AN AGROECOLOGICAL/FOODSHED STUDY OF THE BRITISH COLUMBIA POULTRY INDUSTRY'S MANURE MANAGEMENT PRACTICES: A CASE STUDY OF THE SUSTAINABLE POULTRY FARMING GROUP

by

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ABSTRACT

Since the beginning of the 1980s, British Columbia's poultry industry has grown rapidly and production has become concentrated in the Lower Fraser Valley region. Growth in the industry has led to a significant increase in the volume of manure waste generated. Concentration of the industry in a rapidly urbanizing area with a relatively small amount of cropland available for manure application has meant that ecologically sound manure disposal and storage has proven challenging. Recent research shows that poultry manure is the largest source of surplus manure-based nitrogen and phosphorus in the Fraser Valley. This surplus contributes to water, soil, and air pollution in the region.

The industry-led Sustainable Poultry Farming Group (SPFG) has attempted to deal with the manure problem by redistributing it from areas of intensive poultry production to areas with potential nutrient deficits. Despite a decade of redistributing poultry manure within the Fraser Valley and to the Interior, the SPFG does not seem to be able to "get ahead" of the problem. The industry continues to grow and concentrate in the Fraser Valley, producing increasing volumes of manure.

One of the central goals of this thesis was to articulate an interpretive framework for agri-food systems to study the SPFG's manure management strategy. The framework compares and contrasts the dominant socio-economic paradigm for sustainable agri-food systems, which is referred to in this study as Industrial Agriculture in the Global Supermarket, with an alternative vision, Agroecology and Foodshed. A substantial body of literature, and primary qualitative research conducted for this study suggests that movement away from growth-oriented, industrial agri-food systems and towards more localized agri-food systems that are designed according to Agroecological and Foodshed principles may improve prospects for sustainability.

This thesis concludes that the current manure management strategy employed by the SPFG is not sustainable. It is, at best, at the very beginning stages of a transition to more sustainable manure management. From the Agroecological/Foodshed perspective the poultry industry's manure management problem is viewed as a problem inherent to our highly industrialized agri-food systems, and not simply as a waste management problem. Therefore, a long-term solution to the problem requires a shift towards an alternative strategy that incorporates ecological, social and economic dimensions of sustainability.

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INTRODUCTION

Modern industrial agriculture has had a dramatic impact on world food production. In most countries, the twentieth century marked a shift in agriculture from an intergenerational "cultural art" to an industry dominated by science, technology and business interests.

The goal of industrial agriculture has been to make food production predictable and efficient in order to achieve both higher yields and higher profits. To this end, industrial agriculture strives to overcome what it perceives to be the limiting factors in production – ecological constraints and labour – by employing highly specialized technology, which is powered by fossil fuel energy.

There are, however, several problems associated with industrial agriculture. The overall purpose of this paper is to examine one such problem, the management of the vast quantities of manure produced by the poultry industry in the Fraser Valley of British Columbia.

The development of agriculture in British Columbia's Fraser Valley is in keeping with global trends. It has become more concentrated, intensified, and specialized in recent decades. Animal production, particularly poultry, has grown dramatically since the beginning of the 1980s. Most of that growth has occurred in the broiler sector, and is concentrated in the Abbotsford/Matsqui region of the Fraser Valley. Typical of the trend

for the industry in other areas of the world, growth and concentration has led to significant increases in the volume of manure generated, disposal and storage problems, and pollution in the local environment.

In parts of the Fraser Valley, drinking water is drawn from the Abbotsford Aquifer. Monitoring by Environment Canada of the aquifer for nitrate contamination began in the early 1970s (Environment Canada 2000). Since 1992 the average concentration of nitrate in samples taken from the aquifer has been at levels that exceed Health Canada's 10 mg/L standards (ibid.). The high levels have been attributed, in part, to leaching from poultry manure that is spread and stored on the land above the aquifer.

In 1991, the Sustainable Poultry Farming Group was founded as an industry response to this problem. The SPFG has served many purposes such as, a public relations body for the industry and an awareness-raising/educational organization for poultry producers. Its most notable work, however, began in 1994 with the Groundwater Protection Programme. This programme has two main goals:

- To remove poultry manure from the land base above the aquifer, and deliver it to distant users;
- To develop new markets for poultry manure.

Despite close to ten years of Groundwater Protection Programme operations, however, nitrate levels in the aquifer remain above Health Canada standards, and there is increasing concern that manure-related contamination issues may be transferred to other

areas that receive poultry manure. There is growing evidence that local Fraser Valley crops are over-supplied with manure, and that nutrient imbalance at a regional level is becoming an ever more pressing environmental issue (Bomke 2003, Schreier et al. 2003, Fraser Basin Council 2001, Schreier et al. 2000).

The large and growing volume of manure produced by British Columbia's poultry industry is just one of many factors that contribute to nutrient management concerns in the Fraser Valley. Growing human and other livestock populations also discharge vast volumes of bio-solids into the local ecosystem. Synthetic fertilizers leach into groundwater, or are washed into surface waters. The quantity of nutrients from all these sources exceeds the ability of the region's limited land base to safely absorb them, and therefore they place significant pressure on the local ecosystem (Schreier 2000).

However, the poultry industry is the focus of this study for several reasons:

- Poultry is the fastest growing class of livestock in the region, and industry reports show that poultry manure production will increase substantially over the next decade.

- As a producer-led response to the manure management problem, the Sustainable Poultry Farming Group provides a "window" on how the industry views itself, and the problem it is facing. Over the past twelve years, within the mainstream industry, the Sustainable Poultry Farming Group has taken a leadership role to address the environmental issues that have arisen due to excess poultry manure production in the Fraser Valley. Because of its leadership role, and because it has been in existence for over a decade, the Sustainable Poultry Farming Group has a story to tell, and it has also generated useful data for study.

- The Sustainable Poultry Farming Group does not seem to have been able to "get ahead" of the manure management problem. The industry, which continues to grow and concentrate in the Fraser Valley, produces increasing volumes of manure. It is important to study the industry's mission, goals and actions because, despite its efforts, the problem is getting worse.

- The manure management problem, and the strategy that the industry has devised to deal with it, illuminate larger sustainability issues faced by the poultry industry and industrial agriculture as a whole.

Goals of the Study

Goal 1: Articulate a Framework for Agriculture and Food Systems to Interpret and Study the Sustainability of British Columbia's Poultry Industry Manure Management Strategy

The first goal of this study is to articulate a framework for agri-food systems that can be used to interpret and study the sustainability of the poultry industry's manure management strategy.

The framework developed for this study compares and contrasts the dominant socio-economic paradigm for sustainable agri-food systems (industrial agriculture in a deregulated global economy) with an alternative vision, which is rooted in Agroecology and Foodshed thinking. Agroecology has been defined as the ecology of agriculture. As such it applies ecological principles to design and manage food production systems (Gliessman 1998). Many agroecologists also acknowledge how concepts and insights from ecology can provide insight into "how to deal with questions at the systems level and contribute to the development of sustainable societies" (Francis et al. 2003). Foodshed thinking is a conceptual tool, analogous to the concept of the watershed (Kloppenberg et al. 1996). As water flows through the watershed, food flows through the Foodshed. The Foodshed is a concept that explores ways to increase the food self-reliance of a specific region.

Given the evidence of ecological, social and economic decline associated with the dominant paradigm in agriculture, I argue in this thesis that prospects for more sustainable agriculture and food systems will likely improve if guided by the paradigm of Agroecology in the Foodshed.

Goal 2: Propose Recommendations to Promote More Sustainable Manure Management in British Columbia's Poultry Industry

The poultry industry, through the Sustainable Poultry Farming Group, has devised a removal and dispersion strategy to manage increasing volumes of manure generated by poultry producers in an attempt to improve the industry's prospects for sustainability. Despite close to ten years of pursuing this strategy, the poultry industry has not been able to "get ahead" of its manure management problem. Since the beginning of the 1980s the industry has grown rapidly and has become concentrated in the Lower Fraser Valley. Manure waste has increased dramatically and it has proven challenging for the industry to store and dispose of it in an ecologically sound manner.

In this thesis, the Sustainable Poultry Farming Group's manure management strategy is studied from the perspective of the Agroecology/Foodshed framework for agri-food systems. A set of recommendations to promote more sustainable manure management in British Columbia's poultry industry that are rooted in the framework is laid out in the final chapter of this thesis.

This research is driven by my motivation to be part of the emerging discourse on how to create wide-spread agri-food systems that conserve and protect ecosystems, are

economically viable, and cultivate equitable, just and caring human communities. Albert Einstein once said that it is impossible to solve a problem from the same mind set that created the problem in the first place. My hope is to articulate and apply an alternative "mind set" (Agroecology in the Foodshed) to study the manure management problem and so provide recommendations to facilitate a transition to greater sustainability in British Columbia's poultry industry.

CHAPTER I

CONTEXT AND PROBLEM DEFINITION

1.1 Growth and Concentration of Poultry Production in the Lower Fraser Valley

The Greater Vancouver and Fraser Valley Regional Districts are currently home to approximately 2.25 million people. Experts estimate that the population will double over the next three to four decades (Healy 1997). In recent years, the viability of agriculture as a whole in the Fraser Valley has been undercut by cheap imported food, urban encroachment, industry consolidation and a variety of land-use conflicts. In response, agricultural activity has become specialized, intensified, and concentrated in the region. This has been regarded as necessary to achieve the efficiencies and economies of scale necessary to remain economically viable in the globally competitive food supply system that feeds the region.

Over the past 30 to 40 years, the farming landscape of the region has slowly changed from many small, integrated farms to fewer and larger specialized farms. It is now common to see large and specialized berry, row-crop vegetables, and poultry and dairy farms. Most horticultural crops are now grown in relatively specialized systems, lacking an animal component. Animal production, especially poultry production, occurs in large factory-like housing units.

Table 1 presents the growth trends in animal numbers between 1986 and 2001 in the Lower Fraser Valley, which is the area west of Agassiz where agricultural activity is

most intensive. The data indicate that while the number of cattle and hogs has declined over time, the number of chickens, turkeys, sheep and horses has increased. The most dramatic growth has been in the number of chickens. The number of chickens produced in 1986 was 6,846,054. In the year 2001, that number had jumped to 15,378,887, which is an increase of 124%. Most of the growth in the number of chickens came from the broiler sector, which is the fastest growing sector of the poultry industry having production cycles of approximately 8 weeks.

Table 1: Summary of Changes in Animal Numbers in the Lower Fraser Valley Between 1986 and 2001

	Total Number of Animals in 1986	Total Number of Animals in 1996	Total Number of Animals in 2001	% Change in Number of Animals Between 1986-2001
Cattle	133,057	120,860	118, 769	-10.7%
Sheep	10,862	11,636	11,323	+4.2%
Swine	144,073	122,259	131,181	-8.9%
Chicken	6,846,054	10,559,616	15,378,887	+124%
Turkeys	463,819	748,630	703,288	+51.6%
Horses	8,043	9,603	9,808	+21.9%

Data compiled from Schreier, H. et al. 2003 and Schreier, H. et al. 2000 .

As Table 1 shows, the poultry industry experienced phenomenal growth throughout the late 1980s and the decade of the 1990s. That growth is expected to continue. According to industry research, broiler chicken and hatching egg production is expected to grow at an annual rate of 3.5% between 2001 and 2010 (Sustainable Poultry Farming Group 2002a). The annual growth rates for the layer sector and the turkey sector are projected

at 0.9% and 2%, respectively (ibid.). The projections to 2010 are based on conservative data, and real growth rates may in fact be greater (ibid.).

The bulk of the poultry industry is concentrated in a relatively small geographic area of the Lower Fraser Valley. Research by Schreier et al. (2000, 2003) shows the industry to be heavily concentrated in the contiguous regions of Matsqui, Abbotsford, Chilliwack, South Langley and South Surrey, which is approximately 1/3 of the land base of the Lower Fraser Valley. In 2001, approximately 12.75 million chickens, or 83% of the region's industry, were produced in this area (Schreier 2003). The rest of the industry is scattered throughout the region, from Delta and Richmond in the west to Agassiz in the east, and a small fraction is located outside of the Fraser Valley in other parts of the province. In addition, half a million turkeys are also raised in the Matsqui area.

Between 1991 and 2001 in the Matsqui region the average number of chickens produced on each farm per production cycle rose from approximately 15,000 to approximately 25,000 (Schreier et al. 2003). In Abbotsford, the average number of chickens produced on each farm per production cycle rose from approximately 10,000 to approximately 23,000 over the same time period (ibid.) The size of Chilliwack, South Surrey and South Langley farms also increased during this decade, but the average farm size hovered at 10,000 chickens/farm in 2001 (ibid.).

Poultry industry research, in projections to the year 2010, estimates that for the province 87% of broiler production, 98% of hatching egg production, 95% of turkey production,

and 87% of table egg production will be concentrated in the Fraser Valley (Sustainable Poultry Farming Group 2002a).

1.2 Driving Forces Behind the Growth and Concentration of British Columbia's Poultry Industry

The forces that drive industrial poultry production globally also shape the industry in British Columbia. In the first part of this section, the forces that drive global livestock production in general, and poultry production specifically, are discussed. Following that, several dynamics that are specific to British Columbia's industry are presented.

1.2.1 Global Drivers

Economic Growth

The poultry industry, like most other industries, has been shaped by the economic imperative for growth. The notion that economic growth, measured in monetary terms, is both necessary and desirable is a fundamental economic tenet in most countries of the world.

One of the most important strategies employed to achieve growth in industrial economies is to expand the economies of scale of production. For the poultry industry, and agriculture as a whole, specialization and the substitution of capital for labour have been two of the most important ways to achieve economies of scale. Industrial poultry production is highly capital intensive. Virtually every aspect of production is

mechanized. Animals are housed in large factory-like barns where feeding, watering, and temperature control are automated.

Vertical integration, in which "a firm increases ownership and control of a number of stages in a commodity system" is a structure that is also widely used to achieve economies of scale (Heffernan 2000, 68-69). In Canada, however, the macro-economic policy Supply Management has limited, or at least slowed down, vertical integration. Supply Management helps protect family farms by controlling the market supply of certain agricultural commodities in order to ensure a profitable return to producers. Nonetheless, the global trend towards vertically integrated, intensive poultry production has shaped production methods used in Canada, even if it has not dramatically re-shaped the ownership structure at the farm level.

International trade has long been used to promote domestic economic growth. Because of Supply Management, Canada's poultry industry has been protected from the direct impact of deregulated trade, though there are ongoing efforts by other countries to dismantle Canada's policy. Canadian producers have not been forced to compete internationally, so the scale of our industry is relatively small compared to the U.S., for example. But global trends towards specialization and mechanization do shape the technology choices employed by Canadian poultry producers.

Population Growth, Urbanization and Rising Incomes

Population growth, rising incomes and urbanization are also significant driving forces behind the worldwide growth in livestock production. Research from the International Food and Policy Research Institute (1995) shows that urban populations tend to have higher demand for animal products, and therefore urbanization fosters growth in global livestock demand and production.

Over the last two decades growth in the poultry industry has been a worldwide phenomenon. Of all livestock industries, the poultry industry has experienced the fastest rate of growth worldwide, and is expected to continue to experience rapid growth into the next decade. Between 1997 and 2020 the projected worldwide growth rate for poultry is 80% (de Haan et al. 2001). Most of this growth will be in broiler chickens, rather than in egg or turkey production. Other livestock commodities will grow an average of 50% over the same time period worldwide (ibid.).

Over the decade of the 1990s, chicken meat production globally grew by 72% from 29 million metric tons in the early 1990s to 50 million metric tons by the end of the decade (Aho 2001). Approximately US$40 billion dollars were invested in the world chicken industry during this time period (ibid.). Though the rate of growth in poultry meat production is expected to continue to grow in the first decade of the twenty-first century, the rates are not expected to be as steep as they were in the 1990s (de Haan et al. 2001).

Food Safety and Personal Health

Global growth in the poultry meat sector has been driven primarily by increasing demand in Southern countries, concurrent with increases in urbanization, incomes and population. Demand for broiler meat in Western countries grew at a slightly slower rate. The growth in Western countries occurred concurrent with declines in all other livestock sectors.

The poultry sector in Western countries continues to grow for several reasons. First, food safety concerns have been raised by recent outbreaks of hoof and mouth and mad cow diseases that have managed to curtail consumer demand for red meat across the Western world. Second, health concerns attributed to a diet heavy in red meat have also helped shift the preferences of Western consumers towards white meat. Third, the fast food industry, in response to the shift away from red meat, offers consumers a variety of chicken products. Eric Schlosser (2001) in his study of the U.S.-based fast food industry claims that McDonald's Restaurant's Chicken McNugget (introduced in 1983) caused consumer demand for chicken meat to skyrocket, and led to fundamental changes in the structure of the poultry industry.

Potential Countervailing Forces

While there are myriad forces driving growth in industrial livestock production, several factors may curtail the trend. It may be that growth in the livestock industry (not to mention increasing human consumption of grains with population growth) will increase demand for feed grains, causing grain prices to rise to a level at which it will not be cost-effective to run intensive animal operations. Energy (fossil fuel and electricity) prices

may also rise to a level where margins are reduced, and production is cut back. Water, which is quickly becoming a scarce resource, may also become a limiting factor in production. If it is not readily available, or if it is soon priced according to its value, profit margins in livestock production may decline and with them production.

It is also possible that concerns about food safety will continue to affect consumer demand. We have already seen the impact of both mad cow and hoof-and-mouth diseases on consumer demand for red meat in Western countries. A similar, though less dramatic, dynamic at this point is being played out in the poultry industries of many countries. Recent outbreaks of Avian Flu have led to the slaughter of many poultry flocks, human deaths and may lead to concerns about the safety of consuming poultry products.

Another factor that may curtail demand, particularly in Western countries, is an increasing concern with animal-welfare issues that arise from the housing conditions associated with most industrial animal production. In many parts of Europe, consumer pressure to improve animal welfare has already begun to affect the nature of animal production.

1.2.2 Local Drivers

In addition to the global forces that have shaped British Columbia's poultry industry over time, there are several forces specific to this region that have helped intensify and concentrate the industry in the Lower Fraser Valley.

Trade Deregulation and Globalization

With the advent of the World Trade Organization (WTO) in January of 1995 agriculture, which had hitherto been exempt from many trade regulations, was brought under full trade discipline (Shrybman 1999). The WTO replaced import quotas with less powerful import tariffs. That move was viewed by many as the beginning of an assault on the Canadian Supply Management system. Currently Supply Management in the poultry industry is maintained by a very high (approximately 300%) import tariff. But U.S. politicians, critical of what they regard as Canada's protectionist policy, along with U.S. producers anxious to gain access to the Canadian market, continue the push to dismantle Supply Management (Schmidt 2003a).

According to an anonymous official with the British Columbia Ministry of Agriculture, Food and Fisheries (MAFF), the international trade challenges to Supply Management that began in the years leading up to the WTO contributed to the concentration and intensification of poultry production in the Fraser Valley. In the late 1980s and early 1990s there were discussions within the poultry industry about long-term ecological sustainability. In the wake of the movement towards deregulated trade, and threats to Supply Management, the poultry industry shifted focus to become more efficient and competitive in the event that supply management is one day dismantled.

To achieve the economies of scale necessary to gain a competitive edge in an uncertain future, the industry began to concentrate in the Lower Fraser Valley. The Lower Fraser

Valley was a natural place for the industry to concentrate for several reasons. The industry was already well established there. The relatively temperate climate helped reduce energy, and therefore operating, costs. The proximity to feed suppliers, processors and the province's major markets made this region the most economically profitable place to produce poultry.

Withdrawal of the National Feed Freight Assistance Programme

In the early 1990s, at about the same time that the trade threats to Supply Management began, the national *Feed Freight Assistance Programme* was withdrawn. Funded by the federal government, this program subsidized the transportation of livestock feed grains from the prairies into British Columbia. According to an anonymous official with MAFF, the elimination of this subsidy programme had the effect of further concentrating the poultry industry in the Fraser Valley. British Columbian producers outside the Fraser Valley (particularly on Vancouver Island) slowly closed down. Their quota was purchased mainly by Lower Fraser Valley producers.

Under the *Feed Freight Assistance Programme*, it had been possible for poultry producers outside of the Lower Fraser Valley to remain economically viable. However, with the elimination of the subsidy, feed prices increased to such a high level that many poultry farmers (particularly broiler producers for whom feed costs are highest) were not able to remain profitable in regions of the province outside the Fraser Valley.

The cost of feed is still very expensive in the Fraser Valley especially when compared to regions such as the Prairies, Ontario and Quebec, all of which have ready access to considerable local grain supplies. Nevertheless, because large poultry operations in the Fraser Valley have captured some economies of scale feed costs do not cut into profit margins as deeply as they would for smaller operations in other areas of the province.

Lack of Infrastructure Support for the Poultry Industry Outside of the Fraser Valley

Most of the infrastructure that supports the poultry industry is located in the Fraser Valley. It is economically advantageous for poultry production to be located close to the other key links in the industry. Almost all of the major broiler processing plants in the province are located here because of close proximity to the province's largest markets. The largest egg-grading station, Golden Valley Foods Ltd., is located in Abbotsford. The majority of feed manufacturers, supplements and additive companies, as well as the laboratories that provide drugs and vaccines to poultry producers, are also located in the Abbotsford area.

Raising the Maximum Quota

According to an anonymous MAFF official, the amount of quota that a single farm is permitted to hold has increased substantially over time, partially in response to increasing demand, but also to facilitate growth and expansion of the industry. As documented by Schreier et al. (2003), and reported above, between 1991 and 2001 the average number of chickens produced per farm in each production cycle in the Matsqui and Abbotsford areas rose by approximately 10,000 and 13,000 respectively. Increasing the maximum

quota over time has allowed economically profitable Fraser Valley producers to buy up quota from outlying regions as those producers have slowly closed down, further concentrating the industry in the Valley.

New Quota Is Allocated on a Pro-Rata Basis

When new quota is created in the poultry system, it is allotted on a pro-rata basis. This means that when new quota is issued into the system, it is distributed to existing producers in proportion to the share that they already own. The net effect of this allocation system is that the big producers get bigger (unless they decide to sell off quota, and in that case they earn windfall income). Since most of the large producers are located in the Lower Fraser Valley, the pro-rata system means that the trend towards an already large and concentrated industry in the region is reinforced as new quota is allocated.

1.3 Poultry Manure Production and Ecological Concerns

The growth and concentration of the poultry industry has led to increased volumes of poultry manure waste being produced in the Fraser Valley. Table 2 indicates that poultry manure production rose by approximately 65% between 1991 and 2002. It is expected to rise by another 31% by the year 2010. Manure waste from broilers, the fastest growing sector, will constitute approximately 61% of the total poultry manure waste by 2010.

Table 2: Past and Forecast Manure Production for the Fraser Valley Poultry Industry

	Chicken (yd^3/yr)	% of total	Table Egg Layers (yd^3/yr)	% of total	Turkey (yd^3/yr)	% of total	Breeder Layers (yd^3/yr)	% of total	Total (yd^3/yr)
1991	204,597	44	100,747	22	125,185	27	34,407	7	464,936
2002	439,404	57	104,165	14	157,612	21	67,362	9	768,543
2010	606,496	61	111,552	11	184,667	19	90,100	9	992,816

Sustainable Poultry Farming Group. 2002a.

When manure is spread on crop fields at appropriate times and in appropriate quantities, it is a valuable fertilizer and soil conditioner. However, when improperly stored or applied in excess and/or at the wrong time, manure can become an environmental pollutant. Recent research shows that poultry industry manure is the largest source of manure-based nitrogen and phosphorus in the Fraser Valley (Timmenga & Associates 2003). For the year 2003, the poultry manure-based nitrogen and phosphorus surpluses were calculated at 4, 000 tonnes and 5,700 tonnes respectively (ibid.). The Fraser Valley also has a 7,300 tonne surplus of manure-based potassium, which is derived primarily from dairy cattle (ibid.). According to Timmenga & Associates (2003) "the manure-based nutrient surplus[for the Fraser Valley] is expected to grow by 37% for nitrogen [and] 23% for phosphorus...by 2010 [and] the anticipated growth is entirely based on increased production by the poultry industry" (p. 3).

As a result, poultry manure has become a non-point source of pollution in the region (Schreier et al. 2003, Schreier et al. 2000, Lavkulich et al. 1999, Zebarth et al.1998, Healey 1997, Wassenaar 1995). Between October 1, 2000 and March 31, 2001 the British Columbia Ministry of Water Land and Air Protection (BCMWLAP) inspected agricultural producers for compliance (or non-compliance in many instances) with the *Agricultural Waste Control Regulation*. The most common violation for poultry producers was storing uncovered manure piles on bare ground. Many of the infractions were on soils above sensitive aquifers such as those in or near Abbotsford, Langley, Rosedale, Vedder, Columbia Valley, Nicomen Island, and Agassiz (BCMWLAP 2001).

Also, crop producers that use poultry manure may store it improperly. "Many piles of poultry manure can be found [stored uncovered] adjacent to Delta ditches" (MWLAP 2001). Many of these ditches connect to waterways that drain into the Fraser River (Bomke 2003). If manure solids from run-off get into the water, environmental problems may arise.

While some evidence on manure/nutrient-related contamination in the Lower Fraser Valley is available, more research is required to discern specific nutrient dynamics and associated pollution problems. The section below provides an overview of the water, soil and air quality concerns typically associated with excess manure-based nutrients with reference to Lower Fraser Valley studies where applicable.

Impact of Manure on Water

The nitrogen in manure converts to nitrate form (NO_3) when applied to land, and is readily leached from the soil into ground and surface waters (Van Kleeck 1997). The heavy rains in the Fraser Valley exacerbate these problems. In terms of human health, nitrate may convert to nitrite, which inhibits the ability of hemoglobin to transport oxygen. For infants, a potentially fatal condition called methaemoglobinaemia or "blue baby syndrome" may result. There is also concern that increased nitrate levels may pose cancer risks (Environment Canada 2000).

Water samples from the Abbotsford aquifer, the drinking water source for hundreds of thousands of British Columbia and Washington State residents, have shown nitrate concentrations exceeding 10 mg/L, the acceptable maximum for drinking water defined by Health and Welfare Canada Canadian Drinking Water Quality Guidelines, since 1992 (Environment Canada 2000). In 1980 approximately 25% of the wells had high nitrate levels, and by 1990 that figure had risen to 40% (Schreier 2003). The aquifer lies beneath the most heavily concentrated region of the poultry industry, and poultry manure was identified as a significant source of nitrate pollution in the late 1980s and early 1990s (Sustainable Poultry Farming Group 1994).

Based on his research, Bomke (2003) believes that over-application of manure fertilizer to croplands may be a significant source of water contamination in the Delta region. Over-application likely leads to nutrient leaching into the shallow ground water, and salt

water that lies under many Delta fields. This could eventually pose problems for aquatic systems along the shore from Tsawwassen to Ladner.

Pathogens from animal waste, such as fecal coliform, are another source of water contamination associated with manure (Healey 1997). Pathogens can be transmitted to other animals and humans via water, either in drinking water or through irrigation water used for vegetables and fruits that are eaten raw. In the wake of public-health catastrophes such as the one in Walkerton, Ontario, this issue is of increasing concern as the poultry industry – and as livestock in general – becomes more intensified in the Fraser Valley.

The entry of manure solids directly into waterways may also pose another significant environmental threat. Manure is an "oxygen demanding substance" because it uses aqueous oxygen during decomposition (Van Kleeck 1997). Therefore, if manure is washed into waterways, it may remove oxygen from water during decomposition that would otherwise have been available to support aquatic life.

Aqueous oxygen is also depleted through the process of eutrophication. Water, polluted with high levels of nutrients such as phosphates and nitrates that are found in manure, becomes home to overabundant growth of aquatic vegetation. Over time, aqueous oxygen is depleted due to aerobic decomposition of excess organic matter, including dead vegetation.

Schreier (2003) also makes the point that the nutrient content of manure is not the only water quality concern. Antibiotics and hormones, routinely given to livestock in low doses in feed, also make their way into water systems.

Impact on Soil

While necessary in trace amounts for the growth and health of all living creatures, metals such as nickel, manganese, lead, chromium, zinc, copper and iron can be toxic even in low concentrations. Metals can be found in manure, and if they make their way into the water system they can potentially kill fish, or "bioaccumulate in their tissues, compromising fish health and making them unfit for human consumption" (Van Kleeck 1997, 14).

There is also an emerging food safety concern that using manure as a fertilizer may contaminate crops with pathogens. Organic production requires that manure be composted to eliminate pathogens before it is applied to crop fields, but other producers do not have such stringent composting requirements.

An oversupply of manure can also distort a region's crop production. In many cases research about appropriate application rates for manure is inadequate, and farmers may overapply it to cropland (Bomke 2003). Over application of nitrogen-rich manure can make crops more susceptible to aphids and fungal diseases, and it can also potentially lead to greater pressure from weeds (ibid.). The over application of manure to crops may

also pose a problem because nitrate can become concentrated in crops and cause "blue baby" syndrome in animals and humans that consume them (ibid.).

Air Quality

When manure and urine on barn floors decompose, ammonia is produced. High concentrations of ammonia in barns pose air quality concerns for animals, and for the humans that work in them. Ammonia and dust emissions from barns, vented into the atmosphere, pose other air quality issues for the local environment. Ammonia reacts with acid nitrates and sulfates, which are generated by vehicles and industry (Sheppard 2002). Together they produce fine particulate matter that can damage human lungs. Also, precipitation can cause ammonia in the atmosphere to "rain down" on soil and water, which contributes to nitrogen contamination (ibid.).

The storage and application of manure waste, as well as the venting of barns, also release foul odours into the air. As operations are intensified and suburban sprawl encroaches on agricultural land, this is becoming an important air quality issue for many residents of the Lower Mainland.

Finally, because the poultry industry is large and concentrated, airborne diseases may also pose air quality concerns in the region. Several poultry diseases such as *Salmonella enteriditis*, Newcastle disease, and infectious laryngotrachetis virus are known to be airborne (Sustainable Poultry Farming Group 2002b). Venting of poultry barns may blow these disease germs and viruses into the local environment.

1.4 Summary

Over the last thirty to forty years the structure of agriculture in the Lower Fraser Valley has shifted from numerous small, integrated farms to relatively fewer, larger and more specialized farms. This trend is in keeping with trends in agriculture around the world.

Poultry production has grown and become concentrated in the Lower Fraser Valley over this period, and has become highly specialized and capital intensive. Several forces, both global and local, have contributed to these trends. At the global level, the economic imperative for growth embraced by most nations of the world has led to the development of more efficient production technology and management techniques that have been adopted by British Columbian producers. Worldwide population and income increases, combined with increasing urbanization, have also led to an overall increase in the demand for livestock products. Food safety and personal health concerns associated with the consumption of red meat have led to rising demand for poultry meat, especially in Western countries.

At the local level, the advent of the WTO in the 1990s with its threats to Canada's Supply Management system, and the removal of the federal *Feed Freight Assistance Programme* have helped to concentrate the poultry industry in the Lower Fraser Valley. Other factors, such as the lack of industry infrastructure outside of the Fraser Valley, and decisions around quota levels and allocation have also contributed to a concentration of the industry.

Nutrient management in water and soil, and air pollution associated with concentrated animal production have become concerns in the region for several reasons. One of the major sources of excess nutrients is the large volume of livestock manure. Poultry, particularly broilers, generate a large volume of dry manure with high nutrient concentrations compared to other livestock, and are a significant consideration in the larger issue of nutrient management for the Fraser Valley.

Given the trend towards a larger and more concentrated poultry industry in the Lower Fraser Valley, increasing volumes of manure will continue to generate nutrient surpluses and pose the potential for nutrient contamination. There is a pressing need to envision possible strategies for the transition to a more sustainable poultry industry. Envisioning such a transition requires positioning the industry in the context of the larger food system. Myriad forces shape the region's poultry production and move it either towards or away from greater ecological sustainability. In the next chapter, Research Methods, a framework for interpreting the shape agri-food systems and move them either towards or away from sustainability is presented.

CHAPTER II

RESEARCH METHODS

This chapter begins with an overview of the important role that paradigms play in framing and directing research questions, research design, and the interpretation of findings. The second section of this chapter describes the aspects of my personal intellectual journey that have helped shape the research paradigm used in this study. The next section describes the research paradigm itself, what I call an *interpretive framework for transition to sustainable agriculture and food systems*. In the final section of this chapter, data collection methods are explained.

2.1 Research Paradigms

> *All research is informed by particular worldviews or perspectives held by researchers and scholars within his or her discipline. These perspectives are called paradigms.*
>
> (LeCompte and Schensul 1999, 41)

A paradigm is a set of values, beliefs and assumptions that a researcher holds about the world. Whether or not explicitly articulated, paradigms underlie the way a researcher formulates a problem definition, collects data, and interprets data. Paradigms are a researcher's "way of seeing." In effect, paradigms act as "lenses or filters that influence how we see the world" (Rojas 2001). The way that one sees the world is influenced by many factors such as one's personal, social and cultural experiences, and one's interactions with, and ideas about the natural world.

For several thousand years philosophers have debated and questioned the ways that human experiences (cognitive, biological and social) shape our conception and understanding of what is "real" (Rojas 2001). In doing so, many scholars have questioned the notion of "objective reality" or "absolute truth" – the idea that reality exists independent of human consciousness. Perhaps, so the debate goes, perceptions of reality are in fact highly subjective, and socially constructed by groups and individuals according their "way of seeing" the world. Furthermore, "ways of seeing" are shaped through the complex interaction of in-born personality traits, cognitive styles and interactions with social and natural environments.

Thomas Kuhn (1962) popularized the notion of "paradigm" when, in his landmark work *The Structure of Scientific Revolutions,* he theorized that significant advances in scientific knowledge occur during a scientific "revolution" – a period of time when old perceptions of reality (paradigms) are displaced by new perceptions of reality (Rojas 2001). A classic example of a scientific revolution, or paradigm shift, is the displacement of the Newtonian-mechanical paradigm by Einstein's relativistic paradigm. Einstein's discoveries radically altered scientific perceptions of reality, which in turn led to the development of different ideas about "truth" or "objective reality", and the creation of new scientific knowledge.

Kuhn's ideas about scientific paradigms have been expanded in more recent years to include the notion of social and/or cultural paradigms (Rojas 2001). The notion of social/cultural paradigms recognizes that all human communities, not just scientific

communities, have unique "ways of seeing" that are shaped by social and cultural forces (ibid.).

As indicated in the Introduction, one of the central goals of this thesis is to articulate a framework, or paradigm, for agriculture and food systems to interpret and study the sustainability of British Columbia's poultry industry manure management. The framework developed in this chapter compares and contrasts the dominant socio-economic paradigm for sustainable agriculture and food systems, industrial agriculture in a deregulated global economy, with an alternative vision, Agroecology in the Foodshed.

Agroecology is an emerging paradigm that views agricultural systems as microcosms of natural ecosystems to be managed and designed according to ecological principles. Agroecology is rooted in a holistic philosophy that is concerned foremost with relationships within systems, and interactions between system components.

This approach is not unique to Agroecology. It is the hallmark of systems theory, and is a useful approach for conceptualizing complex systems. It may be contrasted to the dominant industrial paradigm for agriculture, which strives to simplify the inherent complexity of agricultural systems, and focuses on finding linear and single variable solutions to problems. In keeping with a complex systems approach, concepts in Agroecology continue to evolve to encompass issues beyond the ecological aspects of production agricultural Agroecology may also include the ecology of the social and economic forces that shape the structure and design of agri-food systems. Agroecology,

in its broadest sense, is concerned with the systemic relationships and interactions between the social, economic and ecological components of an entire food system. Therefore, Agroecology can provide insight into how to approach the challenges confronting agri-food systems, and can contribute to the development of more sustainable societies for the future (Francis et al. 2003).

Current scholarship on what is called Foodshed thinking is also integrated into the research paradigm guiding this study. The notion of a Foodshed was developed as a conceptual framework to study where food comes from and how it gets to consumers (Kloppenberg et al. 1996). Analogous to the term "watershed", a Foodshed is a metaphor to envision the flow of food into communities. And, like the watershed, the Foodshed is rooted in a specific geographic place and assumes a unity between plant, animal and human communities (ibid.).

A substantial and growing body of literature suggests that movement away from growth-oriented and energy intensive globalization and towards smaller scale economic activity is crucial to improve prospects for sustainability (Pretty 2000, Feenstra 1997, Kloppenberg et al. 1996, Mander and Goldsmith 1996, Mander 1996, Norberg-Hodge 1996, Wackernagel and Rees 1996, Pretty 1995, Daly and Cobb 1994). Norberg-Hodge (1996), for example, explains how re-localizing economic activity might help to alleviate the ecological and social problems brought on and exacerbated by globalization. She argues that with globalization people increasingly import products from great distances that could be produced locally. Globalization, therefore, has meant that people are

becoming dependent "for their everyday needs on products that have been transported thousands of miles" (ibid., 394).

Local economies, such as those described by the Foodshed, wherein production and markets are more closely linked geographically may help to minimize the negative ecological consequences associated with the hyper-specialization in production, and massive transportation infrastructure required to keep the global economy moving. Another upshot might be that as local economies diversify and strive to meet a wider range of local needs, they might become strengthened and/or less vulnerable ecologically, socially and economically.

The goal of re-localization is not to eliminate trade altogether. It does, however, strive to significantly limit the negative social, economic and ecological consequences of unbridled deregulated trade in the global economy. Given my review of the literature, I will argue that there are many compelling arguments to support the proposition that prospects for more sustainable agri-food systems will improve with transition towards Agroecology in the Foodshed.

In this study, another paradigm overarches the Agroecology/Foodshed interpretive framework. It is what LeCompte and Schensul (1999) call an interpretive paradigm. An interpretive paradigm allows researchers to bring the vision inherent in their research to bear upon how they interpret, comment upon and generate knowledge from their research findings. Researchers do not simply report on reality "as it is", but also on reality "as it

might, or should be" (Rojas 2001). Therefore, the interpretive paradigm provides the researcher with the opportunity for normative consideration of research findings. In this way, the interpretive paradigm allows researchers to speculate, and potentially generate new knowledge by interpreting research findings through a "lens" that provides an alternative perspective to the dominant social/cultural paradigm.

While many people may dismiss the notion of bringing ideals and values to bear upon the interpretation of research findings, it is necessary to recognize that ideals and values of one kind or another underlie all research. McIssac (1994) suggests that in order to further meaningful discourse on what sustainability is and how it may be achieved, particularly between parties with different interests, it will be necessary to first make explicit the values, beliefs and assumptions that underlie differing perspectives. The interpretive framework presented in this chapter is an effort to undertake that necessary first step for agri-food systems.

2.2 Personal Intellectual Journey

The personal intellectual journey behind this thesis began when I was an undergraduate student of Economics at Queen's University. To a large extent, that experience shaped the worldview that I bring to this research, and is infused into the research paradigm.

I was drawn to Economics because I felt it was a discipline through which I could explore the forces that shape our world. Several options to achieve this were possible, but Economics, I reasoned, was the dominant force at play in the world, and the job prospects with an Economics degree were promising.

I embarked on the study of economics with great enthusiasm, but soon found myself miserable in the programme. I had great difficulty accepting many of the underlying assumptions of Economics. Though I was taught that economics was an objective and rational science, I personally found it to be too abstracted from reality. For example, I questioned the assumption that important aspects of production such as the environment should be considered external to Economic models. I was largely unconvinced of the Economic logic that human welfare would improve if the "invisible hand" of the market was left alone to allocate resources. Based on my interpretation of what was happening in the world, it seemed that the desire to increase material wealth had compromised many important values. And clearly, the benefits of world Economic growth were not being equitably distributed.

I was unhappy and unmotivated in my study of Economics, and graduated in 1989 with barely passing grades. Afterwards, I worked and volunteered with international development organizations, and community groups in Canada and overseas for several years.

My interest in agriculture and food developed when I was pregnant with my first child. Aware that every mouthful I ate was building my child's body, I became very interested in the health of the food that I consumed. Healthy food, for me, became more than a balance of vitamins, mineral, proteins and carbohydrates. It also meant food that was free of herbicides, pesticides, medications and hormones. It was also important to me

that the nutrient content of the food that I ate came from the soil, not chemical fertilizers. I became convinced that eating food grown in the most natural way possible was best for my health, and for that of my growing child. So, I switched my diet. I tried to eat organic food, and to buy local and seasonal products as much as possible.

When my first child was two, I decided to return to university to rectify the wrongs of my undergraduate degree. I believed that I had the intellectual capacity to do well, and after such a poor undergraduate performance I wanted the chance to try again. My newfound interest in food, and how it is produced, led me to the Faculty of Agricultural Sciences at the University of British Columbia.

After proving my academic potential in a couple of undergraduate courses, I applied and was accepted for graduate work. The faculty had begun a transition in its academic programme, introducing Agroecology as a key stream in the new curriculum. I was accepted as a graduate student "de facto" in the emerging programme, although I was formally enrolled in one of the established specializations.

During my graduate course work I was drawn to the study of Ecological Economics and Agroecology. Ecological economics, in its re-conception of the relationship between ecosystems and human economies, addressed many of the concerns raised in my undergraduate studies of conventional Economics. Agroecology interested me because of its holistic perspective on the relationship between ecology and food systems.

2.3 Research Paradigm: Interpretive Framework for Transition to Sustainable Agriculture and Food Systems

Figure 1 is a schematic representation of the research paradigm. It integrates ecological and socio-economic dimensions of agriculture and food systems, and can be used to interpret the forces that potentially help and/or hinder transitions in agriculture and food systems towards and away from sustainability.

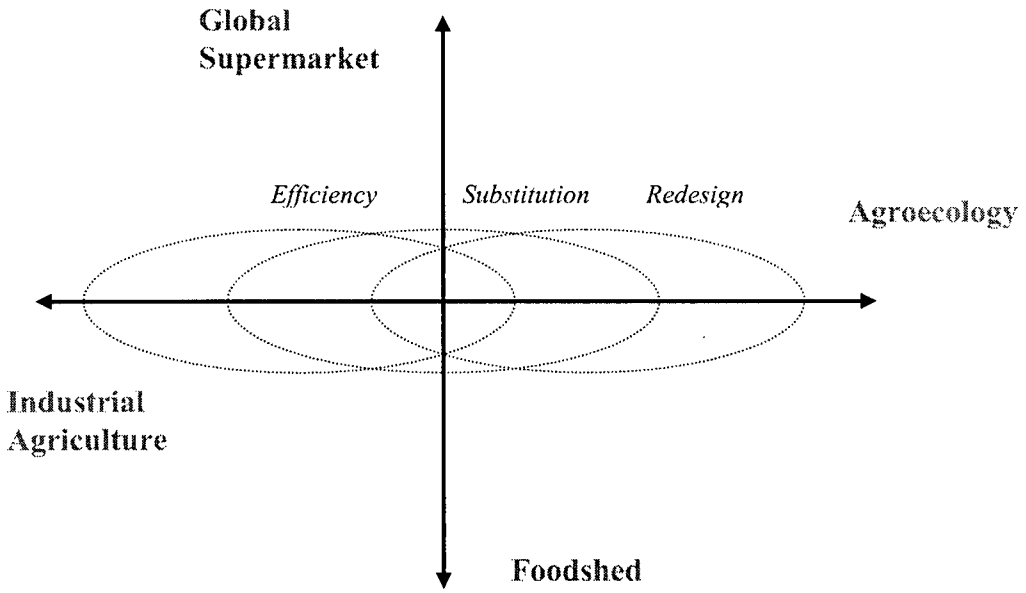

Figure 1: Interpretive Framework for Transition to Sustainable Agriculture and Food Systems

2.3.1 Ecological Axis

Figure 1 consists of two axes, an ecological and a socio-economic. At each end of the ecological axis are two very different paradigms for agricultural production - industrial agriculture and Agroecology. Table 3 compares and contrasts the dominant philosophical

premises of modern science, upon which the paradigm for industrial agriculture is founded, with a set of alternative premises that are the philosophical foundation of the agroecological paradigm.

Table 3: Philosophical Premises of Industrial Agricultural and Agroecology

Industrial Agriculture	Agroecology
ATOMISM: systems consists of unchanging parts and are simply the sum of their parts.	HOLISM: Parts cannot be understood apart from their wholes and wholes are different from the sum of their parts. Parts might evolve new characteristics or totally new parts can arise.
SYSTEMS: Mechanistic. Relationships between parts are fixed, systems move smoothly from one equilibrium to another, and changes are reversible.	SYSTEMS: Might be linear/mechanical, or they might be deterministic yet not predictable or smooth because they are chaotic or simply very discontinuous. Systems can also be evolutionary.
UNIVERSALISM: Diverse, complex phenomena are the result of underlying universal principles which are few in number and unchanging over time and space.	CONTEXTUALISM: Phenomena are contingent upon a large number of factors particular to the time and place. Similar phenomena might well occur in different times and places due to widely different factors.
OBJECTIVISM: We can stand apart from what we are trying to understand.	CONSTRUCTIVISM[1]: Social and most "natural" systems cannot be understood apart from our activities, our values, and how we have understood and hence acted upon these systems in the past.
MONISM: Our separate individual ways of understanding complex systems are merging into a coherent whole.	PLURALISM: Complex systems can only be known through multiple and different patterns of thinking, each of which is a necessary simplification of reality. Different patterns are inherently incongruent.

(adapted from: Norgaard, R. B. and T.O. Sikor. 1987)

The philosophical foundations of industrial agriculture and Agroecology guide farming methods, farm organization and salient research questions. Industrial agriculture is dominated by a paradigm that strives to reduce, simplify and control natural processes.

[1] Norgaard and Sikor use the term subjectivism in the original version of this table. I have changed the term to constructivism because I feel that this term better reflects the nature of agroecological thinking. Subjectivism can often be misunderstood and being "in the mind of" the observer, or researcher. Constructivism, on the other hand, implies interpretation that is rooted in an established way of thinking. While this distinction may not be necessary, I felt it was important to make it clear that agroecology is a systematic, verifiable, and scholarly way of thinking rather than the individual perspective.

Many natural/biological agricultural processes are replaced by technological processes that humans have imposed to control them. Nature is viewed as the limiting factor of production that can be overcome by technological innovation. Large quantities of external inputs such as water, nutrients and energy are used to simplify and control natural processes in order to maximize yield. Industrial agriculture may be characterized by:

- High energy dependence (fossil fuels and electricity)
- High water dependence
- Low labour and management requirements
- Little or no integration of plant and animal systems
- Limited biological and genetic diversity
- Highly mechanized animal and crop production systems
- Antibiotics and vaccines to control animal illness, agri-chemicals to fertilize and control pests and weeds in plant systems.

A good example of industrial agriculture at this end of the axis would be large-scale greenhouse, hydroponic production of vegetables. In this type of production many human-devised technological processes replace biological processes. Even the most industrialized production systems such as these, however, rely on natural processes. Ultimately, natural processes provide all essential inputs to the system, such as water and energy.

Industrial poultry production would also be situated very close to this end of the axis. Industrial poultry production uses technology that is highly specialized and animal management practices that are highly mechanized to control egg and meat production. Genetic diversity is limited. Bird health is maintained by the constant application of medications. Birds are housed in great numbers in factory-like conditions where every

element that affects productive capacity (light, heat, feed, water, ventilation) is controlled with precision by automated systems.

Like any industrial process, animals are "manufactured" with the input of raw materials and wastes and consumable products are exported from the system (Lavkulich 1999). Massive external nutrient and energy subsidies are required to maintain the productivity of industrial poultry production.

Agroecology is rooted in a fundamentally different paradigm than industrial agriculture. In agroecology, agricultural systems are designed to mimic the ecological dynamics of the local, mature, natural ecosystem. Agroecology applies the following ecological principles to the design and management of agricultural systems:

- Diverse species of plants and animals co-existing in dynamic equilibrium
- Solar and other forms of "soft" energy are favoured
- Internal recycling of nutrients
- High efficiency of energy transfer along food webs
- Internal resistance to disease
- Regard for non-crop organisms
- Regard for water conservation
- Emphasis on the interconnections among species
- Recognition of the interdependence of species and their physical environment
- No dependence on exhaustible resources

Spatial boundaries delineate agroecosystems in order to establish what is external, and what is internal to the system (Gliessman 1998). In practice, boundaries are often set at the level of a farm field, an individual farm, or a community of adjacent farms (ibid.). Spatial boundaries have been virtually removed in industrial agriculture, which regards the entire globe as its agroecosystem. Agroecology, on the other hand, is the study of

how to re-integrate agriculture with the ecology of a specific place. Measurable sustainability criteria, the presentation and discussion of which is beyond the scope of this research project, have emerged from these agroecological principles and have been presented elsewhere in detail (LeFroy 1999, Gliessman 1998, Pretty 1995, Altieri 1983).

Because agroecologists think in terms of complex systems, one of the most distinguishing features of Agroecology is that it is concerned as much with the socio-economic system of a farm, as it is with the ecological system. Agroecology takes a "co-evolutionary" perspective to understand the interaction between socio-economic and ecological systems (Norgaard and Sikor 1987). Socio-economic systems are "made up of systems of knowledge, values, technology, and organization" that interact with one another and ecological systems (ibid., 25). Therefore, socio-economic and ecological systems "co-evolve" into agricultural systems.

The co-evolutionary perspective explicitly links human social systems (knowledge, values, technology and organization) to ecological systems. This is important because, if we are aware of these interactions "we can intervene to facilitate co-evolutionary changes which favour people and environmental sustainability" (Norgaard and Sikor 1987, 27).

Ecological Axis Transition Stages: Efficiency, Substitution, and Redesign

In Figure 1, along the continuum between industrial agriculture and agroecology, there are three overlapping transition stages: efficiency, substitution and redesign. Movement from the efficiency to the redesign stage has been described as a transition to more

sustainable agriculture (Hill and MacRae 1992). Similar stages, but different terminology, have been described elsewhere in the literature. The United Nations Development Programme (1995) describes four stages of transition to more ecologically sustainable agriculture: 1) progressive elimination of inputs; 2) efficient use of inputs; 3) input substitution; and 4) system redesign. Gliessman (1998) describes three stages of transition to more ecologically sustainable agriculture. In the first stage, the efficiency of conventional practices is increased in order to reduce the use and consumption of costly, scarce, or environmentally damaging inputs. In the second stage, conventional inputs and practices are substituted with organic inputs and practices. And, in the third stage, the agroecosystem is redesigned according to ecological principles. Each of these stages is described in greater detail below using Hill and MacRae's terminology.

Efficiency

In the first transition stage, efficiency, conventional systems are "made more efficient to reduce both resource waste and environmental impact" (Hill and MacRae 1992). For example, an industrial farm in the efficiency stage of transition would reduce reliance on external inputs such as agri-chemicals and fossil fuels and/or electric energy, and reduce the negative environmental impact of wastes.

The emphasis at this stage is on adapting technology and farming practices, which remain within an industrial model of production. In crop farming, pest monitoring might be undertaken to make pesticide application more efficient. A good example of an

efficiency stage strategy in the poultry industry would be optimizing feed conversion ratios to reduce the nutrient content of manure.

Substitution

In addition to steps characteristic of the efficiency stage, in the substitution stage environmentally harmful inputs and practices are replaced by more environmentally benign inputs and practice. In other words, "ecological technologies" are substituted for conventional technologies. In crop production, large-scale commercial organics typify the substitution stage. Ecological technologies such as Integrated Pest Management (IPM), intercropping, cover cropping and conservation tillage replace the environmentally damaging farm practices common to industrial agriculture.

Organic poultry production generally fits into this stage of transition. Organic birds are raised on organic feed, and with minimal or no medication. This means that an input into the system (feed) is produced in a more environmentally benign way. And, with reduced medication, the waste products (manure and urine) contain less environmentally hazardous substances. It is likely, however, that even organic feed grain will travel long distances to reach the site of poultry production, and the environmental impact of transport may off-set environmental "gains" from organic feed production.

Redesign

The most important, yet least practiced, stage in the transition to greater sustainability is redesign. In the redesign stage, a farm moves beyond substitution of "ecological

technology" applied within an industrial production system. In the redesign stage, the farm is viewed as part of a complex system of the interdependent ecological processes that characterize the local ecosystem. Planning and design are considered in the context of the larger ecosystem, or agroecosystem, in which the farm is situated. In the redesign stage, the principles of agroecology are applied.

It is possible to find many examples of agroecological poultry production in traditional, agricultural systems where mixed farming is practiced. In these systems flocks are generally housed in structures that require little material and energy input. Birds have access to the outdoors and are able to roam freely. A significant portion of the bird's food supply comes from what it forages (insects, seeds, weeds). Nutrient cycles are almost completely closed since chicken manure fertilizes the land that the birds forage from. A limited quantity of nutrients, however, may be imported into the system in the form of grain feed. The design of traditional agroecological systems inherently recognizes the interdependence of different species in their physical environment and allows for different species of plants and animals to co-exist in dynamic equilibrium with minimal dependence on external, exhaustible resources.

Several examples of poultry production systems that move towards the redesign stage have also been documented by the US-based organization *Appropriate Technology Transfer for Rural Areas* (ATTRA). The examples described by ATTRA use a variety of housing arrangements that allow poultry access to pasture. Portable houses or floorless pens are two examples of pastured poultry housing. Typically, these houses are rotated

regularly around a pastured area "so that chicken may forage grass, seeds, and insects" (ATTRA 2002, 2). The pastured area must be fenced to protect the birds from predators, and the birds can retreat to the portable housing at night for warmth and safety. Generally, portable housing contains watering and grain feeding systems.

Floorless pens are usually limited to warmer weather, or warmer climates, because birds are more exposed to the elements. As with the moveable housing units, the pens are rotated regularly throughout a pastured area. Feed and water are provided. It may not be necessary, however, to have a large fenced pasture if the pens can protect the birds from predators. Another pastured poultry option is permanent housing in which birds have access to a yard or pasture (ATTRA 2002). The pasture surrounding the permanent housing is typically segmented into different yards, and birds are rotated through them on a regular basis. Grain feed and water are provided inside the housing.

A farm moving toward the redesign stage might also diversify and integrate crop and animal production. In this case, the portable pens and houses would rotate through fallow crop fields rather than pasture land. "The chickens weed, till and fertilize the beds, [and] help with insect control" (ATTRA 2002, 5). In each of these systems there is an effort to close nutrient cycles. Manure is deposited on pasture, or crop beds, where birds eventually feed during another rotation.

2.3.2 Socio-Economic Axis

At each end of the socio-economic vertical axis of the interpretive framework in Figure 1 are two very different paradigms for the organization of agricultural production and food systems. At one end of the vertical axis is the "global supermarket", and at the other end is the "Foodshed". Table 4 compares and contrasts the two paradigms. Table 4 has been quoted extensively by Rees (1995) where he contrasts the expansionist and ecological worldviews. I have reinterpreted those terms as Global Supermarket and Foodshed to reflect the specifics of this study. Kloppenberg et al. (1996) informed the values, beliefs, and assumptions inherent in the Foodshed.

Table 4: Beliefs, Values and Assumptions of the Global Supermarket and Foodshed Paradigms

GLOBAL SUPERMARKET	FOODSHED
Beliefs, Values and Assumptions about Nature	
• Nature is valued as a source of inputs to the human economy (production value) and a sink for wastes from the human economy. • If natural resources become scarce or depleted, human innovation will create substitutes. • The economy can be dematerialized with improvements in economic and technological efficiency. • No limits to regional or global carrying capacity, trade frees human populations from constraints of local ecosystems, dematerialization of economy will overcome any apparent limitation imposed by local or global carrying capacity.	• Nature has intrinsic worth • Human communities are contained by and dependent upon ecosystems • Natural resources and manufactured capital are not infinitely substitutable, natural resources are often a pre-requisite for, or necessary compliment to manufactured capital • Carrying capacity is finite, trade appears to increase local carrying capacity while in reality most forms of trade deplete global carrying capacity
Beliefs, Values and Assumptions about the Human Economy	
• Human economy is separate and independent from Nature • No constraints on economic growth • Economic growth will improve economic and technological efficiency which will dematerialize economy, improve incomes, improve material well-being and equalize global inequalities • Deregulation of trade in global markets is advocated to increase economic growth • GDP and GNP are adequate measures of welfare	• Human economy is contained by and dependent upon Nature • Human economy must live on natural income and preserve natural capital stocks • Potential efficiency gains through economic growth will not dematerialize economy at a fast enough rate to avert significant and perhaps irreversible ecological damage caused by rapid depletion of resources and dumping of wastes • Economic activity is constrained by moral responsibility to Nature and human communities • GDP and GNP are inadequate measures of well-fare because they do not consider distribution of wealth, social well-being and ecological health • Deregulated free-trade, in its current form, will exacerbate international income disparities and further deplete natural resources

The Global Supermarket

Most people in the North, and increasingly many people in the South, buy their food from the global supermarket. In the global supermarket, transnational corporations dominate

food production, processing and distribution, and take a significant share of the monetary wealth generated by the system. The global supermarket relies on cheap and readily available fossil fuels, and a massive transportation system to keep its shelves stocked.

Farmers, and traditional farm knowledge, are marginalized, and farmers' share of wealth has decreased over time. Most of the wealth generated in the global supermarket comes from the "value-added" sectors of the system such as processing, packaging, transporting, wholesale and retail. Farmers, the producers of the raw material in this massive food production system, earn a very small share of the final price.

Diminishing returns to primary food production has ushered in a trend towards concentrated corporate ownership in the food system and large scale, industrial farming - a structure that can better capture the economies of scale needed to survive in the global supermarket. Small and mid-size producers that cannot capture sufficient economies of scale have been financially squeezed out of production.

In many countries in the South, primary or subsistence agriculture, important for local food security and culture, is often displaced by export production to the global supermarket. Local diets become less diverse, and local citizens become wage labourers for transnational corporations. Local subsistence farmers are often displaced to marginally productive lands, and food security becomes synonymous with the ability to buy food from the global supermarket.

The shelves of the global supermarket are stocked with produce and processed foods from around the world. The range of diverse and culturally unique foods is diminished. The global market values the "perfect" looking food, free of blemishes, bruises or irregularities that highly controlled growing conditions can provide.

Multinational "life-sciences" corporations such as Aventis, Dupont and Monsanto possess a large degree of control over production technologies, often under the protection of intellectual property rights. In conjunction with governments, these types of companies helped develop the Green Revolution chemical and breeding technologies that ushered in the era of the global supermarket. In recent years, these companies have focused much of their research on the next generation of agricultural technology - genetic engineering. The emphasis of these technologies is on high-yield, and the specialized production of a limited variety of plants and animals.

The enterprise of the global supermarket flourishes in an economic climate that promotes growth-oriented, deregulated free-trade, in which the vision for agriculture is a "globally integrated economy where all regions of the world engage in the production of specialized agricultural commodities" for the global marketplace (Shrybman 1999, 45).

The Foodshed

At the other end of the socio-economic axis is an alternative vision for agriculture and food systems. The idea of the "Foodshed" was developed by permaculturalist Arthur Getz (1991). The idea is analogous to that of the "watershed", coined by bioregionalists,

and provides a "rich and evocative metaphor" and "conceptual and methodological unit of analysis" to study where food comes from, and how it gets to markets (Kloppenberg et al. 1996, 1). It also "can provide a place for us to ground ourselves in the biological and social realities of living on the land, and from the land" (ibid., 1).

Kloppenberg et al. (1996) conceptualize the foodshed in the following way:

> "[food] systems in the [Foodshed] analysis are self-reliant, locally or regionally based...comprised of diversified farms using sustainable practices to supply fresher, more nutritious foodstuffs to small-scale processors and consumers to whom producers are linked by the bonds of community as well as economy. The landscape is understood as part of that community and, as such, human activity is shaped to conform to knowledge and experience of what the natural characteristics of the place do or do not permit" (p. 2).

Unlike the "everywhere/nowhere" of the global supermarket, the Foodshed is rooted in a specific place, and assumes a unity between plant, animal, and human communities (Kloppenberg et al. 1996). As such, the notion of Foodshed has the potential to ground us in the ecological, social and economic realities of the place in which we live. In the global supermarket, the social, economic and ecological costs of food production, processing and distribution are often unknown to consumers because end products travel to markets from great distances. In the Foodshed, by contrast, because of the relative proximity between food production and consumption, an understanding and sense of responsibility to ecological, social and economic well-being is promoted at all levels in the agri-food system.

Kloppenberg et al. (1996) articulate five principles upon which a Foodshed is based.

Moral Economy

> The notion of the moral economy stems from the assumption that the global economy gears the global supermarket towards maximizing profits rather than feeding people. In contrast, the Foodshed is guided by a moral economy that is geared towards feeding people, and is responsible for building and maintaining social well-being, economic viability and ecological health. The idea that food is purely an exchange commodity is replaced by the idea that through food production and consumption, human communities can cultivate connections to one another, and to the local land base.

Commensal Community

> Foodsheds are built on commensal communities. Commensalism is a term used in ecology to "designate a relationship between two kinds of organisms in which one obtains food from the other without damaging it" (Kloppenberg et al. 1996). In a foodshed two types of commensal communities thrive: 1) commensal communities among humans, and 2) commensal communities between humans and the land.

Secession and Succession

> Secession is defined at the carving out of space for alternatives to the global supermarket. Within the current global food system there exist myriad examples of secessionist movements such as food policy councils, Community Supported Agriculture, farmers' markets, and small-scale entrepreneurs that support local, sustainable farmers. Secession is a necessary precursor to the Foodshed because it shapes the beginning forms of social organization that move food production and consumption towards the commensal community in the moral economy. Succession is the gradual expansion and extension of secessionist alternatives.

Proximity (locality and regionality)

> In the global supermarket great distances (spatial, temporal, psychological and spiritual) separate people from their food (Kneen 1989). In the foodshed there would be closer proximity between the commensal communities (human and ecological) that comprise the foodshed. While fixed boundaries are not prescribed, the goal of the foodshed is to meet local needs first and to strengthen ties between local economic, social and ecological communities. This is not to say, however, that foodsheds are seen as entirely self-sustaining. Rather, they are envisioned as self-reliant (Kloppenberg et al. 1996). Self-reliance does not exclude the necessity for some trade, but rather emphasizes the need to reduce dependence on far away places to meet local food needs.

Nature as a Measure

> In the Foodshed, humans and ecosystems enter into a commensal community so that human activity on the land is informed by the characteristics and capacity of local ecosystems. Ecological issues are given full consideration in the organization of the moral economy. The economy has a moral obligation to humans and the local ecosystem.

2.4 Data Collection

2.4.1 Manure Management in British Columbia's Poultry Industry: A Microcosm for Study

A microcosm may be conceptualized as a small aspect of the agro-industrial food system that epitomizes and captures the complexities inherent in the larger system. Study of a microcosm allows for holistic thinking and the integration of knowledge to address problems. This may be contrasted to "reductionist" scientific investigation, which typically attempts to study problems in isolation.

The first stage of data collection in this study was to determine a suitable microcosm for study. I first recognized the potential of the poultry industry as a possible microcosm for study when I met a fellow student who is also a broiler producer in the Fraser Valley. My discussions with her about her operation, and some of the broad sustainability issues confronting the poultry industry intrigued me. The issue that captured my attention initially was Supply Management. I envisioned using my interpretive framework to study the ways that Supply Management affects sustainability in British Columbia's poultry industry.

After several weeks of research on the broad topic of Supply Management, however, I began to realize that this topic required refinement. At that point, the story of Aldergrove-based organic egg producer, Mr. Fred Reid, and his conflict with the British Columbia Egg Marketing Board (BMEMB) came to my attention. At that time Mr. Reid had been refusing to participate in the regulated marketing system because he maintained that organic eggs are significantly different than those produced by the mainstream industry and, therefore, should be exempt from regulated marketing.

Initially, I thought Mr. Reid's story might be a suitable microcosm through which I could study sustainability, Supply Management and the poultry industry. After several months of research, however, I found that while Mr. Reid's case was compelling, the history and politics of Supply Management, regulated marketing and the relationship to organic production was leading me into the minutia of policy, and away from broader perspectives on sustainability that truly interested me.

During the research on Supply Management, I encountered literature on the topic of nutrient management in the Fraser Valley. After review of the literature, and discussion with scholars working in the area, I came to realize that the issue of manure management in B.C.'s poultry industry would provide a suitable microcosm for study. Many, if not all, of the socio-economic and ecological forces that shape the global agro-industrial food system have helped to shape the local poultry industry, and to create significant sustainability challenges for it.

The Agroecological/Foodshed framework could be applied to other "microcosmic" aspects of the industry as well. For example, most of the argumentation in this thesis is geared towards the industry as a whole. However, the framework could be also be applied to the microcosm of, for example, an individual farm to understand transition toward sustainability at the farm level.

2.4.2 Qualitative, Exploratory, and Ethnographic Data Collection

Data for this thesis was collected from a review of the pertinent literature, and through formal one-on-one interviews and informal discussions. All of the data collected was qualitative, by which I mean described in words, as opposed to quantitative data, which is numeric (Schensul et al. 1999).

The collection of data was also *exploratory*. What I mean by this is that there was no established methodology to which I could refer to conduct this study. There is no universally accepted theory or model of transition to sustainability for intensive animal industries. Some theory has been developed, and continues to evolve, with respect to how transition from industrial crop production to more sustainable crop production may occur (e.g. Hill and MacRae1992, UNDP 1995, Gliessman 1998). In this study, that theory was adapted for the industrial poultry system. Therefore, this study is exploratory in nature because it is an attempt to conceptualize the ecological and socio-economic forces that shape agri-food systems and explore how they affect the process of transition to greater sustainability in an animal industry.

While exploratory on one hand, data collection was also founded upon the well-established methodology of ethnography. Ethnography is a social scientific and systematic alternative to investigate questions and problems that cannot be readily answered with the more traditional research techniques of the natural and social sciences such as experimentation, or collection of quantifiable data (Schensul et al. 1999).

Ethnography requires that researchers establish research questions, problem statements and theoretical interpretive frameworks in advance of the research itself, though any of these may change or be re-defined as a result of the research process (Schensul et al. 1999). Guided by theoretical frameworks, one of the main focuses of an ethnographic study is "to understand a local population in a broader socioeconomic and political context" (Schensul et al. 1999).

From the beginning in this study, the broad socioeconomic context in which I have situated British Columbia's poultry industry has been the unsustainability of globalizing agro-industrial food systems. The issue of nutrient/manure management in British Columbia's poultry industry is a local symptom of the larger problems associated with globalizing industrial food systems that demand specialization, economies of scale, constant growth and development of comparative advantage to remain competitive in international markets.

2.4.3 Literature Review and Interviews

The initial stage of data collection involved a literature review. In addition to the review of Agroecological literature that led to the formulation of my theoretical approach, I also

conducted a broad-based review of the literature on nutrient/manure management for intensive farming operations in several jurisdictions. This was done to provide a larger context for nutrient/manure management in British Columbia. Following that, I reviewed all of the public documents (newsletters, manure management bulletins, annual reports and the web site) of the Sustainable Poultry Farming Group (SPFG). The SPFG is at the leading edge of the local industry with respect to nutrient/manure management. The documents generated by the SPFG provide a record of the group's discourse on this issue, which is some of the main data of interest in this thesis.

The other way that data was collected was through an *in-depth, open-ended and exploratory series of interviews with a convenience sample of key informants*. An in-depth interview explores "a topic in detail to deepen the interviewer's knowledge" (Schensul et al. 1999, 121). An open-ended interview means that the interviewer is "open to any and all relevant responses" (ibid., 121). An exploratory interview is one in which the interviewer delves into areas believed to be important to the study, but about which the interviewer has little information (ibid., 121). Interviews such as these can prove challenging, and it was important for me to be clear about the theoretical framework, while at the same time remaining open to new information and perspectives. "A convenience sample consists of any group readily accessible to the researcher that reasonably might be assumed to possess characteristics relevant to the study"(ibid., 233).

The convenience sample for this study was drawn from the broad network of producers, governmental/non-governmental, and researchers concerned with the issue of

manure/nutrient management. Nineteen interviews in total, with informants from each of these sectors, were conducted. Appendix I: *Key Informants*, provides greater detail on the number of key informants interviewed in each sector, and more description of the characteristics of a typical informant in each of the three sectors.

The convenience sample was generated primarily through the process of "snowball sampling" (Schensul et al. 1999). The original convenience sample of approximately five informants was obtained through my personal network, and/or "cold calls" to individuals I did not know but, whom I believed would be valuable informants. The convenience sample grew to include nineteen informants through a process of "snowball sampling" (ibid.). Just as a snowball grows incrementally as it rolls down a hill, so too did my sample of informants through referrals.

The identities of all except two informants are confidential. Therefore, in the third and fourth chapters of this thesis - the findings and research agenda respectively – information obtained from an informant is referenced as either "Anonymous", or the sector from which the information was obtained is revealed.

Initial contact with potential informants was conducted in compliance with the University of British Columbia's ethical procedures for research with human subjects. A letter requesting an interview was sent to potential informants via e-mail, fax, and/or post. A sample recruitment letter is provided in Appendix II: *Sample Recruitment Letter.*

Interview dates and times were scheduled when an informant agreed to be interviewed. A list of interview questions was sent to the informant prior to meeting.

With the exception of one interview, which was conducted over the phone for the convenience of the informant, all interviews were conducted in person, one-on-one. At the time of the interview, informants signed a consent form a copy of which is provided in Appendix III: *Consent Form*. Interviews were audio-taped, and transcribed. Personalized thank-you notes were written to each informant following the interview. Follow-up interviews, to clarify confusing interview content, were conducted as required over the phone.

The interview questions were framed and guided by my interpretive framework. Interviews with all informants began with a standard set of open-ended questions on the following general topics:

- The structure and function of the Sustainable Poultry Farming Group;
- Market trends in the poultry industry;
- How the manure management practices of the Sustainable Poultry Farming Group affect the economic, social and ecological sustainability of poultry farming in British Columbia;
- Perspectives on the future of the poultry industry in British Columbia in the free-trade era;
- Vision of a sustainable poultry system;
- Opinions about what policies/actions enhance, and what policies/actions create obstacles for a sustainable poultry system.

In addition to the standard set of questions, informants were also asked an individualized set of questions tailored to elicit their expertise or particular experiences. Appendix IV: *Interview Questions by Sector* provides greater detail on the types of questions asked to

informants in each sector. The questions listed in Appendix IV are general, however, because too much question specificity may reveal the identity of the informant.

Informants were sent a list of questions prior to the interview for their review, and often new questions arose during the interview. The exploratory nature of ethnographic data collection methodology allowed me to pursue issues of interest as they arose before returning to the pre-determined set of questions. In some cases, the informant with whom I was speaking was not able to provide in-depth information on an issue that he or she presented. In this case, the issue was investigated through interviews with new informants (snowball sampling), and a new set of questions.

2.4.4 Triangulation and Representativity

To ensure the reliability and validity of the research, data collected from the literature review was cross-checked during interviews, and vise versa. Also, data collected from interviews was cross-checked by asking the same interview question, often in different ways, to different informants. This process of cross-checking, or repeat investigation of the same data several times from several sources, is known as triangulation. Triangulation is useful and necessary to bring social-scientific rigor to ethnographic research (Schensul et al.1999).

The process of triangulation helped to validate the data collected for this study. However, this study does not make claims of worldwide representativity. As discussed above, this thesis is an exploratory study. An Agroecological/Foodshed analysis of

British Columbia's poultry industry has not been undertaken before. Therefore, part of the purpose of the thesis was to begin to frame the relevant sources from which to collect data to study the industry from this perspective. In this case, I chose the SPFG's literature and interviews with key informants from the population of producers, government/non-governmental people, and researchers connected to the manure/nutrient management issue in the Lower Fraser Valley. The sources I chose do not represent all possible sources, but the literature review and nineteen interviews with a broad cross section of key informants was sufficient to begin to frame the issues, and generate a preliminary research agenda to promote transition to further sustainability.

2.5 Summary

This chapter began with a discussion of the importance of paradigms in shaping the way a scholar approaches research. Paradigms are the set of values, beliefs and assumptions – or worldview- held by the researcher that influence how s/he defines research problems, poses questions, interprets data, and draws conclusions. Paradigms are established over time through the complex interaction of cognitive, biological and social forces that shape human understanding of reality.

In current debates about what sustainability is and how it might be achieved, competing paradigms provide very different answers to these questions. A substantial body of scholarship suggests that a necessary first step in any discussion about sustainability is a clear articulation of underlying paradigms.

The interpretive framework presented in this chapter is my effort to articulate the paradigm from which I approach the study of manure management by British Columbia's poultry industry. To do this, I have juxtaposed the dominant paradigm for agriculture and food systems – industrial agriculture in the global supermarket – with an alternative vision – Agroecology in the Foodshed. I have been explicit about my perception, based on personal experience and study, that a transition towards Agroecology in the Foodshed is likely to provide better prospects for sustainable agriculture and food systems.

To the best of my knowledge, British Columbia's poultry industry has not been studied from the perspective of Agroecology in the Foodshed. Furthermore, there is a dearth of general literature on transitions to sustainable intensive animal systems and/or animal industries. Therefore, this study delves into a new terrain of research where few methodologies and models exist. For this reasons ethnography, an established social sciences methodology that inherently accommodates exploratory research, was chosen as the data collection methodology. Employing the methods of ethnography, data was collected from relevant literature and key informants concerned with manure/nutrient management issues.

CHAPTER III

FINDINGS

The problem of nutrient management associated with large quantities of animal manure is not unique to the Fraser Valley. Environmentally sound nutrient management is an issue of concern in areas of intensive animal production throughout the world. The first three sections of this chapter outline examples of legislative approaches to manure/nutrient management at the international, federal and provincial levels. This overview provides a context for the main focus of this thesis and the fourth section of this chapter, the work of the Sustainable Poultry Farming Group (SPFG). The chapter concludes with a summary and discussion of the SPFG's work vis-à-vis the interpretive framework developed in Chapter II.

3.1 The Netherlands and the Chesapeake Bay Area: International Examples of Legislation to Regulate Manure/Nutrient Management

The Netherlands and the Chesapeake Bay area are two regions, among many in the world, where pollution has been attributed to excess nutrients derived from the manure generated by intensive livestock operations. In response to contamination in local ecosystems, each jurisdiction has devised legislation to regulate manure/nutreint management.

The Netherlands

The Netherlands, a small land-base of approximately 13,000 square miles, is home to approximately 16 million people. Many millions of livestock also live on this limited

land base and crop production is intensive. Beginning in the 1960's livestock manure was identified as a main source of environmental problems in the Netherlands, particularly in the eastern and southern parts where production is most intensive (Wossink and Benson 1999). Livestock in the Netherlands produced far more manure than was required to fertilize crops leading to leaching and/or run-off of excess nutrients into ground and surface water.

In the mid-1980's the Dutch government initiated a *nutrient accounting system,* to be phased in gradually, in an effort to achieve a balance between nutrient production and utilization over time. Wossink and Benson (1999) describe the three-phased approach. In the first phase (1987 – 1990), the rate of nutrient surplus growth was reduced. In the second phase (1990 – 1994), the rate of nutrient application (from both manure and artificial fertilizers) was curtailed. In the third phase (1995 – 2000) the goal was to achieve a balance between nutrient production and utilization. Beyond 2000, the goal has been to continue the balance application.

The *nutrient accounting system* built upon the 1986 *Fertilizer Laws,* which were instituted to curtail what were then mounting environmental problems associated with intensive livestock production (Brandjes 1996). Brandjes et al. (1996) summarize the main tenets of the *Fertilizer Laws*:

> *Compulsory Registration of Manure Production: The number of animals on each livestock enterprise was registered on 31 December 1986. By multiplying the number of animals by their P excretion, a reference quotum of manure per farm was determined, expressed as kg manure P per ha.*

Ban on Expansion of Stock: No farmer is allowed to increase his manure production above the quotum on the reference date, unless manure production remains below 125 kg P_2O_5 per ha. New enterprises cannot gain rights to manure production exceeding 125 kg P_2O_5 per ha. Limitations govern the shift from one animal species to another.

Surplus charge: A manure producer is charged a fee for every kg P_2O_5 per ha over the stipulated manure P production of 125 kg P_2O_5 per ha.

The *nutrient accounting system* legislation has led to major changes in manure management in the Netherlands. The dumping of manure surpluses on agricultural lands has been banned; manure is distributed more evenly across the country and transportation systems to move manure from surplus to deficit areas have been developed; the use of mineral fertilizers has decreased; emissions of NH_3 from manure application has decreased; and surface water quality has improved (Brandjes et al.1996).

The Chesapeake Bay

The Chesapeake Bay, on the mid-Atlantic coast of the United States, is an area of intensive poultry production. Approximately 1 billion birds per year are raised in Maryland, Delaware and Virginia, states whose rivers and streams run into the Chesapeake Bay (Huslin 2003). The Environmental Protection Agency (EPA) has identified poultry manure as the largest source of nitrogen and phosphorus draining into the Chesapeake Bay, and the leading cause of water contamination that threatens both aquatic life and public health (Ribaudo 2003).

Until very recently, regulations for poultry and livestock manure management were mandated under the 1972 federal *Clean Water Act*. Under that *Act* Concentrated Animal Feeding Operations (CAFOs) were established. A CAFO is defined as "a lot or facility

where animals have been, are, or will be stabled or confined and fed or maintained for a total of at least 45 days in any 12-month period, and the animal confinement area does not sustain crops, vegetation, forage growth, or post-harvest residues in the normal growing season. It is not necessary that the same animals are fed or maintained on the lot for the 45-day period nor do the 45 days need to be consecutive" (New Mexico Department of Environment 2003).

In the United States, as far back as 1972 CAFOs were assumed to be point sources for pollution, and were subject to the National Pollution Discharge Elimination System's permit programme (Ribaudo 2003). This programme focused mainly on the treatment of liquid manure before disposal.

The programme, while perhaps suitable to help protect water in the early 1970s, proved inadequate in recent decades. Over the last twenty years CAFOs have become larger, and therefore produce significantly more manure waste. Furthermore, CAFOs have tended to become more geographically concentrated in regions where there are efficient transportation links between suppliers, processors, and markets. The growth and concentration of animal industries has exacerbated pollution problems associated with manure because local croplands have reached and/or exceeded their nutrient absorption capacity. Consequently, manure has been shipped to croplands that are a great distance from the source of production, and in many cases those croplands are also reaching nutrient saturation.

The 1972 *Clean Water* Act did not take into account the potential for pollution from excessive or unsafe nutrient application to cropland (Ribaudo 2003). Recently, EPA regulations have been updated to address this shortcoming. In 2001, the EPA proposed legislation that would require the largest livestock operators to implement nutrient management plans, in addition to obtaining National Pollution Discharge Elimination System's permits. In December 2002 the proposal was finalized, and implementation began in early 2003.

One of the major changes in the updated EPA legislation is that intensive poultry production facilities, which produce dry manure or "broiler litter" are now included in the definition of a CAFO (Hansen 2003). Previously, the CAFO point source pollution designation was given only to liquid manure handling systems (e.g. lagoons). The 2002 EPA regulations require CAFOs to:

- Apply for a National Pollution Discharge Elimination System's permit. (This permit is also required for waste water facilities and municipal sewage operations.)
- Develop and implement a nutrient management plan. The plan must include strategies for on and off-farm manure application and disposal, and can be based on either phosphorus or nitrogen indicators depending on local conditions (Ribaudo 2003). Application levels are to be established according to the assimilative capacity of crops. Annual reports must be submitted to state authorities.

Violations of the terms of the National Pollution Discharge Elimination System's permit and/of inadequate nutrient planning could result in criminal changes, and/or fines of up to $25,000 per day per violation (Hansen 2003).

In the updated EPA legislation large CAFOs are required to comply with federal nutrient management plans.[2] For medium and small CAFOs at this time, nutrient management planning is recommended, but not required (Ribaudo 2003).[3] Authority to implement and regulate the federal legislation occurs at the state level.

3.2 Canadian Manure/Nutrient Management

In Canada, two pieces of federal legislation have implications for manure management the *Fisheries Act*, which is designed to protect and conserve fish habitat, and the *Canadian Water Act*, which is concerned with water quality standards.

In addition to these pieces of federal legislation, the Agricultural Policy Framework – a national dialogue with stakeholders and interested Canadians to develop a comprehensive policy approach to agriculture – is currently evolving (Agriculture and Agri-Food Canada 2003a). The Agriculture Policy Framework consists of five elements: food safety and quality, the environment, science and innovation, renewal, and business risk management.

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[2] A large CAFO is 1) 125,000 or more "chickens other than laying hens" that use dry manure (i.e. litter) handling system; 2) 82,000 or more laying hens that use a manure handling system other than liquid (i.e. wet manure); 3) 30,000 or more laying hens that use a liquid manure handling system (United States Environmental Protection Agency 2002).

[3] A medium-sized CAFO is 1) 37,500 – 124,999 "chickens other than laying hens" that use dry manure (i.e. litter) handling system; 2) 25,000 – 81,999 laying hens that use a manure handling system other than liquid (i.e. wet manure); 3) 9,0000 – 29,999 laying hens that use a liquid manure handling system (United States Environmental Protection Agency 2002).
A small CAFO is 1) Less than 37,500 "chickens other than laying hens" that use dry manure (i.e. litter) handling system; 2) Less than 25,000 laying hens that use a manure handling system other than liquid (i.e. wet manure); 3) Less than 9,000 laying hens that use a liquid manure handling system (United States Environmental Protection Agency 2002).

The Agriculture Policy Framework statement includes recognition of environmental problems associated with manure/nutrient management. For example, the Agriculture Policy Framework states that "key [environmental] pressures arising from agriculture, such as nutrient surpluses...have been increasing [and] there is an increasing need...for government to work together with industry towards a comprehensive solution" (Agriculture and Agri-Food Canada 2003a, 1- 2). To this end the Agriculture Policy Framework recommends the following:

- More research to help understand the state of the agricultural environment. This research needs to made readily available to farmers to help them progress towards more sustainable agriculture.
- A consistent approach to sustainability across all Canadian farms so that environmental action can be comprehensive and co-ordinated.
- Farm-level environmental planning and regional environmental management plans should be developed. Part of this planning would be nutrient management plans at the farms level. The goal of nutrient management would be to balance nutrient application with crop requirements.

Unlike the Netherlands and the United States, however, a comprehensive nutrient management strategy for Canada is only in the developmental stage. The Agriculture Policy Framework is a statement of intent, not legislation. Ontario, in the wake of the Walkerton tragedy wherein several people died after drinking water contaminated by *E.-coli* attributed to cattle manure, has the most stringent manure/nutrient management regulations in Canada. Between 2003 and 2008 every farm in Ontario will be required to develop a Nutrient Management Strategy and/or Nutrient Management Plan.

A Nutrient Management Strategy will be required for farms that *generate* nutrients, such as large livestock operations. In the Nutrient Management Strategy farmers must

document a five year plan for how the manure they generate will be used, and provide agreements with users. The five options for disposal designated by the Ontario Ministry of Agriculture and Food will be:

- Use on own farm land
- Use by someone else on their farmland
- Used by another operation in a process (e.g. mushroom-growing medium)
- Transferred to a broker
- Used for non-nutrient purposes (i.e. incinerated)

The Nutrient Management Strategy will also require producers to document how manure will be stored, to provide an analysis of manure nutrient content, to develop a plans for when/if it cannot be followed, and to calculate the volume of manure produced (Ontario Ministry of Agriculture and Food 2003).

The Nutrient Management Plan is a five-year plan required by farmers that *apply* nutrients to cropland. The goal of the Nutrient Management Plan is to strike a balance between the nutrient requirements of crops and the composition of manure and/or commercial fertilizers. The goal is to minimize negative environmental impacts.

The Ontario Ministry of Agriculture and Food requirements for the Nutrient Management Plan are:

- Analysis of nutrients applied to crops (nitrogen, phosphorus, potassium and total solids)
- Calculation of quantity of nutrients applied to crops
- Storage information (if applicable)
- Contingency plan when/if Nutrient Management Plan cannot be followed (e.g. when weather prevents application and/or storage gets too full)
- Information about cropping practices and application rates
- Landowner agreements that show adequate land base for application.

3.3 British Columbia Manure/Nutrient Management

In British Columbia, management of agricultural waste is addressed under the provincial *Waste Management Act*. Farmers are exempt from the *Waste Management Act* provided they comply with the *Code of Agricultural Practices for Waste Management* (*Code)* (Agriculture and Agri-Food Canada 2003b). With respect to manure waste management, the *Code* states that manure must be applied as a soil conditioner and/or fertilizer in a manner that does not cause pollution (British Columbia Ministry of Water Land and Air Protection 2001).

The *Code* is limited, however, because it does not define what a "fertilizer" is in specific agronomic terms (British Columbia Ministry of Water Land and Air Protection 2001). It is important to make this distinction because the potential for nutrient pollution comes from fertilizers, not soil conditioners. Fertilizers can be the source of surface and/or groundwater nutrient pollution if they are over applied to crops. Soil conditioners, on the other hand, have enough carbon to "soak up" nitrogen so that it is not as readily released into the environment.

To address this limitation, the Ministry of Water Land and Air Protection (MWLAP) has developed manure management guidelines consistent with the *Code* in consultation with the Ministry of Agriculture, Food and Fisheries (MAFF), various producer, commodity and conservation groups, Fisheries and Oceans Canada (DFO), and Environment Canada. For the safe storage of manure the following guidelines are in place:

- *Manure piles stored on fields must be covered with an impermeable material from October 1st to April 1st [the season of heavy rainfall in the Fraser Valley] to prevent runoff and leaching into groundwater;*

- *Manure piles cannot be stored within 30 m (100 ft) of a watercourse or domestic well;*

- *Manure storage facilities (e.g. lagoons) must be of sound construction and cannot be located within 15 m (50ft) of a watercourse or 30 m (100 ft) from a domestic well.*

For the safe spreading of manure the following guidelines are in place:

- *Manure should normally be applied at the same times of the year as chemical fertilizer [i.e. the growing season];*

- *Spreading manure during a high rainfall period [October to April] is not recommended because of its potential for causing pollution.*

(British Columbia Ministry of Water, Land and Air Protection 2002).

MWLAP and MAFF also encourage, but do not make it mandatory for producers to develop an Environmental Farm Plan. This process starts with a formal environmental evaluation of a farm. The goal of the plan is to devise a strategy "that incorporates environmentally safe waste and nutrient management practices into the farm operation" (MWLAP 2002, 4). As discussed in the previous section, through the Agricultural Policy Framework, a federally funded effort is underway to develop a comprehensive Environmental Farm Plan programme for all regions across the country.

On June 13, 2003 British Columbia became the third province (along with Newfoundland and Alberta) to sign on to the Agricultural Policy Framework (Schmidt 2003b). Though it is not clear at this point what the agreement will mean in specific terms for

nutrient/manure management, $30.58 million of federal funds have been designated to Environmental Farm Planning (ibid.). It is possible that an Environmental Farm Planning programme will be in place in British Columbia before the end of 2004, though participation will remain voluntary (Timmenga & Associates 2003).

3.4 Lower Fraser Valley Regional Poultry Manure Management: Sustainable Poultry Farming Group

The Sustainable Poultry Farming Group (SPFG) is a producer-led response to poultry manure management issues in the Fraser Valley. A study of the SPFG manure management strategy provides a window on "state of the art thinking" about how the industry views itself, the problem of manure management at the farm and industry level, and the larger problem of nutrient management in the Fraser Valley.

3.4.1 History, Mission and Goals of the Sustainable Poultry Farming Group

In the mid 1980s a federal senate committee investigated soil degradation throughout Canada. The committee's work culminated in a document entitled *Soils at Risk: Canada's Eroding Future*, which identified manure management as the most pressing soils related issue in the Fraser Valley (Standing Committee on Agriculture, Fisheries and Forestry 1984). Part of the reason that manure was identified as the most problematic issue at that time was because of high nitrate levels in the Abbotsford Aquifer that were attributed in large part to poultry manure.

The SPFG was established in 1991 as an industry response to the contamination problem in the Abbotsford Aquifer. Founding members of the SPFG were drawn from each of the four "feather" commodities (broilers, eggs, hatching eggs and turkeys) and advisors from the MAFF. Commodity group representatives and government officials continue to be its members and directors, and poultry producers at large are members through their respective professional organizations.

The mission of the SPFG is...

"to encourage the development, evaluation, transfer, and adoption of soil and manure management practices and technologies that sustain soil and water productivity over the long term" *(SPFG 1994).*

The goals of the SPFG are:

a. *To demonstrate and evaluate economically viable soil and water management practices aimed at conserving soil and water quality.*

b. *To increase producer awareness of soil and manure management practices needed to conserve soil and water quality and maintain crop production.*

c. *To facilitate preparation and implementation of Best Agricultural Waste Management Planning for poultry producers.*

d. *To determine the location, extent, and degree of environmental degradation that may be related to current farming practices.*

e. *To conduct applied research projects to evaluate and adopt innovative soil and manure management technologies.*

f. To provide services necessary to promote the adoption of innovative soil and manure management technologies. (SPFG 1994).

The SPFG launched its work in 1991 with the help of a $400,000, 3-year grant from the *Canada-British Columbia Soil Conservation Programme.* The purpose of the grant was to conduct further research into the sources of the pollution in the Abbotsford Aquifer. The research concluded that the pollution could be attributed to two sources: 1) leaching from poultry manure that was unsafely stored on the land base above the aquifer; and 2) the over-application of poultry manure on the land base above the aquifer by the raspberry industry (SPFG 1994).

During this period, the SPFG also researched potential markets for poultry manure-based fertilizer and soil conditioner. Out of this research a marketing plan to position poultry manure as a valuable resource for crop and horticultural producers was developed. In conjunction with the marketing plan, a strategy called the *Groundwater Protection Plan* (GPP) was developed. The goal of the GPP was to remove poultry manure from the most concentrated areas of production in the Fraser Valley (Abbotsford/Matsqui), and to sell it to various markets such as the nursery and Christmas tree industries, crop producers in Delta and Richmond, and ranchers in the Interior (Ference, Weicker & Company 1994).

3.4.2 Overview of the Groundwater Protection Programme

In 1994, the SPFG formally began the Groundwater Protection Programme (GPP). The primary goal of the GPP was, and still is, to remove manure from the land base above the Abbotsford aquifer to distant markets. It is also concerned with educating producers

about the environmental issues related to manure management, and it handles manure-related public relations issues for the industry. The first shipments hauled through the GPP were in the fall of 1995.

Until 1997, the GPP received two-thirds of its funding from the *Canada-British Columbia Green Plan for Agriculture.* The industry paid the other third of programme expenses through contributions from their respective professional organizations. Funding for the *Green Plan* ended in 1997. After 1997, the SPFG was funded by at first by the *Investment Agriculture Foundation (IAF),* and more recently by the *Environmental Agricultural Initiative (EAI).* Contributions from producers through their professional associations have also funded the SPFG over time.

Producer Participation in the Groundwater Protection Programme

Currently, the GPP handles approximately 5% of the manure generated by the poultry industry (Timmenga & Associates 2003).[4] The GPP depends on the voluntary participation of poultry producers. Though producers are obliged to support the organization through professional dues, the choice to haul manure with the SPFG is independent. A producer who does not have a readily available market for his/her manure might choose to use the services of the SPFG. For example, producers in the Abbotsford/Matsqui area, where the industry is most concentrated, often need marketing services because local crop farmers are fewer in number, and often over-supplied.

[4] Ninety-five percent of the industry's manure is handled by private contractors. These contractors also deliver poultry manure to various end users. The contract hauling industry impinges on the work of the SPFG and will be discussed in greater detail below.

One of the major challenges for the GPP has been an imbalance between manure supply and market demand. More often than not, particularly in the winter months, supply exceeds demand. Unlike crop production, which fluctuates with the seasons, poultry production (especially for broilers) occurs year round. Broiler producers must clean out their barns every 6 – 8 weeks at the end of each production cycle. This year round production of manure has created storage problems for many Fraser Valley broiler producers. If producers do not have adequate storage facilities they run the risk of causing pollution particularly during the season when demand for manure is low. Manure storage programmes and the SPFG were established, in part, to help producers deal with the build up of manure stocks.

Manure storage programmes were designed to help producers safely store excess manure, particularly in the winter months when the market is weak and regulations prohibit spreading on fields. Until December 2000 the Investment Agriculture Foundation (IAF) funded the *Manure Storage Expansion Programme*, which provided funding for 20% of the capital costs of construction of a storage facility, to a maximum of $10,000 (Fraser Basin Council 2001). Over the course of that project approximately $650,000 was provided by the IAF, and another $3.4 million was invested by producers, in storage facilities (ibid.). Between 1992 and 1998, dairy farmers were the biggest users of the programme. Poultry farmers were second. Twenty-two storage structures (a total investment of $777,486) were constructed by poultry farmers in the Fraser Valley (ibid.).

The IAF project ended in December 2000. A new programme called the *Agriculture Environment Initiative (AEI)* currently provides funding to livestock producers to improve and expand manure storage facilities. Through the AEI, the *Sustainable Manure Management Programme* was established. It provides funding of up to 25% (to a maximum of $25,000) for the construction of manure storage facilities (Schmidt 2002). The poultry industry is the second largest user of this programme (ibid.).

In addition to improving manure storage practices from an environmental perspective, the manure storage programmes have also assisted the GPP in its work. Because it often takes several days for the SPFG to co-ordinate hauling, producers with adequate storage facilities are more likely to use their services.

Obstacles to Producer Participation in the Groundwater Protection Programme

As noted above, the GPP handles only about 5% of the manure produced by the poultry industry. Private hauling companies handle the vast majority of the poultry industry's manure, which is produced predominantly by the broiler sector. Contractors compete with one another to supply the market for poultry manure in the Fraser Valley. That market includes crop farmers in the Delta and some in Richmond, the mushroom industry, raspberry growers, and the bio-remediation industry. A significant amount of poultry manure is also used by the dairy industry to fertilize grasses and silage corn.

A producer interviewed for this study claims that one of the main reasons the SPFG handles such a small share of the industry's manure is that the private clean-out

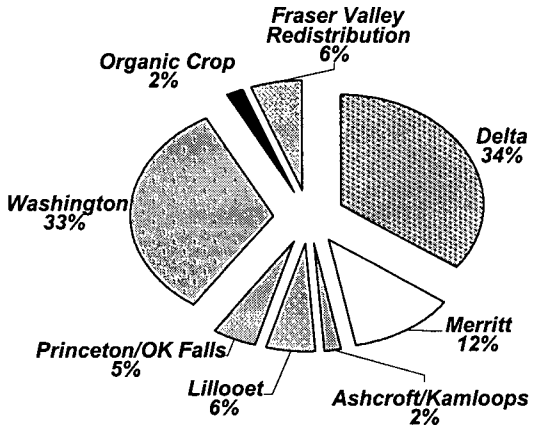
companies provide a faster and more convenient service. Quick and convenient clean out is important especially in the broiler industry where time is money. As noted above, broiler barns require clean-outs every 6 - 8 weeks (the length of a production cycle). The SPFG might take several days to co-ordinate a conveyor and truck to remove manure from the barn. This delay might mean that a producer cannot get his/her next flock into production as quickly. If a producer delays getting the next flock into the barn at the end of a production cycle, there would be significant financial losses over the course of a year.

This financial reality is probably one of the most significant reasons that there are not more producers using the SPFG. For most producers it is more economical to pay the higher price for contractor clean out, than to suffer a slowing down of production to accommodate SPFG scheduling. Contractors offer broiler producers many benefits: quick manure removal (within one day), access to markets, and elimination of the need to make an expensive investment in a manure storage structure.

Groundwater Protection Programme Markets

Since the inception of the GPP, a key part of ensuring the viability of the programme has been to develop markets for poultry manure. Figure 2 shows the most recent data available from the SPFG on market destinations.

Figure 2: Poultry Manure Share Hauled to Distant Markets - 2001/2002



Sustainable Poultry Farming Group. 2002c. p.5.

All markets, except the "Fraser Valley Redistribution" market, are considered distant markets by the SPFG because they are outside of the Abbotsford aquifer area. Distant markets comprise 94% of the total market for GPP shipments. In the 2001/02 hauling season, Delta and Washington State markets held the largest share at 34% and 33% respectively. Organic farmers use approximately half of the manure delivered to Delta (Bomke 2003). The other half goes to conventional crop producers. The Washington State market did not exist in the year 2000/01 (SPFG 2001a). According to a poultry industry official, it arose suddenly in the year 2001/02 to supply the mushroom compost market in that state, but was lost just as quickly in the 2002/03 hauling season. The BC Interior share is 27%, with 2% of that organic. New markets in Princeton, Lillooet, and Kamloops helped to expand the Interior's share from about 15% the previous year.

For many years, crop producers in Delta have constituted the largest share of the distant market for poultry manure. When the GPP started, Delta was one of the first distant markets developed. Peak shipments to Delta occurred in 1999/00 when the volume reached 67% (27,229 yd^3) of total SPFG shipments (SPFG 2000a). In the next year, 2000/01, shipments dropped to 49.4% (26,300 yd^3) (SPFG 2001a). And, as Figure 3 reveals, the decline has continued with the Delta market at 34% (13,636 yd^3) in 2001/02.

The reason for the decline in the Delta market share over time is that once the SPFG established the market, private contractors moved in to compete with the SPFG, and were able to supply manure at prices that undercut the SPFG. A poultry industry representative puts a positive spin on this market dynamic saying that the goal of the SPFG is not to compete with contractors, but to develop new markets for the industry.

Since contractors make most of their money on clean-out services, it is in their financial interest to clean-out and deliver most days of the year. Since crop nutrient requirements are not as high in the non-growing season, contractors may tend to dump (i.e. sell at very low prices) manure in the low season. This may also be true of the SPFG in the Delta region. Large deliveries from the SPFG often occur in the non-growing season, particularly in December after turkeys have been sent to market (Anonymous 2004).

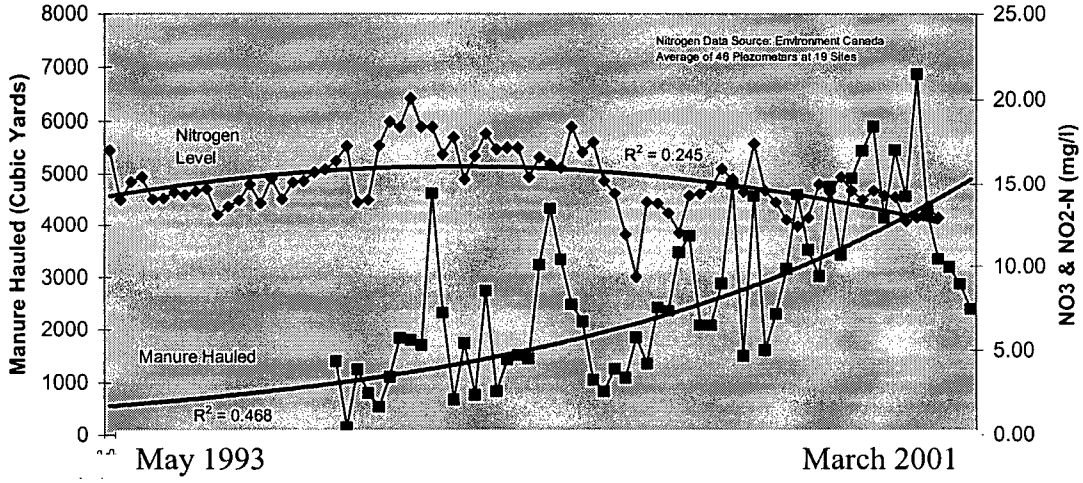
While it may be the mandate of the SPFG to develop new markets, over-supply to and competition for the Delta market has made the work of the SPFG more challenging. Confronted with a large and growing supply of poultry manure, and shrinking markets in

the Fraser Valley, the SPFG has had to work hard to develop Interior markets in recent years. Grassland and organic farms in the Interior are the main markets targeted for development by the SPFG. In the 2002/2003 season of the GPP, the SPFG conducted nutrient budget research in the Thompson-Okanagan, and determined that the largest crop grown in that region, alfalfa/grass forage, could be fertilized with large amounts of poultry manure (SPFG 2003). Efforts to develop this market are underway.

Results of the Groundwater Protection Programme

The original goal of the GPP was to reduce the high nitrate levels found in the Abbotsford aquifer. Figure 3 shows a relationship between increasing volumes of manure shipped off the land base above the aquifer, and decreases in nitrate level between May 1992 and March 2002. This is not correlated data, however. In its 2000/01 Ground Water Protection Programme annual report, the SPFG superimposed the manure removal trend line on Environment Canada well sampling data to illustrate a relationship.

Figure 3: Abbotsford Aquifer Nitrogen Level versus Volume Hauled May 1993 – March 2001



Sustainable Poultry Farming Group. 2001a. p. 8.

The reduction in nitrate levels may be attributed to other activities, as well manure removal by the SPFG. Storage and spreading practices have improved to reduce leaching and run-off over the same time period. Contractors are also responsible for moving significant volumes of manure out of the area.

Despite the efforts of the SPFG, and others, nitrate levels still remain above the 10 mg/L standard set by Health Canada. The fact that nitrate levels remain above health standards may be in part because the time required to recharge the Abbotsford Aquifer is estimated to be about 15 years, so the changes begun in the mid 1990s may not be detectable for several years (Schreier 2003).

Table 5 shows GPP trends for manure shipment to distant markets. Until year 6, the SPFG showed consistent increases in manure shipments, though the rate of increase fluctuated. Between the 2000/01 and 2001/02 hauling seasons, the volume of manure shipped to distant markets shrank by approximately 25%. One of the main reasons for this was the saturation of the relatively close Delta and Richmond markets in the fall of 2000.

Table 5: Increase in Distant Market Manure Shipments from Year 1 (1995/96) to Year 7 (2001/02)

Year of Operation	*Shipment Volume*	*Shipment Period*	*Increase (adjusted)**	
			Over Previous Year	*Rolling Average over preceeding years*
Year 1 (1995/96)	6,200 yd^3	8 months	NA	NA
Year 2 (1996/97)	18,200 yd^3	12 months	+ 96 %*	+ 96 %*
Year 3 (1997/98)	24,930 yd^3	12 months	+ 37 %	+ 67 %
Year 4 (1998/99)	23,675 yd^3	12 months	- 5 %	+ 43 %
Year 5 (1999/00)	40,640 yd^3	12 months	+ 72 %	+ 50 %
Year 6 (2000/01)	53,240 yd^3	12 months	+ 31 %	+ 46 %
Year 7 (2001/02)	40,105 yd^3	12 months	- 25 %	+ 34 %

***Increase adjusted to reflect the increased Shipment Period from Year 1 to Year 2**

Sustainable Poultry Farming Group. 2001a. p. 2

In response to saturation of these markets, the SPFG tried to rapidly expand Interior manure markets (SPFG 2001a). To entice Interior customers, the SPFG's subsidized the price of manure by charging Fraser Valley users of the SPFG programme higher fees. The result was a drop in the number of poultry producers participating in SPFG programme, and consequently a reduced volume shipped by the SPFG. That dynamic is

reflected in the 2001/02 figures (SPFG 2002c). The SPFG also responded to saturation of the Delta market by opening up the Washington State market (Figure 3). Despite attempts to ship into the Interior and opening up the Washington State, the SPFG market still shrunk by 25 %. It is also worth reiterating that during the 7 year period of SPFG activity recorded in Table 5, the number of chickens and volume of manure produced increased dramatically, putting increasing pressure on the SPFG programme.

Table 6 shows where the poultry manure hauled by the SPFG came from during the 1999/00 and 2000/01 hauling seasons. In both years the vast majority of the manure handled by the GPP came from either directly above the Abbotsford Aquifer area, or from the Central Fraser Valley, which the SPFG describes as "nearby" the Abbotsford Aquifer (SPFG 2001a). This is the area where the industry is most concentrated. The rest of the manure, a much smaller portion, came from what the SPFG calls the "Upper" and "Lower" Fraser Valley. The SPFG defines the Upper Fraser Valley as Chilliwack and areas east (SPFG 2001a). The Lower Fraser Valley is not clearly defined in SPFG documents, but it is most likely the region west of the Central Valley (i.e. Langley and Surrey).

Table 6: Source Area of Manure Shipments to Local and Distant Markets

Source Area	**Volume Removed (yd^3)**	
	2000/2001	***1999/2000***
Abbotsford Aquifer	26,830 (59%)	30,925 (50%)
Central Fraser Valley	10,810 (24%)	21,480 (34%)
Upper Fraser Valley	1,970 (4%)	1,450 (2%)
Lower Fraser Valley	5,920 (13%)	8,680 (14%)
Total	**45,530 (100%)**	**62,535 (100%)**

Adapted from: Sustainable Poultry Farming Group. 2001a. p. 2

An official with the poultry industry says that anywhere from 70 – 90 poultry producers (out of approximately 480) in the Fraser Valley use SPFG services. Of the producers who use SPFG services 43% are broiler producers, 27% are turkey producers, 16% are egg layer producers, and 14% are breeder layer producers.

3.4.3 Future Options for Poultry Manure Management

In 2003 the four feather associations of British Columbia's poultry industry, through the SPFG, commissioned the consulting firm Timmenga and Associates "to conduct a review of technologies and practices for handling and beneficial reuse of poultry manure produced in the Lower Mainland of British Columbia" (Timmenga and Associates 2003,3). From that review came a list of options to use the vast quantities of manure projected to be produced to 2010. Timmenga and Associates recommended a multi-pronged approach including the following strategies:

- Transporting raw manure out of the Lower Mainland
- Manure Processing
- Sale to the Organic Industry
- Bio-fuel Development
- Use in Mushroom Compost
- Incorporate Feed Additives

Each of these proposals will be considered in turn below.

Transport Raw Manure Out of the Lower Mainland

The main recommendation of the Timmenga and Associates Report was for the poultry industry to expand shipments of raw and/or pelleted/granulated poultry manure to the Thompson-Okanagan. Their research found that the Thompson-Okanagan is nutrient

deficient in phosphorus and potassium for the main crops grown in the region, alfalfa and alfalfa-grass forage. If marketed at a reasonable price and in a convenient form, the report concluded that alfalfa growers in the Thompson-Okanagan and perhaps the Cariboo could use "significant quantities [anywhere from 15,000 to 125,000 tonnes] of poultry manure as fertilizer" (Timmenga and Associates 2003, 3). Though it is not clearly stated in the report, this is likely the amount of poultry manure the region could use on an annual basis.

There are several factors that may affect the success of a hauling strategy to the Thompson-Okanagan. Part of the optimism about the Thompson-Okanagan is that Timmenga and Associates found it to be nutrient deficient in vast areas of grassland. An official with the poultry industry believes it will be very difficult to saturate that land base (even if private contractors begin to compete in the area) and contends that manure-related pollution issues found in the Fraser Valley, where rainfall is very high, will not be a problem in the arid grasslands of the Interior.

It may not be quite so straightforward, however. Bomke (2004) points out that some of the assumptions upon which the Timmenga report bases its projections may require further examination. For example, the report assumes no return of beef and/or dairy cattle manure, and assumes that nutrients are not accumulating over time from manure and other nutrient sources. Based on preliminary research by Wagner (2004), it appears that poultry manure-derived nutrients may be accumulating in soils. Also, people in the Interior are already concerned about the impact of cattle manure on water quality for fish, and possibly drinking water (Bomke 2003). Importing large quantities of poultry manure

into the region may exacerbate existing water pollution problems, and this may have a negative effect on demand for poultry manure.

High transportation costs to the Interior have, and may continue to affect demand for poultry manure negatively. It is uncertain if long-distance transportation can be economically viable in the long-run. In the past, the SPFG had hoped that customers would assume the transportation costs in the purchase price. This proved not to be the case, however, because poultry manure is viewed mainly as a waste problem of the poultry industry, rather than as a valuable fertilizer for crop production (SPFG 2000b). Producers in the Interior and Thompson-Okanagan may not be willing to pay higher prices for a product that they regard foremost as a waste, and secondarily as a fertilizer. The hope is that if the manure is processed into a fertilizer product, such as a pellet, that it may be more marketable (SPFG 2003, Timmenga and Associates 2003). It remains to be seen if crop and livestock producers will be willing and/or able to pay for a pelleted product.

Markets for SPFG-supplied manure to the Interior and the Thompson-Okanagan may also be hampered by winter road conditions. Severe weather has already limited the ability of transport trucks to deliver to the Interior. There are two possible repercussions for the poultry industry. First, if manure cannot be delivered during the winter months, it will pile up in the Fraser Valley. If Valley producers do not have adequate storage, the possibility of contamination will increase. Also, if the SPFG cannot guarantee supply to

markets on demand, Interior and potential Thompson-Okanagan customers may choose not to do business with them.

Manure Processing

The Timmenga and Associate report concluded that the "Lower Mainland poultry industry could support a pelletizing facility, producing a [value added] custom blended product" that would have value in markets outside of the region (p.4). The report was optimistic that processed manure could be sold into U.S. markets where it is more highly valued. Also, if processed in the Lower Mainland for the larger U.S. market there would likely be some of the processed product available for use in British Columbia and, in the processed form it would be easier to transport it to other areas of the province. Recently, however, after several years of market assessment, a proposal by an American firm for a manure pelletizing plant located in the Fraser Valley was dropped (Schmidt 2003c). The proposal failed because of the inability to secure an adequate and dependable manure supply, and large enough local markets for the pelletted product (ibid.).

It seems that despite the failure of the American proposal, the poultry industry still envisions some sort of manure processing plant in the Lower Mainland. Results of a survey conducted by the SPFG show that 45% of farms that responded to the survey would be willing to supply all of their manure to a processing plant, and 28% would supply a portion of their manure to a processing plant (Schmidt 2003c). In order for a processing plant to be viable, it must have a steady and adequate supply of manure because it must operate at full capacity at all times. As noted above, adequate markets

for the relatively "high end" fertilizer product are also necessary. Even if poultry producers did agree to provide a dependable volume to the processor, the questions of an adequate market would still need to be addressed.

Organic Industry

The report also looked to British Columbia's growing organic industry as a likely market to use composted poultry manure. Market prospects in this sector may be dampened, however, by current debate among Canadian organic certifiers about the use of manure from conventional livestock on organic crops (National Standard of Canada 2002). The possibility of disease-contaminated, medication-contaminated, and/or incompletely composted manure has created food safety concerns. Also, many people in the organic movement are philosophically opposed to industrial farming practices, and do not support its use as a fertilizer for organic crops.

Bio-fuel

In conjunction with the poultry industry, a Lower Mainland company is presently testing a prototype boiler that would "gasify" poultry manure that could then be burned to generate heat in operations such as greenhouses (Schmidt 2003b). This is viewed by the poultry industry as a potentially significant aspect of its manure management strategy, and as a potentially appealing option for greenhouse producers facing increasing fuel costs (SPFG 2003).

Mushroom Compost

Poultry manure is incorporated into the medium used to grow mushrooms. The mushroom industry in British Columbia projects significant increases in production "that would result in a redoubling of its demand for poultry manure" (Timmenga and Associates 2003, p. 4). While using poultry manure in mushroom compost might help create markets for the substance, it may not deal with the larger issue of nutrient management in the region because that mushroom compost will eventually have to be disposed of.

Animal Nutrition

The incorporation of amino acids and/or phytase into poultry feed could reduce the nitrogen and/or phosphorus content of manure by as much as 20 – 30% (Timmenga and Associates 2003). Currently, phytase is incorporated into layer feed but, not into broiler or turkey feed due to "different feed content, different economics and ... expensive feed processing" (ibid., 4). Amino acids have not been incorporated into feed yet due to insufficient "testing capacity for analysis of amino acids in feed ingredients" (ibid. 4).

A few other small scale options exist to handle or reuse poultry manure that were not addressed in the Timmenga and Associates report. They are:

Bio-remediation

Bioremediation engineering companies operate throughout the Fraser Valley. These companies use manure in the treatment of gasoline-contaminated soils. The

nutrients in poultry manure feed soil bacteria that break down fossil fuel pollutants. The SPFG has supplied manure to such companies in the past, but relatively small quantities of manure are required for bio-remediation.

Composting

One other option for poultry manure presently being research is composting it with yard trimmings at the Vancouver landfill (Rogstrand 2003). The compost would be for use on organic crops, and therefore the market would likely be quite small (Bomke 2004).

3.6 Summary and Discussion of Findings

At the beginning of this chapter, examples of international, national and provincial legislation that address the problem of manure/nutrient management were outlined. In the latter half of this chapter the industry-led response to the problem of poultry manure management in British Columbia's Lower Mainland was described in detail. For the past decade, through the SPFG, the poultry industry has implemented a strategy to redistribute manure from regions of intensive poultry production to regions with potential nutrient deficits. As explained earlier in this chapter, the assumption of a nutrient deficit and/or the value of manure as a fertilizer in the receiving environments requires further investigation.

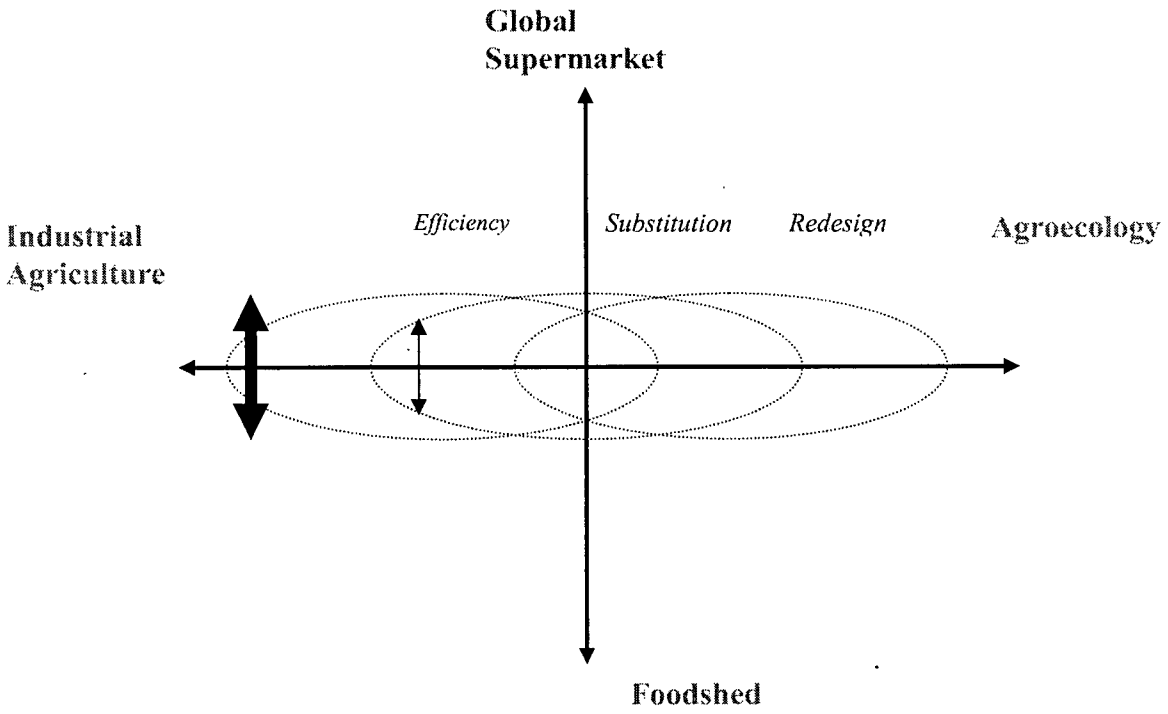
At the inception of the SPFG, market research done by Ference Weicker and Company (1994) guided its manure management strategy. That research advised that there was

market potential for the sale of poultry manure as a fertilizer in the nursery and Christmas tree industries, crop producers in Delta and Richmond, and ranchers in the Interior. As discussed above, over the decade the Delta and Richmond markets have been saturated (if not over-supplied) and the growth in the other markets has been minimal. Going further afield into the Interior has been very challenging. It has been difficult for the SPFG to ensure predictable supply, and customers have been unwilling to pay a high enough price to offset transportation costs. At the same time the volume of poultry manure produced in the Fraser Valley has continued to increase.

In its August 2003 newsletter the SPFG acknowledged for the first time in its publications that poultry manure contributes to nutrient management problems in the Lower Mainland (SPFG 2003). Around the same time the SPFG commissioned Timmenga and Associates to develop a set of recommendations for the handling and re-use of the large quantity of poultry manure projected to be produced to 2010. The recommendations of Timmenga and Associates are similar to those nine years earlier from Ference Weicker and Company. The thrust of the report is to find and develop markets for poultry manure. In the case of the Timmenga and Associates report it offers the prospect of new market potential in the Thompson-Okanagan and niche markets like organics. The Timmenga and Associates report also addresses the need to include processed poultry manure into other forms (e.g. gasification and pelletizing) so that market options can be expanded, and makes recommendations about feed additives to reduce nutrient content in manure.

From the perspective of the interpretive framework, presented in Chapter II, the SPFG manure management strategy over the past ten years and into the future can be placed in two different positions along the transition continuum, as illustrated in Figure 5. On the far left of the diagram is a large, bold arrow positioning the SPFG at the beginning of the efficiency stage of transition to more sustainable manure management. Further to the right is a smaller, fine arrow that positions the SPFG at the beginning of the substitution stage.

Figure 4: Transition Stage Positioning of the Sustainable Poultry Farming Group Manure Management Strategy



The large, bold arrow indicates that the early efficiency stage is the predominant position of the SPFG on the transition continuum. The smaller, fine arrow indicates that the substitution stage is a lesser, but nonetheless noteworthy, stage of transition.

There are two central reasons why the predominant position of the SPFG manure management strategy is at the very beginning of the efficiency stage. Through the work of the SPFG, the poultry industry has tried to reduce the environmentally damaging impact of manure waste on the Abbotsford Aquifer. In this sense the strategy fits the main criteria of the efficiency stage. However, the efficiency gains realized through the relocation of poultry manure are undermined by the increased rate of manure production through the late 1990s and projected to 2010 (see Table 2). SPFG hauling rates are also expected to increase but, as discussed in this chapter, development and servicing of distant markets is challenging. This may mean that hauling activity will not keep pace with growth in manure production in the near future. Given this reality, the efficiency of the current strategy, in terms of making a transition to more sustainable agriculture, is poor.

The second reason for the early efficiency stage positioning is that several sources indicate that pollution issues associated with poultry manure are likely being transferred to other regions in the Fraser Valley (Bomke 2003, Schreier 2003, Fraser Basin Council 2001, British Columbia Ministry of Water, Land and Air Protection 2001). Also, while not calling it pollution, the industry itself acknowledges that "the poultry manure nutrient surplus [for the Fraser Valley] is expected to grow by 37% for nitrogen, 23% for phosphorus, and 2% for potassium by the year 2010" (SPFG 2003). Based on the

experience of other jurisdictions such as the Netherlands and the Chesapeake Bay area, it is likely that a transfer of nutrient pollution is underway, or already occurring here.

It is reasonable, therefore, to assert that the SPFG's manure management strategy has not adequately addressed the environmentally damaging impact of poultry manure. This undermines the efficiency of the strategy from the perspective of the interpretive framework. While the work of the SPFG may have helped reduce nitrate levels in the Abbotsford Aquifer (Figure 3), by relocating manure from above the aquifer elsewhere, the SPFG may contribute to and/or exacerbate larger nutrient management issues in the Fraser Valley.

A report in 2001, *Nutrient Management Planning Strategies for the Fraser Valley,* by the Fraser Basin Council – a coalition of community groups, business and government whose mandate is to promote sustainability in the Fraser Basin - addressed the issue of poultry manure management with respect to broader nutrient management issues. The report concluded that "while removal of poultry manure from sensitive aquifers is a positive step, the long-term sustainability of this approach, given the ongoing expansion of the poultry industry in the Fraser Valley must be considered. While the amount of manure transported has increased, the amount of manure produced has also increased substantially. As well, the impacts to the receiving environment where poultry manure is applied following transport must also be examined" (Fraser Basin Council 2001, 22).

The minor positioning of the SPFG strategy on the transition continuum at the substitution stage indicates that poultry manure replaces the use of commercial fertilizers on crops where it is used. More research, however, is needed to determine the extent to which poultry manure is substituted for commercial fertilizers. According to Bomke (2004) it appears that in the Delta region farmers may be over applying poultry manure, which would undermine its value as a substitute for chemical fertilizers and its positioning on the transition continuum at the substitution stage.

CHAPTER IV

RECOMMENDATIONS TO PROMOTE A TRANSITION TO MORE SUSTAINABLE MANURE MANAGEMENT IN BRITISH COLUMBIA'S POULTRY INDUSTRY

Despite close to a decade of concerted effort, the poultry industry has not been able to "get ahead" of its manure management problem. Since the beginning of the 1980s, British Columbia's poultry industry has grown dramatically and has become increasingly concentrated in the Lower Fraser Valley. Growth in the industry has led to a significant increase in the volume of manure waste generated. Given the relatively small amount of local cropland, ecologically sound manure disposal and storage has proven challenging.

As discussed at the end of Chapter III, from the perspective of this study, the SPFG manure management strategy is at the very beginning of a transition to more sustainable manure management, but its efforts are undermined by increased manure production, and the likely transfer of nutrient pollution to other regions.

In Chapter II, Research Methods, I argued that prospects for more sustainable agriculture and food systems are likely to improve with a shift towards Agroecology in the Foodshed. In this chapter the Agroecological/Foodshed perspective will be used to formulate recommendations to industry and government to promote a transition to more sustainable manure management, and potentially greater sustainability in the industry as a whole.

Two of the key propositions of the Agroecology/Foodshed paradigm are that a) agri-food systems must be considered holistically; and b) agroecological systems should be designed to prevent problems in the first place, rather than trying to solve them once they have occurred. Therefore, in the recommendations, manure management is viewed as part of the poultry industry as a whole, and the poultry industry in turn is viewed as part of the agri-food system as a whole. The significance of this perspective for the recommendations is that the poultry industry's manure management problem is viewed as a problem inherent to our highly industrialized agriculture and food systems, and not simply as a waste management issue. However, this does not mean that there is no room for adaptive changes at the local level to improve the sustainability of the manure management strategy if the industry works with other stakeholders to create the necessary conditions. A constructive dialogue between government, consumers, processors and distributors could be translated into an environment of enabling policies to produce change.

4.1 Recommendations

In this section I present recommendations to promote a transition in the poultry industry towards more sustainable manure management. The first set of recommendations is a joint proposal for government and the poultry industry. As discussed at the beginning of Chapter III, it has taken significant leadership and co-operation between government and industry to tackle manure/nutrient management problems in other regions of the world. Improved nutrient management in the Fraser Valley will also require a strong and unified joint effort. The second set of recommendations is directed more specifically towards the poultry industry and the SPFG.

4.1.1 Joint Recommendations to Government and the Poultry Industry/Sustainable Poultry Farming Group

Table 7 summarizes the set of joint recommendations to government and the poultry industry to improve the sustainability of manure management.

Table 7: Summary of Joint Recommendations to Government and the Poultry Industry/Sustainable Poultry Farming Group

Recommendation #1	The provincial government and the poultry industry should limit further growth and concentration of poultry production in the Lower Fraser Valley.
Recommendation #2	The Environmental Farm Planning process should approach manure/nutrient management from a regional perspective and should be mandatory for poultry (and other livestock producers).
Recommendation #3	Fraser Valley poultry farms should be considered point sources of pollution for the region. Regulations that apply to other pollution point-source industries should apply to poultry farms as well.
Recommendation #4	Funding should support, not undermine, long-term sustainable manure management.
Recommendation #5	Federal and provincial governments should implement taxation and/or subsidization strategies to promote more sustainable manure/nutrient management.
Recommendation #6	The poultry industry, in collaboration with government, should experiment with strategies for diversification in the Fraser Valley.

Recommendation #1: The provincial government and the poultry industry should limit further growth and concentration of poultry production in the Lower Fraser Valley.

The poultry industry has grown rapidly since the beginning of the 1980s. Significant growth in the poultry industry is projected to 2010. The poultry industry's dispersion strategy to manage its growing manure waste problem is not adequate. Despite a decade

of effort to manage manure sustainably, nutrient management problems attributed to poultry manure continue to mount (SPFG 2003, Schreier et al. 2003, Timmenga and Associates 2003, Fraser Basin Council 2001, Environment Canada 2000, Schreier et al. 2000). It seems timely, therefore, for the industry and government to consider limiting further growth and concentration in the Lower Fraser Valley. The already troublesome manure/nutrient management problems will be even further exacerbated, possibly jeopardizing the very viability of the industry, if unbridled growth and concentration of the industry is not curtailed.

Of course, the prevailing ethic says that the market should dictate the size of the industry. However, the idea of limiting growth and concentration of intensive animal agriculture is not necessarily a radical, nor an unprecedented, approach to manure/nutrient management. The Netherlands ordered restrictions on growth of its livestock populations as part of its national nutrient management strategy. Denmark has also restricted stocking densities of livestock to meet nutrient management goals (Schreier 2003). In both cases, the poultry industries of these countries are successful.

There are several ways that the industry could approach the question of limits to growth and nutrient management. First, it could conduct pilot experiments with the Agroecological/Foodshed concept of spatial boundaries to determine an industry size that is more attuned to the carrying capacity of the ecosystem. The Agroecological/Foodshed perspective holds that agri-food systems should have spatial boundaries within which they strive for self-reliance, though not necessarily self-sufficiency. Spatial boundaries

are a necessary consideration for agro-ecosystem sustainability because they help determine what is internal, and what is external to the system (Gliessman 1998). Spatial boundaries provide shorter feedback loops and help foster (though do not necessarily ensure) ecological, social and economic responsibility for a specific place. Spatial boundaries have been virtually removed in industrial agriculture, and the entire globe is regarded as a source of inputs and a sink for wastes.

One finding of this study is that the manure management strategy of British Columbia's poultry industry is not guided by a recognition of spatial boundaries. Typical of industrial agriculture as a whole, the industry does not explicitly consider any spatial and/or ecologically-based restrictions on inputs to production and/or assimilation of wastes. It continues to grow and rapidly intensify by importing inputs into the production system from afar, and relying on a strategy of manure dispersion to deal with its waste.

This pattern continues to occur despite the fact that the ecosystem and market for manure both indicate that its waste cannot be absorbed. As reported in Chapter III, poultry manure is now acknowledged as the largest source of manure-based nitrogen and phosphorus in the Fraser Valley - a region that is already in a nutrient surplus position. In addition, the industry has acknowledged that the Lower Mainland can expect increases in nutrient surpluses that will be "entirely based on increased production in the poultry industry" (Timmenga and Associates 2003, 3).

The industry's main strategy has been to look for local crop and grassland upon which to dispose of excess manure. It has saturated, and perhaps over-supplied, local markets (Delta and Richmond) for several years, and recently has had to look further afield, (first to the Interior, and more recently into the Thompson-Okanagan) in the hope of finding an adequate land base to dispose of the manure. The industry continues to pursue this strategy despite ongoing difficulty of securing markets for raw and/or processed manure.

The difficult question to answer, of course, is "what would be appropriate agroecological spatial boundaries for the Fraser Valley poultry industry?" Another way to ask this question might be "what is the Foodshed for the Fraser Valley?" The answers to these questions would have significant implications for manure management. An Agroecological/Foodshed perspective would help delineate a geographic area with a limited carrying capacity and a limited ability to assimilate wastes which would in turn limit poultry production.

Presently, consideration of spatial boundaries only becomes an issue when problems, such as the nutrient surplus attributed to poultry manure in the Lower Fraser Valley, arise. What would be the implications if planning for industry production was done with a sense of spatial limits? The supply management system upholds many of the principles of the Foodshed in its support of regionally self-reliant poultry markets. Could that sense of regional reliance also incorporate a regional capacity to assimilate waste products?

Perhaps it is even necessary to call for a moratorium on growth in the industry until it provides evidence of a plan for more ecologically sound nutrient management. As the question of limits to growth is considered, a crucial sub-question will be "if not through growth, how can the industry continue to develop?" Perhaps there are some areas of the industry that are more sustainable than others, and perhaps there is room for growth and/or development in those areas? Perhaps the most unsustainable areas could be phased out, or reduced in scale. If the industry were to accept limits to growth and to explore prospects for diversification, it is possible that unexpected opportunities for growth may arise. Recommendation #7, below, discusses the issue of diversification further.

Until the recent outbreak of avian flu, the export market for poultry from British Columbia was growing, and therefore it has likely contributed to the overall growth and concentration of the industry in the Lower Fraser Valley. It is difficult to say at this point if the export market will rebound and continue to grow. It is important to note, however, that avian flu is just another example of the vulnerability associated with the intensification, specialization, simplification of natural systems and international linkages that are characteristic of this industry, and industrial agri-food systems as a whole. For the purposes of this discussion, I will assume for now that the trend towards growth in the export market will continue in the long run if, and when, the threat of avian flu subsides.

From the Agroecological/Foodshed perspective, it is important to ask to what extent the local ecosystem subsidizes the growth in the export market. As production increases for export, manure production increases, exacerbating present manure management problems

in the Fraser Valley. According to one local producer, the industry produces about 10% over quota per year for export, which means that approximately 10% of the poultry manure entering the local ecosystem is from birds produced for the export market. Based on the data in Table 2 (Chapter I) that would mean that roughly 99,000 yd^3 of manure are generated from poultry produced for the export market. That's more than double the volume handled by the SPFG in 2001/02, an amount that puts extra environmental stress on an ecosystem that is already highly stressed and increasingly vulnerable.

This issue of expansion into the export market is complex, especially in light of ongoing appeals from the United States and New Zealand to the World Trade Organization (WTO) to dismantle Canada's Supply Management system. Local producers, though they vow to fight to keep domestic markets under Supply Management, are aware that it may be dismantled in the future. This would add extra pressure on the industry to compete for domestic and international markets with producers from other countries. Perhaps, if producers did not fear a dismantling of Supply Management, they might feel less pressured to build up the local industry to a level at which it could survive in a deregulated market place.

Despite pressure to become globally competitive, it is important to consider to what extent the local land base provides an ecological subsidy to foreign poultry markets. And, we must also consider the flip side of this i.e. the extent to which British Columbia's poultry industry relies on ecological (and economic and social) subsidies from the regions that supply it with inputs such as feed and energy.

Recommendation #2: The Environmental Farm Planning process should approach manure/nutrient management from a regional perspective and should be mandatory for poultry (and other livestock producers).

The Environmental Farm Plan initiative is part of the larger Agriculture Policy Framework of Canada. One goal of an Environmental Farm Planning is to develop a farm-level strategy to incorporate environmentally safe waste and nutrient management practices. In June 2003, $30.58 million was designated to develop Environmental Farm Plans in British Columbia.

The Environmental Farm Planning initiative is focused at the farm level, though Agricultural Policy Framework statements indicate an awareness of the need to look beyond the level of the farm when it comes to environmental planning. "Government could support the development and use of regional, community, or multi-farm planning to facilitate the co-ordination and integration of environmental planning and management at the farm level" (Agriculture and Agri-Food Canada 2003a, 3). Given the experience of other jurisdictions and the mounting evidence of nutrient surpluses in the Lower Mainland, it seems appropriate to direct initiatives and funding in the near future to planning for nutrient management at the regional level. Given that Environmental Farm Planning is funded and underway, it seems to be the most obvious, and potentially the most workable, programme to pursue a regional management strategy.

Several studies (Timmenga and Associates 2003, Schreier et al. 2003 and 2000, Kowalenko 1987) have researched nutrient dynamics in the Lower Fraser Valley and throughout the province. In general, these studies contain data on issues pertaining to

nutrient surpluses/deficits, chemical and manure nutrient sources, and application rates for the province. As well, ministry officials interviewed for this study point to the importance of a regional nutrient management strategy for the Lower Fraser Valley. Together, this information points to the need for a regional nutrient management strategy. Data on nutrient surpluses/deficits in the region could be used in conjunction with farm-level Environmental Farm Planning to develop sound nutrient management strategies for various regions in British Columbia. It would, however, be necessary to develop a coordinated and integrated approach to farm-level and regional nutrient planning.

Environmental Farm Planning will not be effective at a regional level, however, if it remains a voluntary programme. Participation should be made mandatory for all agricultural producers in British Columbia in districts which are near carrying capacity. Mandatory participation is especially needed in the Fraser Valley. As will be discussed in greater detail below, many poultry producers do not believe that there is a manure management problem in their industry. Since this is the case, they may not choose to participate in Environmental Farm Planning, which would undermine the overall efforts and goals of the programme. For the Environmental Farm Planning process to address the serious environmental issue of nutrient surplus in the Fraser Valley, participation by producers in region should be made mandatory by the provincial government.

Recommendation #3: Fraser Valley poultry farms should be considered point sources of pollution for the region. Regulations that apply to other pollution point-source industries should apply to poultry farms as well.

As discussed in Chapter III, Environmental Protection Agency legislation in the United States, as far back as the 1970s, recognized that large livestock operations handling liquid manure are a point source for water pollution. In recent (2003) updates to Environmental Protection Agency legislation, poultry farms with dry manure (litter) are now also considered point sources for pollution.

Even though poultry farms in the Fraser Valley are on average much smaller than poultry farms in the United States, there is mounting evidence that the nutrient dynamics at play in areas such as the Chesapeake Bay area are also occurring here (Bomke 2003, Timmenga and Associates 2003, SPFG 2003, Schreier et al. 2003, Fraser Basin Council 2001, Schreier et al. 2000).

It may be, therefore, that we are reaching (or perhaps are past) a time in British Columbia and/or Canada when we need to look at intensive and concentrated animal operations, such as the Fraser Valley poultry industry, as point sources of pollution. Reference to EPA regulations in the United States may be useful to upgrade current regulations in British Columbia. Manure/nutrient regulations should be drafted with respect to regional carrying capacity, and responsibility for handling manure/nutrients that exceed carrying capacity should be born by the poultry industry.

Recommendation #4: Funding should support, not undermine, long-term sustainable manure management.

The SPFG has received government funding, past and present, to address soil and water conservation issues related to manure management. Several individuals interviewed as part of this study argue that funding to the SPFG has not helped water and soil conservation efforts, but rather has financed the movement of chicken manure around the province at taxpayers' expense. Funding the industry's dispersion strategy may have prevented the industry from having to take a hard look at the problem from a production, pollution, or long-term sustainability perspective, thus delaying and aggravating the problem. The funding may have allowed the industry to deal with the immediate, and very public, issue of contaminated drinking water in the Abbotsford Aquifer, but it may not have moved the industry towards any meaningful transition to more sustainable poultry production for the long-term.

Recommendation #5: Federal and provincial governments should implement taxation and/or subsidization strategies to promote more sustainable manure/nutrient management.

Governments can institute monetary incentives, in the form of subsidies, or penalties in the form of taxes that encourage resource-conserving practices. Farmers use established practices because they are the most economically viable.

It is necessary to identify the types and level of financial incentives and/or penalties required to shift the poultry industry towards more sustainable manure management

practices. It is preferable to provide producers with incentive to shift production practices now, rather than incur significant future public costs for pollution clean up.

Recommendation #6: The poultry industry, in collaboration with government, should experiment with strategies for diversification in the Fraser Valley.

At the end of the 1980s, in the wake of many serious problems associated with industrial agricultural, the United States Department of Agriculture initiated the Sustainable Agriculture Research and Education (SARE) programme. While the vast majority of US agriculture still pursues industrial production for the global economy, the federal government has also invested in a fairly radical mandate, through SARE, to search for sustainable alternatives to industrial agriculture. SARE has conducted research and has established pilot projects throughout the US on sustainable production methods, and alternative processing and marketing options.

Canada does not have a comparable investment in research on sustainable alternatives to industrial agriculture, though some initiatives may come through the Agriculture Policy Framework. Initiatives to explore and experiment with strategies for diversified production on poultry farms should be undertaken by government in collaboration with the poultry industry. SARE projects may provide practical examples of workable diversification strategies that could be applied here.

4.1.2 Recommendations to the Poultry Industry and the Sustainable Poultry Farming Group

Table 8 summarizes recommendations to promote a transition to more sustainable manure management for the poultry industry and the Sustainable Poultry Farming Group.

Table 8: Summary of Recommendations to the Poultry Industry and the Sustainable Poultry Farming Group

Recommendation #1	The SPFG should review its terms of reference with respect to water and soil conservation to include explicit consideration of nutrient management at the regional level.
Recommendation #2	Poultry manure, and the ecological problems caused by it, should be considered an industry-wide, not an individual farm, problem and responsibility.
Recommendation #3	Poultry manure should not continue to be positioned solely as a "valuable resource" for crop agriculture. It should also be considered a waste material.
Recommendation #4	The SPFG should consider the long-term transportation costs of hauling manure to the Interior to assess the viability of the hauling strategy for the future.
Recommendation #5	The SPFG should have an advisory group that consists of members from outside the industry.
Recommendation #6	The poultry industry should limit quota allocation in the Fraser Valley, as a way to curb growth and concentration of the industry in the region. The allocation of new quota should be tied to the ability of the individual farm and/or the whole industry to manage manure nutrients in an environmentally sound way.

Recommendation #1: The SPFG should review its terms of reference with respect to water and soil conservation to include explicit consideration of nutrient management at the regional level.

The mission and goals of the SPFG articulate a mandate for soil and water conservation through "innovative" manure management practices and technologies. The principle practice employed by the SPFG to conserve water and soil is the removal of manure from an area of high concentration (i.e. primarily the Central Fraser Valley) to areas of lower concentration. There has been little success to date developing innovative technologies to manage large volumes of manure, though research is underway into processes such as gasification and pelletizing of manure.

As discussed in Chapters I and III, it appears that the SPFG manure management practices may be transferring pollution problems from individual poultry farms to receiving environments. This fact gives the appearance that the mandate of the SPFG to conserve soil and water may only apply at the level of the individual poultry farm. If this is the case, the terms of reference for the SPFG should be expanded to include a more systematic, industry and regional perspective on the problem of manure and nutrient management. The SPFG's terms of reference with respect to water and soil conservation should include explicit consideration of nutrient management at the regional level, and the impact on water and soil resources. To determine what would be the appropriate "regional level" for nutrient management, the Agroecological/Foodshed concept of spatial boundaries for the poultry system (discussed above) could be a useful conceptual framework.

The SPFG also states that one of its goals is "to determine the location, extent and degree of environmental degradation that may be related to current farm practices." It appears that the SPFG has not fulfilled this goal because the SPFG has disposed of poultry manure on cropland since the mid-1990s (i.e. a current farm practice), but it was not until recently that the location, extent and degree of environmental degradation associated with that "current farm practice" was given serious consideration by the SPFG (SPFG 2003, SPFG 2002a). As stated above, nutrient management at a regional level should be an explicit consideration in the SPFG's terms of reference.

Recommendation #2: Poultry manure, and the ecological problems caused by it, should be considered an industry-wide, not an individual farm, problem and responsibility.

Many poultry producers do not regard the issue of manure waste management as an industry-wide problem, but rather as a problem for Abbotsford/Matsqui producers where the industry is most heavily concentrated (Anonymous 2003). This has been apparent in the past, for example, in conflict over dues to the SPFG (Anonymous 2003). Some producers outside the Abbotsfort/Matsqui have not wanted to pay their dues to the SPFG because they see manure as a problem only for producers in that area. Poultry producers in slightly less concentrated regions may have manure disposal arrangements with neighbouring crop producers. Since they have a way to dispose of their manure, they may tend not to look at the issue from an industry-wide perspective. The fact that many producers are not willing to assume responsibility for manure as an industry-wide problem creates tensions within the industry, and problems for the SPFG, which presents itself as an "industry-led" response to the problem.

According to some ministry officials and producers interviewed for this study, if the SPFG is to improve the efficacy of its work, a greater sense of industry-wide responsibility for the problem is necessary. As stated above, it will likely require government leadership to help position the SPFG as a truly industry-wide response to the problem.

Recommendation #3: Poultry manure should not continue to be positioned solely as a "valuable resource" for crop agriculture. It should also be considered a waste material.

The SPFG operates from the principle that manure is a valuable resource for crop-based agriculture, not a waste product of the poultry industry. This is true when there is a balance between crop requirements and nutrient supply. In the Fraser Valley, however, poultry manure-based nutrients significantly exceed crop requirements (Timmenga and Associates 2003). Many other regions around the world (e.g. Netherlands, Denmark, United States) have accepted that a vast volume of excess livestock manure is a waste product, and deal with it as such. Since the local poultry industry maintains that manure is a valuable resource, it may somehow be giving itself tacit permission to keep producing more.

If the industry were to accept that poultry manure, in the huge excess quantities in which it is produced, is a waste and pollutant it might devise different strategies to manage it. Based on the "market solutions" posed by the industry-sponsored Timmenga and Associates report, Evaluation of Options for Fraser Valley Poultry Manure Utilization, it seems that the poultry industry is determined to continue to position manure as a resource

with market value. It does not seem to want to concede that at least some portion of the manure it produces is a polluting waste, and not a valuable resource. Therefore, it will almost certainly require government leadership to deal with the nutrient management challenges confronting British Columbia's poultry industry and the Fraser Valley region as a whole. In doing so, it will be important to consider questions such as what volume of manure, "at what spatial scale, would poultry manure be a valuable resource for crop production?" and "at what volume and spatial scale does poultry manure become a pollutant?"

Recommendation #4: The SPFG should consider the long-term transportation costs of hauling manure to the Interior to assess the viability of the hauling strategy for the future.

The SPFG's current and future manure management strategy depends on transporting raw manure in the short-run, and possibly processed manure in the long-run, great distances by truck. The market dynamics discussed in Chapter III indicate that Fraser Valley markets are saturated, if not over-supplied, and that the SPFG will have to look farther afield to develop new markets.

Hauling vast quantities of manure to distant markets will become more expensive as fuel prices rise. It may, therefore, become cost prohibitive in the long-run to market manure in the Interior. The SPFG has already experienced a precipitous drop in programme participation during one season when it tried to raise prices to producers marginally to offset transportation costs. Furthermore, as mentioned in Chapter III, many Interior producers view poultry manure as a waste product of the industry rather than a valuable

input into crop production, and therefore are not willing to pay prices that are high enough to cover full transportation costs.

It is quite likely that the SPFG has considered transportation costs in its long-term hauling plan into the Interior. However, their projections may be based on their assumption that poultry manure is a valuable resource, and that crop producers will pay for it. This assumption has proven not to be entirely true, however, and the SPFG has not always been able to cover transportation costs. As fuel prices rise the SPFG will have to consider if the programme is viable in the long-run. It is also possible, however, that the price of petroleum-derived fertilizers will rise as oil prices rise. This may lead to an increased demand for manure fertilizer, and may positively affect the hauling programme. On the other hand, increased oil prices may also drive up feed production and transportation costs, possibly reducing poultry production in the Fraser Valley and the volume of manure generated by the industry.

Recommendation #5: The SPFG should have an advisory group that consists of members from outside the industry.

The leadership and advisory group for the SPFG is comprised of producers and individuals closely aligned with the industry. If all of the decision makers are stakeholders in the industry, then it is logical to assume that their interests will guide decision-making. By and large, those interests are to see the industry grow and become more profitable. Without a broader base involved in manure management decision

making, it will be virtually impossible to develop a strategy that reflects public interest in environmental quality.

A key consideration would be who to include in an expanded advisory group for the SPFG. Should other industries (e.g. crop producers) and/or government ministries become part of an advisory group? It also seems important for the SPFG to work in conjunction with other livestock, and perhaps even municipal waste management groups.

Recommendation #6: The poultry industry should limit quota allocation in the Fraser Valley, as a way to curb growth and concentration of the industry in the region. The allocation of new quota should be tied to the ability of the individual farm, and/or the whole industry, to manage manure nutrients in an environmentally sound way.

There are two aspects of quota allocation that favour large producers, most of whom are based in the Fraser Valley where the industry is already highly concentrated. The practice of allotting new quota on a pro rata basis to established producers, and the ongoing raising of maximum quota per producer (which the large Fraser Valley producers are more likely to have the means to purchase) are two aspects of the quota allocation system that ensure that big producers get bigger, and become more concentrated in the Fraser Valley.

A limit or moratorium on the allocation of new quota allocation in the Fraser Valley could help curb growth and concentration of the industry in the region, and perhaps lead to investment outside the Fraser Valley, even if production costs are higher. It would also be worthwhile to develop a manure management strategy that ties the ability of the

individual farm, and/or the whole industry, in the region to manage manure nutrients in an environmentally sound way. Quota allocation could also be tied to the participation of a poultry farm in the Environmental Farm Planning process.

4.2 Further Research

Research Agenda #1: The poultry industry and government should track where the poultry manure handled by contractors is going, and how it is being handled.

As reported in Chapter III, the SPFG handles approximately 5% of the total volume of manure generated by the poultry industry. The vast majority of the manure is handled by private contractors. Research is needed to determine where this manure is ending up as part of a comprehensive regional nutrient management strategy. It may be that the contract disposal industry will need to come under more stringent government regulation.

Research Agenda #2: Pursue the theoretical and practical aspects of transition from intensive animal systems to more diverse and integrated agriculture.

Most of the literature on conversion from industrial-style to agroecological production systems focuses on cropping systems. Little has been written about the theoretical and practical aspects of transition from intensive industrial animal systems to more diverse and integrated plant/animal systems. The interpretive framework articulated in Chapter II is an attempt to adapt crop-based transition theory for animal systems. A vision for transition from intensive to more sustainable animal systems needs to be accompanied by practical strategies and indicators of progress.

There seems to be a pressing need for this type of research as we confront a number of serious problems associated with large-scale factory farming. In addition to the nutrient management problems considered in this study, other mounting problems associated with factory farming include:

- Animal and human health concerns with outbreaks of diseases such as BSE and, more recently, avian flu;
- Animal welfare;
- Increased antibiotic resistance developed through routine low-dose application of medically important antibiotics to livestock; and,
- Enormous feed, water, and energy requirements of factory farming.

Some specific research questions that could be pursued are:

- What would an Agroecological/Foodshed vision for a sustainable poultry industry in British Columbia look like?

- What is needed to create a shared and widely supported vision of that kind?

- What would be the practical steps to make the transition from intensive animal systems to more sustainable animal production systems?

- What indicators would help measure progress towards sustainability in the poultry system? It is possible that ecological footprint analysis could be used to develop useful indicators for the poultry system. Ecological footprint analysis "accounts for the flows of energy and matter to and from any defined economy and converts these into the corresponding land/water area required from nature to support these flows" (Wackernagel and Rees 1996, 3). Ecological footprint analysis is a well-established tool upon which planning can be based. Progress, with respect to ecological indicators, can be measured. Ecological footprint analysis is also useful because it is not industry specific – it permits indicators of sustainability across industries, and throughout a region, to dovetail.

Research Agenda #3: The research methods used in this study would benefit from critical review. The ideas presented here could be refined and elaborated upon.

This research has taken the perspective that a diverse and integrated agriculture oriented towards self-reliance in local markets offers better prospects for sustainable agriculture and food systems than our current model, which is geared towards industrial scale production for global markets. The values, beliefs and assumptions of this model, although widely argued for and supported in the agroecological literature, should be challenged, confirmed, enlarged upon and elaborated to enrich the theoretical debate about how to promote transition to greater sustainability in industrial animal systems.

The hypothesis that transition towards diversified and integrated crop/animal agricultural system oriented towards self-reliance in local markets promotes sustainability requires further investigation. An emerging body of literature (Beaton and Maser 1999, Feenstra 1997, Mander and Goldsmith 1996, Kloppenberg et al 1996, Pretty 1995, Daly and Cobb 1994) points to the sustainability advantages of a re-localized food system.

4.3 Conclusions

Over the last several decades, the industrialization, specialization, and globalization of the agri-food system has dramatically altered the physical, social and economic landscape of agricultural communities across the globe. A host of ecological problems, such as loss of biological and genetic diversity, water and soil depletion and contamination, and fossil fuel dependence have emerged, threatening the health of the natural systems that we rely on to produce food. Increasingly, control over the structure of food production, processing and distribution, and the wealth generated at these various stages in the food

system, is no longer centered in communities or even nations, but in powerful transnational corporations.

Livestock production typifies the trends in agriculture as a whole. Traditionally, it was common to find integrated crop-animal farms, in which crops were grown to feed livestock. However, in the last thirty to forty years, as livestock production has become more specialized, a shrinking number of livestock farms grow feed crops. Most feed now comes from distant producers that likewise specialize in production. Another phenomenon that has co-evolved with the growth and specialization of livestock industries has been the regional concentration of various links in the production chain.

One of the most pressing ecological concerns to arise in this context of regionally concentrated, highly specialized and intensive livestock production is the nutrient pollution associated with manure. On integrated farms manure was used to fertilize feed crops, which helped ensure relatively balanced on-farm nutrient cycles. On industrial livestock farms, however, a significantly greater volume of manure is produced, and usually there is little or no on-farm cropland upon which to dispose of it.

To address this problem, over the last several decades many industrial farms have disposed of their manure on neighbouring croplands. In regions of very intensive and concentrated livestock production, this has often led to over-application of manure. As a result, nutrient contamination of ground and surface waters has frequently occurred. In regions where neighbouring croplands have been saturated with manure, it has been

necessary to transport manure further afield. In an increasing number of regions, pollution problems are now being transferred to these environments as well.

Poultry production in British Columbia's Lower Fraser Valley is following global trends in poultry production, albeit more slowly due to regulated marketing. It is a growing, highly specialized, technologically intensive and regionally concentrated industry. Predictably, as in other regions of the world, nutrient management problems associated with excess manure production have arisen here as well.

In the Introduction to this thesis I paraphrased Albert Einstein who said that it is impossible to solve a problem from the same mind set that created the problem in the first place. My research for this thesis has shown that British Columbia's poultry industry has not developed a sustainable strategy for manure management. I would argue that a central reason why the industry has not found a sustainable manure management strategy is because it continues to operate from the industrial agriculture "mind set" that created the problem in the first place. It is therefore timely to consider alternative perspectives, or mind sets, on the problem.

In the interpretive framework developed in Chapter II, I compared and contrasted alternative perspectives or "mind sets" for a sustainable agri-food system. The framework integrated the ecological and socio-economic dimensions of agriculture and food systems, and was presented as a schematic and conceptual framework for interpreting the forces that shape agri-food systems. At the extremes, the framework

compared and contrasted the dominant socio-economic paradigm for sustainable agriculture and food systems (industrial production in the global supermarket) with an alternative paradigm rooted in a different set of values, beliefs and assumptions (Agroecology in the Foodshed). The intermediate stages along the ecological axis (efficiency, substitution and redesign) describe transition towards or away from more ecologically sustainable production. Similar stages could be articulated in the future for the socio-economic axis, as well.

It has become increasingly apparent over the last several decades that industrial production for the global supermarket has created many of the problems now confronting agri-food systems. We are in urgent need of an alternative vision for agri-food systems to help frame potentially sustainable solutions for the future. The industrial paradigm, rooted in the values of neo-liberal economics, no longer serves us well. The neo-liberal model of production agriculture, with its primary focus on improving economic returns to land and labour, has relegated some of our most treasured human values to the category of "externality", or to the status of a commodity. Fundamental human interests and concerns such as a clean and healthy environment, community self-reliance, and social and economic justice are not integral to the design of industrial agri-food systems. However, in the wake of significant ecological, economic and social problems associated with industrial agri-food systems, there is an increasing awareness and concern that values beyond the profit maximization goal of industrial agriculture be made integral to the design and function of agri-food systems.

The Agroecology/Foodshed paradigm integrates values and perspectives that may well contribute to developing an alternative "mind set" from which we might potentially develop more sustainable options for agri-food systems. By bringing an Agroecological/Foodshed perspective to bear on the problem of manure management in British Columbia's poultry industry, the focus of analysis becomes much more that a study of how to manage the problem of manure. The broader perspective inherent in the Agroecology/Foodshed perspective allows us to see that the manure problem is a predictable outcome of highly specialized and concentrated industrial animal production systems. To provide long-term solutions to the problem we must begin to question, and provide an alternative vision for, the sustainability of these types of production systems.

An Agroecology/Foodshed perspective on the poultry industry will help reveal design problems that lead to vulnerability in the system, such as lack of diversity, highly concentrated production, dependence on external energy sources, water and land, the extent and types of pollution generated by the industry. It may also facilitate discussion about the relationship between specialization in agri-food systems and food security. An Agroecology/Foodshed approach may also reveal how the wealth of the poultry system can be used to support adaptations towards sustainability, and it may reveal the true costs of the industry that are unaccounted for in the services provided by the ecosystem that sustains current production practices.

We have a moral responsibility to provide adequate and nutritious food equitably to all people for the long-term while protecting natural resources. To do that we need to

develop agri-food systems that protect the environment, use renewable energy sources, and promote human health and community well-being. The perspective of Agroecology in the Foodshed may help us to do that. As discussed in Chapter II, the Agroecology/Foodshed perspective recognizes that agri-food systems are the result of a co-evolution between human social systems of knowledge, values, technology and organization with ecological systems. As Norgaard and Sikor (1987) said, the power of this insight is that if we are aware of these interactions "we can intervene to facilitate co-evolutionary changes which favour people and environmental sustainability" (p. 27).

Most, if not all, of the recommendations proposed in this chapter require political leadership and will to affect change. The lack of such leadership and will is a central challenge for sustainability. Where leadership for sustainability will come from is not clear, but it is clear that it will come from nowhere if we lack a detailed and convincing vision for alternatives for the future. It is my hope that the Argroecological/Foodshed vision formulated in this thesis may make a contribution towards articulating such a vision.

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APPENDIX I: Key Informants

Nineteen formal interviews were conducted during the course of the research for this thesis. Anonymity was guaranteed to seventeen of the interviewees. Two of them, however, Dr. Art Bomke and Dr. Hans Schreier agreed to be named. Since I cannot reveal the identities of the other individuals, I have divided them into the general sectors from which they were drawn to clarify my sources for the reader. The sectors were producers, governmental/non-governmental organizations, and researchers. Each of these categories is discussed below.

In addition to the formal interviews, I had numerous informal conversations over the course of this research project with individuals interested in the research topic. The conversations were with individuals interested in agriculture and food from a variety of perspectives - academia, community food education, food security, the agricultural industry, small-scale farmers, and with people who care about the health of their food and the ecosystem that provides it.

Taken together, the informal and formal interviews (and the review of the literature) allowed me to get the answers to the interview questions from many sources providing for triangulation of the research findings. Bolstering the interview process were regular committee meetings in which members reviewed my ideas and offered comments.

With respect to the formal interviews, in the **producer category** nine interviews with small, mid-size and large broiler and layer producers were conducted. Two of the producers interviewed are, or have been, involved in the Sustainable Poultry Farming Group.

In the **governmental/non-governmental sector** five individuals with wide ranging interests and expertise were interviewed. All of the interviewees, except one in this category, work closely with the poultry industry, including individuals from the *Ministry of Water, Land and Air Protection* and the *Ministry of Agriculture, Food and Fisheries*.

In the **researcher sector** five individuals were interviewed. As stated above, Dr. Art Bomke and Dr. Hans Schreier, both of whom conduct research pertaining to nutrient use and management in the Lower Fraser Valley, agreed to be named in this thesis. The other researchers have a wide range of expertise including supply management, agricultural economics, and agroecology.

APPENDIX III: LETTER OF CONSENT

Opportunities and Obstacles to the Transition to Sustainable Poultry Farming In BC: A Case Study of the Manure Management Practices of the Sustainable Poultry Farming Group

I consent to speak with Marcia Thomson about manure management in British Columbia's poultry industry.

I understand that my participation in this study is voluntary, and that I may refuse to participate or withdraw from the study at any time without jeopardy.

I have put a check mark beside the comments below that apply to me.

____ I have received a copy of the consent form.

____ I do not wish to have my comments attributed to me.

____ I consent to have my comments attributed to me.

____ I want the opportunity to review the report and to withdraw my comments.

____ I consent to the tape-recording of our conversation. The tape will be erased after it is transcribed. Transcripts will be coded and will not identify me.

Marcia Thomson will conduct this interview as part of her research for a graduate degree in the Faculty of Agricultural Sciences at the University of British Columbia (UBC). She may be contacted through her advisor, Dr. Alejandro Rojas, at 604-822-0494. She will be pleased to answer any questions that you may have about the research process.

The interview will take one hour.

The confidentiality of the information and opinions given during the interview will be protected in the following ways:

- only Marcia Thomson and her advisory committee will have access to the data generated through the interview;
- all taped data will be transcribed and then tapes will be destroyed;
- names and personal references will be deleted from transcripts;
- transcribed documents will coded to ensure anonymity;

Appendix IV: Interview Questions by Sector

Below are listed the general set of questions that were asked to interviewees in each category. It is not possible for me to provide an exact list of every interview question for two reasons. First, if I am too specific about the questions that were asked interviewee identity may be revealed. Second, as described in the Data Collection section, unplanned questions that delved into specific issues raised during the interview often arose. Those types of questions are too detailed for the purposes of this appendix, and may also reveal the identity of the interviewee.

Interview Questions by Sector

For producers the general interview questions were as follows:

- How long have you been farming?
- Why do you farm?
- How has your farming operation changed over time?
- How big is your farm?
- What are your production methods?
- Is your farm sustainable? What does sustainability mean to you?
- Is poultry production in the Lower Fraser Valley as a whole sustainable?
- What are some of the sustainability challenges confronting the industry?
- Is manure management a sustainability challenge? Why?
- How do you manage manure on your farm?
- What would a sustainable poultry industry look like?
- What is your opinion of the work of the Sustainable Poultry Farming Group?
- How else could poultry producers and/or the industry manage manure?
- May I tour your barn(s)?

In the governmental/non-governmental category and the researcher category the general interview questions were very similar. They were:

- What is your work/research?
- How did you get involved in this work/research?
- Is there a nutrient management problem in the Lower Fraser Valley? What are some of the most pressing nutrient management issues?
- How does your work relate to nutrient management issues in the Lower Fraser Valley?
- What are the sources of nutrient contamination?
- How does growth in the poultry industry factor into nutrient management in the Lower Fraser Valley? Is poultry manure part of the problem?
- How is poultry manure managed in the Lower Fraser Valley?
- What is your opinion of these strategies?
- What is your opinion of the work of the Sustainable Poultry Farming Group?

- What does sustainability mean to you?
- What would a sustainable poultry system look like?
- Is the poultry industry sustainable?
- What needs to be done to promote greater sustainability in the poultry industry, specifically, and the Lower Fraser Valley in general?
- How does this region compare with other regions jurisdictions in terms of the nature of the nutrient management problem, and the strategies to deal with it?