# THE SCIENTIFIC UNCERTAINTY OF THE HARM AND BENEFITS OF PESTICIDES IN ORGANIC AND NON-ORGANIC FOOD

by

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# ABSTRACT

In this thesis it is argued that the relative safety of organic food versus non-organic food is complex and subjective. Expert and lay people are interviewed using scenarios to assess their differences in understanding of situations involving scientific uncertainty, namely the evaluation of pesticide safety and the control and regulation of the pesticide's use. Ecofeminism is used to analyze the results as it is a theoretic that links the destruction of the environment with social hierarchies. A novel schematic for expanding scientific uncertainty beyond the scientific method is presented as a way for both a more nunaced understanding of scientific uncertainty and for greater civic participation in scientific decision-making.

# DEDICATION

Stanley French and Lillian Robinson.

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# LIST OF ABBREVIATIONS

- PMRA: Pest Management Regulatory Agency
- OECD: Organisation for Economic Co-operation and Development
- Pesticide: A product, organism, or substance that is used to control, destroy, attract, or repel a pest, or to lessen or prevent its harmful or troublesome effect.
- Organic Food: Food that is certified by independent third-party bodies as meeting certain minimum standards around the use of pesticides and fertilizers.
- Non-organic Food: Food that is not certified as being organic.
- CFIA: Canadian Food Inspection Agency
- EPA: Environmental Protection Agency
- CESD: Commissioner of the Environment and Sustainable Development
- IFOAM: International Federation of Organic Movements
- COABC: Certified Organic Associations of British Columbia
- MRL: Maximum Residue Limit – refers to the maximum amount of a pesticide residue that will lead to little or no risk from consumption

- NAFTA: North American Free Trade Agreement
- IPM: Integrated Pest Management
- OPR: Organic Products Regulation

# CHAPTER 1: RATIONALE

For my thesis, I will be presenting results and reflections on the differences people have in situations involving scientific uncertainty. I am interested in a deeper understanding of the relative value of organic food compared with conventional food, a situation that I believe involves scientific uncertainty, and in how ecofeminism rnight inform better communication of food safety and quality.

The hypothesis that I intend to present is that experts and lay people will have a different understanding of the scientific uncertainty of the health benefits and costs of organic and non-organic food. To help introduce these issues, I feel it is useful to discuss how I came to do graduate research on this topic. Indeed, while I don't know how much of my upbringing influenced my interest in organic food, it is still important to reflect on the circumstances that led me to write this rationale.

I grew up in the Lower Mainland of Vancouver in a couple of different cities but always in middle class neighbourhoods. When I was born my mom decided to be a stay-at-home mom while my dad worked at his business every weekday. Because of this, it was my mom who cooked all of the meals for my brother and me; she also cooked my father his breakfast and dinner. When my mom was out for the night, we would always order food so there was a clear expectation in my family that my mother was the one who did the shopping and the cooking. We ate what seemed to be regular food and had meat with almost every meal.

While my father also ate meat with us, I found out later that before he lived with my mother, he ate mostly vegetarian food and fish, but no meat. In his youth, he was somewhat of a hippy and he would sometimes tell us about the summer he spent in Europe where he would sleep in a sleeping bag in a field or under a tarp. Later in his life, he did become a vegetarian in exchange for me quitting smoking.

My mother, on the other hand, grew up in a large, upper-middle class family in Montreal. In her early twenties she married her first husband and they ran a ski lodge in Ontario. After a couple years of abuse my mother divorced this man and moved out to Vancouver.

Thus, even though these events and circumstances of my parents' lives happened before I was born, there was still the history and experiences there to influence my interest in counterculture, environmental and feminist ideals.

In high school, I wasn't really interested in environmentalism and even though over 30 years had passed since *Silent Spring*, I had not heard of Rachel Carson. I spent most of my time reading books on socialism and anarchism and being involved in punk culture. It was at punk concerts where I found animal rights pamphlets and decided to become a vegetarian, even though there was hardly any discussion of food safety at this point. From my vantage point, in the late 1990s it appeared that most of the left was still not interested in environmentalism despite the obvious links to vegetarianism and anarchism.

It was not until my first two years of university at the University of Victoria (UVIC) that I really started to think about environmentalism. It was in a sociology class taught by Dr. Koenig that I was encouraged to think about the links between social justice and the environment. One day he even brought herbs from his organic garden to class.

This was also the same time that I was starting to eliminate eggs and dairy from my diet to become a vegan. Without reading up on the nutritional aspects of a vegan diet, I became mildly anaemic. The sociology class and the physical stress that I placed on my body were both important motivators in thinking about food safety issues. Organic food was an easy thing to focus on because of my perceived sense of avoiding the risk of pesticide residues by buying foods that were labelled organic. I was also being supported financially by my parents and was thus able to afford to buy organic food when it was available without doing much research to confirm that it was worth the extra cost.

After two years at UVIC, I transferred to Concordia University for a change of cities. Since I was still unsure as to what I wanted to major in, I took a variety of courses. One of the courses I took was the Philosophy of Ethics. On the first day of class, the elderly professor, Dr. French, announced to the class that he was our professor and that he was a feminist. There were audible groans from many of the students when he went on to explain that much of the class work would focus on feminism and ethics. While I would have thought of myself as someone who supported women's rights, this was the first time in my life where I really questioned my relationships with women. Soon after starting this class, I started a minor in Women Studies because I believed that if I was truly interested in being a force for positive change, I needed to understand gender and race issues, in addition to class and environmental issues.

While none of the classes that I took in Women Studies dealt specifically with ecofeminism, we did learn about it in our Feminist Theory class. From what I recall, most of the discussions centred around the universalism of ecofeminism and less on the important links between the justification for the oppression of women and the justification for the oppression of the environment. I was also excited to read ecofeminist books by Greta Gaard and Carol Adams since I was already a vegan. Their discussions on why vegetarianism fits with feminist and environmentalist values were especially helpful in having a greater appreciation for ecofeminism and my own ideas of being vegan.

But when reading through ecofeminist books and articles, I always found that most ecofeminist theorists were not discussing issues of privilege. Choosing an environmentally-friendly lifestyle can often be more expensive and difficult to deal with than a conventional lifestyle (this is true with many examples and can include buying less-toxic dish detergent and taking the bus to work when living in a suburb that has extremely limited bus service). Indeed, most of the ecofeminist theorists are themselves well-off and white, and thus have more privilege in North America than people of colour and people with low incomes.

Organic food is a good example of a privileged food. On one hand, the government is tacitly (if not explicitly in some countries) declaring it a niche product and not a healthier product since there is no extra tax on conventionallygrown foods; on the other hand, it is clear that there are inherent risks to ingesting pesticide residues, with little known about the long-term effects. As Shrader-Frechette points out, "[e]ven with sufficient latency periods, it can be difficult to trace diseases to particular substances, because almost no toxic substances leave a unique 'fingerprint' of their presence" (1994, p. 177).

Doing a bit of research on organic food, one can easily establish that there is scientific uncertainty on the health benefits and costs of organic food. Thus, for someone who supports a person's right to make an informed decision about his or her, and his or her children's, health, it is a complicated issue involving science education and income. Should one determine that it is better to be safe than sorry and can afford to buy organic food, then that person will probably buy organic food, but this is not the type of person with whom I am concerned. I am concerned with the person who establishes that there is scientific uncertainty but does not have the financial privilege to avoid the perceived potential risk of conventional food, or is unable to establish a clear understanding of the costs and benefits for himself or herself.

The notion of scientific motherhood is a good example of how this can be problematic. It refers to the responsibility mothers have to raise healthy children but at the same time, being told to follow the advice of experts, such as doctors, and not raise their children in a way that they, as mothers, see best.

Since this is a Master's thesis, it is necessary to focus on a specific aspect of a topic. I feel that since there has not been an ecofeminist study that has examined how different people approach situations involving scientific uncertainty, it is necessary to first establish an understanding of what aspects of uncertainty are important to people and how they reconcile such problems. One way to establish how feasible educated decisions are about situations involving scientific uncertainty is to compare people who can be considered scientific experts with lay people. While such classifications are not simple, I have attempted to at least provide a sense of distinction among the interview subjects.

Lastly, I also feel that organic food provides a good framework for highlighting problems by taking universal positions in complex situations. While many proponents of organic food would probably say that all agriculture should be free of pesticides, such a viewpoint fails to take account of other viewpoints that may view the risks of pesticides as being low, within certain regulatory perimeters, when compared with other pollutants that might threaten human health. Indeed, it might be that the increased cost of organic agriculture might be marginally higher than making changes elsewhere. This is why the scenarios presented ask the interview subjects to consider whether such a scenario is acceptable to them. It is from a well-considered sense of social acceptability that we should be considering how best to be a force for positive change.

# CHAPTER 2: INTRODUCTION

## 2.1 Apples as an Introduction

*"The apple was so cunningly made that only the red cheek was poisoned. Snow White longed for the fine apple, and when she saw that the woman ate part of it she could resist no longer, and stretched out her hand and took the poisonous half. But hardly had she a bit of it in her mouth than she fell down dead"* Snow White by the Grimm Brothers, translated by Paul Heins.

In the 1960s, Rachel Carson's *Silent Spring* alerted people to the potential dangers of broad-spectrum pesticides which persist throughout the food chain. Not only was this a major catalyst for the second wave of environmentalism but it prompted significant developments to be made towards evaluating the effects of pesticides (such as Newton, Amarasiriwardena and Xing [2006]), the level of pesticide residues present in food and in the ecosystem, and reducing the amount of pesticides used in agriculture (such as Integrated Pest Management; see Mullen, Alston, Sumner, Kreith and Kuminoff [2005] for an example).

However, despite these improvements, I, like many Canadians, spend a significant amount of my food budget on foods which I believe to be free of pesticides (organic foods). I do this without any certainty that the extra cost is actually warranted in relation to the potential benefits (such as no pesticide residues).

As with Snow White, I am not going to be certain that an apple has no poison until I get sick. But unlike Snow White, it is highly unlikely that I will get sick immediately after I eat the apple and more likely that any illness will occur years from now.

This is one of the suggested consequences of Carson's book: that there would be a movement of environmentalism that would move focus away from conservation and preservation and toward the dangers from pollutants that operate at unpredictable (thus uncertain) levels in time and space.

The general problem with which I am concerned in this thesis is the ability of people at the grocery store to answer the question, "Is this apple good for me to eat?" While I don't believe that this question can be answered with certainty, we can question food safety regulation in a situation involving scientific uncertainty and examine how, for example, lay people and scientific experts perceive the expert-based regulatory industry.

Apples are used throughout the introduction to this thesis and have been chosen as a consistent example to consider the problems of the scientific uncertainty of organic and non-organic foods. They are a recognizable example for people in Canada because they are grown all over the country and because they are in the Canada Food Guide as a recommended fruit for one's daily intake of fruits and vegetables. Apples were also chosen because of their recurrence throughout Western culture. Examples include: "An apple a day keeps the doctor away"; "The apple doesn't fall far from the tree"; "American as apple pie"; "Apple of my eye"; "The Big Apple"; "One rotten apple spoils the barrel"; Adam and Eve in the book of Genesis; Snow White and the Seven Dwarves; and William Tell.

In terms of pesticides and apples, the following quote from a Health Canada report highlights some background information:

> Apple orchards receive as many as 11 applications per season of a selection of over 30 different pesticides. Chemical applications coincide with the peak reproductive period of wild birds. As well, historic spraying with DDT insecticide has resulted in the contamination of the entire food chain with this persistent organochlorine contaminant...Orchards are more intensively sprayed with pesticides than any other crop (Bishop, Elliot and Williams, 2003).

For this thesis, I interviewed 12 people using scenarios on the evaluation process of pesticides and the regulation of the utilization of pesticides. As I outlined in my Informed Consent form (**Appendix A**), the interviews were designed to deterrnine, "How people judge the level of their concern about pesticide residues in food, in terms of the scientific evidence for the relative toxicity of the pesticide, and also for the ways in which the scientific evidence is used in controlling exposure to pesticides." I have tried to determine if there is a sense from the interview subjects that the relative safety of organic food versus non-organic food is complex and subjective. Comparisons were made between lay people, little to no science experience and experts, people with a high level of science experience (the categorization of expert and lay will be discussed in greater detail in the sections 3.3 and 4.1).

I have chosen to use an ecofeminism lens to analyze my interviews because I am concerned with the scientific uncertainty of pesticides and both human and environmental health. The ecofeminist lens that I am using is one that is based on recognizing the interconnections between social hierarchies and the destruction of the environment, and looks for solutions that empower people to be part of the decision-making processes that affect their lives. The social hierarchy that I am most concerned with is the authority between consumers (lay people as well as scientific experts) and those responsible for production including food safety scientists, farmers and policy-makers.

Because of the explicit expectation that the consumer is to and can rely on those responsible for production a social hierarchy is necessarily implied. Representative democracy is supposed to protect all citizens but as I will demonstrate further on in this chapter pesticide evaluation and control in Canada does not always operate on the basis of putting the health of citizens and the environment first. As a potential solution I will argue for a stronger sense of civic participation where consumers come to expect control over how pesticides are evaluated and controlled.

The introduction of this thesis will first establish the potential difficulties associated with purchasing an apple due to both the scientific and general uncertainties. This will also help to elucidate the differences between scientific and general uncertainty. Following this, I will describe ecofeminism and the specific ecofeminist lens used to analyze the interviews. I will also discuss the current literature on different understandings of scientific uncertainty between experts and lay people. The last section will explain the significance of scenarios for this thesis.

## 2.2 Uncertainty, Scientific Uncertainty and Apples

When a consumer goes to the grocery store, he or she is faced with a bewildering list of attributes from which to choose, even when selecting an apple. This can include where to shop, variety, price, farming method and location of farm. The table below demonstrates this problem.

**Table 1 Apple Prices and Varieties in Vancouver**

| Variety | Conventional Price | Organic Price |
|---|---|---|
| Ambrosia (Canada) | | $2.39 (EA) |
| Braeburn (New Zealand) | $1.69 (SW) | $1.49 (IGA) |
| Fuji (Japan) | | $1.49 (CA) |
| Gala (New Zealand) | $1.29 (IGA) | $2.16 (SW, CA, EA) |
| Golden Delicious (U.S.A.) | $1.29 (IGA) | $1.79 (CA) |
| Granny Smith (Australia) | $1.69 (SW) | $1.99 (IGA, CA, EA) |
| McIntosh (Canada) | $1.79 (SW,IGA) | $1.99 (IGA) |
| Pink Lady (Australia) | | $1.99 (EA) |
| Red Delicious (U.S.A.) | $1.29 (SW, IGA) | $1.99 (SW, IGA) |
| Spartan (Canada) | $1.54 (SW, IGA) | $2.14 (IGA, CA) |

All apples are from British Columbia or Washington state and prices (listed as averages) were recorded in mid-February 2008 from the following grocery stores located in Vancouver: Safeway (SW), IGA, Capers (CA) and Eternal Abundance (EA). According to a produce worker at Capers, most apples come from BC and WA, as the growers in these regions store apples throughout the year and release them at different points in the year. Capers will also carry apples from New Zealand, and other countries, in the off-season.

The Canadian Food Inspection Agency report on pesticide residues demonstrates how complicated decision making based on country of origin can be (Canadian Food Inspection Agency, 1998). One of the problems that this study highlights is the variability of pesticide residues within different countries using different combinations of pesticides, and detecting these differences in residues.

In terms of answering the question, "Is this apple good for me to eat?" the attributes above will all play a role, but in general, the "healthiness" of an apple is usually deduced by looking, feeling and smelling, since it would generally be assumed that apples are going to provide a certain level of nutrition in terms of vitamins, minerals, antioxidants, water, sugar and fiber. Unhealthy indications in apples include the presence of larvae, bruising or rotting, and scabs, although these may not all be obvious upon inspection.

But there are also imperceptible conditions of an apple, such as pesticide residues, which are generally odourless and tasteless. The inability to viscerally perceive residues contributes to the feeling of safety when eating an apple with pesticide residues. However, it is important not to overlook the benefits of pesticides (such benefits are presented at greater length in section 2.5) and one can do this by considering the pre-pesticide era of agriculture which saw large crop losses resulting from fungal damage, bacterial damage and insect damage (such as apple maggot [Canadian Food Inspection Agency, 2007]). Pesticides also prevent the spread of apple diseases such as rust and scabs.

Consumers can use their senses to determine the healthiness of an apple but there are few mechanisms in the human body to indicate potential problems from unhealthy apples. If there are serious apple diseases (such as rotting) and a person bites into the apple, the taste buds might recognize the foul taste. However, to repeat an important distinction, there is no mechanism in the human body to recognize and react to the potential health risk from low levels of pesticide residue.

While people are generally expected to rely on expert-based policy and regulations, it is not clear how certain experts, such as food scientists and toxicologists, are on the health benefits and risks of organic and non-organic food. For an example of a disagreement among scientists on such an issue, see Lu (2006) and Curl (2003) and the responses to these articles in Krieger (2006) and Avery (2006). This example involves the debate over the benefit of reducing pesticide residue exposure in children from, what some perceive as, an already miniscule level of exposure.

With such limited resources available to determine the healthiness of an apple and the myriad of factors, including price and varietals, that may affect uncertainty over which apple to purchase, we should be looking to find tools, such as the scenarios presented in this thesis, to help people make more informed decisions in situations involving scientific uncertainty. Developing such tools first requires an understanding of scientific uncertainty.

A simple differentiation can be made between general uncertainty and scientific uncertainty. General uncertainty can include whether or not there will be a crop (the apple maggot problem is a good example of a situation that can not be predicted) and whether or not the apples will look appealing (situations could arise where the people handling the fruit end up dropping a large portion of the crop resulting in bruising). Scientific uncertainty, on the other hand, arises when there is incomplete information, which could, theoretically, be rectified by doing more research and tests and gathering that information. An example of scientific uncertainty would be the health effects of eating an all-apple diet for 30 days. Such a study has not been performed but could, theoretically, be performed.

In general, scientific uncertainty is thought of as a deficiency in the scientific method. As Shrader-Frechette (1994) points out, this often means that scientists will attempt to do more work to deal with the deficiency, such as using more sensitive tests (p. 101) or increasing the sample size (p. 102). The U.K. National Health Service's system of evidence-based medicine is a good example of variability in what counts as good science, and hence, more certain science.

The Oxford Centre for Evidence-based Medicine system of evidence-based medicine ranks research into 4 levels based on reliability. At the top, there is Level A, which is considered a definition of "good science." Level A includes randomised controlled tests with narrow confidence levels and systematic reviews of randomised controlled tests. Level D, however, is "Expert opinion without explicit critical appraisal, or based on physiology, bench research or 'first principles'" (Phillips, Ball, Sackett, Badenoch, Straus, Haynes and Dawes, 2001).

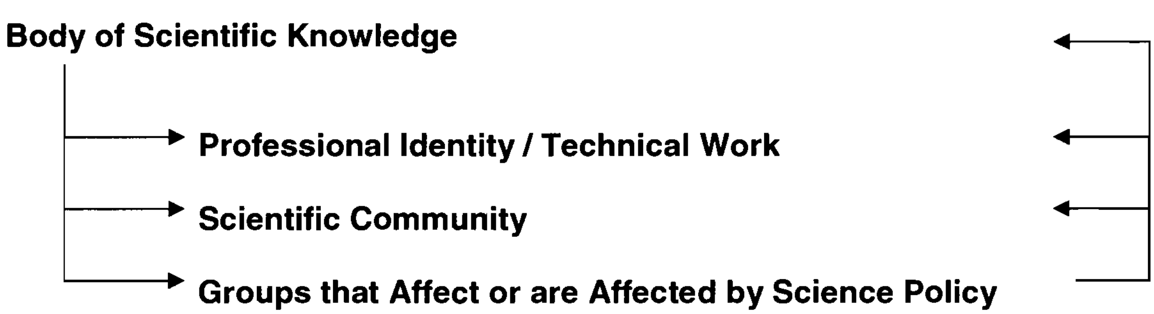
This system is only one example but it generally follows accepted practice in the medical community.

Glancy and Bradford's (2007) article on the admissibility of expert evidence in court in Canada demonstrates how courts have moved away from Level D evidence. In the Mohan case in 1992, necessity and proper qualifications were the main criteria for allowing expert testimony then the J. J.-L. case in 1999 adopted from the Daubert, 1993 standards (from the U.S.A.). The Daubert case included more rigorous standards including peer-reviewed techniques and theories, rate of error, and general acceptability among the scientific community.

What this shift points to is the recognition that, "Simply doing more research... does not always reduce the uncertainty inherent in study results because much uncertainty derives from unavoidable methodological value judgements... inherent in all research" (Shrader-Frechette, 1994, p. 102). As will be discussed in detail in the following section, this is an important part of the science critique from ecofeminists such as Shiva (1988, p.15).

Even Level A type research is dictated by the fact that science is not divorced from social constraints. But the decision to classify Level A type research as the most ideal type of science is based on the desire to differentiate the natural sciences from other forms of knowledge production. In particular, the differentiation is based on explicitly attempting to limit social (such as personal biases) and methodological (such as no control) influence as much as possible. For example, I can claim that the apples from New Zealand are covered with pesticides because New Zealand allows pesticides, but findings from pesticide-residue testing will probably be more valid. However, the residue testing results cannot be taken as scientifically certain just because they are based on current best practices used in New Zealand. More precise methods for residue testing may be available in other countries, such as Australia.

A more expanded schematic for understanding scientific uncertainty will incorporate both issues with the scientific methods and issues affected by social actors. While no schematic exists that elaborates upon possible levels of differentiation, a 4-level schematic appears useful. The 4 levels include: body of scientific knowledge, professional identity / technical work, scientific community and groups that affect or are affected by science policy. The figure below represents both the necessity of a body of scientific knowledge in articulating scientific uncertainty and also the interconnectedness between the levels of scientific uncertainty.




There are numerous examples of scientific uncertainty that fit into these different levels. Shrader-Frechette (1996) describes 4 types for environmental decision-making which have to do with different levels of uncertainty. She lists them as: framing, modelling, statistical and decision-theoretic uncertainty (p. 12). Framing and statistical are examples of scientific uncertainty of the body of scientific knowledge since they all involve decisions made at the experiment stage.

### 2.2.1 Body of Scientific Knowledge

Framing involves determining acceptability of a solution based on a set number of options. It is the scientist's decision to posit 2 or 3 options (as an example) (Shrader-Frechette, [1996], p.13). This type is not relevant to this thesis because I have only offered one scenario to each problem. Statistical uncertainty arises from the fact that one cannot test all apples for unacceptable levels of pesticide residues, because when an apple is tested, it is destroyed in the testing process and is thus not put back into the food supply. The apples tested are applied as representative of the total apple supply.

This level of scientific uncertainty also includes method issues as discussed earlier with evidence-based medicine. If one study of apples from a farm only uses 2 apples, but another uses 1000 apples, the one with 1000 apples would have a higher degree of certainty.

Lastly, the complexity of the ecological prediction being made is included in this type of scientific uncertainty. This is related to methodological uncertainty but refers more generally to the intricacies and fluidity of the ecosystem and human body, whereby it is difficult to allow for controls in scientific experiments in open systems, such as a 20-hectare apple orchard, or with endocrine disruptors (Thornton, 2003).

### 2.2.2 Professional Identity / Technical Work

The second level of scientific uncertainty is professional identity / technical work. This refers to the experimentations that scientists and technicians undertake, and to the professional identity of scientists and technicians. Testing apples for pesticide residues is related to this level of scientific uncertainty because the experiments to determine the ability of the test instrument to accurately measure pesticide residues have already occurred. The specific examples of uncertainty that arise from this level are related to the limits of the person carrying out the tests. These examples often revolve around pragmatic concerns.

Shrader-Frechette's (1996) discussion of modelling is a good example of pragmatic uncertainty. As she points out with systems engineers who say that the computer model has been validated, "such 'validation' language obscures the fact that the alleged validation really only guarantees that certain test results are consistent with a model or hypothesis" (p. 17). The computer cannot change the model itself should changes occur with the ecosystem being studied.

Pragmatic uncertainty also involves problems with time. For example, there has not been a 5-year study comparing the benefits of eating only organic apples versus eating only non-organic apples. Regardless of the scientists' or technicians' intentions, they will always have tools available to them which may only give part of the picture.

Professional identity is important since the person performing the pesticide testing or using the modelling system must use the tools given to him or her to keep his or her job. Should the person be in a position to attempt to change the tools, he or she will face difficulty from the scientific community and might instead opt to not criticize. Thomas Kuhn's (1970) research has illuminated this problem as he discusses how paradigms (agreed-upon sets of knowledge within a specific group such as an academic discipline) have been adopted in scientific disciplines demonstrating the lack of desire for methods and theories that deviate from the norm. He refers to the occasion when this desire is present as a "crisis."

### 2.2.3 Scientific Community

The scientific community provides the basis for the third level of scientific uncertainty and at this level we see how scientific methods are devised and challenged. As Guzelian, Victoroff, Halmes, James and Guzelian (2005) make clear, toxicologists are often using authority-based science instead of evidence-based science. In particular, this article highlights epistemological and inferential uncertainty by discussing causality. The authors point out that "toxicologists… show distressing variations in their biases with regard to data selection, data interpretation and data evaluation when performing reviews for causation analyses" (p. 161).

Epistemological uncertainty arises when scientists proceed with research based on notions of the field of knowledge that may not have been properly defined, or are still debatable, such as described in Haslam and McGarty (2001).

Applying this to the healthiness of apples, the assumption that apples are healthy for all human beings (as there might be a race or ethnicity that is allergic to something in all apples but this might not have been discovered) is an example of this type of scientific uncertainty.

Inferential uncertainty exists because most pesticide testing is carried out on animals and it is only through assumptions made of the similarities between humans and specific animals that these tests are considered reliable. When comparing humans, there are also genetic and lifestyle factors that make people different; for example, one person might be more susceptible to apple diseases than another.

Sarewitz (2004) offers another example of this type of scientific uncertainty whereby different scientific disciplines may disagree with one another over methods of measurement. While this is important to consider, there is no inter-disciplinary disagreement presented in the scenarios in this thesis, so this example will not be discussed.

### 2.2.4 Groups that Affect or are Affected by Science Policy

The last level of scientific uncertainty refers to groups that affect or are affected by science policy. The latter is ambiguous and could mean as diverse a group as all Canadians who eat apples, or only organic apple growers in Manitoba (a small group). Uncertainty due to a lack of institutional interest occurs because public and private funding drives scientific research. The people who administer funding, or who develop policy for those funding bodies, are thus able to dictate what type of research is carried out. This means that important areas of study might be overlooked, such as the interaction of different pesticides that growers seldom, but still occasionally, use on apples. Such a decision might affect all Canadians who eat apples.

Audience-based uncertainty refers to the confusion caused by scientific research being explained in particular ways that are not understandable for certain people (see for example, Green, Duncan, Barnes and Oberklaid [2003]). This confusion results from a lack of consideration for whom the research is being performed. An example of this would be a report issued by the Canadian Food Inspection Agency on pesticide residues in apples which only publishes the amount of residues found, without any explanation as to whether or not that amount is acceptable for all members of a family or just the adults.

Decision-theoretic refers to the framework that guides the decision based on a situation involving scientific uncertainty and as Shrader-Frechetter discusses, it is a difference between using maximum and using expected utility (1996, p. 23). Apples are a good example because there are some risks to eating apples containing pesticides but there are still the apple producers to consider. To ensure that they can sell their product, Canadians are encouraged to eat apples (conventional and organic) despite the potential risks.

Ecofeminist theorists have tended to focus on critiquing the first and last sections of the scientific uncertainty schematic. However, instead of working within the problems of uncertainty, these theorists have limited their critiques to generalizing all scientific methods as inherently oppressive to both the environment and to most people, or to providing case studies of how specific groups of people have been oppressed and/or are fighting back against oppression. But a refusal to engage with, and improve upon, the uncertainties of science does nothing to help women in the Arctic who have dangerously high levels of pesticides, even those that may have already been banned, in their breast milk, despite never using the pesticides (see for example Ayotte [1996], Craan [1998] and Pohl [2000]). These women would be better served by encouraging more research into better residue detection methods and better ways of preventing pesticide leaching.

Despite the tendency not to engage with scientific uncertainty, ecofeminist theory that critiques the dominator consciousness, which justifies the domination of nature and women, has much to offer for analysing the scientific uncertainty of pesticides in food. In particular, ecofeminist theory is useful for examining power imbalances between consumers and those responsible for production for solutions to dealing with these power imbalances.

## 2.3 Ecofeminism and Environmentalism

### 2.3.1 Ecofeminism

Ecofeminism is the theory that social hierarchies (such as those based on sex, race and class) are created and maintained by the same mindset that maintains the domination and destruction of the environment (a dominator consciousness). To better demonstrate the concept of a dominator consciousness, I will provide an overview of the progression of ecofeminist thought and I will also describe some of the main sub-disciplines of ecofeminism. Once I have established this, I will begin to articulate an ecofeminist theory that can engage with the communication of food safety and the issue of the differences between experts and lay people when it comes to scientific uncertainty.

The term ecofeminism was first coined by a French feminist, Françoise d'Eaubonne in the mid 1970s (d'Eaubonne, 1974). In her book, the title of which translates to *Feminism or Death*, she argues that problems such as pollution and the destruction of the environment are decidedly male problems because they are created by a male world that benefits men (p.236). Her solution is to give women the power to make changes because they have the most interest or investment in rectifying these problems (p.251). These ideas would form the foundation for most early ecofeminists as they attempted to celebrate women's closeness to nature as a unique position by virtue of one's sex (see, for example, the anthologies of Plant [1989] and Diamond and Orenstein [1990]). Many writers also sought to articulate a liberatory theory through spirituality, one which relied on Neolithic and Aboriginal history and practices. But as many critiques have shown:

> This turn to the 'old' to reconstruct the 'new' is often characterized by the tendency toward abstraction and romanticization: the desire for an idealized 'golden age' expressed by women who drew inspiration from cultures of the past believed to be free of gendered hierarchy and ecological injustice. (Heller, 1999, p. 44) (See also Merchant [1995] and Biehl [1991]).

A considerable amount of focus has been placed on addressing these radical feminist theories of ecofeminism with a common theme of rejecting the term of ecofeminism altogether or simply renaming ecofeminism to such terms as ecogender studies or environmental feminism (as examples). But the fact remains that women are faced with a disproportionate amount of the problems associated with environmental degradation (for numerous examples of this with respect to pesticides, see the anthology on pesticides and women's health found in Jacobs & Dinham [2003]). So while it is important to take stock of the early problems with ecofeminism, focus should also be placed on finding solutions to the destruction of the environment.

In terms of the relationship between ecofeminism and science, further discussion of popular ecofeminist topics is needed. Scholars such as Val Plumwood (1993) argue that positioning women as closer to nature than men is simply reifying dualistic notions which for centuries have been taken for granted. Dualism, as Plumwood points out, is different from a dichotomy because dualistic thinking requires privileging one over the other. So man's reason or culture is not just different from woman's nature but is also more desirable. This is how philosophers such as Bacon and Descartes can claim that only men can do science or reason properly and only men should have power (such as in the form of patriarchy). But an ecofeminism which rejects science, such as Gruen (1993), and instead relies on ethics to guide decision-making is also guilty of reinforcing dualistic thinking.

Joni Seager (2003, p. 963) uses Audre Lorde's famous warning about using the master's tools to dismantle the master's house to defend her scepticism of science. She states that feminists who engage with mainstream science risk "entering into the 'scientific proof' game on terms that they do not set, and on terms that are stacked against them" (p. 963). But Seager does not encourage more women to take science classes to better understand how scientific theories operate or how they might be critiqued, potentially overcoming the terms that women do not set.

Seager does, however, offer a good critique of scientific uncertainty in environmental problems and encourages a greater focus on the precautionary principle as a guiding tool for policy.

Edwards and Quinn (2005) critique scientific authority, even in situations that appear to be in the public interest. As they point out, without a global gender outlook, "policies such as bans on hazardous pesticides in the United States may result in these products being sold in developing countries and used by untrained and unprotected female agricultural workers" (p. 316).

Marti Kheel (2008) does not reject scientific knowledge but does offer a unique way to look at scientific authority as linked to the destruction of the environment. She says,

> Science and technology often function to give humans an inflated sense of their power… 'Saving' endangered species in 'breeding programs' or zoos merely perpetuates the same managerial ethos that brought 'species' to the brink of extinction in the first place. Humans save 'endangered

species' because of their remorse for human actions and their desire to have ongoing access to the threatened species, or at least the knowledge of their existence (p. 230).

Science may not be important to ecofeminism because of the majority of scholars having their theoretical foundations in feminism (Sturgeon, 1997, p. 178). Even with the attempts of scholars involved in Feminist Science & Technology Studies to increase the focus on science in feminism feminists are still apprehensive of science playing a greater role in feminist theory (Baker, Shulman and Tobin [2001] is a good example of feminist scientists attempting, but not really succeeding, at increasing science literacy among Women Studies scholars).

Reading through the critiques of scientific authority that are present in ecofeminist theory, one thing that becomes apparent is that there is little effort made to distinguish problems with the scientific method and with how decision-making occurs based on the results of the scientific studies. Thus, with the Edwards and Quinn example, it is clear that scientists have determined that these pesticides are harmful but the scientists are not the ones who determine how to dispose of the pesticides or whether to restrict exports (the disconnect between scientists and policy-makers is discussed in greater length in the following section). In this case any health or environmental problems that arise as a result of the disposal of the pesticide cannot be attributed to any masculinist bias in science but instead to a problem with decision-making that is not based on the scientific data available. Indeed it is also clear that few ecofeminists focus on the benefits of science.

In this thesis, I will demonstrate how the ecofeminist concept of the dominator consciousness can be applied to a more holistic approach to critiquing issues of scientific uncertainty. This will not only contribute to the scholarship on scientific uncertainty but it will also demonstrate how ecofeminists can engage with science issues simply by incorporating social issues into issues that would normally be considered the purview of scholars in the natural sciences.

There might also be apprehension on the part of ecofeminists to bridge the gap between philosophical and historical critiques of science and critiques of scientific uncertainty at any of the 4 levels. Both Plumwood (1993) and Merchant (1995) have offered book-length critiques of early science philosophy, but neither makes much effort to investigate the relevance of such critiques to modern science and in turn, both neglect important scientific developments that have benefited women and nature (such as more sensitive pesticide residue detection technologies). To describe an ecofeminist theory that engages with science, I will quote at length Lorraine Code's view of what she and Rachel Carson regard as good ecological thinking. Their definition of ecological thinking, which they also refer to as "responsible knowing," can be used as a theoretical foundation in place of dualistic and dominating thinking.

> [R]esponsible knowing is about more than knowing the surface characteristics and internal specificities of organisms: it requires understanding how those specificities work together, reading them as

> responses, adaptations, resistances to places and circumstances whose local detail and connections with other locations contribute to how organisms, whether human or other, can be (Code, 2006, p.50).

A more holistic approach to science, as described above, will encourage greater focus on the non-method related aspects of scientific uncertainty, in addition to critiques on the limits of the scientific method. A recent strand in ecofeminism appears to offer a viable solution to dealing with issues of scientific uncertainty that addresses many of the current problems with the science system at all 4 levels. Ecological citizenship (MacGregor, 2006) or civic science (Reed & McIlveen, 2006) is, at a basic level, the notion that citizens should play an active role in shaping public policy, including scientific issues. This can take the form of a community forestry pilot project as described in Reed & McIlveen (2006) or more lay participation in professional science advisory bodies.

By examining the problems of liberal solutions to environmental problems and problems raised by the issue of scientific motherhood, one can see why a more social approach, civic participation, is a better way to deal with the question of "Is this apple good for me to eat?"

Louise Crabtree, in her article on an ecofeminist approach to housing and urban planning/design, describes the drawback to a liberal approach where responsibility lies with consumers. As she points out, "financially constrained home-makers cannot make 'green' choices when we still have in place political, economic and physical structures that make unsustainable products and practices cheaper, familiar and more convenient" (2006, p.727). As mentioned earlier, the choice between organic and conventional food is not one based simply on preferences but also involves higher costs. So ecofeminist articles (Dobsch & Ozanne, 2001) that praise well-educated, middle-class women for reducing or altering their consumption based on environmental compassion without interrogating the class realities of such choices end up denying other women such choices. Indeed, such attitudes also encourage "sustainable motherhood" where the work to make the world more sustainable is "now just women's work" (Crabtree, 2006, p.727).

While not specifically classified as being ecofeminist, there is a large body of literature that deals with the issue of scientific motherhood. Jacqueline Litt's (2001) work on interviewing mothers is an important example of social science based research that is aimed at locating "other" voices in understanding the relationship between experts and lay people with scientific information. In general, articles and books on the topic of scientific motherhood have come largely from the field of home economics (such as Apple, [1995]) but there have also been other important historical projects that have demonstrated how mothers have been given the responsibility of keeping a clean household and healthy children while at the same time being told to rely on experts such as doctors (Ehrenreich and English, 1978) and engineers (Cowan, 1983) and not their own knowledge, nor to seek out the information themselves.

The connection between organic food and scientific motherhood is fairly clear as while a mother may wish to decide on her own what food to feed her child, the complicated and uncertain literature on organic and non-organic food renders the mother reliant on experts to tell her what is and what is not safe (unless she can easily afford organic food and can thus pay for precaution if she does not trust the experts). The question of whether this is a useful concept for the interview subjects will be raised in Chapter 4. It may be the case that most people do not rely on expert advice but instead use other tools in their decision-making.

In terms of scientific motherhood being a useful concept for discussing scientific uncertainty, it is certainly the case that it is not easy to follow expert advice when the various experts disagree with one another. The problem over the pesticide Alar, used in growing apples from the 1960s to the 1980s, aptly demonstrates this problem. As Rosenberg, Barbeau, Moure-Eraso and Levenstein (2001) point out, as early as 1973 scientific studies were showing the carcinogenicty of components of Alar (p. 220) but it wasn't until the National Resource Defense Council released a report in 1989 criticizing the EPA for gearing pesticide standards to adults and not children that attention was focused on Alar. Indeed, it is children who consume the most apple juice and apple sauce. Even after the makers of Alar voluntarily withdrew the pesticide, the Canadian government still did not ban it (Feig-Weisbrod, 1990).

A civic science body (perhaps initiated by the government) tasked with answering the question about the apple would consider such issues as empowering people to make their own decisions by considering the available scientific information and describing the various stakeholder positions. This would help to ensure that in situations where lay people have different concerns than experts, whether people with science backgrounds or scientists directly involved with apple toxicology, the concerns of the lay people are properly addressed and contextualized.

### 2.3.2 Environmentalism and Pesticides

Many important points of environmentalism have already been made in the ecofeminist discussion but it is also useful to provide some of the history of the environmental movement in the West.

As mentioned earlier, *Silent Spring* had a big impact on the second wave of environmentalism. Judith McKenzie (2002) points to a shift from a focus on conservation efforts in the late 1800s and the early 1900s to a focus in the 1960s on the negative effects of urbanization and industrialization (p.59). McKenzie states that by the 1980s and 1990s, environmentalism became more conciliatory and many activists who had fought for many years to see radical changes were willing to accept more compromise. Now, as we approach 2010, green consumerism and sustainability are normal aspects of people's lives, making these issues gain more political attention. Although even with the carbon tax initiated in 2008 in B.C., it is unclear when radical environmental change will come to fruition (such as capping carbon emissions to levels that allow for environmental regeneration).

Rachel Carson's book highlighted the long-term dangers of pesticides in food but over 40 years later, there is little action being taken in Canada to ensure stricter and more transparent pesticide regulation. There are virtually no scholarly journal articles that even mention the Pest Management Regulatory Agency (PMRA), let alone critique it, and very few environmental groups in Canada have active campaigns on pesticides. Even groups that advocate for a switch towards organic agriculture, such as the Vancouver Food Policy Council, do little to reform the PMRA.

Organic agriculture is often presented as an alternative to now-conventional methods of farming. While organic agriculture standards vary depending on the certification organization (such variation is itself a cause of uncertainty and will be discussed further on in this section), the general rule is that organic agriculture uses no synthetic chemicals (such as pesticides), uses less mechanized methods of farming and focuses more on biodiversity of crops. Organic agriculture has been around since the beginning of agriculture but it was only with the introduction of synthetic pesticides starting in the late 19$^{th}$ century and early 20$^{th}$ century that people started raising concerns (such as those discussed in Philip Conford's *The Origins of the Organic Movement* [2001]).

The costs and benefits of organic food are numerous and all add to the high level of uncertainty when one compares organic to non-organic. The costs and benefits are varied and include issues around: taste, nutrition, pesticides, agriculture methods, labour requirements and biodiversity.

Pesticides will be the focus of this thesis because they pose a larger threat to people's health than problems association with nutritional content. The literature on nutrition seems relatively stable with a general consensus that organic food may provide a slight increase in some vitamins and minerals of fruits and vegetables, but nothing significant (see, for example, the reviews of the literature by Magkos, Arvanti and Zampelas [2003], Köpke [2005] and Biao, Xiaorong, Zhuhong and Yaping [2003]). Nutrition differences become even less important when one considers that nutrition deficits are extremely rare among Canadians and that a negligible increase in Vitamin C in an organic piece of fruit will have little overall effect.

Canada relies heavily on the U.S.A.'s Environmental Protection Agency (EPA) for scientific support in its evaluation and control of pesticides (this is discussed in greater detail in Chapter 3). While this may make sense from a trade point of view so that food can travel freely from one side of the border to the other, one need only look at variations between OECD nations in approved pesticides (Boyd, [2006]; Rothstein, [1999]) to see that governments are not using a pure science model to determine what pesticides and how much they allow in the food supply. Thus, risks are being taken in relying on the U.S.A. as being the safest country to follow to ensure the safety of food for Canadians. There are actually some reasons to believe that the U.S.A. is not the safest country to follow.

Tim Stroshane (1999) points out that in the past, the U.S.A. used the precautionary principle for pesticide residues limits but changed to a standard based on "negligible risk" in 1996 when it passed the Food Quality Protection Act (see also Ostenn and Padgitt [2002]). This meant that instead of banning any pesticide that produced carcinogens from normal residues, maximum amounts are now allowed. This became a huge problem in 2007 when the unions representing the EPA's scientists said that even those maximum residue limits were enough to be neurotoxins and that the government was wrong to allow them to be used (Local Presidents of EPA, 2006; further comment is provided in Phillips [2006]).

As mentioned earlier there is variation among different certification bodies for standards of organic production. To instil greater consumer confidence in Canada and international markets the Canadian government will institute the Organic Products Regulations (OPR, starting December 2008), which will provide for a universal minimum standard of organic production for all products labelled organic. The OPR is necessary for compliance with European Union mandatory regulations for organic imports and may also make trade with the U.S. easier if the U.S. recognizes the OPR (Government of Canada, 2006). The U.S.'s National Organic Program currently accredits Canadian certification bodies to approve imports but if the OPR is recognized then it would be easier for new organic farms to trade with the U.S.

The *Canadian Gazette* (Government of Canada, 2006) article that discusses the rationale for the OPR demonstrates the cost-benefit analysis that was conducted to determine whether or not to proceed with a national standard or to continue with the current system of provincial regulation. The results indicated that without a national standard consumers would benefit from lower costs of organic food due to oversupply from a lack of export markets but that the economy would suffer, overall. On the other hand a national standard would be more beneficial to most of the other stakeholders in the organic industry (such as growers, exporters and retailers) and the economy overall with the consumer seeing benefits in the form of a better environment (though no dollar figure is attached to this benefit). Thus while the OPR is supposed to address consumer concerns regarding inconsistent standards of organic production the consumer will end up paying more for the same product with a different label as there is no mention of PRMA or CFIA standards changing with the OPR (for example strengthening regulation around non-synthetic pesticides or on allowable drift from pesticide levels from non-organic farms). But it remains to be seen how the OPR will affect prices and consumer confidence in organic products in Canada.

## 2.4 Expert and Lay

Most scholarly work on the topic of expert and lay differences rely on one or a combination of academic credentials (such as Snyder, [2000]), affiliation with professional organizations and aptitude tests within interviews to categorize, interview or research subjects (King, Bartlett, Currie, Gilpin, Baxter, Willoughby, Tucker and Strachan [2008] offer a thorough review of articles that classify therapists of varying disciplines describing all of the classification systems used). If subjects satisfy the requirements, they are labelled as expert and lay if not. The majority of studies examined did not employ an aptitude test with the interview; the K.K. Jensen (2005) article is one exception, so certain assumptions about a universal base of knowledge are made if the main requirement is an advanced science degree in a specific field.

Case study discussions of expert and lay understanding of scientific uncertainty usually offer an easier method of distinction between expert and lay, such as the case studies described in Irwin (1995). In these examples a specific incident has occurred, such as the Mad Cow crisis, and there are two clear groups: the government scientists and decision-makers and the general public. Here the government scientists and decision-makers are the experts and the general public the lay people.

In Section 3.3 I outline how I categorized the interview subjects as expert or lay. I was unable to find any scientists in B.C. who had direct experience with pesticide evaluation or control and were also involved with an environmental organization. Therefore the experts in this thesis are people who have comparatively more science experience (training and professional/volunteer work) than the lay group (although as I discuss in section 4.1 a clear distinction can prove difficult) since formal education cannot be taken as the sole determinant of expertise. Experience at the community level can be an important component of expertise since it involves both technical and practical knowledge of a field of study.

The following literature review introduces current scholarship on the differences between experts and lay people in situations involving scientific uncertainty. Many of the articles compare lay people with experts who are experts in the specific domain (such as toxicology) but the significance lies in how people with science experience perceive both the process of the development of scientific knowledge and how lay people perceive this work. As these studies have shown, there is a common perception of the latter and the former by scientific experts. When I make my comparisons in the results chapter, 4, I will demonstrate how this perception informs the answers of the expert interview subjects in the scenarios on scientific uncertainty. As I will explain further in the following pages, the scientific uncertainty level that is given the most precedence by scientific experts is Body of Scientific Knowledge while lay people tend towards including social considerations into dealing with situations involving scientific uncertainty.

Before proceeding to a discussion on the differences between lay and expert notions of uncertainty and what each group thinks about the other, it is important to point out a complication in the literature. Speaking about the precautionary principle, Van Asselt & Voss (2006) point out that a difference between risk and uncertainty must be clearly delineated. To put it another way, they suggest distinguishing between "uncertain risks" and "safe uncertainties". When thinking about the uncertainties of pesticides, one must consider whether a lack of knowledge of cause and effect can cause damage or if it is something that can be contained within a risk assessment. It is not always clear from the literature whether the articulation of competing senses of risk are based on the certainty that the effects of pesticides will always vary (or stay the same), or whether it is based on the uncertainty of the effects. Such a distinction from my interviews will be clarified in the Discussion section, Chapter 4.

There have been many studies that have examined expert and lay understanding of risk and uncertainty of food. Most find that lay people tend to view food technologies (such as Genetically Modified foods) as more risky than experts do (Savadori, 2004; Madsen, 2005). Alan Irwin writes that experts view lay reasoning as being, “ill informed or fallacious, and to include little distinction between what is relevant and what is not” (Irwin, Simmons and Walker, 1999). This was confirmed by a study done by Frewer, Hunt, Brennan, Kuznesof, Ness and Ritson (2003) when they interviewed experts on how the public conceptualizes uncertainty regarding food risks.

A common model that many experts subscribe to is referred to as the “deficit model.” Articulating this at length will provide a deep insight into the underlying assumptions many experts have towards lay people and how experts may perceive scientific uncertainty. We turn to a paper written by Hansen, among others, and co-written by Frewer which deals specifically with food issues (Hansen, Holm, Frewer, Robinson, Sandøe, 2003):

> [The deficit model's] basic assumptions are as follows. First, that subject to acceptable levels of risk, the optimisation of productivity is a commonly shared value in modern societies. Second, that the acceptable levels of risk associated with optimal productivity are universally, or at least widely, agreed. Third, that scientific knowledge is the most effective, and hence desirable, basis on which to improve both the production of goods and risk control, and therefore, scientific evidence should be the primary guide in risk management. And fourth, if the public does not comply with the advice and recommendations of scientific experts, this is because they have a poor understanding of the scientific reasoning informing that advice, i.e. a 'knowledge deficit' (p. 112).

Some studies have found incongruous reasoning from lay people, such as MacGregor (1999), but Irwin's extensive work (Irwin, Simmons and Walker, 1999; Irwin, 1995; Irwin and Michael, 2003) on public science issues has led him to conclude that lay people often view experts as having a viewpoint that is "unduly narrow and [ignores] what, to the citizen, are crucial aspects of their everyday experience of environmental problems" (Irwin, Simmons and Walker, 1999, p.1324). What we do know about lay people is that the type of uncertainty is irrelevant and instead, when people are assessing risks from uncertainty, issues such as perception of personal control are more important (Miles and Frewer, 2003). As for experts, they are not as consistent as they would like to believe. One important study (Rizak, 2005) surveyed three groups of experts who would loosely fall under the categories of environmental engineers, environmental epidemiologists and environmental chemists. The results showed that when questioned about environmental and food risks, there was, in fact, variation within the disciplines and less so between them.

But there are critiques of these studies that point to expert and lay differences in opinion. Gene Rowe states that, "Gender, race, political worldviews, and affiliation are strongly correlated with risk judgements" (2001, p. 348) and that all of the studies that he examined (articles written before 2001) failed to account for all these things. He does cite some studies performed by Paul Slovic evaluating chemical risks and intuitive toxicology, articles which found that women consistently view risks from chemicals to be greater, and the benefits less, than their male counterparts, including toxicologists. A study on differing notions of risk from electric and magnetic fields among experts found the differences to be explained by education and employment sector (McMahan, 2002).

There is no consensus on whether differences in opinion can be accounted for by expert or lay status or through other factors. The studies presented above demonstrate the difficulty in categorizing expert and lay and in determining one's predisposition towards varying positions on situations involving scientific uncertainty. Instead of evaluating one's predisposition I will be examining whether the interview subjects classified as expert have different views on the scientific uncertainty of these scenarios than the lay interview subjects and what those views mean for answering the question, "is this apple good for me?"

## 2.5 Costs of Organic Apple Production

This thesis focuses on individual decision making around a situation involving scientific uncertainty but it is also important to place this issue in a more global context where we are experiencing both a constant increase in population and a reduction in food production for human consumption (as a result of farmers selling crops for animal consumption and fuel production). Thus, one must also consider the benefits of non-organic food to make a more informed decision when purchasing food.

Organic apples almost always cost more than their non-organic counterparts but it is not always clear what accounts for these extra costs. This section will present some of these issues to help determine whether or not the extra costs are worthwhile. Further examination of government and industry testing and an oversight of pesticides to determine their costs will follow.

According to A. Desmond O'Rourke (1994), the single largest expense for non-organic farmers growing apples is labour (p. 37) (roughly 30% for most Washington state growers). Since organic production is even more labour-intensive than non-organic farming (Pimentel, Hepperly, Hanson, Douds and Seidel, 2005, p.576), this is one of the major factors affecting the increased cost of organic apples. O'Rourke also lists the costs of fertilizers, chemicals and sprays at around 8% of the total cost of apple production. Although organic farming does not include synthetic pesticides, there are still many non-synthetic pesticides (Zang, Fukuda and Rosen [1997] present their findings of residue detection from one natural pesticide) and other inputs which are used. The term "organic" does not mean there is a lack of synthetic pesticide residue on the food (Deaton and Hoehn, 2005).

While many consumer studies on organic food highlight perceived risks and benefits of organic versus non-organic food (Saba & Messina, 2003; Williams & Hammitt, 2001) there are also some that expand the research into why people do or do not purchase organic by examining issues such as price and inter-personal reasons. Both Homer & Kahle (1988) and Chryssohoidis & Krystallis (2005) dispute the contention that organic food purchasers are primarily concerned with the positionality of their purchases as a niche product (Allen & Kovach [2000] and Guthman [2002] both discuss this through the lens of commodification). The former do so with people who shop at natural food stores and the latter focus specifically on organic food. Instead, they find that people value control over their lives including purchasing food that they perceive to be healthier.

But regardless of the reasons for purchasing organic food, the fact is that demand has increased. In the U.S.A., demand has equalled or exceeded 20% every year since 1990 and is the fastest growing agricultural sector as reported by the Food and Agriculture Organization (FAO) of the United Nations (2005). This means that despite the higher prices that producers charge for organic food, more and more people are willing to pay the higher cost. Thus, until there is more supply than demand, or demand has reached a plateau, there will continue to be higher prices regardless of the actual cost of production.

Despite the fact that a recent survey found that the relative yields of organic agriculture could provide enough calories to feed everyone in the world if all agriculture was organic (Badgley, Moghtader, Quintero, Zakem, Chappell, Avilés-Vázquez, Samulon and Perfecto, 2007), most farms operate to increase yield as much as possible. While not all scholars agree on the difference in yields between organic and non-organic, most literature presents findings of greater yields with non-organic farming methods. For example, the National Research Council in the U.S.A. (2000, p. 35) highlights increased yields with non-organic agriculture and cites some studies that indicate up to a 50% increase over organic agriculture. They also cite the ability to grow crops in regions with pest infestations, such as cotton farming in some regions of the Southeast.

Two different Swiss studies reveal some conflicting results regarding yield. A 21-year study found that crop yields were 20% lower using organic farming methods (Mäder, Flieβbach, Dubois, Gunst, Fried and Niggli, 2002) but another study performed over 4 years found that:

> [A] higher input level of pesticides, fertilisers and machinery did not lead to increased yields and receipts. In contrast, the choice of apple cultivars and high investment in pre-harvest labour hours were significantly correlated with high eco-efficiency and high farm income (Mouron, Scholz, Nemecek and Weber, 2006, p.561).

But if it is difficult to secure pre-harvest labour, then pesticides might be the only method available for high yields. Another difficulty that affects overall yields is the reliance on crop rotation for organic farming.

Certification is another cost that farmers must pay. As an example, in the north of the Okanagan, the cost for certification of a farm is $325 a year (Certified Organic Associations of British Columbia, 2008). But the farm must also be a member of the provincial program administrator, the Certified Organic Associations of BC (COABC) and the fee for this is based on a sliding scale between $75 and $1000 a year (2008b). These fees pay for independent monitoring of the farm to ensure producers meet adequate standards and market B.C.-grown organic foods.

The myriad of factors that affect the costs and benefits of organic food versus non-organic food raises the question of how experts and lay people might deal with the issue of scientific uncertainty. The next section will discuss the issue of classifying experts and lay people and will use the literature from food and environmental studies to study how experts perceive lay people.

## 2.6 Interviews

As will be discussed in greater detail in the Methods section, Chapter 3, this thesis relies on two narrative-style scenarios. While interviews often involve direct lines of questioning, the use of scenarios allows for a specific set of plausible conditions to be considered by the interview subject. This is largely because it was assumed that the majority of the interview subjects would not have seen evaluation data for a pesticide. By devising these original conditions, all of the interview subjects would start on an equal level and bias could be controlled to a greater degree than without such conditions. One of the crucial aspects in creating this equal starting level is stipulating that the interview subjects should form their opinions by considering the information provided.

Contact with the interview subjects was made using several different methods including emails, phone calls and mail. The Informed Consent form was provided to all of the people contacted to provide them with an understanding of the procedures of the interview since I was concerned that unless the potential interview subject was a toxicologist (or another expert in pesticides), he or she might not feel able to contribute to the interview.

A purposive sampling method was used because I thought it would be too difficult to establish the total population of experts and lay people from which to devise a random sample. Participants were contacted based on their participation with a community group that was involved in environmental issues, with the assumption being that they might have considered and discussed some aspect of the regulation, evaluation and use of pesticides.

## 2.7 Note on the Style of Writing

In the interest of including a diverse set of viewpoints in scientific decision-making, I have attempted to write this thesis in a plain-English style. Encouraging lay people to engage with scientific decision-making processes includes making as much information as accessible as possible. While there is not a large body of literature on the subject, articles such as Friedman, Hoffman-Goetz and Arocha (2006) and Green, Duncan, Barnes and Oberklaid (2003) demonstrate how "[h]ealth professionals frequently write at the same level for lay readers as they write for peers" (Green, et. al., 2003, p. 700) while also arguing for the importance of writing in plain English to allow a higher level of comprehension among lay people.

# CHAPTER 3: METHODS

## 3.1 Sampling

The type of sampling that I used for my interviews is often referred to as "purposive sampling" (Schloss & Smith, 1999, p. 104). Participants are selected to further specific research questions rather than make representative claims about society. Since two goals of this thesis are to test my hypothesis regarding expert and lay understandings of situations involving scientific uncertainty and to develop more useful scenarios for future use, this method was determined to be more useful than other sampling methods.

For this thesis I chose to do 12 interviews. Arksey & Knight's (1999) recommendation for choosing a sample size sums up how I decided upon my sample size. They write, "For qualitative researchers in particular, sampling is an exercise of judgement which balances practical concerns (time, money, access), with the research foci, and with the degree to which *the researcher* wants to generalize from the data" (p. 58). In terms of practical considerations, access to interview subjects was a problem and this will be discussed further on in this section. With generalizations from data to population, I found that doing a representative study of expert and lay people who volunteer and/or work with environmental health non-governmental organizations (NGOs) would have proven insurmountable without any available figures on how many people can be legitimately considered to be working or volunteering in this sector.

Bekin, Carrigan and Szmigin's 2007 article comparing British and Brazilian conceptions of waste is a good example of another study that uses a purposive sampling method with a small sample of interviews. They only interview "middle-class, working mothers in their thirties and forties with recycling experience to contain the research to a particular set of social circumstances" (p. 223). As I explain in my requirements for participation, I was also interested in containing the research to a particular set of circumstances, although not as specific as Bekin, Carrigan and Szmigin.

Because I ended up with a fairly diverse sample of environmental groups and interview subjects in the greater Vancouver area, I feel that I also abided by Arksey & Knight's (1999) guiding principle of "[trying] to get a sample that allows you to see things from all *relevant* perspectives" (p. 58).

I started my sampling by searching the Internet to find community groups that are located in Metro Vancouver. My initial expectation, as I had outlined in my thesis proposal, was to interview three people each at two lay Non-Governmental Organizations (NGOs) and three people each at two expert NGOs (the distinction between lay and expert type groups will be explained further on). I searched for these groups using keywords such as "food security" and "pesticides." I also found a helpful website, http://www.ecobc.org/, listing almost 400 environmental groups in B.C.

The requirement for these groups was involvement in some aspect of environmental or personal health work where pesticides might be an issue of concern. Based on preliminary evaluations, I found that some groups relied more on the work of scientists and physicians for their research and promotion and thought that this would yield inter- and intra-NGO comparisons with 3 interviews each from 4 different groups. However, as one can see from the table that outlines who was contacted and who responded (see Appendix E), I was only able to get more than 1 interview from 1 group.

The other requirements I had for group selection were based on their location (no group is located out of the metropolitan region of Vancouver), availability and willingness to participate.

Contact was initiated using three methods: formal email (see Appendix B); informal email (see Appendix D); and letter (see Appendix C). The first round of contact involved formal emails to the community groups. The Informed Consent form was attached to the email to validate the research as a university-approved project and to provide more details on the project. A second round of contact involved sending a letter to community groups, along with a self-addressed stamped envelope, and a third round involved informal and formal emails.

Despite some researchers, such as Anderson and Kanuka (2003), who recommend a paper-based initial contact letter, I felt that attaching the Informed Consent form along with the email would be sufficient to convince the participants of the legitimacy of my research. To avoid the problem of spam, as raised by Best and Krueger (2004, p.29), I ensured that each email was sent to only one person at a time, with no bulk emailing. I also ensured that the title of the email was clear as to the full purpose of my email: “Request for interview participants in research project on the research evaluation process of pesticides.”

Using formal email, I sent out 22 emails. From these, 11 groups responded and 3 participated as interview participants. This means a 50% response rate with a 14% success rate for interviews.

For the second round, I decided to try initiating contact through the mail, as I believed that this more formal method of contact might yield more responses. The letter was on regular paper and did not have the SFU letterhead. From the 13 letters I sent out, 5 groups responded and 4 participated as interview participants. This means a 40% response rate with a 31% success rate.

Using informal email, I contacted 6 people, 5 of whom responded and 4 of whom were interview participants. This means an 83% response rate with a 67% success rate.

The 11$^{th}$ interview (Interview 11 in Appendix L) was gained by using the snowball method of sampling whereby those who participate in the interviews are asked if they know of anyone else who might be interested in participating. Considering I asked 10 other participants (omitting the last interview completed), this means a 10% success rate for the snowball method.

While informal emailing was the most successful method of finding interview participants, I was also limited by the people with whom I'm acquainted and the possible networks and email listserves that are available to me. As for comparing formal email to mail, neither method appears to be better at recruiting volunteers than the other. While I was able to secure fewer interviews from people who had been contacted through formal emails, I did receive a greater proportion of responses. None of the responses questioned the legitimacy of my research project and most people were simply unable to participate due to a lack of time.

Some studies have shown that informal emails are more effective than formal emails (Heerwegh, Vanhove, Matthijs and Loosveldt, 2005; Heerwegh, 2005) but the difference is based on providing a person's name in the greeting versus a common greeting, such as "Dear community group." The distinction that I am making in using the terms formal and informal is based on "personalizing" each email by using the proper name of the individual community group versus emailing people with whom I am acquainted or with contacting individuals using their personal business email accounts (and not the generic "info@" email that is common).

For example, I joined 2 professional associations to find experts, the British Columbia Environmental and Occupational Health Research Network (BCEOHRN) and the Society of Environmental Toxicology and Chemistry (SETAC), and was able to find one interview through BCEOHRN. On the BCEOHRN website, I found an email contact for a local scientist who does research on pesticides and was able to identify myself as someone who is also part of the network.

I joined BCEOHRN by accident. I emailed them, under the impression that they were a community group, and they replied by telling me that they were more of a networking group and encouraged me to join for free.

I found SETAC while searching through journals. They are a non-profit organization with chapters around the world. For a $40 USD fee, I was able to join as a student in order to use their database to find local toxicologists, though I did not find anyone to interview. I chose them because they were the only group that I could find that had a large network of researchers and I felt that I could offset the cost by using some of the journal articles that they publish.

I also sent out a request for interview subjects through the Vancouver Food Policy Council email listserve; this method yielded 3 interviews.

I was not able to determine an interview subject's status as expert or lay before the interviews because part of the classification system includes responses from the interview. Since I was not able to determine expert of lay status I completed 15 interviews in total. I chose to omit the latter three in particular because they were all involved with community gardens, a type of group that is already well represented from at least three other interview subjects, but also because these three, were either quite curt in their answers or did not directly address all of the questions.

Once a respondent agreed to participate, he or she was asked to select a convenient location for the interview. The table below lists where each interview took place.

**Table 2 Location of Interviews**

| Location of Interviews | |
|---|---|
| *Interview* | *Place* |
| 1 | Office |
| 2 | Café - respondent's choice |
| 3 | Home |
| 4 | Office |
| 5 | Office |
| 6 | Lab |
| 7 | Classroom near respondent's office |
| 8 | Office |
| 9 | Office |
| 10 | Community center – respondent's choice |
| 11 | Office |
| 12 | Patio of a pub |

Interviews lasted anywhere from 15 to 40 minutes with much of the variation stemming from the length of time spent reading through the Experimental scenario, and the length of responses.

## 3.2 Interview Design

The interview was pilot-tested on 2 colleagues, one of whom was a graduate student in toxicology and the other a graduate student in computer science. No changes were made.

I first gave the interview subjects the Informed Consent form (Appendix A) to sign and discussed any questions they might have about the interview. I then gave them the Experimental Scenario (Appendix G) and waited while they read it. In only one instance did the interview subject see the scenarios beforehand. One of my interview subjects requested them in order for him to participate. After the interview subjects had read through the scenario, I asked them the Experimental Questions (Appendix H). I then gave them the Utilization Scenario (Appendix I). I asked the first two questions from the Utilization question list (Appendix J) and then gave them the Health Canada Food Basket (Appendix K) as a supplement to the third question. The foods that I selected in the basket are based on foods tested for the Total Diet Study (Health Canada, 2005) carried out internationally (with nationally-appropriate foods) on the recommendation of the World Health Organization (WHO). After they answered the questions, the interview subjects were asked to fill out a demographic form.

I conducted the interviews in a semi-structured form (Moore, 2000) where I was interested in "both structured information [such as the questionnaire] and information about attitudes and beliefs" (p.121). I gave the interview subjects as much time as they needed to respond and told them to ask any questions they had while the interview occurred.

With the interview subject's permission, I recorded all of the interviews and then transcribed them.

I was concerned with two main issues when designing the interviews. The first was making it believable as I had requested that the interview participants consider the scenarios as something that might happen in the future and asked them to respond to problems based on the information provided. I chose a narrative approach, one that would follow a fictional pesticide from the experimental stage to the utilization stage. Czarniawska (2004) explains the benefit of a narrative structure: "...the power of the story does not depend on its connection to the world outside the story but in its openness for negotiating meaning" (p. 9). I chose to use scenarios after having read another ecofeminist M.A. thesis that employed scenarios (Bulloch, 2003) to test different responses to the grizzly bear hunt in B.C.

Scenarios are sometimes used in social science research, although in a different manner than in this thesis, and are rarely discussed in social science research methods books. Some examples of different uses of scenarios include using comparative scenarios for the same group of participants (Noakes & Rinaldi, 2006), using different scenarios for different participants to test the content of the scenarios (Wilson & O'Gorman, 2003) and using the same scenarios in different groups to test group dynamics (Karakowsky & Elangovan, 2001). In this thesis, all participants received the same scenarios (Dohnt and Tiggemann, 2006 is an example that uses the same approach) with the same questions to elicit varying responses to both differentiate between expert and lay opinions and to develop more appropriate scenarios.

The second concern I had when developing the interviews was to ensure there was as little information as possible that might bias those with training in the natural sciences. This meant using as little technical jargon as possible to allow all participants to follow the narrative. I also encouraged the participants to ask questions during the interview.

To better understand how I developed my scenarios, the following section outlines the sources of my information and describes how I have included or not included this information. Most of the information is based on the standards of the Canadian governmental agencies responsible for pesticides. In Chapter 4, I outline the requirements for pesticide evaluation based on stricter and less risky standards but in general, to my knowledge, there is no optimum list of requirements that I could use to compare with my scenarios.

Since one of the purposes of this thesis is to assess the ability of people to judge the quality of science in conditions of scientific uncertainty, each section of the scenarios is matched with the corresponding type of scientific uncertainty. This way the reader can see the intention of each section towards raising specific issues of scientific uncertainty. I designed the questions to elicit responses based on the issues outlined below. The last questions after each scenario asked the interview subjects to explain what aspects of the research they consider to be good science and bad science, allowing them to explain whether they think social issues should be considered part of science, and also to demonstrate their level of scientific knowledge by pointing out errors or greater nuance to the scenarios.

I have provided examples of the full scenarios in the Appendix section which are formatted in the same manner in which I presented them to the participants.

### 3.2.1 Body of Scientific Knowledge

- (E[1]) One of the concerns of pesticide residues is whether they're safe for human consumption. For this scenario, consider that by 2010 foods will still contain pesticides. Consider if they are still harmful to your health based on these scientific standards. This scenario reflects the minimum testing that will be required for a company to get approval to market a new pesticide or to market one already in use but approved based on older scientific standards.

The introductory paragraph outlines the specific aspect of pesticide testing that will be described in this scenario. Since the scenario is set in the future, I am able to offer what might count for a sufficient toxicology database whereby the government body that evaluates the tests can determine the safety of the pesticide. This is an example of methodological uncertainty since determining the safety of the pesticide is based on the assumption that the test instruments are accurate and reliable.

Another problem is that the evaluation does nothing to address residues that may or may not occur as a result of prescribed (either experimentally based on the test company's assumptions or based on the limits imposed by the regulatory body) use. In this scenario, it is not the company's responsibility to determine such things. During my analysis, I will be looking to see if the interview participants picked up on this.

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[1] (E) refers to the Experimental scenario and (U) refers to the Utilization scenario

When I mention pesticides already in use in the last sentence, I'm referring to the re-evaluation program that was established by the PMRA whereby all pesticides that were registered before 1995 (Pest Management Regulatory Agency, 2008) will be re-evaluated to account for new scientific standards. However, in 2003 a report of the Commissioner of the Environment and Sustainable Development (CESD) criticized the PMRA for being behind schedule on re-evaluation and for lacking a system to prioritise which pesticides are re-evaluated ahead of others. The report also highlights that the PMRA is heavily reliant on the EPA for its re-evaluation program.

- (E) Long-term delayed-effect test on beagles

  10 at each level of concentration – inhalation for 12 months

  10 at each level of concentration – skin for 12 months

  10 at each level of concentration – mouth for 12 months

  4 died at 400 ppm through inhalation, 3 died at 400 ppm through exposure on the skin and 2 died at 200 ppm, 1 through inhalation and 1 through the mouth after 6 months.

This test is required when the product might come in contact with food; however, 12 months is not necessary if certain requirements are met. I have changed the terminology from short-term (on the PMRA document) to long-term to reflect the 12 month requirement here

While the PMRA does not list the necessary range of doses to be tested, I chose a range that might appear to be legitimate but intentionally left out a control. This means that according to this study, there were no animals tested without ingesting the pesticide, which should be a normal procedure for any scientific experiment. I omitted the zero dose to see which participants would notice this.

The PMRA does not require all three routes of exposure for all tests; see for example Pest Management Regulatory Agency, 2005 and 2005b.

Since I was concerned with not delving too deep into technical information surrounding pesticide application, I omitted details on the other ingredients in the pesticide that would be found in the end product. I also did not include any tests that examined the interaction of godarion with other pesticides it might mix with in the open environment (though this is also not required by the PMRA).

In general, I was looking to provide a good overview of the requirements listed on the PMRA website but I also wanted to manipulate the scenario to include more animals than are required and to change key things such as the duration of tests. I did this to see if even an increase in the amount of animals tested and an increase in duration of the tests would provide people with a feeling of certainty in the safety of the pesticide. All of the numbers of animals are fabricated as are the number of animals that died.

To simplify the scenario, I listed the deaths and for the most part did not report on “abnormal” behaviour that may have occurred. This was done to establish how important such reporting is to the interview participants and to see if any level of death was normal to the participant and not a result of the testing.

- (E) Persistence and bioaccumulation in the environment

  Dissipation field test for 50% and 90% of the pesticide to break down

  1 in clay soil

  1 in silt soil

  1 in sand soil

  While these tests can last up to a year, 90% of the pesticide dissipated in all 3 types of soil by the 8$^{th}$ month. This was true in all 15 soil samples taken from different parts of each field.

Field tests are required although they do not list the specific requirements. Three different types of soil do not appear to be required but instead the soil from the proposed area is (Organisation for Economic Co-operation and Development, 2003). Canada only evaluates the 50% dissipation level and not to a more complete breakdown (ibid).

While the list of requirements for bioaccumulation and persistence from the PMRA does not appear on the website of the agency, documents such as Pest Management Regulatory Agency (1997), which describes some of the harmonization that has occurred with the EPA for pesticide evaluation, do provide some indication as to what is required.

- (E) Bioaccumulation test for living organisms, such as other insects not intended to be killed by the pesticide and for intended and un-intended crops.

  1 in clay soil for 1 year

  1 in silt soil for 1 year

  1 in sand soil for 1 year

  While it appeared to interact well with all soils, it was also effective at killing caterpillars.

Some laboratory studies are required to determine the effect of the pesticide on some non-target species such as earthworms (Pest Management Regulatory Agency, 2004). However there are no formally defined criteria for assessing bioaccumulation and there are no formal requirements for evaluating biomagnification where bioaccumulation may increase as it moves up the food chain (Organisation for Economic Co-operation and Development, 2003).

- (E) Dissipation water test for 50% and 90% of the pesticide to break down.

  1 in still fresh water body

  1 in moving salt-water body

  90% dissipation occurred after 2 months in fresh water and after 1 month in salt water.

Aquatic dissipation tests are sometimes required though only when there is a high probability of the pesticide entering aquatic systems (Pest Management Regulatory Agency, 2004b). When they are required, Canada evaluates the dissipation at only the 50% level (Organisation for Economic Co-operation and Development, 2003).

- (E) Dissipation air test for 50% and 90% of the pesticide to break down

  90% dissipation occurred after 1 month.

  Air dissipation tests are not required by the PMRA.

- (U) Based on this scenario consider how certain you would be of the safety of your food once the pesticide becomes a residue in your food. In 2010, this is what might happen should a Canadian Food Inspection Agency scientist discover above-acceptable levels of pesticide residue in food for Canadian consumption.

As mentioned in the Informed Consent form, I based the scenarios on a plausible situation that might occur in the future. 2010 was chosen as a time that is close to today but still allows for some possible variation of procedure. In Canada, it is the role of the PMRA to determine acceptable levels of pesticide residues in food and it is the CFIA's role to test and enforce such levels. Both are part of Health Canada.

- (U) While testing some apples from the Okanagan she discovers that they have a residue level for the new organophosphate godarion above the maximum residue level set by the Pest Management Regulatory Agency of Health Canada (PMRA). She is surprised to see godarion on the apples since they had not been approved for use on apples.

The maximum residue level (MRL) is the amount of pesticide the PMRA determines will not pose an unacceptable health risk. This number is determined by the toxicity of the chemical and the effects the chemical has on animals at different doses. There is a safety factor incorporated into the MRL to account for the increased sensitivity towards pesticides among people such as children and pregnant women.

When the PMRA sets MRLs, it sets different levels for the same pesticide for different foods; however, this is based on instructions set out by the PMRA for application on that specific type of food. In the case of the scenario, the pesticide is obviously not approved for apples since it is meant for mosquitoes.

- (U) After doing further tests themselves, scientists from the CFIA start to look at where the godarion may have come from. Since the PMRA recently started to record where pesticides are sold and the quantity, the scientists from the CFIA are able to work with the provincial government to see who may have been contracted to do the spraying. They determine who had been doing the spraying and after investigating their spraying practices determine that they had followed the label instructions of godarion. The CFIA contacts the PMRA and Health Canada and are told that the 50% increase in residue is still safe for human consumption and so the apples can still be sold. This is because the maximum residue limit is set at a high safety factor of 100. The CFIA also requests from the PMRA that they do further testing on how godarion travels by air and that they change the label instruction to prevent cross-contamination.

In 2007, Health Canada began to require the tracking and reporting of pesticide sales. As for label instructions, the PMRA sets out precisely how the pesticide may be sprayed, with penalties when the label instructions are not followed. I am not aware of the PRMA increasing MRLs but I was interested in how my respondents would react to such an increase in the MRL due to a safety factor of 100 since it is the internationally recognized minimum (Pest Management Regulatory Agency, 2004d).

The safety factor is meant to capture uncertainties involving human-to-animal extrapolation and differences among humans. A 50% increase would still be above the pre-safety factor level and I wanted to see if this was adequate for the respondents. The 2003 CESD auditors criticize the PMRA on its application of a safety factor by stating that they have not determined the reliability of the assumptions of risk. A lack of acknowledgement on the part of the PMRA that user behaviour does not often conform to label specifications further complicates such problems.

As the anthology *Silent Invaders* (Jacobs and Dinham, 2003) makes clear, there are still many gaps in the research on how pesticides affect different people, especially women and children. The complexity of the ecological prediction being made is the uniqueness of each person. Some people might develop cancer from a small exposure to pesticides and some might never develop cancer regardless of how often they come in contact with pesticides. The safety factor is an inference towards acceptable risk but as will be discussed further in the Discussion section of Chapter 4, this does not mean no risk.

Lastly, I included some follow-up work that the CFIA and the PMRA might perform to ensure public safety.

### 3.2.2 Professional Identity / Technical Work

- **(E) The physical and chemical description includes:**

  Molecular weight

  Chemical composition and structure

  Mode of action

  Phototransformation

  UV-visible light absorption

  Melting Point

  Boiling Point

  Viscosity

  Vapour pressure

Solubility in water, alcohol and fat

Density

Particle size

Metabolites

Lethal Dose levels

Toxicity in animals – within each route of exposure, through the mouth, inhaled and on the skin, 5 levels of concentration of the pesticide are used with 100 parts per million (ppm) being the assumed normal application. The other levels are 400, 200, 50 and 10 ppm. The dosage is set at the expected amount found in the open environment unless otherwise noted.

The above list constitutes common requirements of information (see, for example, Pest Management Regulatory Agency [2005b] and Organisation for Economic Co-operation and Development [2003]). I included many of the necessary requirements of information but I purposely omitted some to see if any of the interview participants were particularly interested in specific types of information. This list is a good example of methodological uncertainty as even such universally agreed-upon concepts as boiling point can be scrutinized for meeting the requirements of good science. Instead it is taken for granted and moves from science to technology.

- (U) Dr. Claire Denis is a scientist contracted by the Canadian Food Inspection Agency (CFIA) to do pesticide residue inspections of food eaten by Canadians. She is given different foods to test depending on the demand, the risk for high residues as determined by the CFIA and on the random selection. Her testing methods are all based on current standards and usually involve 300 pieces of food from the same farm. Based on the residue of each of the samples she can calculate the expected residue level in the entire crop.

According to a Google search, there is no scientist affiliated with the CFIA by the name of Claire Denis. The name was chosen because she is a French filmmaker and because there does not appear to be anyone by that name affiliated with the CFIA.

The prioritization of sampling is explained on the CFIA website (Canadian Food Inspection Agency, 2004) but this is a fair synthesis of how this is done.

I did not want to go into detail about testing so as to not make the scenarios even longer but felt that since this is dealing with the technical application of a scientific method and not the research into more accurate or novel ways of testing for residues, such information was irrelevant. Three hundred pieces of food was a number that I chose at random since I could not find any information as to how many pieces of food per farm might be inspected. But for the purpose of the scenario, I explain that this is a statistically significant number to make a generalization about the farm.

- (U) Each year roughly 220,000 tests are performed in Canada on the entire food supply.

The number of tests is taken from the CFIA website (Canadian Food Inspection Agency, 2004); however, this number applies to all of the tests that the agency performs - not just those associated with pesticides but also veterinary drugs and industrial products that might end up in the food supply. My intent was to assess the acceptability of the amount of tests.

As an example of true numbers, in 2001-2 the CFIA tested 2548 pieces of domestic fruits and vegetables and 13,557 pieces of imported fruits and vegetables (Commissioner of the Environment and Sustainable Development, 2003).

Regardless of the amount of food tested, it is always the case that the amount tested is only representative of the food supply and does not actually confirm the healthiness of any pieces of food actually consumed.

In terms of pragmatic uncertainty, there is no method of testing which does not affect the structure of the food which therefore means that it is impossible to test all food, even if this was desired by all citizens.

### 3.2.3 Scientific Community

- (E) Short-term high dose test on chimpanzees

  2 at each level of concentration – inhalation for 7 days

  2 at each level of concentration – skin for 7 days

  2 at each level of concentration – mouth for 7 days

None of the chimpanzees died at the 200, 100, 50 and 10 ppm levels of concentration. 1 died at the 400 ppm level of concentration through the mouth.

No tests on primates are required and appear not to happen at all. I included them to test participants' views on extrapolation from animal to human data.

In general, there is little research being performed by the Canadian government on the health effects of pesticides, thus contributing to epistemological uncertainty. The 2003 CESD report states that only 3 scientists were working on this in 2003 and it is unclear what priority this is for Health Canada. Thus, extrapolating animal data to humans relies heavily on the research of other nations.

It should be noted that Canada does not have a formal definition of toxicity (Organisation for Economic Co-operation and Development, 2003).

I have also listed whether or not each test is required or "conditionally required" by the PMRA.

- (E) Absorption, distribution, metabolization and excretion test on beagles and rats

3 beagles and 10 rats at each level of concentration – inhalation for 7 days

3 beagles and 10 rats at each level of concentration – skin for 7 days

3 beagles and 10 rats at each level of concentration – mouth for 7 days

1 beagle died at 400 ppm through inhalation on day 2.

According to the *Guidelines for Developing a Toxicological Database for Chemical Pest Control Products* (Pest Management Regulatory Agency, 2005) of the PMRA, these tests are known as toxicokinetic studies and are used to extrapolate animal data to human data in determining how toxic a chemical might be and how it interacts with the body. The cited document states that the most appropriate animal will be used but since I could not determine what this might be, I chose 2 animals. Toxicokinetic studies are also performed over a longer period of time such as 90 days (depending on the animal). This is a required test of the PMRA.

The variety of animals throughout this scenario allows participants to comment on the varying applicability of animal data to human data. By reporting on the deaths of different animals (regardless of the type of observations being performed), this allows for inter-species comparisons.

- (E) Lifetime cumulative effects test on rats

  15 at each level of concentration – inhalation for 2-3 years

  15 at each level of concentration – skin for 2-3 years

  15 at each level of concentration – mouth for 2-3 years

  All the rats lived for their expected lifespan of 2-3 years.

This is not a required test. I chose rats because they have a shorter lifespan than many animals. The long-term studies performed to ascertain potential chronic effects of the pesticide are normally shorter than this test.

- (E) 3 generation reproductive test on rabbits

  10 at each level of concentration for the first generation – inhalation

  10 at each level of concentration for the first generation – skin

  10 at each level of concentration for the first generation – mouth

  80% of the rabbits in the 3rd generation survived past 6 months in all levels of concentration and routes of exposure except for 50 and 10 ppm where the survival rate was above 90%

Reproduction studies are required; however, 3 generations are not mandatory and the preferred species is the rat. Since one of the components of this study is the prenatal development toxicity study and the preferred animal is the rabbit, I chose the rabbit.

- (E) Genetic damage and mutation test on Chinese hamsters

  10 at each level of concentration – inhalation for 12 months

  10 at each level of concentration – skin for 12 months

  10 at each level of concentration – mouth for 12 months

3 died at the 400 ppm concentration level and 4 died at the 200 ppm concentration level all from different routes of exposure. Mutation was observed only at 400 ppm and only through the mouth.

Genotoxicity tests are required and the Chinese hamster is an option for species choice. These studies are designed to examine the effects of the pesticide on the animal's genes.

- (E) Neurotoxic behaviour test on hens

  12 at each level of concentration – inhalation for 1 month

  12 at each level of concentration – skin for 1 month

  12 at each level of concentration – mouth for 1 month

  No hens died but abnormal behaviour was observed at 400, 200 and 100 ppm levels of concentration, at all routes of exposure.

Neurotoxicity studies are required with one of the tests being performed on hens. Some of the neurotoxicity studies are only required with organophosphates. These studies are designed to examine the effects of the pesticide on the nervous system.

- (E) Long-term low dose test on trout (no direct application of pesticide to the body of the trout)

  20 at each level of concentration - for 8 months

4 trout died, 1 at 50 ppm, 2 at 200 ppm and 4 at 400 ppm.

No tests on fish are required although such tests might be requested. I included them here to provide data that some people might believe to be necessary.

A full list of tests that are required by the EPA is available on-line (Environmental Protection Agency, 2007). Each document provides specific information on each test and includes information such as the preferred animal, how the test is performed and the number of animals necessary.

### 3.2.4 Groups that affect or are affected by science policy

- **(E) Efficacy**

  By comparing the current crop losses due to the pest and the potential increased yields from using the new pesticide godarian was found to increase yields by 14% over other possible pesticides and 25% over Integrated Pest Management system.

As the PMRA states, evaluations of pesticides are made based on the risk to human and environmental health and the potential economic value (Pest Management Regulatory Agency, 2004c). There is no indication as to how these yields were calculated, such as over what period of time the tests were performed. Testing might occur during a limited amount of time with favourable weather conditions which are not reflective of normal weather patterns. Without knowing how these yields were calculated, we are unsure for whom these figures are relevant. Are the farmers getting an accurate sense of an improved product or are consumers being put at risk with a product that may be novel but not actually able to give them lower prices?

- (E) The evaluation package contains the physical and chemical descriptions, the toxicity in animals, the persistence and bioaccumulation in the environment and the efficacy of godarion.

The majority of the technical information provided was taken from the PMRA website, despite the fact that Canada has no test guidelines for toxicity studies of its own (Pest Management Regulatory Agency, 2005).

Canada uses guidelines from the OECD and the EPA but the PMRA publishes some requirements for a toxicology database. I decided to use the Canadian information because of my assumption that should the interview participants have researched this information, they would have focused on how Canada regulates pesticides. I could not find any examples of a completed toxicology database to base this on, so instead relied on what was listed as required information.

As an example, one can view documents such as the *Reregistration Eligibility Decision (RED) for Malathion* report (Environmental Protection Agency, 2006) which provides an overview of the scientific studies that were used to approve malathion after re-evaluating it. This document is 195 pages long and as mentioned in the CESD report, it was found that submissions for evaluation for a new pesticide can be as large as 175 binders.

Further to this is the OECD report *Persistent, Bioaccumulative, and Toxic Pesticides in OECD Member Countries* (Organisation for Economic Co-operation and Development, 2003) which surveys 12 OECD countries (including Canada) and explains the differences in requirements for pesticide evaluation between the countries. As the Boyd (2006) report found, these differences mean that there are 60 active ingredients used in 1,130 pesticides which are legal in Canada but illegal in other OECD nations.

Without explanatory guidelines available to Canadians, there is no way to understand why the Canadian government feels it is acceptable to have these pesticides available. Such a lack of transparency raises the questions of whose interests are being protected - the pesticide producer, consumers or both.

- (E) Straub Chemicals is a leading pesticide manufacturer based in Vancouver. The Research & Development department has created an organophosphate, named godarion, which has been shown in preliminary trails to being quite effective at killing mosquitoes and much less effective at killing other species. Danielle Huillet, the lead researcher, is reviewing the tests to hand in for evaluation and is preparing a summary which is here presented:
- (U) Instead godarion had been approved by the PMRA for mosquito spraying because of an outbreak of West Nile earlier that year.

Straub Chemicals is a completely fabricated corporation and according to a Google internet search, there are no known chemical corporations named as such. Nor is there a Danielle Huillet who works for this company. Straub and Huillet are a famous German/French couple who have directed numerous movies but are fairly unknown in North America. The intention of selecting these obscure names was so that they did not bias the interview participants. This is why I did not choose a company name such as “Bonsanto” which bares a striking similarity to a pesticides-producing corporation, Monsanto. Godarion is also a completely fabricated pesticide and based on a search of known pesticide names, did not seem similar to any of them. Godarion is based on the last name of French filmmaker Jean-Luc Godard.

The family of pesticides (insecticides to be specific), organophosphates, was chosen because of its use in killing mosquitoes. This ties in with the questions I have regarding West Nile outbreaks.

A common news item in the newspapers has been the reporting of West Nile virus; in particular the amount of people who die as a result of contracting the virus (Kyle, 2007; Bonnell, 2007). Often omitted are the methods used for killing the mosquitoes that carry the virus, which often involve spraying pesticides. As the scenario questions indicates, I am interested in finding out how my respondents will react to this pesticide being both approved and fast-tracked for the purpose of dealing with West Nile. Pesticides will often drift from intended crops to unintended crops, explaining why it is common to find pesticide residues on organic foods.

Such a problem raises issues of decision-theoretic scientific uncertainty because it is not simply a matter of increasing food yields or killing naturally occurring toxins (should the organophosphate also be intended for food crops) but also involves preventing death from West Nile virus. Those who are more at risk of contracting West Nile virus might be more inclined to accept the risks of this pesticide over someone who is less likely to contract the virus and is instead more concerned about pesticide residues.

- (U) [Godarion] had already been approved for mosquito spraying by the Environmental Protection Agency of the U.S. so the PMRA fast-tracked the approval process. Dr. Denis contacts the CFIA and informs them that the apples have 50% more residue than the maximum residue level.

The PMRA appears to rely heavily on the Environmental Protection Agency of the U.S.A. for their pesticide evaluation program and are working towards greater harmonization with the U.S.A. (Pest Management Regulatory Agency, 2006). The intent of this sentence is to give a sense of urgency towards the West Nile virus outbreak to explain why fast-tracking may have occurred. However, discussing the EPA is also intended to raise issues of the general reliance on one country by another for its scientific data and decision-making. I am interested in finding out if my interview subjects are concerned about the complexity of the ecological predictions being made and if it is fair to make inferences from two such ecologically-diverse nations as Canada and the U.S.A.

Lastly the 50% above the MRL is based on the hypothetical MRL that might be established in the case of drift.

As the OECD document on pesticide evaluation requirements by country demonstrates, Canada has less stringent requirements than many European nations. Based on my research, the above scenario appears to be a generous assessment of the types of tests and species required for evaluating a pesticide. This will be further examined in the Discussion section of Chapter 4.

Below are summary tables of the key additions and alterations I made to the scenarios from the information I took from the PMRA and CFIA websites. I have also included a brief discussion of the intended purpose of these additions and alterations. Indeed, the questions asked after each scenario also provided the information listed in the scenarios.

The questions that were asked after each scenario can be found in the Appendix sections H and J.

**Table 3 Experimental Scenario Summary**

| Experimental Scenario Additions or Alterations of Normal Pesticide Evaluation | Intended Purpose |
|---|---|
| Introductory paragraph. | Outlines the parameters of the scenario to let the reader know how they will evaluate the information. |
| Names of company, researchers and pesticide. | Are not associated with any known entities to ensure no bias is introduced. |
| Physical and chemical description list. | Many of the required descriptions are provided here but some are omitted to allow for interview subjects to point out missing ones. |
| Concentration levels used in the animal testing. | A control (zero dose) is omitted as one way to potentially differentiate between expert and lay since this is a fundamental requirement of scientific testing. |
| Reporting on deaths that occurred during testing. | While some abnormal behaviours were reported, I relied mainly on deaths to determine the significance of this type of reporting to the interview subjects. |
| Animals used in the testing. | Animals were chosen to comply with the PMRA requirements but additional animals were also included to determine whether there was a sufficient range of species used and how applicable different ones might be to human extrapolation. The purpose is to also determine what might constitute an acceptable minimum to the interview subjects. |
| Persistence and bioaccumulation studies. | Some studies were included despite not being required by the PMRA to also determine an acceptable minimum. |

**Table 4 Utilization Scenario Summary**

| Utilization Scenario Additions or Alterations of Normal Pesticide Use and Regulation | Intended Purpose |
|---|---|
| Introductory paragraph. | Outlines the parameters of the scenario to let the reader know how they will evaluate the information. |
| Names of company, researchers and pesticide. | Are not associated with any known entities to ensure no bias is introduced. |
| Number of pieces of fruit tested per farm. | While chosen at random, 300 is explained as being an adequate number to extrapolate data to the whole farm. However the interview subjects are asked in the interview to explain if this number is adequate to them. |
| Number of tests performed. | The number given is greater than the amount actually performed on food but is provided to determine if it is an acceptable minimum to ensure that the interview subject can feel that the food he or she is eating is safe. |
| Godarion being fast tracked by the PMRA. | This information is included to discuss the issue of the reliability of the EPA for Canadian pesticide evaluation. |
| Other actions taken by government agencies. | While this is not based on fact, it is meant to sound realistic and to raise issues around government responses to unacceptable levels of residue. The safety factor issue also allows interview subjects to discuss the science of such a concept and how malleable it is. |

## 3.3 Analysis of Data

In general, I analysed the interviews for two types of information: (1) demographic and some responses for the purpose of classification as expert or lay and (2) keywords and common issues raised and not raised among participants for the purpose of understanding how people perceive an issue involving scientific uncertainty.

**Table 5** shows the categories I used to classify the interview subjects. These include demographic classifications and expert / lay classifications. In terms of personal bias, I feel that the categories Highest Degree, Found Errors and Pesticide Related Project (as employment or as a volunteer) would help to differentiate between the experts and lay people. My bias is based largely on the assumption that an expert would have a high level of academic training in science (Highest Degree) and would therefore be able to spot errors in the scientific method (Found Errors). The expert would also have had some experience working on a Pesticide Related Project.

**Table 5 Demographic and Interview Classification**

| **Demographic and Interview Classification** | | | | |
|---|---|---|---|---|
| Interview | Sex | Work | Volunteer | Highest Degree |
| Age | Residence | Income | Used Pesticides | Organic Food Purchases |
| WTP Extra for Organic Food | Seeks Info on Organic Food | Found Errors | Pesticide Related Project | |

I had considered developing a test on pesticides and toxicology to give to the interview subjects but decided against this for two reasons. The first is the problem of making interview subjects, potential or realized, feel more like they're proving their ignorance, something I believe caused many people to decline my request for an interview. Indeed, some of the lay people raised such sentiments in their interviews. The second is the reliability of the test. In one study performed in Nigeria, 246 students and 8 teachers were tested for achievement in biology and their scientific literacy (Mbajiorgu, 2003). The researchers found that there was no significant relationship between scientific literacy and achievement in biology. In general, I feel that there is a reasonable enough gap between the knowledge and experience of the experts and the lay people to treat them as discreet categories.

**Table 3** and **Table 4** indicate specific points I was looking for when analysing the data. As Arksey and Knight (1999) point out, "[T]he way data are analysed is largely determined by the research design. In turn, the design ought to be guided by thought about data analysis" (p. 155). The two tables provide an overview of issues I thought would be raised but as the results indicate, some of the issues were not commonly raised by the interview participants. It is important to point out and understand why they were not raised. One general issue, not mentioned in the tables, I was looking for in the interviews was the extent to which interview subjects were limiting their definition of science to the scientific method and leaving out the other 3 levels of the scientific uncertainty schematic.

I did not feel that the interviews were long enough to warrant using computer-based programs such as SIMSTAT or SPSS, and coding the responses numerically would have proven difficult because of the open-ended nature of the questions.

## 3.4 Literature Reviews

Literature reviews involved database searches and reading through bibliographies of relevant articles. I also used the Web of Science database citation search, which allowed me to determine where researchers have been citing other researchers and where specific debates may have taken place.

# CHAPTER 4: RESULTS AND DISCUSSION

## 4.1 Expert and Lay Understanding of Scientific Uncertainty

The tables that show the results of the demographic questionnaire and interview classification, based on the schematic that was presented in **Table 5 Demographic and Interview Classification,** are presented in Appendix L. Because of the low number of people interviewed, it is not possible to determine the statistical significance of these answers or to show any correlation between answers found in the interviews and the demographic make-up of the interview subjects. Having a statistically significant study of this nature would be quite difficult because there are no statistics on how many people are employed or volunteer for food-oriented community groups. Many of these groups only last for a short time or go through periods of adjustment depending on public support.

However, the demographic results do provide some context for what is discovered from the interviews. Indeed it is also interesting to note that the demographic results confirm the findings of large-scale research projects that attempt to categorize attributes that make people more likely to purchase organic food, such as Robinson and Smith (2003) and Lockie, Lyons, Lawrence and Mummery (2002), both of which demonstrate that women, people with higher incomes and people with higher education are more likely to purchase organic food. So one can note that people with a greater income are more likely to have a higher level of science education and are also more likely to pay more for organic food.

A summary of these results includes:

**Sex:** In total there were 6 males, 5 females and 1 other sex.

**Age:** 1 was under 25, 7 were between the ages of 25 and 35, 3 were between the ages of 46 and 55 and 1 was between the ages of 56 and 65.

**Residence:** 11 lived in an urban setting and 1 lived in a semi-urban setting.

**Education:** 3 had a B.A., 4 had an M.A., 1 had a B.Sc., 3 had a PhD and 1 had an M.Sc.

**Income:** 1 earned less than $15,000, 2 earned between $15,000 and $25,000, 3 earned between $25,000 and $35,000, 1 earned between $45,000 and $55,000 and 4 earned over $85,000.

**Past pesticide use:** 7 said yes and 5 said no.

**Percentage of food purchased that is organic:** 42.7% average

**Willingness to pay extra for organic food:** 42.9% average

**Seeks information on organic food:** 7 said yes and 5 said no.

**Found errors in the scenarios:** 4 found errors and 8 found none.

**Work or volunteer:** 6 worked with their community group and 6 were volunteers.

**Pesticide-related projects:** 6 were involved in pesticide-related projects and 6 were not.

My hypothesis was that there was a difference between experts and lay people in their understanding of situations involving scientific uncertainty. In order to confirm whether or not my interview results confirm or disconfirm my hypothesis, a differentiation between experts and lay people must be established. Had it been the case that 6 of the interview subjects were scientists with the PMRA and the other 6 were people with no science training and little information on pesticides, it might have been easy to categorize the subjects into 2 groups. Reading through the interviews, however, it is clear that I have a spectrum of demographics and responses.

Some interview subjects with advanced degrees in science spoke little and thus demonstrated less expertise than some who had little or no science background yet spoke at length about technical aspects of pesticide evaluation and enforcement. Thus, for the purpose of comparison, I have chosen 2 groups of 2 people based on science background, involvement in a pesticide-related project and the ability to spot errors in the scenarios.

The group of lay people was composed of the 2 subjects who had no science education, were not involved in any pesticide-related project and did not find any errors. The expert group was comprised of the 2 interview subjects who had PhDs in a scientific field, were involved in pesticide-related projects and found errors. This comparison constitutes the opposite ends of a spectrum as the other 8 interview subjects did not conform to the bases of either group.

### 4.1.1 Comparing Lay and Expert Responses

**Table 6 Comparing Lay and Expert Responses**

| | **Fulton – Table 9** | **Jocelin – Table 10** | **Lorayne – Table 14** | **Ray - Table 17** | **Difference** |
|---|---|---|---|---|---|
| *Experimental Scenario* | | | | | |
| **High or Low Level of Scientific Certainty in the Safety of the Pesticide** | | | | | |
| | Mid | Low | Too early to say | Low | Little difference |
| **Enough Species Tested** | | | | | |
| | Yes | Yes | Yes | Yes | No difference |
| **Enough of a Range of Concentrations** | | | | | |
| | Yes | Yes | No control | Can't be determined | Experts need more information |
| **Continue Using Organophosphates Against West Nile Virus** | | | | | |
| | No – there are alternatives | No | Yes but maybe not this pesticide | Depends on the alternatives – cost/benefit issue | Some difference |
| **Stop the Testing to Stem the Malaria Outbreak** | | | | | |
| | No - historical evidence of not enough testing (ex. DDT) | No, there are alternatives | No, go with something known | Yes such a situation is possible | One expert disagrees with the rest. |
| **Aspects of Research as Good Science** | | | | | |
| | Can't judge | Number of species tested | Good that it is monitoring death rates | Not enough scientific context to answer | Variation among all |
| **Aspects of Research as Bad Science** | | | | | |
| | Can't judge | No long-term effects, lack of interaction information in the ecosystem, not being carried out by an independent | Not targeted at the proper species, not enough modelling of where the pesticide will end up | Not enough scientific context to answer | Variation among all |

| | | | | | |
|---|---|---|---|---|---|
| | | body | | | |
| | | | | | |
| *Utilization Scenario* | | | | | |
| **Certainty of Science of Residue Level Testing** | | | | | |
| | Low | Uncertain | Not applicable to the information provided | Uncertain | Little variation. |
| **Enough Sampling** | | | | | |
| | Adequate | No idea | No answer | Yes | No variation. |
| **Food Basket as Representative of Canadian Population** | | | | | |
| | Representative of mainstream data but not for immigrants | No | Fairly typical | Seems reasonable | Lay people have some concerns – some variation |
| **Enough tests** | | | | | |
| | Unsure | No | Nothing to base this on | Rely on CFIA scientists | Variation between 1 expert and 1 lay person. |
| **Percentage Tested of Food Supply to Feel Safe** | | | | | |
| | Soil testing is better than residue testing | Eventually 100% | Probably adequate | Probably adequate | Agreement between experts with variation between lay people |
| **Prudent to Fast Track Godarion based on U.S.A. Information** | | | | | |
| | Not necessarily | No | Normal practice | Yes --- they have better environmental standards | Experts disagree with lay people |
| **Aspects of Research as Good Science** | | | | | |
| | Adequate Sampling | The fact that they are testing food | No answer | Can't answer, must rely on government scientists | Experts find no good aspects. |
| **Aspects of Research as Bad Science** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | Fast tracking, changing residue allowances, overall lack of information | Fast tracking, changing residue allowances | Changing residue allowances, not enough detail on how foods are sampled from the food basket, fast tracking, unclear labelling change | Can't answer, must rely on government scientists | Little variation except for 1 expert. |

**Table 6** illustrates that there is usually some variation between experts and lay people in this sample; thus, my null hypothesis that there is no difference between experts and lay people is false. In general, it appears that the experts in these interviews are more willing to rely on the government scientists to do a proper job of keeping Canada's food safe, something which is often found in the literature (as discussed earlier in the Introduction, Chapter 2 on Expert and Lay and Methods, Chapter 3).

While both experts and lay people had reservations about the type of information in the scenarios, the experts looked for more and/or different scientific information, indicating a need for relying on deductive reasoning rather than inductive reasoning. Ray was reluctant to label anything in the utilization scenario as science which indicates an adherence to science only involving the body of scientific knowledge and not including any of the social aspects. His reluctance might be explained by the lack of a hypothesis in this scenario, a necessary component of the scientific method, as the scenario dealt with monitoring pesticide residues, not experimenting with methods of experimentation. The opinions from the other interview subjects were not as clear as Ray's, so for future scenarios I would add a question that explicitly asks if people view science as being confined to the scientific method, or if social issues are also part of science in their opinion.

These responses seem to indicate that lay people tend to view food technologies, such as pesticides, as posing greater health risks than experts. (This is also similar to the findings in the literature on expert and lay people's perception of food technologies and risk and with the deficit model). As will be discussed further in the next section, this has to do with a lack of trust on the part of many lay people, and some experts. Fulton's response about the problem with the lack of early DDT testing is a good example of this.

The two scenarios did prove, for the purpose of comparison between expert and lay, to be an adequate test of determining errors in the scientific procedures of the experimental scenario and the introduction of potentially greater risk in the utilization scenario. This was a crucial part of the research design as I needed a variety of ways to differentiate between interview subjects that included more than looking at their academic credentials.

However, the scenarios did demonstrate that the interview subjects were not in their domain of expertise, which seemed possible considering the lack of pesticide research and policy work that occurs in the community groups in the area. All of them mentioned at some point their lack of training or knowledge on, at least, a particular topic. While some of the subjects with science education were able to find errors in the scenarios, not all of them did and only 1 person, Lorayne, used a technical acronym, indicating prior specific knowledge of pesticide evaluation and utilization. There were also very few instances of people finding missing components of a toxicology database and no one brought up the fact that Straub chemicals has no responsibility to do residue testing.

Even though things such as a control are crucial components to all scientific testing, it is clear that expertise in other domains does not necessarily transfer to this domain. But to reiterate, these particular 12 interview subjects, rather than 12 random people, are important for this thesis because they are all part of environmentally-concerned community groups where pesticides might be of particular importance. The interview subjects classified as experts are people with considerably more science experience than the people classified as lay. The implication of this is that even with considerable science experience (such as a PhD in the natural sciences) it is difficult to answer the question of "is this apple good for me?"

As for any mention of the benefits of non-organic food, there were none. This subject can be posed in future uses of the scenarios but no one mentioned that, as an example, using pesticides is good science in the utilization scenario, or that it was good science that godarion increases yields in the experimental scenario.

## 4.2 Discussing the Results Through an Ecofeminist Lens

### 4.2.1 Pesticide Industry and a Dominator Consciousness

The process of re-evaluating pesticides in Canada has been a slow and inconsistent process according to the March 2008 report of the Commissioner of the Environment and Sustainable Development (CESD). Particularly troubling are the 235 remaining active ingredients in pesticides that are to be re-evaluated based on recent developments in pesticide testing since 1995. The CESD states that the PMRA has set a goal of 2 years for completion but also notes that it took the PMRA 6 years to complete the re-evaluation of 166 active ingredients, that the target for completion has changed 3 times since the beginning of this decade and that the PMRA "never developed a detailed action plan with timelines to guide its progress" (Commissioner of the Environment and Sustainable Development, 2008).

The report does find some improvement in the monitoring of pesticide residues in Canada and points out that the CFIA is working towards testing for the 190 active ingredients that the CESD found were not being tested for in 2003. New methods are being developed and researched to increase the number of active ingredients being tested from 269 in 2003, to 300 currently, and up to 140 additional ingredients in the future.

In terms of the pesticide industry, Agriculture and Agri-Food's 2007 report on pesticide pricing and availability in Canada describes the market as such:

> The Canadian pesticide industry at the retail level is worth about $1.2 billion (1996) which represents approximately 3% of the world

pesticide market. The world pesticide industry is dominated by a relatively small number of manufacturers (approximately 15) supplying a large number of active ingredients. It is estimated that 10 of these companies produce 90% of the world's active ingredients.

In the U.K., the pesticide industry is an over $1billion CDN industry. But Jules Pretty also states that consumers in the U.K. pay roughly $250million CDN for cleaning up water from leached pesticides (2003, p. 41).

As Rachel Carson describes it, the war on insects is a war that will never be won (1962, p. 8) since insects will develop immunities to the pesticides. Thus the pesticide industry will, most likely, always be able to devise new pesticides to kill the new pests. Instead of attempting to control the pests through more sustainable methods of pest control such as organic farming, biodynamic and Integrated Pest Management, the pesticide industry maintains its ability to make money.

Vandana Shiva discusses such problems of the dominator consciousness by describing how science operates. She points to three ways that this form of knowledge excludes other forms of knowledge:

> (i) ontological, in that other properties are just not taken note of; (ii) epistemological, in that other ways of perceiving and knowing are not recognized; and (iii) sociological, in that the non-specialist and non-expert is deprived of the right both to access to knowledge and to judging claims made on its behalf (1988, p.30).

Applying Shiva's analysis to pesticides, it becomes clear why alternatives to pesticides might not be considered when testing for a new pesticide, why theoretical foundations of toxicology may not be considered when evaluating pesticides and why few studies of pesticides have studied the impact on farm workers that handle the pesticides (Reeves & Rosas, 2003, p. 17).

But resistance to the problems associated with the dominator consciousness occurs on many levels and has assumed a greater standing since the early 1960s when the second waves of both the Environmental movement and the Women's movement took form; the inspiration for these two movements came after the publication of *Silent Spring* (1962) and *the Feminine Mystique* (Friedan, 1963). While few explicit links were made until the 1970s and 1980s, it is clear that both movements were based on the capacity to resist a dominating consciousness by placing more control in the hands of the people who have borne the problems associated with the destruction of the environment and the oppression of women.

Incorporating the responses from the interview subjects, we can gain a better sense of the specific concerns that were raised with the scientific uncertainty of pesticides. As Shiva has pointed out, science cannot be limited to what is normally thought of as science - namely the body of knowledge produced by the scientific method. The responses demonstrate concerns against the dominator consciousness and include concerns for social issues.

### 4.2.2 Body of Scientific Knowledge

Most of the issues involving the body of scientific knowledge, as discussed by the interview subjects, were addressed in the first section of this chapter.

The problem of scientific uncertainty due to the complexity of the ecological prediction being made will always exist, as long as pesticides are used in open environments. For example, during my literature review I found very few papers which address changing temperature and its effect on pesticide residues, if even to say there is little relationship between the two (see Ma, Li, Harner and Cao [2007] for an example of a paper that discusses how pesticides affect surface air temperature). So our knowledge of changing soil climate and pesticides is very limited.

### 4.2.3 Professional Identity / Technical Work

When asked to consider the potential cost of residue testing, many interview subjects stated that they thought the acceptable percentage of residue testing was one that was statistically representative of the food consumed in Canada. But an alternative answer with which some responded was similar to the one Kerrie presented: “As a percentage, you’d probably be safe with 1 or 2 percent. Although if you eat organic it avoids quite a lot of that problem” (**Table 13**).

The percentage of food tested is an example of pragmatic uncertainty because all food cannot be tested for residues, as testing destroys the food and testing is expensive.

The introduction to Guzelian et. al.'s 2005 article on evidence-based toxicology is especially relevant to this section as the authors state as a way of explaining the importance of their paper that, "Toxicologists often fail to acknowledge explicitly (particularly in regulatory and policy-making arenas) when shortcomings in the evidence necessitate reliance upon authority-based opinions, rather than evidence –based conclusion" (p. 161). This means that while it would be helpful to have test instruments that detect what toxin in a person's body gave them cancer, such an instrument does not exist. Methods of inference must be used and in the Guzelian, et. al. paper, this can mean going on experience or colleague-consensus instead of evidence to make policy decisions. Such positions do little to refute the potential for toxins to have later-term effects.

Using authority-based opinions in toxicology also highlights how professional identity plays a role in scientific uncertainty. Guzelian et. al. point to the lack of acknowledgement that authority-based conclusions are being made instead of the more ideal evidence-based conclusion. Such a lack of acknowledgement points to either a belief that authority-based conclusions can be as reliable as evidence-based conclusions, or to an implicit effort at preserving one's authority.

However, some interview subjects had more trust in the scientists doing the residue testing. Zack (**Table 12**) says, "[a]nd really for all of its shortcomings the scientists [at the federal government] have had the training that is, about what we can offer as a society right now."

Fulton, on the other hand, took a novel approach to residue testing which would radically change the work of technicians. He states, "[T]he thing is for me to feel safe that the food that I'm eating is not really about residue testing. It's more about the whole method, basically what it comes down to is the health of the soil for me" (**Table 9**).

### 4.2.4 Scientific Community

The current regulatory industry for pesticides does not conform to Zack's idea of good science:

> Probably the most hopeful element of good science is that it's subjected to peer review… that it's done among a wide community, that it's done transparently and [that it's] subjective and responsive to wide scale criticism and improvements. That's the important part, there's a lot of eyes on it and that it's responsive (**Table 12**).

The epistemological foundation of the industry does not allow for a responsive system due, perhaps, to the deficit-model mindset of policy-makers and scientists, or perhaps to a lack of sufficient people working at governmental organizations such as the PMRA. (The 2003 October Report of the Commissioner of the Environment and Sustainable Development (CESD) outlines many of the issues being affected by the people and policy at the agency).

But as the 2003 report of the CESD also explains, there are benefits to pesticides. This makes it necessary to reconcile environmental and development objectives. Farmers are not the only people who see economic benefits from pesticides; people who work in factories that produce the pesticides and the people who work in the oil industry who supply the pesticide industry with raw material also benefit. So all citizens both suffer and benefit from the consequences of pesticides. But it should be decided to what extent people will suffer and benefit at the expense of others based on a sense of equality and understanding of interconnectivity between all humans and the environment.

Karin Bäckstrand's (2004) critiques of eco-modern, eco-feminist and post-modern interpretations of science and civic participation are useful for this discussion despite her position that ecofeminism rejects outright scientific rationality. Though this is the case for most ecofeminist scholars, alternative approaches, such as one which seeks to critique problems in the regulatory industry for pesticides, have rarely been discussed. Instead, she recommends that we can:

> attempt [to] redefine and modernise scientific rationality, by making it more sophisticated, reflexive and self-critical. Sub-politics and the critical 'counter-experts' of ordinary citizens and grass-root movements will enhance the reflexive dimension of science, which will ultimately propel the democratisation of scientific expertise (p. 710).

As a stepping stone to discussing changes to the scenarios further on, I quote Sherilyn MacGregor (2006) who states that "[i]f citizenship is about self-expression and discovery and a commitment to developing a political ethic in a public sphere, then the project of feminist ecological citizenship must address the question of how these aspects might be cultivated" (p. 225).

Therefore the scenarios must be developed so as to address the complexity of the uncertainties (scientific and otherwise) in a way that challenges members of the community group to seek meaningful actions that can be taken to ensure that their voices are heard and that others are heard as well.

Animal testing concerns were raised by several interview subjects. In particular, Lorayne raised the issue around the amount of animals tested in the scenarios, saying, "I also don't want to encourage a lot of animal studies either so you know, I think this is enough animals that are exposed" (**Table 14**). Chelsey agreed and looked to alternatives; "I would wonder if there were other ways to test these products without having to use animals" (**Table 16**).

The subject of animals and ecofeminism has been taken up by many ecofeminists. They see speciesism as another type of hierarchical domination like racism and sexism (Gaard, 2002; Adams, 1993) and such considerations cannot be ignored if the goal of ecofeminism is the elimination of all aspects of the dominator consciousness. In her article, which includes a significant focus on animal experimentation, Lori Gruen explains that one of the consequences of animal testing is the reinforcement of a falsely objective and detached scientific community, one that is more concerned with "progress" than with making real improvements to people's lives (1993). And animal testing ignores the health of the animal. Nowhere in the literature on organic food is it mentioned that one of the benefits of eating organic is that less animal testing is needed (or possibly none, depending on the use of natural pesticides, such as the one discussed in the introduction to the article by Zang, Fukuda and Rosen [1997]).

Most people who expressed concerns with animal testing were doing so from a moral position. One interview subject did express concerns over extrapolation from animals to humans by saying, "Well I'm not a trout and neither are my kids so I guess they're closest to chimpanzees; as I said I don't know what else the chimpanzees were exposed to so I don't know how much that would compare to what my life or my kids' life is like" (Audrey, **Table 11**).

Animal testing also raises the issue of how effective an inference one can make from animals to humans. Certain animals yield applicable results for different tests and the scenarios reflect this in the wide variety of animals tested. However, because all animals are different (though this might change with the advent of better cloning technology), there will always be some variation within species. There will also always be variation among humans since no human lives in a completely controlled environment. Thus safety factors, which are meant to statistically account for applicability from the results yielded during animal testing, are applied. However these statistical calculations are only meant to approach, but not attain, a risk-free level as is outlined in the Food Protection Quality Act.

Tim Stroshane (1999) points out that the U.S.A. used to use a more precautionary approach for pesticide residues but changed to a standard based on "negligible risk" in 1996 when it passed the Food Quality Protection Act (see also Ostenn and Padgett [2002]). This meant instead of banning any pesticides that produced carcinogens, maximum amounts were now allowed. The shift in policy became a problem last year when the unions representing the EPA's scientists said that even those maximum residues limits were enough to be neurotoxins and that the government was wrong to allow them to be used (Local Presidents of EPA Union, 2006) (More comment is provided in Phillips [2006]). If empowering parents to make good decisions about the food they feed their children is important to our society, ignoring the very scientists who are supposed to determine the safety levels will not instil much confidence. Such a disagreement between scientists and policy makers highlights the need to distinguish between levels of the schematic. In this case, the position of the policy makers is that there is enough uncertainty about the need for a precautionary approach that maximum residue limits are acceptable or that there is enough certainty the maximum residue limits will be adequate for human safety.

### 4.2.5 Groups that Affect or are Affected by Science Policy

The results presented in this thesis demonstrate some clear concerns with who is performing pesticide evaluation and residue testing. One concern could be that making money might be more important than public health. One paper written on this subject by industry scientists cites “chronic resource limitations on the public sector” (Barrow, 2006, p.153) as one of the reasons why industry performs these tests but their other reason might be more telling; namely, that it reflects "the free enterprise view that those who benefit from an activity should bear the costs of that activity as well...” (p.153).

With the model of producer-pays, there is no opportunity for those who may suffer the consequences to express concern including the participation of people who live near the factories where the pesticides are produced. As Alexus explained, "Part of my concern about residue levels in food is that the PMRA, which is supposed to be part of Health Canada, is very much an industry lobby group in the experience that I've had with everything from working with farm workers to doing consumer products" (**Table 18**).

Another common problem that several interview subjects found was the type of people excluded by virtue of the foods listed in the basket. Many believed that Asian people in particular would be excluded from the food basket since these respondents felt that the foods that Asian people might eat were not on the list. However, some believed that testing certain vegetables would capture similar vegetables (Ray, **Table 17**). For example if lettuce was tested, it would stand as a test for bok choy. Betty took a different approach and focused on the potential for people with lower incomes being excluded from protection from residue testing. She stated, "Are we serving a population that can afford to eat the foods on this list or are we serving a population that's not?" (**Table 19**)

Conversely, many interview subjects believed the food basket was fairly representative of most Canadians. The food basket does not address shifting demographics, however, and with more and more Canadians born in other countries, this might mean it should contain radically different foods. Without adjusting demographic concerns, we run into a problem of statistical uncertainty, as one can hypothesize that these foods were calculated to be representative of all Canadian food purchases.

Speaking to the issue of audience-based uncertainty is the question of how different nations can have radically different standards and requirements for pesticide evaluation as indicated by the OECD report *Persistent, Bioaccumulative, and Toxic Pesticides in OECD Member Countries (2003)*. While it is clear that different nations have different environments (and radically different environments within those nations when considering nations such as Canada) it is unclear as to what extent this determines the variation.

For example, it is unclear why Norway would have more stringent requirements of evaluation for persistence based on vapour pressure. As discussed in the introduction, it appears that differences in requirements might be related to risk assessment. So if a nation does not require additional testing as Norway does for vapour pressure levels when considering persistence, then one can assume that the decision makers in that nation have determined this to be low-risk. Rothstein, Irwin, Yearley and McCarthy (1999) offer many explanations for differences between nations, in particular the control that the pesticide companies wield over the government regulatory bodies in determining evaluation policies and procedures (p. 256).

But efforts are underway in Canada, the U.S.A. and Mexico to harmonize pesticide regulations through the North American Free Trade Agreement's (NAFTA) Technical Working Group on Pesticides with the expressed goal of "develop[ing] a coordinated pesticides regulatory framework among NAFTA partners that will allow for the creation of a North American market for pesticides and make work sharing the way of doing business in the continent" (Environmental Protection Agency, 2008) . In Canada this has meant an increase in allowable residue limits in 40% of pesticides (Patterson, 2007). As Richard Aucoin, the chief registrar of the PMRA, explains in the same article, the U.S.A. allows higher residue limits because of the normally warmer temperature which means more pests.

Some of the interview subjects did, however, express some trust in the U.S.A.'s pesticide evaluation program when faced with an outbreak of West Nile virus. As Clark states, "It's the kind of thing that being fast tracked to control a specific outbreak but not to give long term registration I feel that's a prudent response" (**Table 20**). Although Jesse disagreed with the fastracking of godarion by saying, "I really feel like, and certainly we have different situations and different ecological realities here than they do in the United States so I think that the more testing the better" (**Table 15**).

Only 2 interview subjects discussed the issues raised in the interviews with respect to children or to being a parent and neither expressed any desire to rely on normal expert advice. However, the issues raised from the critique of scientific motherhood are applicable to all people considering all of the interview subjects reported that they do the food shopping alone or with their partner. As Rima Apple discussing scientific motherhood states, "A woman's place remained in the home where mothers were accorded full responsibility for all things domestic... though still being told that mothers needed the assistance of medical and scientific authorities in order to carry out their maternal duties successfully" (1995, p. 178).

As was mentioned in the introduction, motherhood is also invoked as a position of strength, one which rejects the assumption that mothers are caught in the bind of scientific motherhood.

Discussions of activist work taken up by mothers (such as anti-militarist groups described by Sturgeon in 1997) appear to argue that motherhood can transcend basic nurturance to go to great lengths to protect one's children from risks such as those from the threat of nuclear war (which can be considered short-term, long-term, acute and chronic, depending on one's views).

Harriet Rosenberg (1990) argues that such activist work need not radically change notions of motherhood and states, "[L]ove, attachment and security are still highly valued, and these values in relation to the home have been politicised" (p. 140). Penny Van Esterik argues the same when discussing the intersection between women's rights and the right to food. She argues that "[W]omen's identity and sense of self is often based on their ability to feed their families and others; food insecurity denies them this right" (1999, p. 225) although I would add, "their ability to feed their families and others *healthy food*."

However, invoking motherhood ideology as a way to argue for ecofeminist activism and theory can also be problematic when it is used to argue for women's (at least partially) natural connection to nature and its protection. Sherilyn MacGregor (2006) refers to this as eco-maternalism and explains that proponents "emphasize that the link they make is a socio-material and experiential one: women's mothering and caregiving work mediates the relationship between people and nature and thereby engenders a *caring stance* towards nature" (p. 4, italics original). As MacGregor asks, "Is [motherhood] all about care and cooperation? Or are more complex and multilayered interpretations possible?" (p. 64). These other possibilities include, "religious belief, academic training, scientific and philosophical curiosity, national and regional forms of identity [and] attachment to places or landscapes" (p. 64) and MacGregor points out that few of these have been discussed in ecofeminist literature.

The ethic of care is even more problematic when applied to men. Even if it is true that "[M]othering *work* is no longer distinctly feminine" (Ruddick, 1994, p. 35), it is still the case that men earn more than women and as a result, the majority of children who are poor are poor because their fathers earn little money or because their fathers are absent and give little to no child support (Marsiglio, Amato, Day and Lamb, 2000, p. 1182). So there is still incentive for families to be structured with the male being the principle breadwinner, although that does not mean that the mother is not working outside of the home, in addition to her domestic work (Luxton, 1990). In terms of normative appeals to gender-based thinking, when explaining the risks of food technologies for children to fathers it would be more successful to appeal to a man's abstract thinking and concern for justice (MacGregor, 2006, p. 63) than to an ethic of care.

Thus while an ethic of care is a meaningful basis for arguing for the need for greater control of pesticide use (as an example) to many people a citizen-based approach can have a much broader appeal. MacGregor defines a citizen-based approach as "provid[ing] an inclusive space for the public performances of political subjectivity that destabilize and resist dominant ideologies of gender" (p. 6). These spaces can range from a small community group to complete overhauls of the socio-political structure, such as a society based on social ecology where people live in small cohesive groups and where everyone gets to determine how their group will function (this is a very limited definition of social ecology where the important point is that there would be only limited decision-making structures beyond the small group, ie. no federal and provincial structure). For the purpose of this thesis I will focus on greater control over scientific decisions within a similar socio-political structure to the current one.

More public participation in scientific decision-making has been put forward by social scientists as a possible solution to social distrust or rejection of governmental scientific bodies (Shrader-Frechette [1985] outlines some specific structures for increased public participation). Often described through case studies, these articles (such as the articles on the Mad Cow crisis as discussed in the following paragraph) outline where public dissent has occurred, how experts responded to such situations and in some cases, how the public was allowed to participate.

The Mad Cow crisis in the U.K. has received particular attention (see, for example, Miles and Frewer [2003] and Irwin [1995]) because the government went to great lengths to convince the public that there was no concern when the story first broke. As the Lynn Frewer, et. al., study (2003) demonstrates, such a response is seen as ideal by many scientists. Frewer, et. al., sum up the position of the majority of the scientists interviewed by stating, "that providing the public with information about uncertainty would increase distrust in science and scientific institutions, as well as cause panic and confusion regarding the extent and impact of a particular hazard" (p.75).

But subscribing to these deficit models (as discussed in section 2.4) can lead to two major problems. The first is that "because [these deficit models] de-emphasize the consideration of affected interests in favour of 'objective' analyses, [these deficit models] suffer from a lack of popular acceptance" (Renn, Webler and Wiedemann, 1995, p.1). This is to say that recommendations or findings from scientists would not automatically be rejected but more that some people need to know that their interests are being considered. As one interview subject said, she does not feel like U.S.A. and Canada harmonization does anything to help her as a mother, in terms of raising healthy children (Alexus, **Table 18**).

The second problem identified is, "because they rely almost exclusively on systematic observations and general theories, they slight the local and anecdotal knowledge of the people most familiar with the problem and risk producing outcomes that are incompetent, irrelevant, or simply unworkable" (p.1). As Alexus explained, her experience on one government advisory committee was that there were more people represented from industry than all others combined, including consumers and farmers.

Community groups using the revised scenarios to discuss issues of scientific uncertainty presents a good start towards greater civic participation.

The following section explicates the definition of the deficit model and describes what a shift away from it might look like. I do so by comparing the status quo and the alternative, component by component of the deficit model.

### 4.2.6 Deficit Model and Civic Science

Referring back to the definition of the deficit model on page 38 and using apples as an example there are four important components of the deficit model. The first is that a common value shared by people in modern society (such as Canada) is to grow as many apples at as low of a price as possible (optimizing productivity), assuming acceptable levels of risk. In section 2.5 I explain how the cost of apple agriculture is broken down and how organic agriculture affects yield. In general organic agriculture is more expensive for farming and produces lower yields, thereby increasing the price even more than just from the cost of agriculture.

A civic decision making model would open this assumption up to discussion. The increase in demand for organic food (with sometimes lower yields and higher prices) as discussed on page 42 is a good indication of a large segment of Western societies rejecting the first component of the deficit model. Civic decision making would allow for the presentation of all viewpoints to determine whether the optimization of productivity is in fact a shared value and if not, what model of production is more desirable (such as subsidies for organic fruits and vegetables to bring the prince in line with non-organic food).

The second is that the level of acceptable risk found in the value of optimizing production is at least widely agreed upon by all people in that society. An example of this is the tacit approval of how pesticides are evaluated and controlled in Canada (I say tacit since there is little public complaint directed towards the PMRA). Setting aside the lack of media scrutiny over the PMRA, the definition of acceptable risk is contentious among active participants in pesticide evaluation and control. As I discussed on pages 33-4 the EPA scientists disagree with the government over maximum residue limits and feel that the government is taking too much risk with their decisions. Thus despite the scientific evidence produced by the scientists, which most likely involved higher risk tolerance than is desired by lay people (as I discuss on page 37), the government adopted an even riskier policy.

The passing of the Food Quality Protection Act in 1996 (as discussed on pages 99-100) by the U.S.A. government is further evidence that there is not universal agreement on acceptable levels of risk since the act allowed greater risk from pesticides than before. It is hard to imagine that there was a large grassroots movement of citizens pushing for an increase in carcinogens so long as they posed only a negligible amount of risk or that food prices were reduced as a result of greater risk.

A civic decision making model would be able to actually determine acceptable levels of risk based on the interests of human, animal and environmental health, growers, pesticide producers and personal cost. Acceptable risk might still include the use of some synthetic pesticides and does not necessarily mean that universal organic agriculture is ideal. Depending on the situation, it might be that there is less risk to human health from a pesticide used against apple scabs than from the scabs itself. A shift away from the deficit model does ensure that the definitions of acceptable risk are no longer strictly decided by non-governmental organizations (such as COABC) and the provincial, municipal and federal government bodies (such as the CFIA and the PMRA). For example as discussed on pages 102-3 the PMRA has allowed increased residue limits based on trade decisions and not human and environmental health decisions.

The third component is that when dealing with issues of risk management for pesticide residues from apples scientific evidence is the best and primary type of information needed for decision making. This presents an interesting problem because while the definition of the deficit model does not explicitly limit the definition of scientific evidence to that from the natural sciences such a limit is implied. The OECD (2003) paper is a good example of this where the biological, chemical and physical aspects of toxicology are generally agreed upon but ecological scientific evidence requirements varies from country to country. There is little acknowledgement of this oversight and little concern over the ecological scientific disagreements from a human, environmental and animal health standpoint since most attempts to harmonize pesticide evaluation standards are for market harmonization.

Civic decision making emphasizes the expanded definition of effective and desirable knowledge to include other sources of knowledge at all stages of decision making. This includes both expanding the definition of science to include other disciplines such as ecological sciences and social sciences and also local and traditional forms of knowledge which might not be directly related to the sciences. Growers and consumers would be able to have their input and hear from others on ways to improve the production of goods and risk control. All of the interested groups would be able to discuss all issues of the scientific uncertainty schematic as the issues raised in section 4.2 are varied and complex. Thus even animal rights organizations would have the opportunity to discuss the problems associated with animal testing which can include problems with human to animal extrapolation to the ontology of animals.

And it is only through building understanding of different epistemologies on all components of the deficit model that consensus can be built since the deficit model relies on the assumptions of a solitary point of view, all of which inform one another. Vandana Shiva's critique of scientific knowledge, as discussed on pages 92-3, is especially pertinent to a critique of the deficit model, in particular her focus on the epistemological constraints of the production of scientific knowledge (for example prioritizing particular disciplines of science, such as chemistry and biology) and the sociological constraints whereby lay people are not encouraged to make their own decisions (as discussed regarding scientific motherhood on pages 29-30), which is discussed in the next paragraph. An ideal form of civic decision making would not only encourage greater participation within decision making bodies but would also encourage the institutions responsible for the production of knowledge (such as schools and grant making organizations) to understand the problems of the deficit model and work towards adopting the principles of civic decision making.

The fourth component is described as when people purchase organic apples they are doing so because they do not understand the scientific advice from scientists who say that foods grown with conventional methods are just as safe as organic methods. However, as I discuss on page 39 scientists themselves are not as consistent as they would like to believe when it comes to complying with expert advice, nor should it go without saying that expert recommendations often come from authority-based and not evidence-based grounds (as I discussed on page 95).

In terms of this component it is important to stress both the necessity for scientists to consider other forms of knowledge and to not condescend to lay people and that a certain level of domain specific knowledge is necessary for critiquing toxicology (as an example). Any move towards civic participation in scientific decision making would require lay people to become familiar with how toxicology is performed and studied (as Appendix M demonstrates there was a clear desire from interview subjects for such information when answering questions regarding the scenarios). In other words there would be a duty on both sides (experts and lay people ) to become more familiar with each other's basis and requirements for reliable knowledge to work towards a working model of science based on good evidence and open debate. The article by Reed &

McIlveen which analyzes a community forest pilot project, as discussed on page 28, provides a good example of a move towards civic decision making that emphasizes both lay and expert knowledge and participation.

In the next section, I will outline the changes that I have identified as being more useful for community groups to better understand that the relative safety of organic food is complex and subjective and how their group can engage with issues involving scientific uncertainty (such as pesticide evaluation policy of the federal government).

## 4.3 New Scenarios

The following quote is one of the few comments made on the scenarios by the interview subjects. "[The utilization scenario] is way more easy to understand. I like this one better. You should turn [the experimental scenario] into this somehow" (Chelsey, **Table 16**).

There were, however, numerous components missing according to the interview subjects in order to make a more informed decision (see Appendix M for a full list for both scenarios). This lack of direct scenario critiques means that I should have added a specific question on how to improve the scenarios. However, it might also be the case that the Informed Consent form was adequate in describing the purpose of scenarios and that the interview subjects were focused on responding to the questions based on accepting the scenarios as plausible situations. The question that I could have asked at the end of the interview would encourage people to step outside of the frame of each scenario and consider it as an educational tool and critique it from that standpoint.

Based on the types of information raised, and not raised, by the interview subjects, I have identified four main areas in which the scenarios should be changed. They involve issues of pesticide activism, social value of food, readability and domain expertise and the 4-level schematic of scientific uncertainty.

### 4.3.1 Pesticide Activism

In terms of setting priorities, it is important to consider the overall goals and focus of discussing pesticide issues. For example, in British Columbia, agricultural pesticides account for less than 25% of pesticides used in the province; the vast majority are wood preservatives and anti-sapstain chemicals (ENKON Environmental Limited, 2003). Of all the pesticides used in the province, Creosote accounts for 47% and is listed as a possible carcinogen by the EPA (Environmental Protection Agency, 2007b). Thus, if one's goal is to see as big an impact as possible in the reduction or elimination of pesticides in B.C., focusing on Creosote might be more effective than on an organophosphate.

This scenario would encourage avoiding problems with "efforts to reduce pesticide-related risks to consumers and farmworkers often neglect the possibility that measures to reduce the target risk may introduce or enhance countervailing risks" (Gray & Hammitt, 2000, p. 665).

Background information on the history of pesticides, the structure of the pesticide industry, the structure of the pesticide regulatory bodies, critiques of toxicology and benefits of pesticides would also be included.

The first thing the participants would discuss is what sort of goals they'd like to accomplish through discussing these issues and using these educational tools. A scenario or background report that lists such issues would certainly change the issues that are considered in the experimental and utilization scenario. Indeed, it would change the entire structure of the scenario and provide greater domain expertise to the participants by giving them some sense of an epistemological foundation based on more established goals, rather than simply helping out a kind grad student (as might have been the case). Instead, it is hoped that the scenarios would be considered in the context of an over-arching civic policy on pesticide use for food that recognizes different people's interests in the current structure and how those interests might change in different structures.

### 4.3.2 Social Values of Food

The social values of food is another topic that might be useful to discuss before reading through the scenarios. Here, the participants can be encouraged to reflect on their relationship to food. Food has a deeper meaning than simply nourishment and by discussing cultural connections to foods, the participants would be asked if they are willing to risk more for culturally-significant foods. For example, if turkey contained more pesticide residues than chicken, would this prompt people to eat chicken instead of turkey at Thanksgiving? Apples raise specific issues because of their association with health: “An apple a day keeps the doctor away.” The participants would be asked whether or not they would assume apples are more healthy than oranges and also what they believe it is about apples that would “keep the doctor away.”

The local food movement encourages a deeper connection between consumer and producer (Fonte, 2008, p. 202). Without resorting to romanticizing food production, participants could discuss such issues as the benefits of pesticides to producers and the health risks of pesticides to farm workers.

### 4.3.3 Readability and Domain Expertise

A simple change that might make the scenarios easier to understand would be to change the titles from “Experiment and Utilization” to “Pre-Application and Post-Application.” Such a change would capture the potential for on-going experimentation and would also change the emphasis of the Utilization scenario to allow for more consideration towards regulatory control of residues.

Chelsey’s complaint (at the start of this section) was valid in the sense that the experimental scenario relied heavily on expert knowledge but there is little that can be changed without more in-depth background knowledge of toxicology. One solution would be to provide community groups with the Council of Europe’s (1992) toxicology database. This short book outlines all of the tests required for evaluating pesticides, describing them in detail, including all of the information that is required within the test. This could be used as a checklist against the experimental scenario that I devised. Participants would be asked to discuss whether scientific jargon is necessary and to what extent changes could be made to make it easier for lay people to understand the meaning behind the jargon.

However, even this database (which provides much more detail than the PMRA) does not contain many of the missing components listed in Appendix M. Addressing the possibility of such requests (as listed in Appendix M) as ensuring that animals are exposed to the same myriad of chemicals that humans are exposed to (pragmatically difficult) is why these scenarios would be used in community group settings. Certain limitations, based on cost or physical impossibility, must be addressed against a more over-arching sense of what role pesticides should play in our lives. The potential risks of not being able to determine specific types of information must be weighed against the benefits of pesticides.

While it is not possible to avoid relying on domain expertise for this scenario, questions would be expanded to include discussions on epistemological uncertainty since it might be the case that some people would like to see different standards of risk or animal testing inference. Other questions would address issues of pragmatic uncertainty such as whether or not it is feasible for 10-year animal studies on the effects of pesticide residues, and issues of methodological uncertainty such as why scientists might not have agreed on basic concepts like melting point and the implications for assumptions of today's methods involved in toxicology.

Participants would also be encouraged to discuss what they believe to be good and bad science and the extent to which outside interests such as economics, sociology and politics determine science. Once this has been established, they could discuss what a good regulatory structure would look like.

While the narrative structure of the scenario was more appealing to the interview subjects, they placed less attention on the issues raised here. I feel there are two main problems with the utilization scenario. The first is the lack of detail on how pesticide residues are tested, and the second is a lack of questions.

A revised utilization scenario would include more detail on how scientists test for residues. This would mean discussing limitations to current residue testing methods as raised by the CESD (2008) report. I would also provide a hypothetical cost for each test which people could use to calculate what reasonable percentage of the food supply should be tested, from a health and economic standpoint.

Asking more questions about things such as alternatives to the residue testing structure, why Straub chemicals is not responsible for residue testing, and why so many different government bodies are involved might have encouraged more discussion of the risks of this structure of residue testing and enforcement. For example, Audrey (**Table 11**) felt that instead of focusing on testing for residues, we should be regulating “what is allowed to go in the crops.”

Lastly, after the participants have read through both scenarios I would ask them to explain what they believe an expert needs to know and the skills that he or she should have in order to make good decisions in a situation involving scientific uncertainty and how close they feel they are to these requirements.

### 4.3.4 Scientific Uncertainty Schematic

To encourage greater consideration of science beyond the scientific method, the new scenarios would include a section to discuss the 4 levels of the scientific uncertainty schematic. By identifying the different levels, the community group participants could discuss the importance of each level towards greater scientific certainty and the relationship between the levels. By encouraging a more expanded sense of science, lay people may feel more empowered to question how decisions regarding pesticide residue testing are made.

A more nuanced discussion of scientific uncertainty is also helpful for questioning the certainty of scientists, or if certainty is a measure that one reaches towards but is ultimately unattainable. This will help in the discussion of how to approach problems of scientific uncertainty by considering the relative safety of organic versus non-organic food as a complex and subjective issue, and whether "more science" will make problems more certain.

## 4.4 Methodology

As one can see from **Table 7 - Contacting Community Groups,** there were many groups that did respond to my request for an interview but no interview took place. Some of the people who replied to my request responded by saying that the members of their organization were too busy to participate. There were some who were interested in participating but we could never find a time to meet for the interview or they stopped responding to my emails for no apparent reason. I also communicated with two community groups who felt they had no one who was qualified to participate, which is something I discuss further in the next paragraph. However, it should be noted that I did not detect any pattern to the type of community group that ended up participating versus those that did not.

While there were several reasons why some groups denied my request for an interview, there were still numerous groups that did not respond to my request. I feel this might be due to three reasons. The first is the notion of donor fatigue where community groups might feel overwhelmed by requests for help from others and might be too busy to respond to such requests or might not see any benefit from using their time to be interviewed. The second reason is a lack of understanding of my research topic, or at least the perceived lack of understanding. This was a common issue brought up by interview subjects where they expressed the belief that they were not qualified to answer my questions (but were at least willing to be interviewed in the first place). Even though I felt I had sufficiently addressed this issue in my Informed Consent form, this did not appear to be something that many people agreed with. Lastly, there may have been a fear of “proving one's ignorance,” since the evaluation process of pesticides does not appear to be common knowledge, even among those who promote organic food or the elimination of pesticides.

In Chapter 3, I discussed how I contacted the various community groups using formal email, informal email and letter. Sometimes changing the method and content of the initial contact can obscure the results of the responses. Thus while there is a bit of variation between what was said in the initial contact and in the Informed Consent form, the participants were always provided with a copy of the Informed Consent form. I felt that while the general spirit of the content remained the same, a condensed form might make people more interested in participating. I also encouraged people to ask me questions about the interview in the initial contacts and while there were the two groups that did not participate because they felt their group mandates were not suitable for my research, there was still a dialogue with them, at least for a couple of emails.

The choice of a purposive sampling method proved to be the most effective method available for attaining interview subjects. Even by using a snowball method in addition to purposive sampling, snowballing only yielded 1 interview.

In terms of the responses received, I felt gaining a varied set of interview subjects involved with different types of community groups to be important. Had they all been from groups concerned with the same issues (such as all from urban gardening groups), then it would have been something that I would have had to re-evaluate.

**Table 2 - Location of Interviews** indicates that most of the interviews took place in the interview subjects' own offices, which was their choice of location. This was to ensure that they felt comfortable and that it was at a convenient location and time. None of the interview subjects appeared to be nervous and/or rushed during the interview.

I have explained the process of the interview and Informed Consent form in Chapter 3. Most participants read through the Informed Consent quickly and some expressed concern over their ability to answer the questions due to a lack of expertise on the science of pesticides but I assured them that there were no wrong answers and that it was an opinion-based interview. Chelsey (**Table 16)** did not want to read the Informed Consent form so had me explain it to her. She told me that she felt I needed to be clearer in my Informed Consent form that the scenarios were fabricated and that I needed to be more clear in explaining my research goals.

While Chelsey felt that the fabrication was placing bias on my research, I feel that I was clear that I was expecting the interview subject to consider, or envision the scenario that I had laid out. Regardless of whether or not the scenario was true, I was trying to evaluate what different people would say to such a situation. While there are technical terms used, they were all unavoidable because there is no alternative word available. I attempted to use as much narrative as possible in the experimental scenario but it was still necessary to list all of the testing that is done on animals.

However, I do need to acknowledge that the use of technical terms will bias people with training and education in science. I did explain to all interview subjects that they were always welcome to ask questions about anything, including technical terms, but very few people asked any questions about the technical terms. Thus it is difficult to speculate as to whether everyone had at least a rudimentary sense of what was discussed in the toxicology database, or if people were unwilling to ask questions for various reasons.

My advice to future researchers would be to provide a page of background information on toxicology that all interview subjects could read before or during the experimental scenario. This way the interview subjects would have what would basically be an expanded scenario (given to every participant) and might feel more confident in giving more detailed responses instead of asking for help.

In terms of classifying respondents as expert or lay, based on responses and background, the scenarios and the questions proved to provide many opportunities for distinction. Some studies such as King et. al. (2008) rely on a more domain-specific classification system which includes, "peer nominations (to assess reputation); self-nominations; peer ratings of clinical skill, interpersonal skill, and mentorship; a measure of critical thinking ability; and therapist and peer ratings of family-centred behaviour" (p.9). This is an ideal method of classification because of its exhaustiveness but it would be more appropriate for a study that might compare responses from toxicologists.

Referring to recent debates around expertise boundaries in the Science and Technology Studies literature, Kerr, Cunningham-Burley and Tutton (2007) cite Collins and & Evans' work on defining expertise (p. 388). Expertise is based on three categories: contributory, interactional and referred. Contributory means the ability to engage with the science of one's domain; interactional means the ability to engage with other interested parties; and referred means the ability to apply one's expertise from one domain to another. Thus, work that builds on my thesis might employ more focus on the interview subject's domain expertise to determine some sense of contributory and interactional expertise.

The same article is also useful for identifying common methods of distinction between experts and lay people by discussing the content analysis work they performed at academic and social gatherings on issues of science. They cite such occurrences as people giving their academic credentials, using technical language, quoting statistics and the use of subject positions (such as referring to the superiority of expert positions). Heyworth (1999) also identifies other methods of distinction including conceptual understanding and problem-solving strategies used (often shortcuts when multiple strategies are available) (p. 209).

# CHAPTER 5: CONCLUSION

The purpose of this thesis was to examine the problem of scientific uncertainty in relation to organic and non-organic food by asking the question, "Is this apple good for me?" Using interviews from 12 people involved in community groups, I was interested in seeing if experts and lay people had a different sense of scientific uncertainty, if there was a sense that the relative safety of organic versus non-organic food is complex and subjective, and whether there was a sense of scientific uncertainty going beyond the level of Body of Scientific Knowledge.

The interviews demonstrated the difficulty in categorizing interview subjects as lay and expert but after making a distinction, it was clear that there was a difference in understanding of scientific uncertainty between experts and lay people. In terms of complexity and subjectivity, the responses indicate an acknowledgment of the complexity of scientific uncertainty but some of the interview subjects with advanced degrees in science were less supportive of scientific uncertainty being subjective. The interview subjects, for the most part, were not explicit in expanding the realm of scientific uncertainty beyond the scientific method, but many did seem open to this possibility based on the concerns they raised.

To demonstrate the complex and subjective nature of my topic, I provided an overview of the myriad of issues affecting the choice of which apple to buy. While a common response to potential pesticide residues is to purchase organic, this response does not adequately address the benefits of pesticides such as a potential for greater yields. I also described in detail the problems with pesticide evaluations and regulations that have occurred or are occurring in Canada and the U.S.A.

By expanding the constraints of what comprises scientific uncertainty to include 3 levels aside from the scientific method, the various factors affecting decision-making become clear. Determining which pesticides to re-evaluate first can be an economic or political decision, or both, as is determining what requirements a government will have for components necessary for a toxicology database. These are all subjective decisions.

Ecofeminism was chosen because of its focus on both human hierarchy and environmental problems; allowing for solutions that benefit both. I presented issues of scientific motherhood as one theory where dealing with scientific uncertainty is particularly difficult. While mothers are expected to feed their children healthy and safe food, they are also expected to rely on expert advice for what is healthy and safe. With a situation involving scientific uncertainty where even the experts do not agree, mothers must be able to access useful information to make their own decisions and also be encouraged to participate in civic decision making.

Civic decision making has been put forward as a method to help answer the question, "Is this apple good for me?" At the community group level, these scenarios, with the changes discussed above, can be used to help people engage in problems of scientific uncertainty towards solutions that benefit the environment and people. This will help people answer the apple question when they are shopping and will also encourage more efforts towards more diverse participation at the policy-making level.

It is my hope that this thesis will encourage greater focus on science issues within ecofeminist theory. I feel that an expansion of scientific uncertainty to incorporate the other levels will help ecofeminists to engage with science instead of rejecting the scientific method since this draws on their strengths as most do not come from a science background (mostly from the social sciences).

This thesis has had a positive impact on the way that I view situations involving scientific uncertainty. I am more willing and interested in examining the complexities of decision-making for food. As an example, I've become interested in reading more of the studies that the producers have solicited to defend against vegetarian and vegan claims against meat. The beef lobby in the U.S.A. paid for a study on water usage in beef production which refutes some of the earlier water usage studies. Before doing this thesis, I would have completely ignored the beef lobby study; now I'm interested in examining the methodology and comparing it to the other water usage studies.

The task of answering the question "Is this apple good for me?" is not easy but with co-operation and a willingness to understand and reflect on the issues we can empower people to make more informed decisions.

# APPENDIX A INFORMED CONSENT FORM

*Lay and Expert Understanding of "Good Science": the Uncertainty of the Harms and Benefits of Pesticides in Organic and Non-Organic Food*

This interview is part of a study to investigate the ways in which people make decisions about what constitutes good science and scientific certainty. In this study, I am focusing on food safety, and in particular about what makes some food seem safer than other food – specifically how people judge the level of their concern about pesticide residues in food, in terms of the scientific evidence for the relative toxicity of the pesticide and also for the ways in which the scientific evidence is used in controlling exposure to pesticides.

The purpose of this interview is to develop two scenarios to be used for educational purposes, to enable community groups to discuss the ways in which scientific certainty may or may not be a part of pesticide use.

As you may already know, scenarios are narratives set in the near future and are based on real-life situations, so should include as representative a set of information as possible. As well, scenarios are often constructed to give a range of possible outcomes – for this study I am interested in a best-case scenario (where you would feel that there was high scientific certainty about the effect of pesticide residues, or the amounts of residues to which we are exposed), and a worst-case scenario (where there is low scientific certainty).

The two scenarios which you will be given cover two aspects of pesticides – the first is about the evaluation process a pesticide manufacturer will go through for a new organophosphate pesticide. I've picked organophosphates because they were amongst the first pesticides to be industrially produced and also because they were amongst the first to be reviewed by the federal government in the move towards global harmonization of pesticide regulation. As well, organophosphates, as neurotoxins, are particularly good examples of the dilemma of using pesticides – they kill insects because they interfere with nerve impulse transmission, but they can kill other species with nervous systems as well.

There are several acronyms and technical terms in the scenarios and I have provided a glossary at the end of the second scenario that explains these. Please let me know (make notes as you go through the scenarios, or tell me during the interview) of any other terms which you think should be included in this glossary.

After each scenario I will ask you questions specific to that scenario. Once we've gone through the scenarios I will ask you demographic questions and questions related to your use of pesticides (such as gardening) and your habits related to purchasing organic food.

Any information that is obtained during this study will be kept confidential to the full extent permitted by the law. Knowledge of your identity is not required. You will not be required to write your name or any other identifying information on research materials. Materials will be maintained in a secure location.

Due to the small sample size (12 interviews) there is a chance that your answers could reveal who you are and those answers could potentially be subject to a court subpoena. However, I do feel that this topic has a very low risk of yielding any information that could be criminal or could jeopardize your job. Permission has been given from your organization for you to participate in this study but you may at any time stop the interview for any reason at all. Please let me know if there are any risks or concerns that I have not addressed.

Simon Fraser University and those conducting this research study subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of participants. This research is being conducted under permission of the Simon Fraser Research Ethics Board. The chief concern of the Board is for the health, safety and psychological well-being of research participants.

Should you have any complaints or questions regarding research ethics you can contact:

Director of the Office of Research Ethics
8888 University Way
Simon Fraser University
Burnaby, British Columbia, V5A 1S6

or you may contact the Director Research Ethics directly at hal_weinberg@sfu.ca
If you'd like a copy of the results, would like to give feedback on the results before they are published, or for any questions, you can contact me at bmilne@sfu.ca

Your signature on this form will signify that you have received a document which describes the procedures, possible risks, and benefits of this research study, that you have received an adequate opportunity to consider the information in the documents describing the study, and that you voluntarily agree to participate in the study.

Name

Organization

Signature

Date

I consent to the use of the name of the organization to which I volunteer or am employed by (please initial next to your response):

YES NO

# APPENDIX B INITIAL EMAIL SENT TO COMMUNITY GROUPS

I am an M.A. student at Simon Fraser University and would like to know if it would be possible to interview some of the people that work with your organization. My thesis deals with the scientific evaluation process of pesticides and I would like to create educational materials for community groups to enable them to discuss and understand such processes. The interviewees would be required to read through 2 scenarios of scientific evaluation and then answer some questions. This should take 30 to 60 minutes.

The answers that the interviewee provides would not be attributed as official policy of your organization but with the organization's and the interviewee's permission I would like to mention the name of the organization but only so that affiliation is disclosed to the reader.

I have included the informed consent form that I will be giving to the interviewees and please note that it has been approved by the Office of Research Ethics at the University.

Please let me know if you have further questions or if you deem my request satisfactory could you please forward this request for interviewees to your organization or let me know how I might go about contacting people.

Thank you kindly,
Ben Milne
M.A. Candidate, Women Studies

# APPENDIX C LETTER SENT TO COMMUNITY GROUPS

Date

Hello Community Group,

I am an M.A. student at Simon Fraser University and would like to know if it would be possible to interview some of the people that work with your organization. I'm looking for people that have either a professional interest in pesticides, such as toxicologists and nutritionists, or people with a personal interest in pesticides, such as people concerned with food production and food safety.

My thesis deals with the scientific evaluation process of pesticides and I would like to create educational materials for community groups to enable them to discuss and understand such processes. The interviewees would be required to read through 2 scenarios of scientific evaluation and then answer some questions. This should take 30 to 60 minutes.

The answers that the interviewee provides would not be attributed as official policy of your organization but with the organization's and the interviewee's permission I would like to mention the name of the organization but only so that affiliation is disclosed to the reader.

Please let me know if you have further questions or if you deem my request satisfactory could you please forward this request for interviewees to your organization or let me know how I might go about contacting people. I have included a self-addressed stamp envelope, could you please return this indicating whether or not your organization can participate, or email me this information.

Thank you kindly,
Ben Milne
M.A. Candidate, Women Studies
bmilne@sfu.ca

(Please circle one)

Our organization cannot participate

This request has been passed on to potential interviewees; you may follow up by contacting:

_______________________________________________

# APPENDIX D INFORMAL EMAILS SENT TO COMMUNITY GROUP MEMBERS

My name is Ben Milne and I'm a grad student at SFU. I'm doing my thesis on the scientific uncertainty of pesticides and I was wondering if it would be possible to interview you. My interview deals with the scientific evaluation and control of pesticides from the federal government. I've drafted 2 scenarios that you would read and then respond to with some questions.

If you're interested I can meet up with you wherever is convenient.

Thank you kindly,
Ben Milne

p.s. I've attached the informed consent form which will give you more information and I'm also happy to answer any questions you might have.

---

I'm a grad student at SFU and I'm currently doing my M.A. on the scientific uncertainty of pesticides. I'm looking for people to interview and was wondering if you would be at all interested in being interviewed. The interview takes 20-45 minutes and involves reading 2 scenarios on the evaluation and control of pesticides by the federal government. I have attached my informed consent form for more information.

Thank you kindly,
Ben Milne

---

My name is Ben Milne, you might remember me as I used to come to the VFPC meetings fairly frequently in 2005 and 2006. Anyway, I'm wondering if you would be interested in being interviewed for my MA thesis. I've attached the informed consent form which should explain most things but I'll give you a quick run-down. I have 2 scenarios on pesticide evaluation and pesticide enforcement, in relation to residue levels on food, that I would have you read and then answer questions on your opinions. Most of it has to do with scientific certainty and how confident you feel after reading the scenarios. As a nutritionist I'd be especially interested in hearing what you have to say.

Let me know if you have questions and if you are willing to be interviewed I can meet you anywhere that's convenient for you.

Thank you kindly,
Ben Milne

---

I'm an M.A. student and I'm doing my thesis on pesticides and scientific uncertainty. I found your email in the BCEOHRN database and was wondering if you'd be interested in being interviewed. I've attached my informed consent form but to briefly summarize I'm looking for the differences between lay and expert opinions on the relative uncertainty of pesticide evaluation and utilization at the federal level. The information I collect will then be used to help community groups (especially those that deal with food security issues) begin to discuss issues around science and public trust of government protection.

The interview should take roughly 20-40 minutes and I can meet you wherever and whenever is convenient for you.

Thank you kindly,
Ben Milne

---

This is Ben Milne, we met a while ago at some of the food policy council meetings. I'm currently trying to do interviews for my thesis and I was wondering if you'd be interested in being interviewed. It will only take roughly 30 minutes and all it involves is you responding to 2 scenarios that I've developed on pesticide evaluations and regulation.

I've attached the informed consent form, but let me know if you have more questions.

Thanks,
Ben

# APPENDIX E CONTACTING COMMUNITY GROUPS

**Table 7 Contacting Community Groups**

| Group Name | Date Sent | How it was Sent | Response Received | Further Remarks |
|---|---|---|---|---|
| City Farmer | 10/15/06 | Formal Email | Yes | Unable to do Interview |
| Pollution Probe | 10/15/06 | Formal Email | Yes | No one in Vancouver |
| Environmental Youth Alliance | 10/15/06 | Formal Email and Follow-up Phone Call | No | |
| David Suzuki Foundation | 10/15/06 | Formal Email | Yes | Unable to do Interview |
| Sierra Legal Defence | 10/15/06 | Formal Email and Follow-up Phone Call | Yes | No expert in Vancouver |
| Canadian Association of Physicians for the Environment | 10/15/06 | Formal Email | No | |
| Farm Folk / City Folk | 10/15/06 | Formal Email | Yes | 1 Interview |
| Sierra Club | 11/01/06 | Formal Email | No | |
| Adbusters Media Foundation | 11/10/06 | Formal Email | No | |
| Midwives Association of B.C. | 11/10/06 | Formal Email | No | |
| Quest Outreach Society | 11/10/06 | Formal Email | No | |
| Youth Environmental Network | 11/10/06 | Formal Email | No | |
| B.C. Medical Association Environmental | 11/10/06 | Formal Email | Yes | But then stopped responding |

| | | | | |
|---|---|---|---|---|
| Health Committee | | | | |
| B.C. Nurses Union | 11/10/06 | Formal Email | Yes | Sent to Listserve but no responses |
| Canadian Coalition to Stop Food Irradiation | 11/10/06 | Mail | No | |
| B.C. Environmental Network Educational Foundation | 11/10/06 | Mail | No | |
| Federation of B.C. Naturalists | 11/10/06 | Mail | Yes | Forwarded to Burke Mountain Naturalists – 1 Interview |
| Health Action Network Society | 11/10/06 | Mail | No | |
| Port Moody Ecological Society | 11/10/06 | Mail | Yes | 1 Interview |
| Saving Our Living Environment | 11/10/06 | Mail | No | |
| Science For Peace at UBC | 11/10/06 | Mail | No | |
| Soil and Water Conservation Society | 11/10/06 | Mail | No | |
| Check Your Head | 11/10/06 | Mail | Yes | 1 Interview |
| EarthSave Canada | 11/10/06 | Mail | Yes | 1 Interview |
| International Center for Earth Renewal | 11/10/06 | Mail | No | |
| Lifeforce Foundation | 11/10/06 | Mail | Yes | Unable to do interview |
| Native Plant Society of B.C. | 11/10/06 | Mail | No | |
| Alternative and Integrative Medical Society | 12/05/06 | Formal Email | No | |
| My Own Back | 12/05/06 | Formal Email | Yes | Unable to |

| | | | | |
|---|---|---|---|---|
| Yard Garden | | | | connect |
| Your Local Farmers Market | 12/05/06 | Formal Email | No | |
| UBC Farm | 12/05/06 | Formal Email | Yes | 2 Interviews |
| Hazardous Materials Association of B.C. | 01/25/07 | Formal Email | No | |
| Council of Canadians | 01/25/07 | Formal Email | Yes | Did not feel their group was suitable for this study |
| West Coast Environmental Law | 01/25/07 | Formal Email | Yes | Did not feel their group was suitable for this study |
| Food security group (anonymous) | 01/25/07 | Informal Email | Yes | 1 Interview |
| B.C. Food Protection Association | 02/02/07 | Formal Email | No | |
| B.C. Cancer Agency | 03/02/07 | Informal Email | Yes | 1 Interview |
| Reach Clinic | 04/30/07 | Informal Email | No | |
| Labour Environmental Alliance Society | 05/03/07 | Informal Email | Yes | 1 Interview |
| Canadian Association of Physicians for the Environment | 05/03/07 | Informal Email | Yes | Unable to connect |
| Integrated Pest Management Demonstration Garden | 06/26/07 | Informal Email | Yes | 1 Interview |

# APPENDIX F COMMUNITY GROUPS THAT CONTACTED ME

**Table 8 Community Groups That Contacted Me**

| Group Name | Date Sent | How it was Received | Further Remarks |
|---|---|---|---|
| Maple Ridge Community Garden | 01/02/07 | Contacted me through Food Policy Email | 1 Interview |
| Queen Quadra Elementary Garden | 01/04/07 | Contacted me through Food Policy Email | 2 Interviews |
| Canadian Cancer Society | 05/28/07 | Referred from another interview | 1 Interview |

# APPENDIX G EXPERIMENTAL SCENARIO

One of the concerns of pesticide residues is whether they're safe for human consumption. For this scenario consider that by 2010 foods will still have pesticides. Consider if they are still harmful to your health based on these scientific standards. This scenario reflects the minimum testing that will be required for a company to get approval to market a new pesticide or to market one already in use but approved based on older scientific standards.

Straub Chemicals is a leading pesticide manufacturer based in Vancouver. The Research & Development department has created an organophosphate, named godarion, which has been shown in preliminary trials to being quite effective at killing mosquitoes and much less effective at killing other species. Danielle Huillet, the lead researcher, is reviewing the tests to hand in for evaluation and is preparing a summary which is here presented:

*The evaluation package contains the physical and chemical descriptions, the toxicity in animals, the persistence and bioaccumulation in the environment and the efficacy of godarion.*

***The physical and chemical description includes:***

*Molecular weight*
*Chemical composition and structure*
*Mode of action*
*Phototransformation*
*UV-visible light absorption*
*Melting Point*
*Boiling Point*
*Viscosity*
*Vapour pressure*
*Solubility in water, alcohol and fat*
*Density*
*Particle size*
*Metabolites*
*Lethal Dose levels*

***Toxicity in animals – within each route of exposure, through the mouth, inhaled and on the skin, 5 levels of concentration of the pesticide are used with 100 parts per million (ppm) being the assumed normal application. The other levels are 400, 200, 50 and 10 ppm. The dosage is***

***set at the expected amount found in the open environment unless otherwise noted.***

Absorption, distribution, metabolization and excretion test on beagles and rats

*3 beagles and 10 rats at each level of concentration – inhalation for 7 days*
*3 beagles and 10 rats at each level of concentration – skin for 7 days*
*3 beagles and 10 rats at each level of concentration – mouth for 7 days*

*1 beagle died at 400 ppm through inhalation on day 2.*

*Long-term delayed-effect test on beagles*

*10 at each level of concentration – inhalation for 12 months*
*10 at each level of concentration – skin for 12 months*
*10 at each level of concentration – mouth for 12 months*

*All died at 400 ppm through all routes of exposure and 20 died at 200 ppm after 6 months.*

*Lifetime cumulative effects test on rats*

*15 at each level of concentration – inhalation for 2-3 years*
*15 at each level of concentration – skin for 2-3 years*
*15 at each level of concentration – mouth for 2-3 years*

*All the rats lived for their expected lifespan of 2-3 years.*

*3 generation reproductive test on rabbits*

*10 at each level of concentration for the first generation – inhalation*
*10 at each level of concentration for the first generation – skin*
*10 at each level of concentration for the first generation – mouth*

*75% of the rabbits in the 3rd generation survived past 6 months in all levels of concentration and routes of exposure except for 50 and 10 ppm where the survival rate was above 90%*

*Genetic damage and mutation test on Chinese hamsters*

*10 at each level of concentration – inhalation for 12 months*
*10 at each level of concentration – skin for 12 months*
*10 at each level of concentration – mouth for 12 months*

*10 died at the 400 ppm concentration level and 4 died at the 200 ppm concentration level all from different routes of exposure. Mutation was observed only at 400 ppm and only through the mouth.*

*Neurotoxic behaviour test on hens*

*5 at each level of concentration – inhalation for 1 month*
*5 at each level of concentration – skin for 1 month*
*5 at each level of concentration – mouth for 1 month*

*No hens died but abnormal behaviour was observed at 400, 200 and 100 ppm levels of concentration, at all routes of exposure*

*Long-term low dose test on trout*

*5 at each level of concentration – inhalation for 8 month*
*5 at each level of concentration – skin for 8 month*
*5 at each level of concentration – mouth for 8 month*
*4 trouts died, 1 at 50 ppm through the mouth, 2 at 200 ppm through the skin and 1 at 400 ppm through the mouth.*

*Short-term high does test on chimpanzees*
*2 at each level of concentration – inhalation for 7 days*
*2 at each level of concentration – skin for 7 days*
*2 at each level of concentration – mouth for 7 days*
*None of the chimpanzees died at the 100, 50 and 10 ppm levels of concentration. 1 died at the 200 ppm level of concentration through the mouth and 3 died at the 400 ppm level of concentration, 1 through the mouth and 2 through inhalation.*

***Persistence and bioaccumulation in the environment***

Dissipation field test for 50% and 90% of the pesticide to break down
*1 in clay soil*
*1 in silt soil*
*1 in sand soil*
*While these tests can last up to a year, 90% of the pesticide dissipated in all 3 types of soil by the 8th month. This was true in all 15 soil samples taken from different parts of each field.*

*Bioaccumulation test for living organisms, such as other insects not intended to be killed by the pesticide and for intended and un-intended crops.*
*1 in clay soil for 1 year*
*1 in silt soil for 1 year*
*1 in sand soil for 1 year*
*While it appeared to interact well with all soils it was also effective at killing caterpillars.*

*Dissipation water test for 50% and 90% of the pesticide to break down*
*1 in still fresh water body*
*1 in moving salt water body*
*90% dissipation occurred after 2 months in fresh water and after 1 month in salt water.*

Dissipation air test for 50% and 90% of the pesticide to break down
*90% dissipation occurred after 1 month.*

***Efficacy***

*By comparing the current crop losses due to the pest and the potential increased yields from using the new pesticide godarian was found to increase yields by*

*14% over other possible pesticides and 25% over Integrated Pest Management system.*

# APPENDIX H EXPERIMENTAL QUESTIONS

Do you believe that there is a high or a low level of scientific certainty in the safety of this pesticide?

If there is a high level, is it sufficient enough for you to consume goods sprayed with this pesticide?

Were enough species tested and was there enough of a range of concentrations?

What sort of information not presented would you want to know to make a more informed decision?

Knowing that some people die from West Nile virus do you think that we should continue to use these organophosphates even if they pose some threat to human and environmental health?

If half-way during the testing of this new organophosphate there was an outbreak of malaria would you stop the testing and use it since up to that point it was determined to be a superior mosquito killer but there was still some uncertainty on long-term health effects?

What aspects of the research would you classify as good science?

What aspects of the research would you classify as bad science?

# APPENDIX I UTILIZATION SCENARIO

Based on this scenario consider how certain you would be of the safety of your food once the pesticide becomes a residue in your food. In 2010, this is what might happen should a Canadian Food Inspection Agency scientist discover above-acceptable levels of pesticide residue in food for Canadian consumption.

Dr. Claire Denis is a scientist contracted by the Canadian Food Inspection Agency (CFIA) to do pesticide residue inspections of food eaten by Canadians. She is given different foods to test depending on the demand, the risk for high residues as determined by the CFIA and on the random selection. Her testing methods are all based on current standards and usually involve 300 pieces of food from the same farm. Based on the residue of each of the samples she can calculate the expected residue level in the entire crop. Each year roughly 220,000 tests are performed in Canada on the entire food supply.

While testing some apples from the Okanagan she discovers that they have a residue level for the new organophosphate godarion above the maximum residue level set by the Pest Management Regulatory Agency of Health Canada (PMRA). She is surprised to see godarion on the apples since they had not been approved for use on apples. Instead godarion had been approved by the PMRA for mosquito spraying because of an outbreak of West Nile earlier that year. It had already been approved for mosquito spraying by the Environmental Protection Agency of the U.S. so the PMRA fast-tracked the approval process. Dr. Denis contacts the CFIA and informs them that the apples have 50% more residue than the maximum residue level.

After doing further tests themselves, scientists from the CFIA start to look at where the godarion may have come from. Since the PMRA recently started to record where pesticides are sold and the quantity, the scientists from the CFIA are able to work with the provincial government to see who may have been contracted to do the spraying. They determine who had been doing the spraying and after investigating their spraying practices determine that they had followed the label instructions of godarion. The CFIA contacts the PMRA and Health Canada and are told that the 50% increase in residue is still safe for human consumption and so the apples can still be sold. This is because the maximum residue limit is set at a high safety factor of 100. The CFIA also requests from the PMRA that they do further testing on how godarion travels by air and that they change the label instruction to prevent cross-contamination.

# APPENDIX J UTILIZATION QUESTIONS

How certain are you of the science used to determine residue levels in food?
Is there enough sampling done?
After reviewing the possible food basket used by the CFIA for prioritizing sampling consider how applicable it is to all Canadians. How well does it reflect the eating habits of children? Of recent immigrants?
Are enough tests performed?
Consider the potential cost of residue testing. What percentage of the entire food supply would you want tested to feel certain than the food you are eating is safe?
Considering that the U.S. has more scientific resources than Canada, was it prudent of the PMRA to fast-track the evaluation of godarion to stem the outbreak of West Nile?
What aspects of the research would you classify as good science?
What aspects of the research would you classify as bad science?

# APPENDIX K HEALTH CANADA FOOD BASKET

**Dairy, Eggs and Alternatives:** Whole Milk, 1% Milk, 2% Milk, Skim Milk, Yogurt, Ice Cream, Evaporated Milk – Canned, Cream, Cheese, Cottage Cheese, Processed Cheese, Butter, Canned Cream Soup, Mayonnaise, Eggs, Milk-based Formulae, Soy-based Formulae

**Meat:** Beef Steak, Roast Beef, Ground Beef, Fresh Pork, Cured Pork, Veal Cutlets, Lamb, Luncheon Meats – Cold Cut, Luncheon Meats – Canned, Wieners and Sausages, Eggs, Chicken and Turkey, Liver Pate, Marine Fish, Fresh Water Fish, Canned Fish, Shellfish, Canned Meat Soup, Canned Broth Soup

**Breads, Grains and Legumes:** White Bread, Whole Wheat Bread, Rye Bread, Cake, Cooked Wheat Cereal, Corn Cereal, Oatmeal Cereal, Rice and Bran Cereals, Cookies, Crackers, Danish Donughts and Croissants, White Wheat Flour, Muffins, Pancakes and Waffles, Mixed Pasta Dishes, Plain Pasta, Apple Pie, Other Pies, Rice, Buns and Rolls, Other Breads, Canned Baked Beans, Peanut Butter, Mixed Cereals, Microwave Popcorn, French Fries, Shelled Seeds, Nuts

**Fruits, Vegetables and Juices:** Broccoli, Celery, Rutabagas, Beets, Corn, Carrots, Cauliflower, Mushrooms, Lettuce, Cucumbers, Onions, Peas, Potatoes, Peppers, Potato Chips, Canned Vegetable Juice, Tomatoes, Canned Tomatoes, Canned Tomato Sauce, Canned Apple Juice, Canned Applesauce, Raw Apples, Bananas, Canned Pineapple, Plums and Prunes, Blueberries, Cherries, Raw Citrus Fruit, Canned Citrus Juice, Frozen Citrus Juice, Bottled Grape Juice, Grapes, Melons, Raisins, Raspberries, Strawberries, Kiwi Fruit, Cooking Fats and Salad Oils, Margarine

# APPENDIX L INTERVIEW RESULTS

**Table 9 Interview 1 Results**

| Demographic and Interview Classification 1 | | | | |
|---|---|---|---|---|
| Fulton | Male | Work | Volunteer: NA | BA Environmental / Historical Geography |
| 25-35 | Urban | $25000-35000 | Home Use | 30% Organic Purchases |
| 50% Extra for Organic Food | Seeks Info on Organic Food | Found No Errors | No Pesticide Related Project | |

**Table 10 Interview 2 Results**

| Demographic and Interview Classification 2 | | | | |
|---|---|---|---|---|
| Jocelin | Other | Work | Volunteer: NA | University Student |
| 25-35 | Urban | $15000-25000 | Farm and Tree Planting | 50% Organic Purchases |
| 50% Extra for Organic Food | Seeks Info on Organic Food | Found No Errors | No Pesticide Related Project | |

**Table 11 Interview 3 Results**

| Demographic and Interview Classification 3 | | | | |
|---|---|---|---|---|
| Audrey | Female | Work: NA | Volunteer | MA Social Psychology |
| 25-35 | Urban | Over $85,000 | No Pesticide Use | 15% Organic Purchases |
| 30% Extra for Organic Food | Seeks Info on Organic Food | Found No Errors | Municipal Policy on Cosmetic Pesticides | |

**Table 12 Interview 4 Results**

| Demographic and Interview Classification 4 | | | | |
|---|---|---|---|---|
| Zack | Male | Work | Volunteer: NA | BSc Agronomy |
| 25-35 | Urban | $25,000-35,000 | Home Use | 95% Organic Purchases |
| 100-150% Extra for Organic Food | Seeks Info on Organic Food | Found Errors | No Pesticide Related Project | |

**Table 13 Interview 5 Results**

| Demographic and Interview Classification 5 | | | | |
|---|---|---|---|---|
| Kerrie | Male | Work: NA | Volunteer | PhD Molecular Biology / Genetics |
| 46-55 | Urban | Over $85,000 | No Pesticide Use | 75% Organic Purchases |
| 100% Extra for Organic Food | Does not Seek Info on Organic Food | Found No Errors | No Pesticide Related Project | |

**Table 14 Interview 6 Results**

| Demographic and Interview Classification 6 | | | | |
|---|---|---|---|---|
| Lorayne | Female | Work: NA | Volunteer | PhD Pharmacology |
| 46-55 | Urban | Over $85,000 | No Pesticide Use | Less than 10% Organic Purchases |
| 10% Extra for Organic Food | Does not Seek Info on Organic Food | Found Errors | Bioaccumulation Research | |

**Table 15 Interview 7 Results**

| Demographic and Interview Classification 7 | | | | |
|---|---|---|---|---|
| Jesse | Male | Work: NA | Volunteer | MSc student in Sustainable Food Systems Education |
| 25-35 | Urban | Less than $15,000 | No Pesticide Use | 60-70% Organic Purchases |
| 50% Extra for Organic Food | Seeks Info on Organic Food | Found Errors | Integrated Pest Management Education | |

**Table 16 Interview 8 Results**

| Demographic and Interview Classification 8 | | | | |
|---|---|---|---|---|
| Chelsey | Female | Work: NA | Volunteer | MA International Development |
| 25-35 | Urban | $25,000-35,000 | Pesticide By-law Inspector in Halifax | 20% Organic Purchases |
| 20-30% Extra for Organic Food | Seeks Info on Organic Food | Found No Errors | No Pesticide Related Project | |

**Table 17 Interview 9 Results**

| **Demographic and Interview Classification 9** | | | | |
|---|---|---|---|---|
| Ray | Male | Work | Volunteer: NA | PhD Statistics / Epidemology |
| 46-55 | Urban | Over $85,000 | Research work | 5% Organic Purchases |
| 10% Extra for Organic Food | Does not Seek Info on Organic Food | Found Errors | Bloodstream Studies of Pesticides | |

**Table 18 Interview 10 Results**

| **Demographic and Interview Classification 10** | | | | |
|---|---|---|---|---|
| Alexus | Female | Work | Volunteer: NA | MA Public Policy |
| 56-65 | Semi-Urban | Over $85,000 | No Pesticide Use | 80% Organic Purchases |
| 35% Extra for Organic Food | Seeks Info on Organic Food | Found No Errors | Health and Policy of Farm Workers and Pesticide Use | |

**Table 19 Interview 11 Results**

| **Demographic and Interview Classification 11** | | | | |
|---|---|---|---|---|
| Betty | Female | Work | Volunteer: NA | BA Psychology |
| Under 25 | Urban | $45,000-55,000 | Home Use | 50% Organic Purchases |
| 10% Extra for Organic Food | Does not Seek Info on Organic Food | Found no Errors | Promotes Ending Use of Cosmetic Pesticides | |

**Table 20 Interview 12 Results**

| Demographic and Interview Classification 10 | | | | |
|---|---|---|---|---|
| Clark | Male | Work: NA | Volunteer | MSc student in Biology |
| 25-35 | Urban | $15,000-25,000 | Gardening and Landscaping | 15-20% Organic Purchases |
| 20% Extra for Organic Food | Does not Seek Info on Organic Food | Found No Errors | No Pesticide Related Project | |

The groups that the interview subjects are affiliated with include: Check Your Head, UBC Farm, Port Moody Ecological Society, Farm Folk / City Folk, Earthsave Canada, Burke Mountain Naturalists, a Local Food Security Group, BC Cancer Agency, Labour Environmental Alliance Society, Canadian Cancer Society, SFU Biological Sciences Demonstration Garden.

And all interview subjects stated that they do all of the food purchasing or share the duty with their partner.

# APPENDIX M INFORMATION INTERVIEW SUBJECTS WOULD NEED TO MAKE A MORE INFORMED DECISION ABOUT THE SAFETY OF THE PESTICIDE

*Experimental Scenario*

*Animal Testing*: inclusion of animals being exposed to all chemicals that humans are exposed to; tests on bugs; more detailed bioaccumulation data; more background information for context; what the correlation is between death and consuming the pesticide; other factors that could contribute to death; information on how extrapolation from animals to humans work; more long-term studies; more species tested for lifetime tests; a control for the concentration levels; metabolized toxicity levels; tests on worms and shrews; more details on application into animals; test frogs; test bugs; test birds; inter-generational studies should show behavioural, immune, reproductive and intellectual development; test more insects.

*Background Information and Context*: more information on West Nile Virus; more chemical interaction studies; information on what constitutes a safe pesticide; how the pesticide rates to other pesticides; comparison between quantities applied here and how farmers would actually use the pesticide; other health indicators; context based statistical analysis with other health issues; profitability instead of yield increases; how dissipation occurs; systemic analysis of net benefits; should be compared to a similar pesticide; how much pesticide was used in the tests in addition to the active ingredient; scientific context for interpreting the results; background information on how this research applies not just to average males but others as well.

*Environmental Information*: longer water and soil testing (persistence); information on ecosystem interactions; what regions this pesticide will be used in, what type of weather conditions can be expected for where it will be used, more long term studies and more detailed information on application in tests; Crop-specific info; translocation on crop; part of the crop actually consumed; time of application; yield increase information that is compared with all inputs that a farmer might use; where dissipation goes; better bioaccumulation data; modelling of where the chemical will travel in the environment; test other plants; accumulation in plants data; what crops it would be intended for; difference in residue levels at harvest and at point of sale.

*Other Information or Requirements:* Occupational information; testing being done by an independent body; effects on humans; stability of the molecule; UV absorption; culture results; Octanol-Water Partition Coeffecient; no human testing; bioaccumulation test for living organisms; chronic human toxicity levels.

*Utilization Scenario*

*Background Information and Context:* More information on the methodology of residue testing; effectiveness levels of the tests; what they are testing for; what the minimum accepted residue levels are based on; where processed foods are procured from; information on how the pesticide interacts with its surrounding environment; more information on how food is dispersed and consumed across the country; more information on where the farm is located; where the spraying occurred; have not adequately described why it's an outbreak of West Nile virus.

*Other Information or Requirements:* more exhaustive list of foods in the food basket; comparison of Canadian and U.S. standards for pesticide evaluation; edge effect of farm needs to be taken into account to determine from where to pick the pieces of food; should not be determine by a budget; peer reviewed; done among a wide community of researchers; done transparently; subject to wide scale criticism and improvements; more attention to seasonality of foods and how this would impact prioritizing for sampling; disclosure on who is paying for the research.

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