmental issues is urban agriculture. The question asked to address this topic was, "To what extent could urban agriculture be used?" The general sentiment of the interviews can be summed up in three quotes; the first was speaking about the difference between the typical Cuban yard versus a typical yard in Winnipeg.

> One guy was saying that he has like a hundred different species of plants that produce, fruits, nuts and vegetables on his property, all this great stuff like mangoes. In the end, it's in the city. If you think of a yard like that here, it's going have grass… It's going to be Kentucky Bluegrass that's been fertilized and artificially watered. The output is nothing, zero edible output, but all of these inputs are harming the environment. Everything bad is going in and nothing good is coming out.

Another respondent answered that, "We have these huge parks with manicured lawns, and you just have to wonder what the hell is going on. I would envision these public spaces intermixed with food production. It's amazing what can be produced on small amounts of land." The third furthered a similar sentiment by stating that, "there is a lot of wasted space in terms of peoples' yards. They are just big green, sterile expanses of nothingness." There is a vast amount of wasted space inside the City of Winnipeg; if even a small percentage of this space was used for growing food, there would be a huge decrease in the amount of food imported into the city. As noted above, there are no estimates on the amount of space that is currently being wasted growing lawns. However, the Toronto Food Policy Council argued that it is not unreasonable to think that a city could produce as much as twenty-five percent of its fresh produce from within the city limits (Toronto Food Policy, 15). There is also the added benefit that cities are microclimates, and because of the amount of concrete, the city will always be a couple of degrees warmer than any rural part. One respondent argued that to find examples of urban agriculture that have been instituted successfully, one only has to look to Caribbean countries.

> I think Cuba will be a huge area from which we could learn from. I have worked in Haiti and natural disaster strikes this area fairly frequently, and the speed at which communities can bounce back is astounding. Urban agriculture allows for a much more dispersed production system. It allows knowledge to exist outside of specialized farmers. You have urban dwellers that can hold down a job and also produce a good amount of food.

One respondent noted that the biggest issue with urban agriculture is that, "I think the land is too valuable. Like anything that you could grow carrots or you could put up a parking lot and make a lot more money." While discussing this topic, the number of respondents pointed towards two concepts that had gone unnoticed. The first is the old concept of the victory garden during the Second World War. This was where the British and United States government actively encouraged households to begin growing as much of their own food as possible. The second is a newer concept known as Small Plot Intensive (SPIN) Farming. SPIN farming might just be the solution to the problem of adequate income for urban agriculture.

SPIN Farming

SPIN Farming was raised a number of times throughout the interview process as a potential way to increase food production within the city. Also, it was revered as having potential for people within the city to earn a living from growing food. Small-Plot Intensive (SPIN) Farming utilizes small plots of land (smaller than an

acre) to plant numerous densely planted, high-value crops (Urban Partners, 2007). This system relies on using a zoning practice, similar to that found in permaculture. There are three zones; the first of these zones is the smallest. It requires the least attention and should be devoted to single harvest, low value crops, such as root vegetables. The second zone allows for harvesting two higher-value crops per season. The third is the most labour intensive but also the most profitable. It is planted with high-value, quick growing crops that allow for at least three harvests throughout the season. By removing the farming practice from the rural setting, the creators of SPIN also removed the largest barriers to farming: land and capital. The land used by SPIN farmers is often land that has been rented from home-owners that goes unused from year-to-year.

The data available shows that Manitoba currently lacks production of fresh fruit and vegetables. An increase in SPIN farming in Manitoba would result in a higher yield of fresh produce in the province.

Community supported agriculture is also a possible alternative to industrial agriculture. The question designed to address this topic was, "What is the potential for community supported agriculture?" A number of respondents argued that there seems to be huge potential for farmers to take advantage of this concept. The major

issue that might hold back community shared agriculture from becoming the dominant form of agriculture is that, "Unfortunately for Manitoba, our farmers are so reliant on the export market. We produce far more food than we can consume, and so it can't support all of our farmers." This is especially true for the hog and grain sectors of Manitoba agriculture. What might be possible is to transform some of the huge grain farms into much smaller independent farms that grow more suitable produce.

The last topic that was discussed was the use of vertical agriculture to both alleviate the need for long distance shipping and turn some traditional farms back to natural habitat. This particular topic was discussed fleetingly throughout numerous interviews and was eventually dropped from the interviews altogether. This decision was made mainly due to time constraints. When first brought up, the term vertical agriculture was often thought of as using vertical spaces within a garden. However, when it was explained that this was not the idea that was being discussed and subsequently Despommier's idea was outlined, the respondents figured that far too much money was required to start something like that. Also, they questioned whether or not there was any way a greenhouse would be able to make as much per square foot as an office building.

At some point during many of the interviews the question, "Do you think the solution is moving towards organic, labour-intensive, small-scale and local farms?" was asked. The answer more often than not was simply, yes. The issue of organic farming has already been dealt with. Labour-intense farms are important to cut down on the amount of oil used during the production of food. One respondent stated there needs to be a "Re-orientation of technology to a scale that is more human… we need to start substituting out technology for human labour." Another respondent argued the value of having a small-scale, diverse farm is that the waste products of the livestock become the fertilizer for the next year. The farm becomes one step closer to having a closed loop system. Some further statements made by other respondents maintain that small-scale diverse farms are much more resilient due to the fact that the biodiversity is much greater. Two respondents argued that for many years, a great many people made a living off of a quarter section of land (160 acres). However, over the years it became much more difficult to make enough money to survive, and many farms became consolidated into much larger farms. They have noticed that there have been many more families moving back to a quarter section property and thriving on it. A third argued that, "Farmer's markets are a way that a family run farm can be sustainable either as a way to supplement the farm income or as a dedicated farm type model… A farm that might be too small or too inefficient to produce large volumes of a single commodity, can somehow by diversifying into retailing become sustainable again." The issue of locality was interesting. Most

argued that there is a need to rely more heavily on local farms, but one respondent argued that trade has always been persistent in all forms of agriculture. Manitoba might be able to heavily reduce the amount of trade that is required, but there are certain products necessary to the health of the population that are simply not available in Manitoba's bio-region. Salt is a good example of this. This leads back to the question of: what is necessary?

NGOs and Retailers and the Issue of Education in Social Change

After the solutions were discussed, the topic was changed to instituting the changes required. This began with the question, "What is your organization doing to address some or all of these issues?" Two respondents explicitly answered that they were trying to educate the public about the issues at hand, all of the rest answered the same way, albeit implicitly. Education is also what is most required in helping to institute change. They argued that the market place is not as transparent as it ought to be. Consumers are unable to choose the best option because they have no idea that there is a problem to begin with. Educating the people who may not have the information to make the informed choices is key. Ecological modernization argues that this type of consumption practice is called "political consumption" (Spaargaren and Cohen, 2009: 263). Political consumption occurs when consumers use their "purchasing practices as a source of power for promoting sustainable transitions"

(ibid, 2009: 263). Essentially, every time we shop we either vote for or against certain types of agriculture. They further argue that NGOs have become the primary agents through which this occurs (ibid. 2009: 263). If this is true, then all we need to do is simply choose the option that fits our particular ecological preferences. However, one respondent argued that even as an educated consumer, it was near impossible to make the right choices. "I tried to live that ideal, as part of my environment and ethics courses I have tried to live for two weeks, living the David Suzuki lifestyle. I'll tell you it just about killed me. I'll tell you it's hard. You go to the super market and read all the frigin' labels. A thirty minute shopping trip turns into an eight hour odyssey." It is clear that those choices simply are not available. Depending on how one chooses to look at it, this is either a failure of ecological modernization, or a process of the treadmill of production. Ecological modernization argues that consumers simply have to make the proper choices at the market. Consumers simply cannot make these informed choices because they do not exist.

If most organizations are taking part primarily in the education process the question becomes are these organizations doing enough? The answer is no they are not. The issue, however, is what else are they supposed to do? Education is the starting point. If consumers do not know enough about the problems regarding industrial agriculture, these organizations cannot just start attempting to overhaul the

system. The power that is wielded by these organizations comes from being backed by a large support group, made up primarily by the general public. They have no choice but to start with education in the hopes that they can garner enough support to start implementing adequate change.

Knowing how they were attempting to institute change, the follow up questions were, "Ideally, what do you think is needed by your organization to achieve the goals you have set out?" and "What would improve your organization's capacity to effect the desired change?" Again, all of the organizations answered in the exact same manner; "We need more money." One respondent wondered how much they might be able to accomplish if they had the same amount of money as George Weston's[3] marketing campaign.

The Expected Role of the Government in Social Change and Corporate Interference

Three questions were asked regarding what the government's role could be in the institution of change. The first was "What role do you think the government should play in addressing these issues (federal, provincial, municipal)?" The second

[1]George Weston began a bakery and has since grown to own Loblaw's and Real Canadian Superstore. Loblaws is the largest food distibutor in Canada.

was, "What role do you think they are currently able to play?" The last question was, "What changes are needed to allow them to respond more effectively?" Two interviewees argued that the government is responsible for leading the process of social change. They argued that it is their responsibility to institute laws and taxes that help institute change. This prescription is standard in ecological modernization (Harper, 213). They call it incentive shifting, where governments help create a social environment by penalizing the environmentally destructive practices (ibid. 213). Overall, the respondents argued that the government plays only a small, but important role at the beginning of the process. The respondents argued that the government is responsible for funding the non-governmental organizations that are responsible for initiating the process. After the awareness increases enough and the electorate starts to sway towards the principles of the NGOs, then the government has the opportunity to step in and institute even greater measures to effect social change. Some academics from the ecological modernization camp are starting to realize that it is becoming increasingly necessary for the changes to be implemented from the bottom-up (Fisher, Fritsch and Andersen, 149-150).

One interviewee reflected on the government electing to support the corporations rather than the grassroots organizations. "Changes will come from the grass roots movement. Unfortunately, they [the government] are responding to

corporations rather than to grass roots." The problem is that corporations have their own agenda to follow.

> Our agriculture system does not exist in a vacuum; it exists throughout the food web. The biggest player is the middle. The middle being the corporate sector and is becoming increasingly concentrated. They control on one side, inputs, and on the other side, processing, retail and transportation. When you look at the profits gained by the middle sector you see very quickly where that value is accruing. There will be some inertia within that system and a reluctance to change. A change at the farm level is only changing a very small part of the food web. Understanding where the power lies in that system will help one decide how to start changing that web. There are a lot of powerful players in that web, who may or may not have any interest in changing.

The respondent above makes reference to what might be the largest hurdle in the quest to change our food system. There are many authors who argue that the power in our food system lies in the middle, exactly as the respondent argued. The food system is shaped like an hourglass; there are many farmers on one side that are responsible for producing all of our food, and there are more consumers on the other side that have to purchase the food, but in the middle there are very few corporations that join the two sides together (Murphy, 2008: 528 and Howard, 2009: 88).

These corporations are becoming both horizontally and vertically integrated. Horizontal integration occurs when one company or corporation owns and controls most of one type of industry. Tyson Foods Inc. and Pilgrim's Pride Corporation own forty percent of the U.S. poultry market (Murphy, 2008: 530). Vertical integration

occurs when one company owns all of the links along a commodity chain. Take for example, ConAgra,

> in 1990 it entered the seed business. Since then it has formed a joint venture with DuPont and formal relationships with some of the seed companies involved in biotechnology. ConAgra owns 100 grain-storage elevators, 2,000 railroad cars, and 1,100 barges. ConAgra is the largest turkey producer and second largest broiler producer. It also owns and operates hatcheries. ConAgra hires growers to raise its birds and then it processes the birds in its own facilities. This broiler meat can then be purchased as fryers under the name Country Pride or in further processed foods such as TV dinners and pot pies under the labels of Banquet and Beatrice Foods. From the basic raw material for agricultural production to the retail store, a significant proportion of the food system is owned and controlled by ConAgra (Heffernan, 2000: 69).

The National Farmers Union explains what the effects are of the scenario where many farmers sell to few corporations, and how this is getting worse for the farmers. NFU argues "as competition increases, prices and profits decrease, and vice versa. Thus, by increasing competition among farmers, so-called "trade" deals predictably decrease or eliminate profits. And by fostering a dramatic *decrease* in competition among agribusiness corporations, trade deals dramatically *increase* profits for these companies" (National Farmers Union, 2001, emphasis in original).

Another respondent agreed that corporations have their own agenda and that "Democracy is a frustratingly slow process… I have spent some time attempting to create change by direct participation within the political system itself. I wouldn't do

that again." This interviewee went on to argue that, "The industry has been developed with all the employment and investment on the landscape, you can't change it. It's too late. Imagine all of the people who work in the industry [and would lose their jobs] and you don't pull the plug on it. You commission another study perhaps but you don't change it." The politician may not be willing to change the order of priorities.

The Case of Inadequate Change and the Importance of Farming

Regardless of whether politicians are willing/able to make required changes, David Korowicz argues it will not matter; peak oil will eventually cause a collapse of the entire industrial economy, not just agriculture (Korowicz, 30). The most often discussed collapse is the Linear Decline. This argues that a reduction in oil availability at a rate of 2 or 3 percent annually, causes a similar decline in the economy. The two more probable decline curves are the oscillating decline and the systemic collapse (Korowicz, 31-33). The price of oil will cause a collapse in consumer demand due to a lack of disposable income. This in turns causes a crisis of over-production, leading to skyrocketing unemployment. Now that all of those people will be able to find work in the agricultural sector, these people will be able to grow our food. The profession of farming now finds itself as the most important

profession. Ultimately, this situation will help increase the number of farmers in Canada.

As noted earlier, after Cuba went through a transition caused by peak oil, Cuba required approximately, fifteen to twenty-five percent of the population to become farmers in order to grow enough food. According to Statistics Canada, the population of Canada is about 34 million people, while the population of Manitoba is 1.2 million (Statistics Canada, 2010). If Canada and Manitoba requires approximately fifteen to twenty-five percent, then we would require between 5.1-8.5 million and 180 000-300 000 farmers respectively. One respondent reflected,

> there has been a large concern over the collapse of rural communities. There was a lot of discussion about how best to repopulate these communities. One point that was very seriously considered was to bring third world farmers over to let them farm. I thought, "save your time, that was already done and the market place removed them. You need to change the economic situation and the farmers will return.

This respondent argued that when Canada was establishing itself, it had a very aggressive immigration policy that brought farmers over from Europe to populate and farm the Canadian Prairies. Over the years, the market place slowly dispersed these farmers from the landscape and into the cities, due to an ever-increasing scale of technology and decreasing number of farmers on the land.

Implementing Change: Top-Down or Bottom-up

The respondents argued for some role that the state is to play in the process of change. It might be to institute certain taxes or incentives; it may be to fund NGOs. Whatever their role is, at the moment they are unable to achieve it. They cannot achieve any change because there is too much money and power concentrated in the middle of the hourglass.

The process of change must be led by grassroots organizations and individual consumers. Change, according to the respondents, has to be led by an educated public. "If the consumer was educated they would look at it and say, 'well, no, thank you.'" Another respondent argued "Consumers need to start demanding this option but at the moment consumers don't know this option is there and so they don't demand it." On the other hand, what about an educated consumer at the farmer's market? For example, "Consumers, if they care about stuff like the environment, they can have a real impact on how their food is grown for them. They can choose to support the farmers who are doing things the way they want, whereas, in a retail environment you don't often have those choices. You can only choose from what is presented to you. It's more of a two-way interaction." Educated consumers must begin "speaking with their wallets." In taking part in all of these exchanges, farmers and consumers can quite literally cut out the middleman. As long as farmers and

consumers can have a direct relationship with one another, the power that is held by corporations in the middle is nullified. There are situations where a direct relationship between the farmer and consumer might not be possible. In these situations, companies like FOOD and Eatit.ca have some usefulness, as long as these companies never lose sight of the reasons they began.

It's not just the corporations that might be unwilling to change or governments that are slow to change, one respondent noted. There are just some people who care so desperately about having their steak just a little bit more tender that, "They don't care whether that calf had a pleasurable life." Yet another argued, "You can't make people change but you can give them the ability to."

If the NGOs are able to adequately influence the public perception of the issues, and individual politicians are astute enough to notice, then the government is able to start instituting policies that effect the necessary social change. Two respondents claimed that the most important thing to do is to remove the "red tape" surrounding small-scale farms. One respondent stated that,

> For many years there was this rule that farmer's markets could only be open fourteen days a year and you are looking at the guy who defeated it just by ignoring it. On the fifteenth day they came and said, 'you are gonna have to close down.' And I said, 'like hell we will, go get a cop.' They finally changed it [the regulation] to as many days as you want. Fourteen days was arbitrarily chosen… It became buried in bureaucracy and written in stone. There are a lot of rules like that.

Another respondent used the example of raw milk, saying that "purchasing raw milk does not need to be supported by a health inspector as long as, I, as a consumer, can go to the farmer's land and learn about the process by which they obtain raw milk. I become educated and there is a level of trust that is established." The two respondents are essentially arguing that there needs to be "recognition of multiple scales of production" and that each requires different regulatory systems. The respondents argued that, in order to succeed, small-scale farms need to be de-regulated. One of the reasons regulation became necessary in the first place was because the general population became out of touch with the food production practices. Another reason they became necessary is that food production practices slowly became more about profit and efficiency, then about quality. These two factors required that government organizations became required to enforce regulations.

Undermining Self-Sufficiency Through Policy

The policies surrounding agriculture are in need of a substantial overhaul. According to one respondent, the policies have slowly moved from a "public policy approach to a market based approach." The policies need to be revised and "Instead of looking at the economics of agriculture, we need to look at the eco-system health

and food health." In other words, what should be important in formulating policy is not how much things cost but rather how are they affecting future sustainability. The issue with a market-based approach is that "The market can only respond to demands, it cannot respond to needs."

Several respondents referenced the issue of free-trade and the allocation of subsidies. Both have the same effect. One respondent noted that the North American Free Trade Agreement (NAFTA) has changed the ability of Mexican farmers to grow food for domestic use. Furthermore, subsidies that are paid to North American farmers, have undermined the ability of other countries to feed themselves; "Other countries can't compete to feed themselves when food from the US is cheaper to get as food aid, than it is to grow themselves."

Food available domestically is often covered under cheap food policies. These cheap food policies require review. There are a number of factors that force food prices lower, and in some cases lower than they cost to produce. Government subsidies are, in effect, a direct transfer from taxpayers to farmers in order to increase their income. This allows farmers to sell their product at a cheaper price. Corporations are required to achieve only one thing; profits for their shareholders. This creates competition between food companies attempting to achieve a greater market share and to increase net profits. These companies have slowly eroded the

percent of food dollar which farmers receive (Hodges, 2005: 8). This is why one respondent argued, "The worst paid people in our society are the ones looking after our children and [the ones] feeding us." A report issued by the National Farmers Union agreed that it was the power distribution in the agricultural market that is responsible for the prices of food (National Farmers Union, 2005: 8). Hodges goes on to argue that consumers actually pay for their food three times. The first and most obvious instance is at the register. The second and less obvious time is through farm subsidies. He argues that the third time requires decades to show itself, which are environmental costs. This is due to the detrimental effect that poor husbandry is having on the land (Hodges, 2005: 9). This is the externalization of costs process that capitalism takes part in and in this case at the expense of the commons.

The cities also have to help out with the formation of their policies. In order for any form of urban agriculture to be successful, the city must make it easier to become diversified, even on a small scale. One respondent argued that cities like Winnipeg and Brandon must start to allow its citizens to maintain small chicken coops and beehives. You have to allow people to become "self-reliant."

The Expectations for and the Perceived Roles that Manitoba Agriculture Food and Rural Initiatives Play in Social Change

There was a point in most of the interviews where respondents expressed their views about what Manitoba Food And Rural Initiatives (MAFRI) could do better. MAFRI specifically was asked to consider three points. The first stated they had no idea whether there were contingency plans in place if a worst-case scenario actually played out. The second pleaded that MAFRI engage citizens and allow them to have input into the decision making process. Another respondent argued that it would be really helpful if MAFRI were to really throw some "weight behind the things it talks about."

The province of Manitoba and the city of Winnipeg have not been quiet on the subject. Both sets of governments have instituted programs to help increase local food security. The federal government appears to support these programs by way of funding. Northern Manitoba is recognized as being the most food insecure area of the province. The provincial government has instituted the Northern Food Initiative. The program attempts to increase local food production in northern communities.

The Manitoba Sustainable Agriculture Practices Program (MSAPP) is

another program that was has been instituted by the province. MSAPP is an incentive based program designed to help farmers reduce their greenhouse gas emissions. They offer "Beneficial Management Practices" which include: "reduced greenhouse gas emissions from manure storage, manure land application, reduced tillage, spring fertilizer application, perennial cover for sensitive land, cover crops, improved pasture and forage quality, grazing and pasture management planning, and increased perennial legumes in annual crop rotations." They have also incorporated research and development into the program in order to consistently offer the most up-to-date information on the practices they are promoting.

The correction of several environmental issues is addressed by the Environmental Farm Action Program (EFAP). The stated goal of this program is to "reduce identified risks and improve management of water resources, air quality, soil productivity and wildlife habitats." Similar to the MSAPP program, the EFAP program is an incentive based program that rewards farmers for instituting "beneficial management practices."

Both MSAPP and EFAP programs are designed around the use of technological solutions to help reduce the amount of greenhouse gas emissions caused by agricultural activities. The MSAPP program focuses on general

agricultural activities, while EFAP focuses specifically on manure management practices. Both programs rely on voluntary implementation of the 'best management practices.' Farmers have to prepare an application and wait for an inspection before carrying out the improvements. The farmers are then required to have a re-inspection completed before the funding is paid out. According to MAFRI's annual report for 2010-2011, the MSAPP approved 180 projects in Manitoba worth about $2 million in upgrades. The projects approved included, "conservation tillage, cover crops, organic farming, effective nutrient management, manure management, handling and proper storage, and shelterbelts and riparian buffers" (MAFRI, 2011). MAFRI needs to continue to implement these projects and continue to support farmers in reducing the emissions of greenhouse gasses. MAFRI should attempt to continue increasing the programs' effectiveness. MAFRI might be able to achieve further participation by lessening the requirement of a project's completion before funding is paid out. It is understood that this requirement is necessary to prevent people from taking advantage of government funding, however, by reimbursing farmers in increments for the completion of segments of the overall project might relieve some of the overall financial burden placed on farmers.

The Manitoba Organic Transition Program (MOTP) was designed to help farmers transition from industrial agriculture to organic agriculture. This program

was designed to help pay for the certification costs of the transition process. Farmers were allowed to collect up to $800 every year for up to three years. The program required farmers to become certified before having the opportunity to apply for reimbursement. According to the MAFRI's 2010-2011 annual report only twelve producers applied to the MOTP. MAFRI states that the this intake increases organic production in Manitoba by "3,593 acres of forage, 1,536 acres of wheat, oats and flax, 1,650 acres of miscellaneous crops, 180 beef cattle and 170 dairy cattle" (MAFRI, 2011). This is the program that MAFRI should actively be recruiting participants for; yet, the MOTP only had twelve participants enter the program. MAFRI should increase awareness about the program as well as the benefits to becoming certified organic. Increasing organic agricultural production in Manitoba has a multitude of benefits, both economical and environmental.

Woodlots have been the subject of concern lately. Woodlots have the ability to capture and store large amounts of carbon. The provincial government has instituted an education program that teaches farmers how to manage the woodlots on their farms. At this point, MAFRI is not willing to subsidize this practice, however, better management of woodlots has the ability to both increase the carbon sequestration on farms, but also to diversify farm income, through the sale of low-grade wood for firewood to the milling and finishing of construction grade lumber. The benefit of this type of diversification of farm income is that it can occur after the

harvest is over. If managing woodlots is as beneficial as MAFRI argues it is, then it might be wise for them to offer more incentives than just education. The outlay of capital required to purchase the equipment necessary to adequately log an area is significant. MAFRI could encourage this practice by offering financial supplements on the initial start-up cost.

Ecological Modernization and Limits-to-Growth on Social Change

When it comes to social change, both ecological modernization (EM) and limits-to-growth (LtoG) have articulated ideas. EM began arguing that governments and states were responsible for creating the social change. They argued for "a radical increase in resource productivity, incentive shifting, biomimicry, a service and flow economy and investing in natural capital" (Harper, 340). All five of these changes must be instituted from the top-down. Consumers play no role in making these changes. However, more recently EM has begun to argue that these changes are occurring much too slowly. As such, EM has modified its argument to encourage more bottom-up changes. They use the automobile to point out that manufacturers are moving slowly. As noted earlier, Gonzalez argues the automobile is progressing towards the ecological modernization of the internal combustion engine rather than the ecological modernization of personal transport (Gonzalez, 207-225). His main

argument is that we can no longer wait for the institution of appropriate policy but rather individuals need to begin actively pressuring for change.

Modernization is the solution for EM; "this will involve new information and communications technology (ICT)- enhanced machinery, as well as new, low-impact chemistry and bio-technology. In this way agribusiness can be made ecologically more sustainable" (Huber, 46-47). The problem that Huber does not address is that even if the gasoline-based power train is removed from the machinery, the machinery itself requires the use of natural resources to produce. The iron required for the steel is still a finite resource. The energy required to produce and transport the machinery is still not diminished. Bio-technology has been in development for some time and it still has not proved to be overly useful (see discussion on pg. 32). Huber goes on to argue, "another option is organic farming, which avoids heavy machinery and relies on natural fertilisers and pesticides (Huber, 47).

LtoG is much more rooted in a bottom-up approach to social change. Rob Hopkins author of the *The Transition Handbook: From oil dependency to local resilience* can offer some insight on the idea of social change. Hopkins comments on his experience with change: "any coherent national response will also need government and business responses at all levels. However, unless we can create this

sense of anticipation, elation and a collective call to adventure on a wider scale, any government responses will be doomed to failure, or will need to battle protractedly against the will of the people" (Hopkins, 2008: 15). The point he is making is that in order to achieve a complete and effective change, it will need to be undertaken at both the grass roots level as well as at the national level, and every level in between. He goes on to state, "governments generally don't lead, they respond. They are reactive, not proactive" (ibid, 76). Essentially, Hopkins is arguing that reform must begin at the grass roots level and be taken up by the state afterwards.

Hopkins argues that any community that is well situated to thrive through a period of forced change will have to be resilient (ibid, 54-55). Resilience, as Hopkins understands the term, is the ability of an ecosystem to withstand any external pressures and enforced changes (ibid, 54-55). Resilience contains three necessary attributes; diversity, modularity and tightness of feedbacks (ibid, 54-55). Diversity relates to the overall number of species but also relates to the types of employment. More diversity leads to higher resilience. Modularity refers to the level of connectedness between things. A higher level of connectedness can result in much less resilience. Hopkins uses the example of the recent international bank crisis caused by the over lending of money to high-risk house buyers in the U.S. (ibid, 56). Banks all over the world were sent into a spiral of collapse because of the interconnectedness between them. Centralized governance and international

consumption have created feedback loops that are too long for the consumers to be directly affected by the consequences. We know little about the living and working conditions of the tomato farmer in Mexico or the worker in electronic recycling centers in China. In a localized system, individual actions have consequences closer to home and therefore, are easier to recognize (ibid, 56). Both theories argue that social change will begin at the grassroots level but in order to be effective it will require participation by all involved.

Pfeiffer argues that a significant shift is required for our agricultural production methods. He states, "a sustainable food system would entail, but not be limited to, localized agriculture, no-till agriculture, composting, natural and organic farm management practices, farmer's markets, urban and community gardens, co-operatives, and community supported agriculture (CSAs)" (Pfeiffer, 53). Heinberg goes on to argue that the world population is far too numerous; he argues a sustainable number would be somewhat fewer than 2 billion (Heinberg, 196).

A Critical ReAssessment of Ecological Modernization

Throughout this chapter we have heard how the respondents think and what they know about agriculture as it is practiced in Manitoba, how this relates to the

environmental crises that we face if nothing is done and how they view the implementation of change. Limits-to-growth (LtoG) and ecological modernization (EM) argue two different points. Respondents that perhaps would have classified themselves as proponents of one view, nevertheless argued for points of the other and vice versa. While the choice between these perspectives was clear to me at the outset of this research, it has significantly more challenging for me to to pick a 'winner' between the two theories. There is no doubt that these environmental issues could potentially end our civilization just as environmental issues and food availability have ended other civilizations before us.

One of the main criticisms of EM is that if fails to adequately deal with the issues of material production and consumption. That is, regardless of how efficient production and consumption become, at some point natural resources have to be consumed in some part of the process. Proponents of EMT retort that EM is,

> not focused on the question of ''how much,'' but rather on the restructuring of social practices of consumption along criteria of ecological rationality. Sometimes this might result in (the need for) downsizing some consumption and lifestyle patterns, while increasing others. But as more consumption does not equal more additions and withdrawals, less consumption does not automatically mean less additions and withdrawals. The question is thus not ''how much is enough,'' but ''what consumption is environmentally sustainable'' and how can we turn unsustainable consumption practices into environmentally more sound ones (Mol and Spaagaren, 2011: 264).

If agriculture is carried out using the original implementation of organic agriculture

the use of non-renewable resources is virtually zero, while renewable resources are used a lot slower than it takes to regenerate them. EM has recently claimed (not without contestation) that organic agriculture highlights the achievement of the theory in practice (see Obach, 2011). When the price of oil has increased to the point where fossil fuel based agriculture is no longer possible, EM will probably celebrate it as a crowning achievement. Yet it all seems to be rather ad hoc.

EM argues above that it is not the question of 'how much?' but what is 'environmentally sustainable?' On the contrary the question is 'how much?' There is a finite amount of land available for agriculture. This land is only capable of producing so much food in a given year. Global population continues to rise and agriculture is being forced to produce as intensely as possible in order to keep up. This intensive agriculture is using the renewable resources required for agriculture at a rate that is beyond the recharge capacity (water, soil, etc).

We know how to improve the soil, we know how to use less water, we know how to improve the system in every way that is necessary and yet we are not able to implement any of these things to any degree that is environmentally meaningful. Fred Magdoff et al. argue,

> capitalism presents us with the paradoxical reality of a rapid growth of food production and perpetuation of overproduction (relative to markets and income distribution) on one hand, accompanied by the

> reinforcement of social exclusion and thus the growth of hunger on the other. The latter is not, as is sometimes thought, mainly a result of population growth (which has generally been surpassed by the growth of productivity in agriculture), but instead a consequence of the fact that the immediate object of food production is not human sustenance and well-being but the growth of profits (Magdoff et al., 2000: 9).

The power in the middle of the hourglass is responsible for the worsening of the majority of the environmental issues associated with agriculture. Corporate capitalists are currently holding the power and as long as they are in control of the food system there will be no change to the status quo.

Chapter 6: Is Manitoba Well Situated to Address and Adapt to the Looming Environmental Crises?

A multitude of topics have been discussed concerning the idea of food security in Manitoba. The first section dealt with gathering data around Manitoba's agricultural and food procurement practices. The second section helped us comprehend the environmental issues and potential crises that will affect the ability of Manitoba to continue to produce food. Solutions and social change were the topics examined in the third section. This chapter will provide a summary of the analysis of the interviews followed by concluding comments. Lastly, I will identify the limitations to this research and also identify areas where future research is still required.

A Summary of Manitoba's Food Production and Procurement Practices

The data available for analysis around Manitoba's food production and procurement practices is limited. Nobody is really quite sure how reliant we are on importing food, although two respondents estimated that we import around 75 to 80 percent of the food Manitobans eat. None of the respondents cared to venture a guess of how much of what we import is necessary. The respondents argued that if some crisis forced Manitobans to consume only what were grown here, we would not

starve, although there might be some "expectation dissatisfaction." In the future, if we were to eat only Manitoban food, we would be able to have a fairly diverse diet. Obviously, Manitoba's geographical situation would limit our choices, but the respondents argued that we could provide all of the possible food groups the caveat being that there would need to be some change in what is currently grown. The amount of food storage capability is currently unknown. However, if we invest some money into the infrastructure, Manitoba has the ability to increase our storage capacity significantly. A company like Peak of the Market could offer fresh frozen produce year round, this would be mutually beneficial for all involved. The addition of greenhouses could provide the majority of the produce we eat during the winter.

In the event that we do have to rely on food produced from Manitoba, a rather pertinent question became, what is the sustainable population range? The vast majority of respondents had no idea how many people could be sustained on any given acre of farmland. One respondent argued that there was around 13 000 000 acres of arable land in Manitoba and that enough food could be grown on that land to sustain all of the current population, albeit, at a lower standard of living. As shown earlier when compared the other issues Manitoba is facing population size is a lesser issue (Angus and Butler, 2011).

A Summary of Environmental Issues Faced by Manitoba

The topic of the second section of questions was environmental issues. Peak oil and climate change were the two issues that most argued are the most important issues that will affect Manitoba. The respondents argued that the two issues are intertwined, and that to solve one is to solve the other. That is, in order to arrest climate change we need to stop using fossil fuels. Peak oil will dramatically affect the way in which agriculture is practiced in Manitoba and around the world. The most likely scenario that the respondents pointed out, is that the cost of industrial production of food increases when the price of fossil fuels increase. This in turn inflates the price of food. There were, however, respondents that questioned whether or not imported produce is less sustainable than produce that was grown here in greenhouses. Greenhouses require materials to be built and energy to heat and light during Manitoba winters. It is simply not known whether one is more sustainable than the other.

Climate change will affect the way in which agriculture is practiced in Manitoba. Unfortunately nobody fully understands the implications. The respondents argued that water availability would be one of the primary issues. This will more than likely be causally linked to the increased rate of evapo-transpiration due to warmer climate conditions. Precipitation patterns are likely to be altered.

Some argue that there will be more instances of prolonged drought and flash floods. Drought can be mitigated by the use of irrigation, however, if seasonal rainfall does change significantly, ground water might not be available during the times it is required. In the case where extended droughts occur, the most efficient use of water is drip irrigation. However, the labour and cost to set this up would be quite immense. Drip irrigation would also require no-till practices. Byrne *et al*., argue that Manitoba stands to see an increase of precipitation due to the more humid Gulf of Mexico air becoming more prevalent as the temperatures increase (Burne *et al*., 64). Manitoba may actually witness an increase in production due to longer, warmer, growing seasons.

Animal protein consumption is on the rise across the globe. It was clear that industrial meat production was viewed by respondents as being wholly unsustainable. Feeding grain to animals is very inefficient. However, it was argued that in Manitoba, animal proteins are for the most part grown on land that would not grow other crops. It became clear that it was not a grain versus meat question, but rather, natural landscapes versus meat. Hog barns in Manitoba were the exception to this. Porcine grown in Manitoba are most often grown in confined animal feeding operations (CAFOs). The concentration of these animals creates a situation where the surrounding land cannot adequately absorb the waste products. This leads back to the aforementioned water issues. Animal husbandry if carried out with

appropriate methods, is a good way for a farm to rely on less outside inputs. Manure from these animals can replace chemical fertilizers. It was agreed that the people in our society consume too much animal protein. However, vegetarianism is not entirely the solution. Relying solely on vegetation to survive entails the destruction of too many natural landscapes.

Chemical inputs have replaced traditional farming knowledge. The use of chemicals is responsible for increasing crop output for the entire 20th century. The use of chemicals has detrimental effects on the environment. Nutrient loading in the soil is responsible for around one-third of the nutrients that end up in Lake Winnipeg. The nutrients in the water cause algae blooms that wreak havoc on marine life. The process of creating these chemical inputs requires significant quantities of fossil fuel. They require even more fossil fuels to transport and apply.

Water and soil were two issues that agriculture has to address. Irrigation requires fossil fuel based pumps. Furthermore, the amount of water being used for this is affecting the flow of major rivers. This issue will be compounded as climate becomes worse. Soil erosion has been a problem for years. One respondent noted that after a windstorm, all of the ditches around his property were filled in with soil. This issue was recognized and shelterbelts were installed. However, with the increasing size of machinery the shelterbelts have slowly been removed. The

introduction of zero-till agriculture and increasing the number of fields that lie in summer fallow has lessened this problem.

The use of chemicals has also led to a reduction in soil quality. The implementation of monocrop systems and lack of rotational planting has reduced soil quality even further. With a coming reduction in the quantity of fossil fuels available, farmers will have to begin replacing nutrients and building soil microbes without the use of chemicals.

A Summary of the Possible Solutions and Implementing the Change Required

Organic agriculture allows for absolutely no chemical inputs. This alone saves significant amounts of fossil fuel. Once the soil has recovered from withdrawal from chemicals, it is possible to achieve similar production rates when compared to industrial agriculture. The increase of organic matter in the soil helps to protect the plants from moderate events of flooding and drought. The knowledge surrounding organic agriculture appears to disappearing. There are increasingly less numbers of individuals who still retain traditional farming knowledge in Manitoba. However, there are many regions in the world that still make use of traditional farming methods and as such we might be able to rely on others to help us relearn the skills required, much as Cuba did during their imposed peak fossil fuel scenario.

Different models of agriculture were discussed: polyculture, permaculture, urban agriculture, spin farming, community supported agriculture and vertical agriculture. Each of these types of agriculture have their own sets of benefits and drawbacks. All agriculture types, except vertical agriculture, are seen as possible solutions to the crises we face. Unfortunately, all of these types of farming are woefully understudied and need significant amount more research. Many of the respondents argued that moving towards a smaller-scale, labour-intense and organic farming system is a shift that is required.

The issue of locality is still an interesting one. Manitoba has always had to rely on trade to maintain a basic level of sustenance. There is a list of produce that simply cannot be grown or is not available in this bio-region. Salt is a good example. The issue of trade will have to be dealt with. This, however, leads back into the question of what is necessary?

Education is the primary goal for many of the organizations interviewed. The question is, is education enough? The answer is, of course, a resounding no. However, if NGOs require a base of support before the state begins to take them seriously and the general consumer remains ignorant of these issues, then these organizations have little choice but to continue with education. In order to

accomplish this, these organizations require adequate levels of funding. All of the organizations argued that they can do very little with the funding they are currently being given.

The respondents actively called on Manitoba Agriculture Food and Rural Initiatives to help institute the essential changes towards sustainability. Some respondents argued that MAFRI should lead the way, while others argued that they should help the NGOs garner support and then step in and institute the changes. In effect, relying on both top-down and also bottom-up methods of social change. The unfortunate part is that corporations have stronger pull in the implementation of policy. The power in the middle of the hourglass is far too strong.

Conclusions

The question asked at the beginning of this thesis was: how will the environmental issues that we face, affect Manitoba's agriculture, Manitoba's ability to adapt to a period of rapid change, and its ongoing ability to continually feed its population? There seems to be little doubt that Manitoba is going to be affected by these environmental crises.

Peak oil and climate change will drastically alter our ability to feed ourselves.

The respondents and the literature argue that these two issues are twin threats, which need to be addressed immediately. Peak oil has the capability to completely cripple our food production and procurement system. Climate change will alter the growing conditions to which agriculture has become accustomed. The increasing consumption of animal protein needs to be examined. In Manitoba, given the production conditions, the production of animal protein is not as much of an issue, especially when compared to the growing population. World population will continue to expand for the next 40 years before we will see the benefits of below replacement fertility rates that are now the reality in many parts of the world. This will cause the need for increasing use of both renewable and non-renewable natural resources in the near term.

Peak oil will continuously increase the cost of production of food. In turn, this will raise the cost of food to the consumer. There is no question that agricultural production has to drastically reduce the amount of oil that it currently uses. This means that farmers will have to start relying on more labour intensive and organic techniques of production. The use of labour on farms will also require a reduction in size of each individual farm. The average farm size in the early 1900s was around a quarter-section. A quarter section was small enough to allow some combination of animal power and human labour to carry out the work necessary. If the average farm shrinks, the number of farmers has to be increased.

The overall effect of climate change on Manitoba agriculture is unknown. It is suspected that climate change might alter precipitation patterns, causing more instances of droughts and flash floods. Increased evapo-transpiration caused by a rise in temperature, is likely to cause water use issues. Manitoba has to prepare for these issues. Water storage facilities have to be created to allow farmers to make use of precipitation that falls outside of the growing season.

At least part of the problem that is causing these environmental issues is a continued increase in the global population. Global population increases require that agriculture continue to increase its production rates as well. Most literature argues that the world could sustainably carry around 1-2 billion individuals. Other sources argue that world population is not as problematic for sustainability than other environmental issues (Angus and Butler, 2011). The global population has just recently passed 7 billion. The majority of the population resides in the global south, and less developed countries. These are not the individuals that are responsible for creating the environmental crises that we are facing. The more developed global north is responsible for consuming the majority of world's resources, and it is the consumption that has to cease.

More of the global population is ingesting a greater proportion of their calories

from meat. Meat production has come under a lot of scrutiny lately. The amount of calories of grain that is fed to animals being raised for slaughter compared to the amount of calories supplied by animals is disproportionate, and should be severely curtailed. The respondents argued that Manitoba livestock (except for pork) is for the most part grazed on land that would not support any other type of agriculture. The debate that has been ongoing between grain for animals and grain for people is not present in Manitoba agriculture. The respondents argued that animals play a very important role in the ability of a small-scale farm to become a closed loop. That is, requiring very little energy and nutrients from off the farm.

Manitoba's agricultural production and food procurement practices follow industrial practices. This type of agriculture has been designed to use large amounts of fossil fuel inputs to produce food. Some of the food produced stays for local consumption; most of it ends up on the market to be shipped out of province. Food is then purchased from the market and shipped long distances to get to Manitobans for consumption. In that case, where a rapid change occurs due to inordinately high fossil fuel prices, Manitoba is not well situated to change quickly. According to the respondents, we would not starve, but we would have to eat a lot of pork and grain products. However, in the case where this change occurs over a period of several years, during which we are smart enough to start making the transition, Manitoba has enough arable land to support its current population with solely local production,

albeit at a lower level of consumption. According to the respondents, Manitoba also has the ability to increase storage capacity so that we are able to continue to eat certain fresh vegetables all year long as well as all sorts of canned and preserved fruits and vegetables. This is extremely positive.

Manitobans have already started to rely more heavily on Manitoba produce. Farmer's markets have been increasing in both size and numbers. Organizations like FOOD and Eatit.ca have increased consumption of local produce. Peak of the Market, Manitoba's root vegetable marketing board, has begun to take advantage of this increase in 'buy local' movement. Yet, each of these organization's market share represents a tiny percentage of the total food consumption in Manitoba. Manitobans have to rely more heavily on produce that is grown here, but it is simply not available in any significant quantity. The successful implementation of pork, poultry and dairy marketing boards, have allowed Manitoba farmers to continue producing and profiting from Manitoba markets.

The importance of water requires that water quality has to be preserved. It cannot be used as recklessly as it is being used now. The amount of chemicals that are running off of agricultural land must be prevented. Although, as the price of fossil fuel increases, this change will occur. Animal and human manure also has to be prevented from entering the water system. The nutrients that are entering into the

water system are creating water quality issues in our underground system and eventually ending up in Lake Winnipeg where they are effectively killing the ecosystem.

Soil is of the utmost importance to growing food. The use of agricultural chemicals is destroying the soil organisms that are beneficial to agriculture. This prevents the soil from taking care of itself, which leads to increased crop failures due to disease. There has been an overall loss of shelterbelts in Manitoba; they have been removed to allow for the use of machinery that is increasing in size. Shelterbelts help prevent soil erosion. Plants require top soil to grow in.

The discussion of alternatives to industrial agriculture was based around the idea of organic agriculture, and a myriad of ways which it is practiced. Among those discussed were: polyculture, permaculture, vertical agriculture and biodynamic agriculture. The capital and materials required to produce a vertical agriculture building basically eliminates it from contention. However, the important distinction was not which of these was suitable to replace industrial agriculture, because in a lot of ways they are all the same. It has more to do with the intrinsic implications of organic agriculture. Organic agriculture has traditionally meant the opposite of industrial agriculture; the idea that nature is more suitable than machine. The idea is that agriculture should be practiced by small-scale, local, labour intensive, farms.

Indeed the important distinction is the distinction between the new rise of industrial organic agriculture and the traditional organic agriculture.

The food system has to move towards this idea of the traditional organic farm. The issue is that there is an enormous amount of power held by corporate entities located in the centre of the food system that control all aspects of industrial agriculture. The food system is shaped like an hourglass; there are many producers selling to a few distributors (who will become even fewer in the coming years). These distributors are then selling to a very large number of people, the general public. The easiest way to subvert the system is to opt out. This can be achieved two ways; people can start growing some of their own food, or they can establish direct connections with the farmers who grow their food. These connections can be established through farmer's markets or CSAs. Eatit.ca and Fresh Option Organic Delivery offer services to the general public that make the connections to the farmer for them, and in return, distribute the organic food for the farmers. While this arrangement is still not ideal, it makes sense in some situations; for example, the organic farmer that does not have the customer base to distribute all of the food grown.

Our society has developed all of the tools and knowledge necessary to implement the required changes, in order to prevent the environmental issues

associated with agriculture. Yet, we stand by idle, unable and unwilling to achieve any meaningful change. It leads one to believe that there are other factors are at play. Magdoff et al. are completely right, that food stopped being produced merely for sustenance and health. Food started to be grown for profits. It is because of this economic system that our society has been unable to institute the change necessary to mitigate these environmental crises.

The global solution to these problems is summed up in the saying, "Dismantle Globally, Renew Locally" (Jensen, 2005). The food system has become so global in scope, that the only way to correct this is by ensuring every region returns to a locally based system. This study has Manitoba as its focal point and as such is rather parochial in scope. If these problems combine in such a way as to produce conditions that Jared Diamond argues are possible in his book, *Collapse: How Societies Choose to Fail or Succeed*, then it will not matter what Manitoba has done to ensure its safety. Just as the Anasazi, Mycenean Greeks, Romans, Easter Islanders, Mayans and many other societies before have collapsed; our society is not immune to this possibility. Diamond defines the term collapse as "a drastic decrease in human population size and/or political/economic/social complexity, over a considerable area for an extended time" (Diamond, 2005). I completely agree with the respondent that argued, "We have the capability to do globally, like what happened locally with other nations who became out of balance with nature".

Limits of the Current Research

If anything can be stated with authority, it is that there is simply not enough known about the production practices and capabilities of Manitoba. The data that were collected for this portion of the interviews were extremely enlightening. It was hoped that these participants would be able to respond with facts and figures, which would paint a clear picture of Manitoba agriculture. Instead, what was discovered was an extremely limited knowledge base on Manitoba agricultural practices. To be clear, each of the respondents was highly intelligent people. The information that was being searched for is simply not available. It is suspected that either it has not yet been collected, or if it has been, then it is being closely guarded. It is suspected that some of the data required to adequately understand where our food comes from are being kept by large grocery retailers. These companies have little to gain and potentially a lot to lose from the release of this data. As such, it is possible that these data will never be published.

I know that there is a lot of data collected about specific farms across Canada, but it is collected under the condition that individual farm statistics remain confidential and only aggregated data is produced. A further limitation in this area is that while unfortunate, many of the people who would have had the best ability to

answer questions regarding production, storage and transportation figures, declined to be interviewed. Indeed, nearly half of those who were approached declined to be a part of the research project. Some of the reasons for not participating were that they did not possess the knowledge to participate. Few did not believe that their organization stood to gain anything from participating, while others were just simply too busy. Some did not offer any reason in particular. In spite of the uneven willingness to participate in this research, the project made an important contribution by gathering a significant amount of insightful data. In the end, those that did participate offered a wide range of opinions tempered by experience and of interest because they operated from both limits-to-growth and ecological modernization theories as they strove to make sense of the food system, and gauge its problems and promise in unstable times.

There are a number of limitations to the studies methodologies. The use of the criterion selection method allowed for me to select respondents on the basis that they were experts in the field. There is no doubt that when I was selecting "experts" to be interviewed, I inevitably missed some portion of these experts. It is entirely possible that the missed respondents could have provided more data.

Another limitation I encountered while interviewing the respondents was time constraints. The individuals that I was interviewing were for the most part extremely

busy. I had to remain conscious of how long each interview was lasting. Originally, I had expected each interview to last between 60-90 minutes. However, the breadth of the subject area and the willingness of each individual to speak often stretched the interviews out significantly longer. Unavoidably, some of the questions were set aside due to time constraints.

The indices used may help others complete a study of their own agricultural and food production system. As this is meant to be an evaluation of the level of security achieved for Manitoba's food system, it cannot and should not be generalized to any other food system. Since this study is composed of a small number of expert respondents, there is a chance that if someone else were to complete this study again, the results may differ.

The question "What are the most important issues facing Manitoba agriculture?" was designed to elicit spontaneous responses from the respondents regarding their current knowledge of the food system, and to determine whether there were any issues of particular importance. There turned out to be no way to elicit a spontaneous response. The letter that was presented to the potential respondents as a requirement to gain informed consent as required for ethics approval telegraphed the intent of the study so participants knew from the outset the scope of the research.

Areas of Future Research

This study is an exploratory study, which has never been undertaken for Manitoba. As such, virtually every topic needs further research. Climate change research has to continue to become more specific in its modeling programs. This will help determine what crops are still viable in Manitoba and how best to prepare for changes in the precipitation pattern. A list of best practices for water storage systems like rainfall storage or the use of berms and swales, will alleviate the need for river diversions or the reliance on aquifers. Overall, more knowledge is required on climate change and how Manitoba can best prepare for its consequences.

Oil production is ultimately going to begin to decline. It would be very useful to know how quickly it will decline and when the decline will start. Unfortunately, all we can do is get better at estimating when this might occur. We will never know exactly when we have peaked with production until after it has already happened.

The study of organic agriculture has to be funded by all levels of government. Organic agriculture is the only alternative to industrial agriculture. We do not have a good grasp on to the production capabilities of organic agriculture or ideal crop rotations. We need more information about using polyculture, permaculture, and biodynamic agriculture. The information of these types of food production practices

is exceptionally limited. Overall, I was unable to determine how may people can be sustained on a per acre basis, and as such we do not know with any certainty the number of people that can be sustained using only Manitoba agriculture. Urban agriculture has to be studied. Given the potential oncoming crises, it is concerning that there are no current estimates of the amount of land that could be used for urban agriculture nor is there an estimate of the quantity of food that could be produced on that land. We need more research on how to increase the amount of market share for farmer's markets and CSAs. These two types of agriculture need to be embraced to equalize the distribution of power in the market.

Lifecycle analysis needs to be carried out on the sustainability of different growing methods. It was heavily questioned in the interviews whether or not produce could sustainably be grown in Manitoba outside of the natural growing season. Furthermore, we need to compare that to lifecycle analysis of identical produce grown in other parts of the world. It might actually be more sustainable to rely on California for our produce in the winter, while using our own when it is available. Produce from California for example may be grown with very little embodied fossil fuel energy, since they can rely much more heavily on the sun during the winter months. It is probable that the transporting might be the only energy use to grow a California cucumber. Compare this to the amount of energy required to grow that same cucumber in Manitoba in winter. There is the energy cost

of building, heating and lighting a greenhouse. The question becomes which cucumber has a higher embodied fossil fuel input?

Manitoba has implemented successful marketing boards for Manitoba's farmers. It would be worthwhile to research the use of marketing boards outside of the products that are already covered. For example, one respondent argued that honey produced in Manitoba competes with honey produced in many other countries, like Germany.

This thesis has attempted to treat Manitoba as one region with one set of requirements. However, southern Manitoba has the ability to produce the majority of its own food. Northern Manitoba, being a food desert, has a completely different set of unique characteristics that require research.

Trade has always been an integral part of Manitoba's agricultural system. Given Manitoba's bioregion, trade is likely to always be necessary to some extent. The question of "what is necessary?" is interesting. A completely cultural answer is- what we are currently relying on. That is, everything is necessary from kiwis from New Zealand to honey from Germany. There is no limit to what should be brought in and from where. Ultimately, we need to understand "what is necessary?" from a biological standpoint. We need to decide what is actually required to maintain a

nutritionally healthy diet and a healthy food growing system. Do we need Florida oranges for vitamin C or is pine needle tea an acceptable alternative?

Education seems to be the overarching theme in implementing social change. The question then becomes: are there more efficient ways to expand the education required of the general public? Are there better ways than education in which to create the change necessary? We may have to wait until the crisis is upon us to mobilize an alternative system much like the case in Cuba. But an alternative plan needs to be prepared and ready for implementation when the time comes. Research of this nature helps us understand what that alternative will need to cope with and even a general outline is a good place to start.

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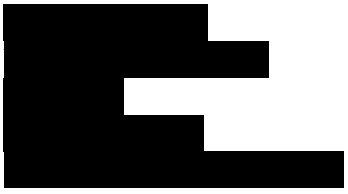
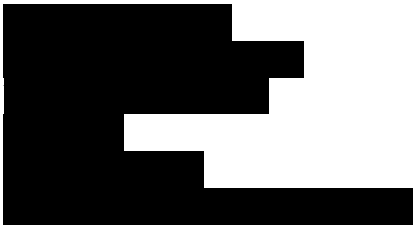
Appendix A – Recruitment Letter

Nick Sasaki M.A Candidate


Dr. Rod Kueneman


Dear Potential Research Participant,

I have selected your organization for participation in a study that I am completing as a component of the Master's program in the department of Sociology at the University of Manitoba. Your organization was selected due to the specialized knowledge that you have gained regarding agriculture in Manitoba. I have obtained your organization's mailing address from your website.

The research that I am conducting and the questions that I will be asking concern the issues of agriculture and sustainability which appear to be looming on the horizon or may already be experienced in Manitoba. These issues include, a decrease in fossil fuel supply and/or sharp increases in cost, climate change, availability or price of agricultural chemicals, aquifer depletion, soil erosion, exhaustion and degradation, as well as the global increase in production of meat products and increasing population. It is my intention that we can discuss the likely impact of such changes and that we are able to discuss potential solutions to these issues.

The length of the interview will ultimately be dependant upon by the amount of information that you can furnish as well as any thoughts you have about this issue. However, it is estimated that each interview will be about 90 minutes in duration. The need may arise for a follow-up conversation, (a phone call should be adequate) in the event that I need clarification regarding your response or in the event that additional issues come to light as a result of my discussions with other participants.

This conversation would be short and only require and additional few minutes of your time.

It is very important to emphasize that your participation is completely voluntary and you withdraw from the research at anytime without prejudice or consequence.

I would like to thank you in advance for contemplating participation in this research. Please find attached a consent form that outlines further details of the study. We will review the form together when we meet and I will then ask for your written consent to begin the interview. I have provided the form in advance so that you can review it and think it over prior to our meeting. If you have any questions or concerns, please contact me or my advisor, using the contact information provided above. I look forward to working with you. At your convenience, please contact me to set up an interview time.

Sincerely,

Nick Sasaki

Appendix B – Follow-up Letter

Nick Sasaki
[redacted]

Date: 10 December 2009

Dear:
I wanted to follow up on the initial letter that I sent to you. The initial letter requested your participation in a research project that I am conducting through the University of Manitoba as a fulfillment of the master's program.
The subject of this study is regarding environmental issues that may affect Manitoba agriculture and food procurement practices. As an organization that works within the area of food security I believe you would provide an extremely useful view on this topic.
I recognize that your time is valuable. The interview process would take no more than 90 minutes, and I can accommodate your schedule in terms of meeting time. I would like to follow up on this letter with a quick phone call in a few days' time, to ask again for your participation in the project. If you would prefer I not call, please get in touch with me at [redacted] and let me know that you will not be participating in the research.
Sincerely,

Nick Sasaki
M.A. Candidate

Appendix C – Consent Form

Consent Form

An Evaluation of Food Security In Manitoba: An Issue of Supply and the Role of NGOs

Nick Sasaki

This consent form, a copy of which will be left with you for your records and reference, is the record of your granting an informed consent to participate in this study. At the time of granting this consent, you are satisfied that you understand the nature of this research project, its purpose, and the use to which the information you furnish will be put. You understand that while we cannot guarantee confidentiality and anonymity, we will not directly identify you as the source of any ideas, or quotations that are used from your contribution. You also understand that you will have an opportunity to review and correct our presentation of your ideas and that you have the ability to require the removal of any idea or quote derived from your input to this study.

This study is being completed as a requirement of the Master's program offered at the University of Manitoba in the Department of Sociology. It is an evaluation of food security in Manitoba, specifically those issues that are related to the supply of food. The ultimate outcome is to assess how well Manitoba is situated to address and adapt to potential issues with the supply of food. It is our hope that this research will allow us to make recommendations that may help to ensure food security in Manitoba through the changes ahead.

Your participation in this study will consist of a single, in-person interview, with the possibility of a short, follow-up telephone conversation. The follow up conversation would take place in the event that during data analysis either clarification is necessary or in the event that new issues come to light that were not discussed at the time of our interview. The interview will take place at a location of your choosing. The length of the interview will ultimately be determined by the amount of information and discussion that you wish to provide.

The follow-up telephone conversation would be very short in and only require a few additional minutes of your time. At the end of this document there is a section where you can agree to be contacted for a follow-up conversation. You are, of course, free to decline to participate when called. You are only providing me permission to contact you by phone in the event that I think it would be necessary. I am also

completely willing to meet you again in person, if that is your wish, instead of by way of a follow-up by phone.

The subject matter of the interview will be the practice of agriculture in Manitoba. As such, I do not anticipate any negative emotional or psychological consequences deriving from your participation. However, if at any time you feel that you would like to discontinue the interview, either in whole or in part, you are free to do so without consequence.

A recording device will be used with your permission. The recording of our interview is to assist me in getting an accurate understanding of your contribution. The tape will be physically destroyed upon the completion of the project. The recordings will be stored in a locked room in a locked drawer and will only be available to me and, if necessary, by my supervisor, Dr. Rod Kueneman.

All precautions to protect confidentiality will be taken. You will never have any of your comments directly attributed to you. However, there is a very small number of people and organizations working towards food security in Manitoba and as such it is possible that other participants may be able to correctly attribute some of your comments to you. As such we cannot guarantee confidentiality. Since the initial interviews will be taking place face-to-face, anonymity is impossible.

As a participant, you will be given a draft of my analysis of your interview to review to ensure that your viewpoint is correctly represented. At this point you will have the opportunity to require the correction or deletion of any comments. You will also be given the opportunity to request a copy of the entire thesis. After the summary of results and the final draft of the thesis has been delivered, I would make myself available for any questions, comments, or feedback. The results, and full thesis will be available by April 2010 and an electronic copy of it is available to you at your request.

There is no financial compensation to be paid to you as a participant of this study. However, all participants and their organizations will be acknowledged in the thesis for their participation.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. This includes the researcher's obligations to report any discovery of information regarding child abuse. You are free to withdraw from the study at any

time, and /or refrain from answering any question you prefer to omit, without prejudice or consequence. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation.

Nick Sasaki
Contact Phone Number – [redacted]

Dr. Rodney Kueneman Project Supervisor
Contact Phone Number – [redacted]

This research has been approved by the Psychology/Sociology Research Ethics Board (PSREB). If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Secretariat at 474-7122, or e-mail margaret_bowman@umanitoba.ca. A copy of this consent form has been given to you to keep for your records and reference.

Researcher's
Signature_____Date_____

_____ I agree to be contacted for a follow-up conversation if necessary.

_____I would like a summary of the results.

_____I would like an electronic copy of the final copy of this study.

Participant's
Signature_____Date_____

Partipant's Contact Information_____

Appendix D – Interview Schedule

1. If Manitobans were to eat only food produced within Manitoba, what types of food would Manitobans be eating in each of the four seasons?
2. How much food is brought in from outside of Manitoba during the various seasons?
3. How much of that is necessary?
4. What capacity does Manitoba have to develop or enhance its food storage capacity in the event that we must increasingly rely on local food production?
5. What kind of yield is possible with organic agriculture?
6. How does this compare with industrial agricultural practices?
7. Do you know how many people can be fed by the cultivated acreage of Manitoba farmlands?
8. What about polyculture and permaculture as ways of increasing yields?
9. To what extent could urban agriculture be used?
10. What is the potential for "community supported agriculture"?
11. What are the most important issues facing Manitoba agriculture?
12. Have you thought about peak oil and the ramifications of expensive fossil fuel inputs?

    Chemical fertilizer, insecticides/herbicides/fungicides, machinery, transportation, processing, refrigeration, cooking.
13. How have herbicides, pesticides and fertilizers affected food in Manitoba?
14. Is there any estimate as to the amount of chemicals used per acre?

15. If fossil fuel production declines and input costs increase dramatically what effect will this have on food production and what alternatives may be possible?
16. What about the effects of climate change? What might we anticipate as the consequences for local food production and for distant food supply sources currently being used?
17. Increased frequency of extreme weather events?
18. What are your thoughts on the impact of the meat-based diet?
19. Is increased reliance on a plant-based diet a likely requirement in response to anticipated disruption of current food production practices?
20. World population is continuing to grow, what does this mean for food security?
21. Have you thought about issues around water depletion?
22. Soil Erosion? Soil exhaustion?
23. What is your organization doing to address some or all of these issues?
24. Ideally, what do you think is needed by your organization to achieve the goals you have set out?
25. What would improve your organization's capacity to effect the desired change?
26. What role do you think the government should play in addressing these issues? (federal, provincial, municipal)
27. What role do you think they are currently able to play?
28. What changes are needed to allow them to respond more effectively?

Appendix E – Food Miles Discussion

Food Miles In Manitoba

It would seem that most people in Manitoba do not know where our food is produced. Yet, all of us must at one point come to the realization that cucumbers, lettuce and any other fresh produce simply cannot survive in Manitoba for approximately six months out of every year. The food that is consumed in Manitoba is transported to us from other provinces and countries. A review of the literature in Canada regarding this topic shows that there are very critical errors made by researchers of this topic. This section attempts to account for all of the food that is consumed in Manitoba.

The term "food miles" has come to represent the distance that food travels from where it is produced to where it is consumed (Pirog, Van Pelt, Enshayan and Cook, 1, Bentley and Barker, 3, LifeCycles Project Society and Xuerub, 5). There have been four authors in Canada who have studied the distances that food travels to their respective cities. Three of these are located in Ontario, Toronto, Waterloo and Kingston. The fourth is located in in Victoria, British Columbia. All four of these reports are based on another published by the Leopold Center for Sustainable Agriculture located at Iowa State University.

Each of these studies relies on Annika Carlsson-Kanyama's paper, "weighted average source points and distances for consumption origin-tools for environmental impact analysis." In this paper Carlsson-Kanyama outlines two methods for calculating weighted averages of origin for food products. The first of these, is the Weighted Average Source Points (WASP) and utilizes geographical co-ordinates which are used to calculate the average source point (Carlsson-Kanyama, 17-18). They are harder to understand as the final calculation is returned as a geographical co-ordinate. All of the studies mentioned previously used the second of these tools called the Weighted Average Source Distance (WASD). This provides a final calculation that is measured in a form of distance (i.e. miles or kilometers). That is, the final calculation produced by this method is a distance from the point of consumption. The use of distances that the majority of people understand makes the results easier to understand and communicate.

The Iowa study for example calculated the WASD of grapes in the years 1972-73, 1988/89 and 1998-99 and noticed that it had increased significantly (1 590, 2 848 and 2 839 respectively) (Pirog et al., 26). The LifeCycles Group in Victoria, set up an interactive website for consumers in British Columbia to input data from a shopping excursion where local foods were bought and tells the individual, both how many food miles and greenhouse gas emissions were saved. The three studies in Ontario attempt to calculate each cities respective food miles. The Toronto food

miles study collected seven types of food from a local farmers market and asked the farmers where each foodstuff originated and then went to a local supermarket and purchased a similar item. They calculated the distance that each item and its partner travelled and compared the results. They found that the items that were locally produced had an average travelling distance of 101 kilometers while those bought at the supermarket had an average distance of 5 364 kilometers (Bentley and Barker, 7).

The next two studies from Ontario, Waterloo and Kingston attempt to account for all types of food that is imported into Canada. The two studies are essentially the same as the Kingston study was carried out after the Waterloo study and uses essentially, the same methodology (Lam, 1). The types of food that each researcher studied had to contain certain characteristics; each food item could be locally grown or raised, items had to reflect both fresh and preserved products and represent foods that people in the region would normally eat on any given day, among others (Xuereb, 7 and Lam, 2-3). Both studies rely on data obtained from the Strategis Canada web site, which uses Harmonized System Codes (HS) to show how much of a certain product is imported, from international origins. This web site reports its data as monetary value. The Xuerub reports that the, "58 commonly-eaten food items travel 4,497 km on average" while Lam argues that the average for all products that he studied is 4 685 km which is just slightly higher than Waterloo's average (Xuerub, 15 and Lam, 4).

There are many problems with all of the Canadian studies that have been completed to date. By basing its calculations on only food that was bought at one farmers market and also at one grocery store, the Toronto Food Share studies' sample is both far too small and unrepresentative of the system as a whole. It does not represent adequately the different import origins or the variety of food items that are available. The methodology employed by the Bentley and Barker assumed that the labelling of food products was correct and that the food did indeed come from the same place that the label stated. Furthermore, all of the food items that originated from the United States are calculated in two parts; the first from the state of origin to Los Angeles and then from Los Angeles to Toronto. This was argued for on the grounds that, "a contact with the Ontario Food Terminal indicated that most items from the United States of South America in fact pass through Los Angeles, CA". First, of all the contact said most not all and to calculate all is a mistake that represents an unwarranted addition of miles. It may be true that most food travels through Los Angeles but there is no data backing this assertion up and to calculate it as such is a costly mistake.

The three other food miles' studies are critiqued because they each used similar methodologies to analyze the food miles data. One of which seems to be unavoidable with present data sources the other more problematic. The first mistake that each made is to use the same web site, Strategis Canada, as their source of data. This

represents a rather critical problem for all of these studies as the web site only reports the data for each category in monetary value. The original WASD calculation that Carlsson-Kanyama put forth uses weight as the type of measure. The problem with using money value as the measure is that ten pounds of potatoes represent far less value than ten pounds of Macadamia nuts for example and as such the weighted average becomes skewed towards the more expensive products. For ease of calculation, let us say that Macadamia nuts are ten times as costly per pound than potatoes. So it would take ten pounds of potatoes to make the equivalent value of one pound Macadamia nuts, and, making everything else equal, the difference between the two represents a significant extra cost for shipping the potatoes. There is also the problem of price difference found within the same commodity across space and over time. Value as represented by the market has the ability to fluctuate from second to second. So the 100 dollars might buy 100 pounds of potatoes from Manitoba but it might buy 120 pounds from Saskatchewan but may only buy 80 pounds from North Dakota. Each represents the same amount of value but shipping costs would be vastly different. Especially when you consider that those who buy potatoes do not generally purchase only 100 dollars worth but rather vast amounts to feed entire cities. Here in lies the problem for researchers in Canada attempting to complete food miles studies, all of the data that is currently available to food miles researchers is expressed in value.

The second issue is one that may prove to be more fatal for these studies than the first. Each of these studies involves the usage of the data available from the Strategis Canada web site. As such, the data presented only represents international shipments of goods and does not take into account either inter-provincially traded or locally produced food items. Xuerub and Lam calculated food miles of 4 497 km and 4 685 km, respectively. However, both only included data from international trade. A precise weighted average would include all sources of food from all locations. This point is made even clearer when one takes into account that if you were to drive east from Toronto you would only travel about 3 000 kilometers to St. John's, Newfoundland. Furthermore, if one were to travel west it would take only about 4 350 kilometers to get to Victoria, British Columbia. That means, if food were imported from anywhere in Canada it would represent a reduction in food miles. This, of course, before taking into consideration that Kingston and Waterloo are located in areas that have some of the most productive soils in Canada. Victoria is also is located near regions that produce large amounts of fresh produce. In defense of these studies it must be noted that data is simply not available for inter-provincial trade, at least at the level of aggregation that these researchers are wanting. Currently, it is only available in three large groups; the first is fruits, vegetables and other food products, the second, meat, dairy and fish, while the third is simply grains. Xuerub looks at very specific food items, "The list of food items was expanded during the study to include more specific variations of the food items

(for example, garlic was expanded to fresh, dried and powdered)" (Xuerub, 7). It is the search for individual trees that is the reason why these studies simply cannot account for the forest. Any researcher attempting to account for food miles must account for the entire system. The LifeCycles Group and Xuerub admit that this is a problem, but they fail at recognizing the extent to which it is a problem.

This study makes an attempt to take a broader view of the food system and is able to account for all of the food produced, imported, exported and consumed in Manitoba. Like three of the previous studies the Strategis Canada web site is used for international imports of food products into Manitoba, as well as international exports. Statistics Canada census data is used to determine inter-provincial imports and exports to and from Manitoba. Manitoba agriculture data is found in Manitoba Agriculture, Food and Rural Initiatives' (MAFRI) Agriculture Yearbook 2005. In order to account for all food products consumed in Manitoba individual products had to be disregarded. That is to state, every tomato, cucumber, and onion could not be accounted for but rather the category of fruits, vegetables and other food products (from here forth called simply fruits and vegetables) was formed. The same must be argued for breakfast sausages, cottage cheese and salmon, which became meat, dairy and fish. Cereal grains and associated products, such as flour and bread, became simply grains. The Weighted Average Source Distance was then calculated using all of the data available. It is important to note that in the calculation of the WASDs for

Manitoba the international data was not included as the amount of food that is imported from countries outside of Canada and the United States is responsible for a minimal amount of food. This type of import represents, as will be shown in more detail later, 0.1 percent of meat, dairy and fish, 0.2 percent of grains and 3.8 percent of fruits and vegetables.

Weighted Average Source Distance calculation has been used by all researchers, except the Food Share group from Toronto, who have attempted to calculate food miles in Canada (Lifecycles, Xuerub, 6, Lam, 4). This formula has been modified for Canadian usage as the value of k in Carlsson-Kanyama's calculations is a measure of mass (Carlsson-Kanyama, 18). As noted previously this is a necessary substitution due to data availability. The formula for WASD is

$$= \frac{\Sigma_{(k=1)} (v_{(k)} * d_{(k)})}{\Sigma v_{(k)}}$$

where:

Σ = sum of

k= the different locations of consumptive origin

v = value ($) of imports from each location of production origin

d = distance (km) from each location of production origin to the point of consumption

The data retrieved, at this point, is only available in an already amalgamated form and is reported only as monetary value. Food products shipped from outside of Canada and the United States were listed only by country. However, products that were shipped from inside of these two countries are less aggregated and were listed by province or state. To calculate distance from the point of origin to Manitoba capital cities of provinces and states are used. Capital cities are not necessarily major shipping centers. Victoria for example is the capital of British Columbia but most shipping traffic would more than likely travel through Vancouver. Selecting capital cities as the place of origin provided a straightforward solution to the problem of having to justify every city that is selected. Selecting cities in the United States would pose an especially daunting task as each state could have not just one or two but multiple cities that could act as shipping centers.

It is assumed that food products shipped within Canada and America is completed using ground shipping via trucks. The distance between the cities was calculated with the assistance of the web site www.mapquest.ca. This web site provides driving directions, approximate times and distances for anywhere in Canada and the United States. Distances given by the web site are calculated in miles and as such, distances were then converted to kilometers by multiplying by 1.6. It is important to note that two very critical distances have not been calculated, as it would require untold amounts of work. The first is the distance that food products

have traveled from the farm to the distribution point. The second is the travel distance between Winnipeg to the specific location of consumption.

Local production for local consumption was calculated using local production minus that which was exported. Foods that were produced within Manitoba and that were not exported became that which was locally consumed. The assumption with local production as with all other points of origin, is that, the origin of agricultural products from Manitoba is the capital city of the province, this means that Winnipeg is both the origin and destination. When calculating the WASD the value for Manitoba production was multiplied by zero, which added nothing to the sum of the numerator but added significantly to the denominator. Thus, having the effect of greatly reducing the food miles for Manitoba.

The exception to this is category of fruits and vegetables. This is due to the odd fact that we export more than we produce. Fortunately, MAFRI's yearbook provides at least the beginnings of an explanation. Manitoba grows a significant amount of potatoes. The price farmers receive for potatoes that are sold as fresh produce is significantly higher than what is paid to them for that which becomes processed food, $0.385 per kilogram as opposed to $0.175 per kilogram (MAFRI, 37). However, the potatoes that are processed before being exported are sold for more money than what the farmers were paid for the potatoes, $257 500 000 compared to $138 730 000 (MAFRI, 37 and MAFRI, Manitoba Exports Fact Sheet).

Processing of course takes an input of capital and labour, which then raises the price of the potatoes.

As a consequence of this oddity, the calculation that is performed to figure out the amount that Manitoba consumes of its locally grown fruits and vegetables has a final answer of a negative number. That is, Manitoba has a negative local production rate. For the purpose of calculating the WASD for fruits and vegetables this has a severe effect on the final distance calculated. If the formula is carried with a negative Manitoba production, the numerator is not changed as any number multiplied by zero is simply zero, and becomes neither negative or positive. However, the denominator is affected since the denominator in this calculation is simply the summation of values from each source of food. The addition of a negative number becomes simply a subtraction. In this case a subtraction of about $400 000 000. This is a rather large proportion of the total calculation and reduces the total of the denominator significantly. When the calculation is performed the net effect is a much larger number as the final calculation, in this case 4 294 km instead of 1 936 km if Manitoba is calculated as having zero production. The final calculation with Manitoba having zero production should be viewed as the more correct final answer as the proportion of fruits and vegetables that Manitoba receives leans heavily to Canadian provinces we will see.

Fruits and vegetables travel the farthest for consumption in Manitoba travelling on average 1 936 km from the point of origin. Partially this is because Manitoba does not have the climate to support the vast majority of fruits. Furthermore, instead of growing and a wide array of vegetables Manitoba grows mostly potatoes for export. The majority of fruits and vegetables are shipped in from other Canadian Provinces and they represent roughly 89 percent. Manitoba imports about 7 percent of its produce from America. Imports from Guatemala, Mexico, Chile and Peru make up the majority of the last 4 percent.

Fruits, Vegetables and Seed	Amount of Food (in Canadian Dollars)	Proportions
Manitoba	$0.00	0.0
Canada	$689 900 000.00	0.890
United States	$55 516 119.00	0.072
Other International	$29 619 767.00	0.038
Total	$3,694.00	1.00

Meat, dairy products, and fish travel the second largest distance to get to Manitoba's dinner plates with a distance of 1 060 kms. As with fruits and vegetables Manitoba receives most of its meat products from other provinces in Canada, but only at a rate of 53.4 percent. Surprisingly, Manitoba produces a rather large amount of its own meat, 42.1 percent to be exact. This means that 95.5 percent of Manitoba's meat, fish and dairy products are obtained from within Canada. Only 4.4 percent is imported from the U.S. which leaves about 0.001 percent for other international countries.

Meat, Fish and Dairy	Amount of Food (in Canadian $)	Proportions
Manitoba	$474 051 744.00	0.421
Canada	$601 700 000.00	0.534
United States	$49 832 713.00	0.044
Other International	$1 180 991.00	0.001
Total	$$5336.00	1

As expected, grain products have the lowest food miles for Manitoba, with an average travelling distance of 405 kms. Manitoba produces 46.9 percent of its own grain product. Canadian imports and American imports represent 22.9 and 29.9 percent respectively. Of the thirty percent of grain imports to Manitoba from America North and South Dakota as well as Minnesota account for roughly 91 percent. Other international countries represent 0.002 percent, which is marginally more than they did for meat products and this is only because Manitoba imported $199 150 worth of product from Thailand, all of the other countries combined for $106 538 worth of product.

Grains	Amount of Food (In Canadian $)	Proportions
Manitoba	$68433800.00	0.470
Canada	$33400000.00	0.229
United States	$43593135.00	0.299
Other International	$305688.00	0.002
Total	$145732623.00	1

The United States is Manitoba's favourite international trading partner. Trade between Manitoba and the United States accounts for roughly 30 percent of grain

products but only 4.4 percent of meat, dairy and fish and 7.1 percent of fruits and vegetables. Other imports from countries outside of these account for very little of Manitoba's food system at 0.002, 0.001 and 3.8 percent respectively. It is rather shocking when Xuerub claims that most of Waterloo's beef imports originate from Colorado, Kansas, Australia, New Zealand and Nebraska and argues that it travels on average 5 770 kms (Xuerub, 13). Manitoba's meat products appear to have a much closer origin only travelling about 1 060 kms on average, with about 95 percent of it either produced locally or from other parts of Canada.

Fruits and Vegetables

Interprovincial Imports	Fruits and Vegetables (value in Canadian dollars)	Distance to Winnipeg in Miles	Distance to Winnipeg in KM	Amount of Imports * Distance to Winnipeg
Prince Edward Island	1600000	2151.97	3443.152	5509043200.00
Nova Scotia	13100000	2211.85	3538.96	46360376000.00
New Brunswick	17400000	1946.42	3114.272	54188332800.00
Newfoundland and Labrador	300000	3018.12	4828.992	1448697600.00
Quebec	76800000	1563.01	2500.816	192062668800.00
Ontario	298400000	1223.11	1956.976	583961638400.00
Saskatchewan	35900000	353.87	566.192	20326292800.00
Alberta	158700000	808.08	1292.928	205187673600.00
British Columbia	87700000	1425.29	2280.464	199996692800.00
Sub-Total for Interprovincial	689900000			1309041416000.00
International Imports (US)				
	16			
Illinois	769309	982.8	1572.48	1209723016.32
Mississippi	74624	1455.29	2328.464	173759297.54
South Dakota	201783	548.26	877.216	177007276.13
Minnesota	3724594	459.11	734.576	2735997362.14
Wisconsin	1117663	709.1	1134.56	1268055733.28
Kansas	11640	802.49	1283.984	14945573.76
Nebraska	77723	668.66	1069.856	83152417.89
Arkansas	320878	1202.53	1924.048	617384674.14
Alabama	172499	1566.29	2506.064	432293533.94
North Carolina	271138	1668.38	2669.408	723777946.30
Georgia	923237	1551.95	2483.12	2292508259.44
Iowa	1834	698.06	1116.896	2048387.26

Colorado	40557	1070.54	1712.864	69468625.25
California	23129795	1834.87	2935.792	67904267122.64
Pennsylvania	72987	1507.01	2411.216	175987422.19
Louisiana	11048	1561.18	2497.888	27596666.62
Florida	11606393	1771.47	2834.352	32896603212.34
Missouri	82	965.14	1544.224	126626.37
New Jersey	103833	1617.81	2588.496	268771305.17
Indiana	34222	1028.32	1645.312	56305867.26
Ohio	279844	1162.62	1860.192	520563570.05
Massachusetts	309057	1704.06	2726.496	842642674.27
Virginia	153495	1635.79	2617.264	401736937.68
North Dakota	3683965	366.24	585.984	2158744546.56
Washington	505460	1442.31	2307.696	1166448020.16
New York	55418	1640.21	2624.336	145435452.45
Tennessee	1	1300.82	2081.312	2081.31
Texas	2226276	1474.13	2358.608	5250912383.81
Kentucky	13075	1180.47	1888.752	24695432.40
Idaho	1351950	1339.85	2143.76	2898256332.00
Hawaii	224240		0	
Arizona	2583915	1843.47	2949.552	7621391656.08
Maryland	129824	1560.44	2496.704	324132100.10
Michigan	416630	1025.78	1641.248	683793154.24
Oregon	109243	1519.62	2431.392	265612556.26
Wyoming	455628	977.7	1564.32	712747992.96
Puerto Rico	145434			
Oklahoma	96042	1089.19	1742.704	167372777.57
South Carolina	49288	1636.01	2617.616	129017057.41
Montana	28054	918.28	1469.248	41218283.39
Nevada	25176	1719.91	2751.856	69280726.66
Maine	7144	1659.76	2655.616	18971720.70
New Mexico	1102	1424.76	2279.616	2512136.83
Utah	19	1295.57	2072.912	39385.33
SubTotal For US	55516119			134054743771.15
International Imports				65

Italy	5227			
France	601			
Germany	29508			
Chile	3475615			
Re-Imports Canada	93486			
South Korea	94			
Ecuador	490340			
Netherlands	129871			
China	43776			
Guatemala	8292159			
Brazil	179459			
Vietnam	796			
Thailand	4713			
Colombia	1135430			
Peru	2986136			
Iceland	117			
Spain	8693			
Costa Rica	1264505			
Mexico	6413639			
Belize	1735701			
Honduras	1097549			
Argentina	876254			
Dominican Republic	329834			
Morocco	299503			
New Zealand	286802			
South Africa	113474			
Turkey	71774			
Nicaragua	38433			
Switzerland	37188			
Bahamas	33915			
Israel	33088			
Jamaica	31933			
Belgium	20256			
Panama	17892			
Greece	15122			
Australia	12786			

India	8748			
Phillipines	2729			
Taiwan	2480			
Egypt	110			
Algeria	24			
Slovakia	7			
SubTotal	29619767			

WASD for fruits and vegetables

Sum of v * d	Sum of v	Sum of v *d / Sum of v
1443096159771.5	$745416119.00	1936.66 km

Meat, Dairy and Fish

Inter-provincial Imports	Meat, Dairy and Fish	Distance to Winnipeg in Miles	Distance to Winnipeg in KM	Amount of Imports * Distance to Winnipeg in KM
Prince Edward Island	5400000	2151.97	3443.152	18593020800.00
Nova Scotia	5700000	2211.85	3538.96	20172072000.00
New Brunswick	3100000	1946.42	3114.272	9654243200
Newfoundland and Labrador	6600000	3018.12	4828.992	31871347200
Quebec	134800000	1563.01	2500.816	337109996800
Ontario	184900000	1223.11	1956.976	361844862400
Saskatchewan	72900000	353.87	566.192	41275396800
Alberta	137700000	808.08	1292.928	178036185600
British Columbia	50600000	1425.29	2280.464	115391478400
Sub-Total for Inter-provincial	601700000			1113948603200
International Imports (US)				
				17
Illinois	7940702	982.8	1572.48	12486595080.96
Mississippi	5936602	1455.29	2328.464	13823164039.33
South Dakota	4910562	548.26	877.216	4307623555.39
Minnesota	4902098	459.11	734.576	3600963540.45
Wisconsin	4742313	709.1	1134.56	5380438637.28
Kansas	3571366	802.49	1283.984	4585576802.14
Nebraska	3232865	668.66	1069.856	3458700017.44
Arkansas	2824329	1202.53	1924.048	5434144563.79
Alabama	2014375	1566.29	2506.064	5048152670.00
North Carolina	1781796	1668.38	2669.408	4756340496.77
Georgia	1504954	1551.95	2483.12	3736981376.48
Iowa	1358003	698.06	1116.896	1516748118.69
Colorado	1246739	1070.54	1712.864	2135494350.50
California	770667	1834.87	2935.792	2262518013.26
Pennsylvania	683300	1507.01	2411.216	1647583892.80

Louisiana	678824	1561.18	2497.888	1695626323.71
Florida	571083	1771.47	2834.352	1618650243.22
Missouri	279771	965.14	1544.224	432029092.70
New Jersey	183462	1617.81	2588.496	474890653.15
Indiana	180173	1028.32	1645.312	296440798.98
Ohio	81027	1162.62	1860.192	150725777.18
Massachusetts	80535	1704.06	2726.496	219578355.36
Virginia	75448	1635.79	2617.264	197467334.27
North Dakota	73100	366.24	585.984	42835430.4
Washington	60371	1442.31	2307.696	139317915.22
New York	41074	1640.21	2624.336	107791976.86
Tennessee	33967	1300.82	2081.312	70695924.70
Texas	24503	1474.13	2358.608	57792971.82
Kentucky	22124	1180.47	1888.752	41786749.25
Idaho	13945	1339.85	2143.76	29894733.20
Hawaii	5232		0	
Arizona	3554	1843.47	2949.552	10482707.81
Maryland	2119	1560.44	2496.704	3477804.51
Michigan	1503	1025.78	1641.248	2466795.74
Connectitcut	116	1675.5	2680.8	310972.80
Oregon	67	1519.62	2431.392	162903.26
US Virgin Islands	44			
SubTotal For US	49832713			79773450619.42
International Imports				
				60
Italy	394652			
France	205654			
Germany	199058			
Chile	71698			
Re-Imports Canada	69346			
Trinidad and Tobago	60200			
South Korea	56339			

Ecuador	27828			
Netherlands	26324			
China	21476			
Guatemala	10735			
Indonesia	10067			
Bangladesh	9034			
Brazil	7515			
Norway	2366			
Vietnam	2155			
Paraguay	1037			
Guyana	949			
Malaysia	759			
Thailand	642			
Colombia	620			
Sri Lanka	600			
Fiji	525			
Congo	399			
Peru	392			
Maldives	225			
Iceland	218			
Venezuala	107			
US Minor Outlying Islands	29			
Denmark	15			
Spain	12			
Costa Rica	11			
Nigeria	4			
SubTotal	1180991			

Manitoba's Local Production and Consumption

Production	Export	Production – Export
$1784365000	$1310313256	$474051744.00

WASD Calculations for Meat, Dairy and Fish

Sum of v *d	Sum of v	Sum of v * d/ Sum of v

1194196105563.42	$1125584457	1832.18 km

Grains

Inter-provincial Imports	Grains	Distance to Winnipeg in Miles	Distance to Winnipeg in Kilometers	Amount of Imports * Distance to Winnipeg
Saskatchewan	23900000	353.87	566.192	13531988800.00
Alberta	9500000	808.08	1292.928	12282816000.00
Sub-total for Inter-provincial	33400000			25814804800.00
International Imports (US)				
Illinois	14505	982.8	1572.48	22808822.40
South Dakota	3640750	548.26	877.216	3193724152.00
Minnesota	16478106	459.11	734.576	12104421193.06
Wisconsin	42306	709.1	1134.56	47998695.36
Kansas	27	802.49	1283.984	34667.57
Nebraska	167956	668.66	1069.856	179688734.34
Arkansas	1152409	1202.53	1924.048	2217290231.63
Alabama	6017	1566.29	2506.064	15078987.09
Georgia	8441	1551.95	2483.12	20960015.92
Iowa	1192154	698.06	1116.896	1331512033.98
Colorado	76395	1070.54	1712.864	130854245.28
California	170410	1834.87	2935.792	500288314.72
Pennsylvania	28640	1507.01	2411.216	69057226.24
Louisiana	10	1561.18	2497.888	24978.88
Florida	62034	1771.47	2834.352	175826191.97
Missouri	383467	965.14	1544.224	592158944.61
Indiana	156280	1028.32	1645.312	257129359.36
Ohio	8936	1162.62	1860.192	16622675.71
North Dakota	19632544	366.24	585.984	11504356663.30
New York	7405	1640.21	2624.336	19433208.08
Tennessee	72	1300.82	2081.312	149854.46
Texas	250215	1474.13	2358.608	590159100.72
Maryland	2592	1560.44	2496.704	6471456.77
Michigan	71432	1025.78	1641.248	117237627.14

Oregon	82	1519.62	2431.392	199374.14
Wyoming	29918	977.7	1564.32	46801325.76
South Carolina	7	1636.01	2617.616	18323.31
Montana	10000	918.28	1469.248	14692480.00
Maine	15	1659.76	2655.616	39834.24
New Mexico	10	1424.76	2279.616	22796.16
SubTotal For US	43593135		9-38	33175061514.20
International Imports				
Italy	2			
France	6898			
Germany	884			
Chile	42698			
Re-Imports Canada	17			
South Korea	1509			
Netherlands	6			
Vietnam	700			
Paraguay	155			
Thailand	199150			
Mexico	2			
New Zealand	2156			
Belgium	223			
India	39849			
Mongolia	5371			
United Kingdom	3932			
Burma	2086			
Austria	38			
Sweden	12			
SubTotal	305688			

Manitoba's Production and Consumption

Production	Export	Production - Consumption
$1104641000	$1036207200	$68433800.00

WASD calculations for Grains

Sum of v * d	Sum of v	Sum of v * d / Sum of v
58989866314.2	$145426935	405.63 km