Perceptions of Pesticides among Farmers and Farm Family Members

by

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Abstract

The spraying of pesticides has been shown to pose a risk not only to applicators, but also to those who live on farms where pesticides are applied. Providing the farming community with the information they need to manage pesticide risks is an important process that requires understanding how this community perceives pesticides. The objective of the research was to describe how farmers and adult farm family members perceive the risks and benefits associated with pesticide use and to describe the practices used by this community to control pesticide exposure. The project used a cross-sectional survey design (telephone survey) and was conducted with a randomly selected sample of 370 farm women and men who grew berries, grapes, and tree fruits in British Columbia. Survey questions were developed using a conceptual framework that included elements of the Precede-Proceed model, Farm Structure model, and the Psychometric Paradigm. Overall, perceptions of pesticide risk were found to be low to moderate in this farming community. Concern was highest for the health of pesticide applicators and lowest for the health of those in non-farming communities. In multivariable models, the key factors associated with increased perception of pesticide risks included: ethnicity (European descent), attitudes about vulnerability and concern about farm injuries, being knowledgeable about pesticide health risks, having experienced an adverse health effect from pesticides, growing mixed crops, and having a small farm. Regarding exposure control practices, 62% of farms had tried Integrated Pest Management (IPM) techniques and 63% of pesticide applicators wore personal protective equipment during pesticide application. Only 14% of respondents who washed clothing worn during pesticide application used the laundry practices recommended by the provincial government. Although increased perception of pesticide risk was associated with the use of IPM, other cultural, social and psychometric factors were also found to be significantly associated with this practice, even after controlling for risk perception, including: ethnicity (European descent), trusting the government, increased pesticide knowledge, having experienced an adverse health effect from pesticides, and growing grapes. It is anticipated that the results of this project will be useful for the development of risk communication initiatives for this population.

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Dedication

For my grandmother, Mavis Darney

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1.0 Overview of Research

1.1 Introduction

Agriculture is British Columbia's (BC) third most important resource sector, employing over 250,000 people and generating $1.6 billion in annual revenue (1). Over 20,000 farms are operating in the province, and it is estimated that one in 12 people in BC is employed in some aspect of the agricultural economy (1). The majority of crops grown in BC are sprayed with pesticides[1] to control insects, weeds, fungi, moulds, and other pests. Statistics Canada estimates that $23 million worth of pesticides was applied on BC farms in 1995 (2).

Although much is known about the short-term effects of pesticide exposure, the long-term effects of human exposure to these compounds is less clear. Research continues to explore associations between chronic pesticide exposure and diseases such as cancer and Parkinson's disease. The potential genotoxic, immunotoxic and reproductive effects of pesticide exposure are also being examined. The results of such research may have important implications for end-users and policy makers. Yet, in Canada, regulatory changes are slow and, according to some critics, mired by problems at the federal regulatory level (3, 4). To illustrate, consider that of the 405 pesticide active ingredients scheduled for regulatory review in 1999 by the Canadian agency responsible for pesticides, only 17 had been completed by 2002 (3).

Concerns over pesticides are apparent in many ways, although the alternatives to these compounds are few. While there is growing interest in non-chemical farming techniques and many consider ways to reduce chemical use, less than 1% of Canadian farms are certified organic operations (5). Some cosmetic uses have been banned in Canadian urban centers, but these changes are not widespread. Given that pesticide use will continue in the agricultural community, it is critical that those who are exposed to pesticides have the information they need to effectively assess and manage the risks from pesticide use.

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[1] The word "pesticide" is an umbrella term for insecticides, fungicides, herbicides, rodenticides, and other chemicals used to control pests.

The process of communicating risk-based information about pesticides presents a number of challenges. Ultimately, the goal of such risk communication programs is to help communities and individuals protect themselves and others from hazards. For pesticides, a range of protective practices has been documented to reduce both direct and indirect exposures, including adoption of personal protective equipment (PPE), changes to mixing and application techniques, and use of alternative methods (6).

Evidence suggests that simply providing risk information may not be adequate to change pesticide-related practices. Evaluations of general farm safety programs have determined that many are not successful at changing farmers' behaviors (7-9). These types of programs are often constructed around the assumption that all that farmers require to change their behavior is more information– "If farmers only knew what the health risks and hazards were, they would change their behaviors appropriately" (9). However, farm community research has shown that there is no clear relationship between farmers' knowledge levels and safety practices (10-12). Farm knowledge assessments have revealed in some cases that farmers know all too well the risks that they face in their occupation, but that their behaviors are influenced by other factors (9, 10, 13). Knowledge, while important, may be but one influence on how people understand and react to risks (14).

Changing farm safety practices may require communication that addresses risk from a broader perspective. In particular, it has been suggested that farm health and safety programs need to understand cognitive and cultural processes, such as farmers' perceptions and attitudes about the risks that they face, in order to be more successful (8). Research in other fields supports such suggestions, indicating that how people perceive hazards plays a dynamic role in what they are willing to listen to about the hazards and ultimately how they might assess and manage these hazards (15).

Perception of risk is a complex process that reflects a range of social, cultural and environmental factors. Research in this rapidly growing field has shown that not all people react to risks in the same manner. Social and demographic variables such as age, gender and ethnicity have been shown to affect how people perceive and assess risk (16, 17). Perceptions of risk have also been shown to reflect the intrinsic characteristics of the hazard itself, such as whether a hazard is undertaken voluntarily, or if it is common-place and familiar (18).

Risk outcomes such as the benefits gained, and who the recipients of the benefits are have also been found to influence risk perception (19-21). Understanding farmers' perceptions of pesticide risks therefore requires a comprehensive assessment of the range of underlying factors expected to shape people's attitudes and beliefs about risk.

Although farmers' perceptions of pesticide risk are important, farmers are not the only group at risk in the farming community. Research has also shown that farm family members share in the burden of disease and injury related to farm hazards (22-25). Exposure to agricultural chemicals has been documented as occurring not only in association with occupational tasks such as mixing, applying, or harvesting in treated fields. Outside of such direct exposures, pesticides can drift during application and contaminate areas outside of where crops are planted. Pesticide residues have been measured around farm homes and in areas where farm children play (26). Exposure can also occur inside farm homes, as agricultural pesticides have been measured on home surfaces, carpets, and in house dust (27). Other practices such as laundering clothing worn in treated fields or storing pesticides in the home may contribute to accidental or indirect exposures (28). Such research clearly indicates a need to address the management of exposure risks for all those who either live or work on farms, not just the farm operators.

Learning how the farming *community* perceives pesticide risks and the practices they currently use to control pesticide exposure will provide an important background of work through which appropriate risk communication strategies can be developed. Key to this process is a broad understanding not only of the perceptions and practices themselves but the factors that influence perceptions and practices for both farmers and adult farm family members.

This research examined pesticide-related perceptions and practices in a population of berry, grape, and tree fruit farmers and family members in British Columbia, Canada. This population was chosen because recent research among berry and tree fruit farmers has indicated that Captan, a fungicide, is more toxic that previously believed (29, 30). Captan is applied throughout British Columbia to control mould and rot in tree fruit, berry, and grapes crops. A comprehensive understanding of the perceptions and practices of those exposed to this compound is essential in order to improve communication of risk information regarding

Captan in BC. This study was designed to address these important gaps in knowledge and to gather information that could facilitate further risk communication efforts for this population.

1.2 Study Objectives

This study had both primary and secondary objectives. The primary objectives of this research were to:

1) measure the perceptions and practices regarding pesticide use;

2) measure factors that may influence perceptions and practices;

3) describe the associations between these factors and perceptions and practices.

in a population of farmers and adult farm family members on tree fruit, berry, and grape farms in the province.

A secondary objective was to describe avenues for communication about pesticide risks within this community.

The results of this research endeavor to provide a more comprehensive understanding of how the tree fruit, berry, and grape-growing communities currently understand and manage the risks they face from pesticide exposure. This knowledge will be instrumental to any further risk communication work with this population.

1.3 Summary of Study Methods

This research was conducted using a cross-sectional survey carried out on a randomly selected sample from the population of BC tree fruit, berry, and grape growers. The survey was designed to measure perceptions and exposure control practices related to pesticides in this community. It was developed using a conceptual framework tailored to the needs of this project. Qualitative research was conducted before the development of the survey, to ensure that the language and response options were appropriate to all members of the tree fruit, berry, and grape-growing communities.

Study participants were all adults who lived on farms where tree fruit, berries, and grapes were grown. The survey was designed to include equal numbers of men and women to

ensure that the research captured the perception and practices of farmers and their family members.

1.4 Thesis Structure

The thesis is divided into six chapters, including this introduction. Chapter Two provides **background and context** information about farming in BC and about the use of pesticides in general and Captan in particular. Chapter Three provides a **systematic review** and synthesis of the pesticide perception literature relevant to this work and presents the conceptual framework that guided the development of the survey instrument and analysis. Chapter Four details the **methods** used in the project. Research **results** are presented in Chapter Five. Chapter Six includes a **discussion** of the results and concludes with recommendations for future research.

2.0 Background and Context: Farming and Pesticides

2.1.1 A Brief History of Fruit and Berry Farming in BC

The following sections provide a brief overview of the history of agriculture in BC, including settlement patterns and ethnic diversity.

2.1.2 Settlement Patterns

Agriculture in BC began not as an industry, but rather as a method of survival for those who had come either for the fur trade or to prospect for gold. Small homesteads with gardens sprang up throughout the province in the mid 1800s, but Father Pandosy, a Jesuit priest, is credited with planting the first apple tree in BC in 1862 (31).

Figure 2-1 Father Pandosy's Apple Tree (31)

Travelers passing through the Pacific Coast and Fraser Canyon areas seeking riches in the gold fields, needed supplies. Hence, fruit and vegetable farms became common along the Fraser River. During this period, Lytton was home to the largest orchard in BC, which reached 300 acres by the end of the Gold Rush. Apricots trees and grape vines are still present on this land, now part of the Lytton Indian Reservation (31).

Cattle ranchers who were established in the southern Okanagan areas of Winfield, Coldstream, and Summerland, also planted fruit trees during the 1870s, and British aristocrats attempted to develop a small orchard community in Wallachine. By the 1880s, a small but prosperous fruit industry had sprung up in the Fraser Valley to feed the growing forestry industry. The Canadian government's census for 1891 counted 6,500 farms stretching from Vancouver Island to the Okanagan and further east to the Kootenay region (32).

Research and development for the growing fruit industry was fostered by experimental farms set up by the government of the Dominion of Canada in Agassiz and Summerland. These stations, which still operate, helped to develop BC varieties such as the Spartan Apple, the Ska-ha Apricot, and the Star Sweet Cherry, all of which are suited to BC's growing conditions (31). These facilities also offered training and expertise to newcomers who were settling the land.

Berry growing in BC shares a similar history. Although the First Nations people in British Columbia had been collecting indigenous berries (such as huckleberries, salmon berries and wild blueberries) in the coastal areas, commercial berry growing did not begin until the late 1800s (33). Strawberry farms were successful along the Fraser River in areas such as Richmond and Mission and were used to feed those who traveled up and down the river (the official crests of towns such as Burnaby and Maple Ridge, which border on the Fraser, have strawberries on them to commemorate this early industry). The town of Mission was known as "The Home of the Big Red Strawberry," and jam companies, which evolved into packing houses, were set up to deal with the surplus of fruit (34). Berry growing also proved popular in the east Kootenay area, and by the 1920s, Wynndel, a town near Creston, was called the "Strawberry Capital of the World" (35).

Cultivated high-bush blueberries were developed in the early 1900s in the United States, and these were found to grow particularly well in the Fraser Valley, where wild blueberries already flourished (36). Domestic cranberries were introduced in 1924 and some of these plots are still operating.

J.W. Hughes planted the first commercial vineyard in 1926 near Kelowna. Previously, Father Pandosy, of the Okanagan Mission, had planted grapes along with his apple trees but the use of the resulting wine was reserved for sacramental rather than commercial purposes. The grape industry grew slowly in BC until the late 1970s, when estate wineries were established with the help of international expertise. From 1970 to the year 2000, the wine industry in BC grew dramatically. Over 100 new vineyards have appeared throughout the province, from the east coast of Vancouver Island, north to Tappen[2] and as far east as Trail.

2.1.3 Ethnicity and the BC Farm Community

BC's fruit, berry, and grape-growing communities are composed of people from a broad spectrum of ethnic backgrounds. This tapestry of cultures, including British, Dutch, German, Portuguese, and South Asian is the result of a number of different global and local forces, each of which has left an imprint on the farm community.

The first farms in BC were those of First Nations people who lived in the southern coastal region of the province. The Sto:lo people grew Indian potatoes in the delta areas of the Fraser River (37). When the British settlers arrived, they set aside areas specifically designated for aboriginal farming. However, First Nations farming did not progress as the British colonialists desired, and aboriginal people began to work for the white farmers who were settling the area (37).

The British immigrants who had come for the fur and gold trades settled into farming along the Fraser Valley in the mid 1800s. The British also settled the Okanagan region; however, settlement in this location was promoted and controlled by officials operating in the UK, where BC's Okanagan region was marketed to the "gentle" or upper class of British

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[2] Two BC wineries, Recline Ridge in Tappen and Larch Hills in Salmon Arm are among the most northern wineries in North America

Society (38). Growing tree fruits was described in the British promotions as a leisure activity rather than as the backbreaking work of "regular" farming. As Jason Bennett describes in his thesis, "The True Elixir of Life: Imagining Eden and Empire in the settlement of Kelowna", the British who settled in this region established a racial and class order that was quite different from settlement in the rest of Canada. Bennett cites a 1908 brochure as illustration:

> Kelowna has much to offer. To be among the orchards when the bloom is on the tress and the air heavy with perfume, one feels that life has its compensations. Among cultured people—because the fruit grower has time to read, and is not milling and toiling half the year and stoking furnaces the other, half-congenial surroundings, and health, bracing influences, life is raised to a higher sphere… (38)

British settlements expanded to Vancouver Island and into the ranchlands of the central and northern Interior. People of British heritage remained the dominant cultural group overall in British Columbia (as well as in fruit and berry farming) during most of the 20th century. The demographic profile for Kelowna, the largest city in the Okanagan Valley, showed that visible minorities made up less than 5% of the population in 2001 (39).

Indian immigrants have also played a role in the evolution of BC agriculture. British Columbia has historically had a small Sikh community. A few hundred Sikh immigrants arrived in the early part of the 20th century to work in the forestry sector. Many of these Sikhs were from the Punjab, an agricultural region of India. As the Indo-Canadian community grew, some families were successful enough to buy their own farms (40). Immigration from India was highly restricted during the first half of the 20th century; for example, women from India were not allowed entry to Canada until the early 1950s. Changes in Canada's Immigration Act in 1977 have allowed easier entry to Canada for many nations, including India (41). Additionally, from the mid 1970s to the mid 1980s, economic and religious tensions mounted in the Punjab. Many Sikhs left the Punjab during this period, and went to join established Sikh communities around the world (42). Many of these new Sikh immigrants came to British Columbia, worked in the forest industry, and purchased farmland. Family members who were not employed could work on the farms (42) and many of these family-operated farms have become successful enterprises. As the Punjabi community has grown, so too, has the number of Punjabi-owned and operated farms in BC's primary berry-and fruit-farming regions. The 2001 Census found Punjabi to be the second

most commonly spoken language after English in Abbotsford (43), and the third most common language spoken after English and Chinese in the province (44).

Japanese farmers also contributed to the evolution of BC's farming community. Immigrants from Japan began to arrive in BC in the 1870s and most Japanese immigrants took employment in the fishing industry. As the Japanese settled and earned money, many purchased farmland in the Fraser Valley and on the Gulf Islands. The Japanese were successful farmers, and the Japanese Berry co-op, open to all farmers, was started in 1919 in Surrey (37). However, the Japanese involvement in berry growing ended abruptly. In 1941, Japan bombed Pearl Harbor, Hawaii, and the United States declared war on Japan. Canada responded by incarcerating over 22,000 people of Japanese origin and sending them to internment camps throughout British Columbia (45). The Canadian government confiscated the homes and possessions of all internees, including their farms and fishing boats. In 1943, the government began selling off these assets, often cheaply[3]. Many of the Japanese farms were sold to other immigrants and to Canadian soldiers who were returning from World War II. The Japanese berry industry did not recover after the war ended.

Chinese immigration to British Columbia began in the mid-1850s, during the gold rush (37, 46). As the gold rush wound down, many Chinese people went to work on farms and orchards around BC. However, the Chinese quickly provoked the ire of the British farmers through the creation of their own successful market gardens (37). As a result, the British officials of the day implemented policies that limited the ability of Chinese people to own farms in British Columbia. A lobbying effort occurred between 1917 and 1922 to prevent Asians from breaking into the Okanagan fruit production market. Motions in council, such as the following were made:

> The 1918 convention of the United Farmers of British Columbia carried a resolution calling on the Provincial Government to consider measures preventing Oriental aliens from acquiring control of agricultural lands (Convention Elects, 1918). (47)

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[3] After the war, the interned Japanese were given the option of returning to Japan or settling east of the Rockies. By 1950, families were allowed to return to BC, although the Japanese berry industry was not revived. The Canadian government was also sued for selling the property of the interned Japanese, and in 1988 the federal government paid out over $12 million to the internees' survivors as compensation. Although some berry and fruit farms in the province are run by people of Japanese origin, these numbers are significantly lower than in the early part of the 20th century

In the southwestern region of BC, restrictions were made to ensure that Chinese immigrants were unable to compete with the white farmers. Regulations were passed that resulted in Chinese people being prosecuted for hoeing their own gardens on Sundays (37). These policies were eventually relaxed after World War II and Chinese vegetable farms began to flourish in the Richmond and Fraser Valley area, although proportionally few Chinese people took up orcharding or berry farming.

Other European cultures immigrated to BC to farm, although in significantly fewer numbers than in other parts of Canada. Finnish and Norwegian immigrants settled on farms primarily on Vancouver Island and along the mid coast of the province during the late 1800s (37). The Doukhabors and other Anabaptists leaving Russia in the early 1900s settled in the eastern and central regions of BC World War II (WWII) also brought new European faces to BC's farming population. Large numbers of Jewish Germans had arrived in BC to escape WWII and they took up farming. After the war, Dutch immigrants whose farms were destroyed in WWII settled on farms around the province (48).

The Canada-Portuguese bilateral agreement in the 1950s introduced another culture to the BC farming community. During this period, Canadian farmers were in dire need of labour, and Portugal, specifically the Azores, was undergoing financial difficulties. Most of the Portuguese immigrants began their lives in Canada as farm-workers but eventually established their own orchards in the Southern Okanagan Valley (32).

2.1.4 Conclusion

Empire-building, racism, poverty and war resulted in a culturally diverse, yet relatively European-centric[4] settlement of BC farms. The effect of these forces is clearly illustrated in the current demographic structure of the fruit, grape, and berry sub-sectors. Apple- and soft fruit-growers are predominantly of British and European heritage. Berry-growing is more culturally diverse, although people of Punjabi origin are the major growers

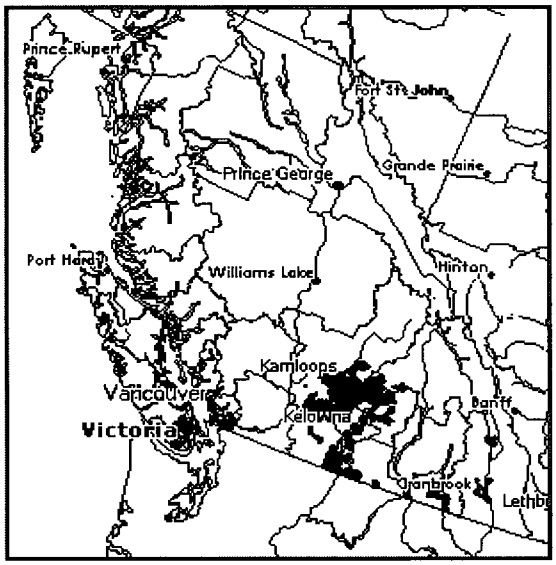
[4] In 1996, less than 11% of BC farmers reported their mother tongue was a language other than English, French, German, Ukrainian or Dutch

in the Fraser Valley region of the province, not far from where the original Sikh population settled in the early 1900s.

2.2 Farming in the 21st Century

Today, British Columbia produces over 200 agricultural products, ranging from traditional crops (for example apples, berries, and peaches) to new introductions (including ginseng, kiwi and seabuckthorn[5]). Almost half of BC's farms are located in the southwest corner of the province or on Vancouver Island. The Thompson-Okanagan area contains another 25% of farms; the remainder is spread over the Cariboo, Peace, and Kootenay regions.

Figure 2-2 Distribution of British Columbia Farms (49)



Since 1973, the Agricultural Land Commission, an independent body set up to preserve agricultural lands and to encourage farming, has governed the use of agricultural land in BC. Although BC is a large province, only a small part of its land mass is considered useful agriculturally and even less of that is considered 'prime land.' In the introduction of

[5] Seabuckthorn is hardy deciduous shrub that produces berries high in vitamin C, A and E,. The berries are used to create a medicinal oil.

her report, "Stakes in the Ground", Dr. Maura Quayle, Dean of the UBC Faculty of Agricultural Sciences, states:

> Agricultural land is scarce in British Columbia. Of the land in British Columbia, less than 3% is capable of supporting a range of agriculture; just over 1% is considered prime agricultural land, and less than 0.01% is capable of producing the tree fruit we associate with 'Grown in BC' pride (50).

Despite this small growing region, over 20,000 farms currently operate in the province.

Although the modern agriculture industry continues to expand the range of products grown in BC, many of the original farmed products, such as tree fruits and berries, remain the most popular with growers. The Census of Agriculture for 2001 determined that 48,330 acres of fruit were planted in the province in 2001 (51). The following is a brief overview of the tree fruit, berry, and grape industries, where they are produced geographically in BC, and their current contribution to BC's economy.

2.2.1 Tree Fruit, Berries and Grapes Today

a) Tree Fruit

The tree fruit and berry commodity groups are currently two of the top ten products grown in the province (52). Tree fruit, including peaches, pears, apples, kiwis, nectarines, plums and figs are now grown throughout BC, with the Okanagan Valley remaining the most popular growing region. BC produces about 30% of all apples grown in Canada and 60% of all cherries produced in Canada.

Table 2-1 Average Annual Fruit Production and Revenues

	Acres planted in the Interior	Average Production (lbs)	Average Annual Farm Gate ($)
Apples	12,600	275,000,000	42,000,000
Cherries	2,200	6,100,000	7,600,000
Pears	740	15,800,000	3,800,000
Peaches	1,400	12,000,000	4,200,000
Apricots	400	2,000,000	830,000
Plums/Prunes	325	1,300,000	327,000
Totals	17,665	312,200,000	58,757,000

Source: British Columbia Ministry of Agriculture (53)

Apples are the most important crop in the tree fruit commodity group, but the BC apple growing community has been experiencing difficulties. The number of apple orchards and the number of apples produced has undergone a steady decline since the early 1990s (52). Other tree fruit commodities mirror this decline, although not as dramatically. The 2001 Census of Agriculture reported that the number of hectares planted with tree fruits was approximately half that farmed in 1971 in BC, and had decreased 20% since 1996 (51). Factors such as poor growing conditions and the high cost of labour are often cited as the reasons for the erosion in the industry (52). Many in the tree fruit industry also point to the Free Trade Agreement with the United States as a significant culprit in the decline. Since the Free Trade Agreement was established in 1989, the Canadian market has been flooded with less expensive fruit grown in California and Washington. Canadian farmers, who must deal with harsher climates as well as more expensive labour and production costs, have difficulty competing with lower cost US fruit. The decline in productivity is not isolated to BC. Agri-Food Canada reported in 1996 that apple production had also declined in Ontario, Quebec, New Brunswick, and Nova Scotia (52).

b) Berry Crops

Blueberries, strawberries and raspberries have been the mainstays of the BC berry industry for over 100 years. Apples and other tree fruit production have declined, but blueberry acreage has increased 30% since 1996 (51).

Table 2-2 Berry Crop Total Sales, 2001 (54)

Berry Type	Total Sales
Blueberries	$ 33,182,000
Raspberries	$ 17,000,000
Strawberries	$8,510,000
Cranberries	$12,632,000
Other Berries	$557,000

Blueberry production has become lucrative. In 2001, 46 million pounds of blueberries were grown in BC, making the province the second largest producer of blueberries in the world (55). The number of farms growing blueberries continues to increase, and the operations range in size from a few acres to 300 acres, although the majority of blueberry farms are less than 20 acres. Almost 99% of BC's blueberries are grown in the Fraser Valley.

Raspberries are predominantly grown near the town of Abbotsford in the Fraser Valley, with some production in the North Okanagan and on southeastern Vancouver Island. BC raspberry production is particularly vulnerable to weather, as raspberries do not thrive in very hot or very cold temperatures. As a result, production volumes vary from year to year (56).

BC's cranberry industry has annual revenues valued at $ 25 million. Over 17 million kilograms of cranberries are produced each year in cranberry bogs throughout Richmond and the Fraser Valley. Most cranberries grown in BC are processed into juice or jelly (57).

Unlike the other major berry crops, strawberries can be grown almost anywhere in BC. However, like raspberries, most commercial growers are situated in the Fraser Valley, with some grown in the North Okanagan and Vancouver Island regions of the province (58). BC produced over 3 million kilograms of strawberries annually – nearly a quarter of all strawberries produced in Canada (58).

A number of other types of berry varieties are grown commercially in BC including gooseberries, red and black currents, loganberries, and blackberries. Some, such as blackberries, are particularly hardy and are grown throughout the province.

c) Grapes

In 2001, over 2,861 acres were planted with grapes, more than triple the area grown in 1996 (51). BC is the largest wine-producing province in Canada, followed closely by Ontario (59). The Okanagan region (which includes the Okanagan and Similkameen Valleys) is home to the greatest number (90%) of BC's vineyards, although a small and lucrative growing region has evolved on Vancouver Island and in the Fraser Valley. Over 70 wineries operate in BC, a significant rise from the 13 that operated in 1980 (60). Chardonnay and Merlot grapes are the most frequently grown, followed closely by Pinot Blanc and Pinot Noir (60).

The success of BC's wineries has overshadowed the table grape industry. Over 38,000 cartons of fresh grapes were grown in the province in 1998 (61). The Sovereign Coronation grape, developed in the 1970s at the Summerland Agri-Food Research Centre in BC is the main variety grown in the province for table consumption (62).

2.2.2 Conventional and Alternative Farming in BC

Conventional farm techniques, which include the use of chemical pesticides and fertilizers, are practiced on most BC farms. However, other methods of farming (described as "alternative" for the purpose of this research) are being used instead of conventional practices. Alternative farming includes three categories: certified organic farming, "transitional-to-organic" farming, and "non-certified organic" farming.

The Certified Organic Association of British Columbia, or COABC governs the certification process for BC farmers. The regulations for certification are extensive. Growers are prohibited from using chemical fertilizers, pesticides, and genetically modified seeds. Farmers are encouraged to follow a code of practice that includes crop rotation and stream and soil management (63). The definition of "organic" used by the COABC reads:

> Organic farming is an agricultural production system that promotes and enhances biological diversity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony. (COABC March 2002)

Because of BC's diverse growing conditions and commodities, 14 organic certification agencies operate throughout the province, regulating organic growing for their region and crop type.

Transitional to organic farms are on the path to becoming certified organic. Typically, this is a three-year process that includes practicing organic techniques as well as having soils tested for pesticide residues.

There are no standards applied to non-certified organic growers in BC, also referred to as "no-spray" or "spray-free" farms. Research in the United States on these types of farm found that reasons for not becoming a certified include not wanting to pay for the certification process (which can be costly), not being able to control the land yourself (e.g., land owned by someone else), and not having a certification body for the type of crop grown (e.g., specialty fruits or berries) (64).

The number of farms practicing alternative agriculture in BC is not known. Statistics Canada asked about organic farming for the first time in its 2001 Census of Agriculture. In British Columbia, 319 organically certified farms responded to the census (approximately 1.6% of all farms in the province). However, this number is thought to be less than of the actual number of organic farms operating in the province, because of response errors and the under-coverage of those growing organic crops (65). Of the organic farms that replied, most (84%) were fruit, berry, vegetable, or greenhouse crops. Outside of certified organic farms, little is known about the prevalence of "non-certified" farms operating in the province.

2.3 Rationale for Studying Farm Families

BC farm families, in particular, are an under-studied group. Of the 20,290 farms operating in BC in 2001, 98% were family owned (66). On these farms, 30,320 people were

considered operators, 36% of them women. BC has the highest rate of female farm operators in Canada (compared with the national average of 24.6 %)(66).

Traditionally, agricultural health and safety research has focused on male farm operators. Few studies have explored the farm work-related injuries of women who live and work on farms (67), although recent initiatives have begun to investigate the health of farm spouses (generally women) and children (Ontario Farm Family Health Study, Agricultural Health Study in Iowa and North Carolina, Prairie Ecosystem Study in Saskatchewan, Canadian Agricultural Injury Surveillance Program, and the Farm Family Health and Hazard Surveillance projects in a number of US states). Family members who undertake farming tasks in either paid or unpaid capacities represent a significant proportion of the farming population, yet they are an under-researched group. In the Agricultural Health Study cohort, 51% of farm women reported working in the fields, and 50% of children over age 11 did farm chores (28). Recent research on the involvement of women in U.S. agriculture demonstrates that an increasing number of women are participating in the day-to-day operation of farms (67). Canada's Census of Agriculture also has documented a growing number of women who identify themselves as primary farm operators (Census of Agriculture, Statistics Canada 1996).

Children's farm work also tends to mirror that of adults, including pesticide-related work. Curwin et al's (68) research on Iowan farms found that 6 out of 32 children (aged 5-12 years) were directly exposed to pesticides through handling or working in treated fields. A study of North American farms found that a significant proportion of children, even in the youngest category studied (7-9 years old), were assigned farm work (69). In Canada, research has determined that many farm children's injuries are a result of exposures to operating farm equipment and vehicles (70). Factors potentially associated with such injuries include the presence of children in areas where farm equipment is operating, and having children perform farm tasks that are inappropriate for their age (71).

Direct participation in farm work by women and children results in exposures to many hazards, including pesticides and other farm chemicals, which are traditionally associated with injuries and illness among male farmers. In addition, farm family members are indirectly exposed to farm hazards such as pesticides, because their farms are typically

both their work and home environment. Chemicals and fertilizers sprayed on crops can drift and settle into farm homes through windows, doors, and other openings. Recent research in the United States and Canada has determined that chemicals sprayed on fields around a farm can be detected inside the farm home (26, 72, 73). Homes in close proximity to sprayed farmlands have been shown to have higher household levels of pesticide residue than homes that were farther away (74). Research on organophosphate pesticides found that children living in close proximity to sprayed farmland had higher levels of pesticide metabolites in their urine than children who did not (27).

Farm chemicals enter the home through drift and by being tracked in and deposited on carpets (75, 76) and on pets (77, 78). Additional routes of entry include the consumption of food that has been grown and sprayed on the farm (79) and the washing of contaminated clothing in the family washing machine (28, 80). Farm family members and farmers themselves can also inadvertently bring pesticides into the home through poor hygiene practices (e.g., not washing hands properly before meals) (81-83) and not changing clothes before entering the home (68, 84).

Children living on farms are especially vulnerable to pesticide exposure for several reasons. Playing with toys left outside during spraying and the propensity of young children to put things in their mouths contribute to their exposures to pesticides (78, 85, 86). Children also spend time on floors and carpets, which have been shown to be reservoirs of pesticide exposure in homes (87). In addition, because children are of relatively small body size and are undergoing rapid physiological development, the negative impact of chemical exposures on their health may be exacerbated. Research on farm children in Washington State found pesticide metabolites levels increased as the age of the children in the study decreased (75).

Women living on farms may also be susceptible to inadvertent (and therefore unprotected) exposures. Because women are traditionally perceived to be less involved in farm work than the primary farm operator (67, 88), many women living on farms may not have received proper training to deal with farm hazards. Women may also be less likely to take the necessary protective action when potentially exposed to farm chemicals because they may perceive themselves to be at lower risk of exposure compared with the primary farm operator (23, 89). Moreover, women are often responsible for handling and laundering

clothing that has been worn for spraying or in the fields. Clothing worn during these activities has been shown to be contaminated with pesticide residues (90, 91). These items of clothing, if mixed with regular family laundry, can contaminate both the laundry equipment, and potentially the other clothing in the same wash (80, 92).

In summary, farms represent a highly complex intervention setting, and farm family members constitute a unique research population. However, little research has focused on this important segment of the farming community. Women and children living on farms represent a large and growing segment of the farming population who experience serious injury and disability from exposure to farm-based hazards. Pesticides represent one such farm-based hazard to which women and children may be both directly and indirectly exposed by virtue of living *and* working on farms. In order to develop appropriate health protection intervention approaches, new research is needed to better understand this important segment of the farm community.

2.4 Pesticides

Pesticides are unique chemicals in that they are purposely introduced into the environment and are designed specifically to kill living organisms. After World War II, the focus of agricultural chemicals shifted from pest *control* to pest *eradication*, as synthetic pesticides became cost-effective and widely available (93). Pesticide use emerged as a standard practice of modern, Western agriculture and is, by and large, considered essential to the viability of the food production in Canada. As a report on sustainability in Canadian agriculture, states:

> Canada's primary food industry generates $20 billion in revenues annually. This income would be drastically reduced if pesticides were not used regularly and extensively in Canada's main agricultural regions. Until alternative pest-control programs are effective, the $190 million spent annually in Canada on pesticides (mostly herbicides and insecticides) is an economic necessity. (94)

Concern over the effects of pesticides on human health arose during the 1950s and 1960s. Rachel Carson's seminal work, "Silent Spring" (95), highlighted the negative impact of pesticides on the health of the environment and the people who lived in areas where

pesticides were being applied. Carson set the stage for the modern environmental movement and other contemporary anti-pesticide groups.

In Canada, many environmental and health advocates, including the Canadian Association of Physicians for the Environment and the David Suzuki Foundation, have called for more research regarding pesticide use. A number of jurisdictions across Canada have decreased or have banned the application of pesticides in public places for cosmetic purposes (e.g., Halifax, Hudson, Quebec City, and Toronto). A number of groups have called for more stringent regulations around pesticide use in Canada including the World Wildlife Fund and the Sierra Club of Canada. In her 2002 report to the House of Commons, the Commissioner of the Environment and Sustainable Development, Johanne Gélinas, suggested that the federal government was not doing enough to manage pesticide risks in Canada (3). Commissioner Gélinas stated that more effort should have been made to identify the risks posed by pesticides.

> ... the whole situation is confounding. The processes we have observed seem to defy timely, decisive, and precautionary action. Many of the root causes of problems we found in 1999 continue today: under-resourced commitments; major gaps in scientific knowledge; and burdensome regulatory processes. None of this augurs well for the protection of our health. In my opinion, the current situation and future prospects are not environmentally, economically, or socially acceptable (3).

Additionally, the Commissioner noted that funding cuts to the federal agencies responsible for regulating pesticide use in Canada have made the job of regulation and review more difficult.

Though concerns about the effects of pesticides abound, their use has continued to escalate. In Canada, it was estimated that over 35 million kilograms of pesticide were applied in 1991 for agricultural, forestry, domestic and industrial purposes (96). While pesticide use appears to be declining overall in Canada, a report comparing environmental indicators in Canada to other OECD nations suggests that Canada's pesticide tracking system "lacks credible information on pesticide use" (97). In British Columbia, a study commissioned by the provincial government reported almost 1 million kilograms of agricultural pesticides were applied in 1995, up from the 688,592 kilograms used in 1991 (98, 99). Moreover, pesticide residues have been found in places where pesticides have never been applied, such

as the Canadian Artic. Because they now appear to be ubiquitous in our environment, the importance of understanding the effects of these compounds is underscored.

2.4.1 Pesticides and Health

The intrinsic toxicity of pesticides makes them a concern to the health of those who apply them and to those who are indirectly exposed. The effects of pesticides on human health can be divided into two categories; acute effects and chronic effects. Acute effects associated with pesticide exposure include rashes, headaches, blurred vision, nausea and vomiting, changes in heart rate, muscle weakness, respiratory paralysis, mental confusion, convulsions, coma, and in some cases death. The types of acute effects are dependant on the chemicals applied and the route of exposure. A few classes of pesticides in particular (organophosphates and carbamates, inorganic compounds, and pyrethroids) have been shown to be responsible for over half of the cases of acute pesticide-related illness world wide (100). Acute pesticide exposure has also been cited as the leading cause of poisoning in Canada (101).

Although acute effects of pesticide exposures are well substantiated, the relationship between pesticides and chronic effects is less clear. Elevated levels of cancer have been noted in some farming populations and pesticide exposure has been postulated as a possible cause. A review of research conducted on pesticide-exposed workers noted increased rates of several types of cancer, including leukemia; non-Hodgkin's lymphoma; multiple myeloma; soft-tissue sarcoma; and cancers of the skin, lip, stomach, brain, and prostate (102). Recent research in Ontario found significantly elevated levels of breast cancer in women who had ever worked on farms (23, 103). A review of the literature on childhood cancers determined that residence on a farm was associated with higher rates of cancer in children (104). Farming has also been associated with higher mortality from prostate cancer in British Columbia (105). Positive relationships have been found between pesticide exposure and: non-Hodgkin's lymphoma (106-108), leukemia (109), multiple myeloma (110) and brain cancer (107, 111). While clear evidence does exist for the carcinogenic potential of many classes of pesticides in animal studies, the role that pesticides play in the etiology of cancer

in humans is not certain. Farmers are exposed to a wide range of toxins through their work, including chemicals such as gasoline, solvents, and biological agents such as moulds and bacteria. Many of these agents have also been noted to be carcinogens. Much of the etiologic research is hampered by an inability to accurately assess pesticide exposure. Additionally, as multiple pesticides are often applied during a growing season, singling out certain classes of pesticides to determine health effects can be difficult.

Cancer is not the only chronic condition that has been attributed to pesticide exposure. Extended exposure to pesticides has been linked to reproductive and neurological disorders as well. Birth defects and changes in the sex ratios of offspring have been attributed to pesticide exposure (112-114). Spontaneous abortion has also been linked to pesticide exposures during particular stages in conception (115, 116). Neurological problems have been associated with organophosphate pesticide use (117) and a relationship has also been shown between depression and high-level exposures to pesticides (118). Additionally, numerous studies have found associations between Parkinson's Disease and pesticide exposure (119-121) prompting additional research to explore the possible relationship between pesticides and the development of this condition (122, 123).

2.4.2 About Captan

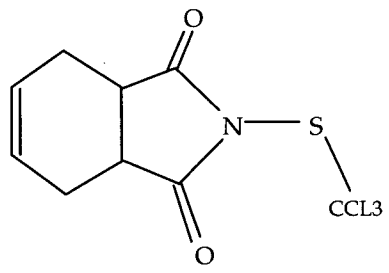
Captan is one of the most commonly applied pesticides in the BC tree fruit and berry industries. Captan is considered a relatively non-toxic compound in Canada and is used widely in both commercial and domestic formulations. However, investigations into the toxicity of this compound raise doubts about its safety. The following is a review of the toxicity of this compound, its regulatory history, and assessments of exposure that have been conducted in Captan exposed farm populations.

Captan is a broad spectrum fungicide used to control botrytis fruit rot and blight, downy mildews, gray mould, scab, brown rot, and certain types of Anthranose in fruit, grape, and berry crops (See Appendix A). Captan is also used as a seed treatment and root dip to prevent seeds and roots from rotting and as a post-harvest dip to apples, cherries, and pears (124). Trade names for Captan include Maestro, Captex, Essofungicide, Agrox, FLIT and

Drillbox; Captan and Maestro are the most common names ascribed to this product commercially.

Captan is an alkyl-thio dicarboximide compound and is part of the thiocarbamate chemical family. Other fungicides in this family include Captafol and Folpet.

Figure 2-3 Chemical Structure of Captan



The acute toxicity of Captan is considered to be relatively low. Oral LD_{50} in rats range from 9,000 mg/kg (125) to 12,500 mg/kg (126) and 7,000 mg/kg in female mice (127). Inhalation studies with mice have determined considerably higher LD_{50} levels of 1,700-3,700 mg/m^3 /2 hours for male and female rats respectively (127). Captan is known to be an irritant to skin and the mucous membranes of the respiratory tract and eye (128). No respiratory problems or nervous system damage have been attributed to Captan.

The long-term effects of Captan and the implications for human exposure are less clear. In particular, controversy has existed over the carcinogenic potential of Captan based on animal testing. Currently, new concerns are being raised about the potential for Captan to damage DNA and the role of Captan in impairing reproductive function (30, 129, 130).

Captan was one of a number of compounds involved in a scandal surrounding a testing laboratory—International Bio Test (IBT), a leading toxicology facility that tested the safety of pesticides, food additives and drugs. During the late 1970s, IBT was found to have falsified data used to register 134 pesticides, including Captan. Re-testing was required for many chemicals, and the Canadian government reassessed the toxicity of Captan during this period. After great deliberation and much public debate, the Canadian Expert Panel deemed Captan suitable for continued use on food crops in Canada (131).

In the 1980s, the United States Environmental Protection Agency (US EPA) initiated a re-evaluation process over concerns regarding Captan's ability to produce oncogenic effects in mice and rats. In 1989, the US EPA published its position document on Captan, allowing continued use on tree fruits, nuts and berries and select vegetable crops, although use was no longer allowed on citrus fruits, avocados, root vegetables, melons and other vegetables (132). Research published during this period concluded that Captan was carcinogenic in both low and higher doses in two rodent species (133). Captan was classified as a probable human carcinogen (EPA class B2) based on its ability to produce malignant tumours in multiple studies (134).

In 1999, the US EPA completed another reassessment of Captan through its re-registration program. It was determined that Captan did not pose a health concern to the public from exposures in food or drinking water, although its use was banned on lawns, to reduce residential exposures, especially to children. Particular concern was noted over the ability of Captan to irritate eyes in those working in areas where Captan had been applied (132). Regulations with respect to Captan use were tightened; including lowering recommended application rates, increasing the amount of protective equipment required during application, and extending the re-entry intervals for crops such as blueberries, raspberries and grapes to 72 hours. Worker notification is also required to inform those entering Captan-treated fields about eye irritation from exposure (132).

Beyond the work of the US EPA, researchers have continued to find associations between Captan use and disease in humans. Captan and Atrazine (a herbicide) were found to be associated with prostate cancer in farm workers in California (135). Captan was one of a number of pesticides associated with non-Hodgkin's lymphoma in a cross-Canada study (136). Investigations of berry harvesters working in regions treated with Captan noted a positive association of frequency of genetic damage (micronucleus count) with weeks worked per season and duration of employment as a farm worker ((129). Research conducted with farmers and farm workers found increased levels of DNA damage in those with shorter re-entry times to Captan-treated fields. (30).

Reproductive damage has also been noted in populations exposed to Captan. Animal research found that Captan exerted toxic effects on reproductive organs (137, 138). In

humans, increased time to pregnancy was found in farm couples exposed to Captan and other pesticides (130). Additionally, altered sex ratios of offspring born on farms has also been noted with fungicide use in general (112).

Captan use is now banned or severely restricted in eight countries around the world, including Sweden, Finland, Australia and Norway (139). However, no regulatory changes have been made in Canada. Captan is on the list of chemicals to be re-evaluated by Canada's Pesticide Management Regulatory Agency, although the agency was not able to provide a definite schedule for when this review would occur[6].

Captan has been used successfully to treat moulds and fungi problems for the past 50 years, and few resistance problems have been associated with its use. Other fungicides are available to treat fungal disease in fruit and berry crops, but more restrictions apply to the use of these chemicals, such as longer time to harvest or limited crop application. Captan is also relatively inexpensive compared to new fungicides that have come on the market. Additionally, only Captan is registered for use on all berry crops with a minimum of two days to harvest. As a result, the use of Captan, despite its potential health concerns, is likely to continue.

2.4.3 Exposure to Captan

Captan is licensed for fruit, berry, and grape crop use in British Columbia and is a recommended treatment for scab, moulds, and botrytis in these crops. It is currently categorized as "slightly toxic" by the Ministry of Agriculture, Fisheries, and Food, based on the LD_{50} for its acute toxicity. No special certification from the provincial government or the Worker's Compensation Board is required for its application (140).

Captan is one of the top three pesticides sold in the province and sales continue to increase. In 1996, just under 30,000 kilograms of Captan were sold (141). Fungicides are sprayed throughout the province, although their use patterns correlate with the fruit and berry growing areas. The three sub-regions with the greatest application of fungicides in 1995 were the Fraser Valley and the Lower Mainland (over 22,000 acres sprayed), and the Okanagan

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[6] Personal correspondence with personnel from the Canadian Pesticide Management and Regulatory Agency, June 2003

(over 21,000 acres sprayed). Fungicide use on Vancouver Island is concentrated in the southern part of the island (1,234 acres sprayed) (2). The wet climatic conditions of the Fraser Valley make Captan desirable to farmers concerned about rot in their berry crops. Strawberry crops, which lay close to the ground, are particularly vulnerable to moulds and mildew. Apple scab is also a particular problem for apple crops in BC (see Appendix A).

Several studies have attempted to assess exposure to Captan in agricultural operations. A large-scale survey of fruit growers in the Netherlands determined that farmers and their family members were exposed to Captan during and after spraying (29). This research also noted that both respiratory and dermal exposure levels were higher during application than during work in fields after application. However, this study found that farmers spent only a small amount of time applying Captan, and as a result, re-entry work might have been the prime contributor to exposure. Other research has also noted dermal exposure during re-entry to be an important determinant of exposure (142).

De Cock et al. (29) also conducted in-home exposure assessments and detected Captan on the floors of the farmer's home in the Netherlands. Captan contamination levels varied in measurements taken on kitchen tables, sinks, and windowsills. Inhalable levels of Captan were detected indoors, and exposure was found on people's hands using hand-rinsing methods. Although the levels of Captan measured inside the homes were lower than those found on leaves and berries in the fields, there was little doubt that Captan application on nearby field could contaminate farm households (29).

As with other pesticides, protective measures can be taken to reduce exposure to Captan. Studies of fruit pickers have determined that the type of protective clothing worn when working in Captan-treated fields influenced exposure. A study to assess the protection provided by glove use found significantly lower levels of THPI, a Captan metabolite, in the urine of women who wore rubber gloves versus those who wore no gloves (143). Dermal exposure on hands was also found to be high in a study of strawberry harvesters wearing cotton gloves (144). An assessment of strawberry harvesters demonstrated that the principal areas of concern for dermal exposure were hands, forearms, and lower legs (145). Similar research has corroborated this finding (146).

Exposure to pesticides can also be reduced through proper laundering techniques. Captan is relatively insoluble and as a result, proper laundering is required to remove residues from contaminated clothing. The BC government recommendations for the laundering of clothes worn for mixing and applying pesticides include the following:

1) Use a pre-soak cycle.
2) Use rubber gloves.
3) Separate clothing from other household laundry.
4) Clean washing machine by running it through an empty cycle with detergent to remove residues (140).

However, some research has found that despite adherence to washing recommendations, complete removal of pesticides from clothing may not be possible in normal clothing laundering (147).

Re-entry periods are designed to protect workers from exposure to pesticides during application and from pesticide residues in treated fields. The current re-entry period for Captan on fields in British Columbia is 24 hours, unless the formulation specifies longer on the label (140)[7]. Detectable levels of Captan residues have been noted to transfer to fieldworkers' clothing in fields past 24 hours. (148). Research on strawberry pickers noted that Captan adsorption onto clothing increased rather than decreased post re-entry times; clothing worn for work 48 hours after application had twice the levels of Captan adsorption than those worn 24 hours after spraying (144). Research conducted in the Fraser Valley of British Columbia detected measurable amounts of Captan on leaves, berries, and dermal patches worn by pickers at 49 days post-spray, in a field sprayed only once with Captan (30). In the United States, the 1999 US EPA recommendations included waiting 72 hours before entering berry and grape fields treated with Captan. Some, but not all of the pesticide labels on Captan products sold in Canada, reflect these changes (149).

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[7] Some formulations sold in Canada recommend 72 hours specifically for blueberries, raspberries and grapes, e.g. Maestro 75, 2002 Arvesta Corporation.

In conclusion, given the widespread use of Captan and its uncertain potential for harm, it is important to engage with farm families about the risks this compound may present. Where Captan use is prevalent, stricter exposure control practices may be necessary precautions for exposure management. Educating the BC farm community about these health and safety issues will require a more thorough understanding of the population at risk. This should include an investigation of how pesticide risk is perceived in this community and the factors that contribute to these perceptions, as well as the exposure control practices currently used in this community.

3.0 Pesticide Risk Perception and Practices: Literature Review and Conceptual Framework

3.1 Introduction

The chapter is composed of two sections. The first section begins with a brief overview of the broader field of risk perception research. Then it provides a summary of the previous research conducted on pesticide risk perception, pesticides exposure control practices, and the factors suggested as influencing these variables. The second section of this chapter introduces the conceptual framework created specifically for this project to guide the development of the survey instrument. This framework integrates the diverse body of research conducted on pesticide risk perceptions and practices and provides a foundation for organizing and interpreting the wide range of factors associated with these variables. This section concludes with a description of the measures previously used in pesticide risk perception and exposure control practices research.

The literature reviewed in the first section of this chapter was identified through manual and computer database searches. Searches were limited to works written in English and used a range of computerized sources and keywords included in Appendix B. The review examined perceptions and exposure control practices research pertaining to farmers, spouses, and children who live on farms. Farm worker research was excluded because farm workers' pesticide perceptions and practices may differ from those of farmers and farm family members for three important reasons. First, farm workers often have little to no control over their work environment (150-152),. Farmers, conversely, have control over many aspects of pesticide use and application. Issues of control have been cited as important influences of risk perception (153). Second, farm workers are not financially responsible for farm operations. This burden of economic risk affects farm families' perception of their farm operations. Finally, most farm workers' permanent residences are not on farms. Some farm workers do live on farms during certain seasons in worker housing, but this is different from the situation of farm family members who live on farms year round.

The literature review included research conducted on farms in North America and, to a lesser extent, Europe and Australia. Excluded from this review were studies from emerging nations, because farming practices in these countries are often very different from the practices used in Western industrialized agriculture[8]. Also excluded was research pertaining specifically to tertiary commercial agricultural activities, such as slaughterhouses, feedlots, and packing plants.

The purpose of this literature review was to synthesize what is currently known about pesticide risk perceptions and exposure control practices in farm communities and to examine measurement tools that have been used in previous studies of pesticide risk perception in the farming community. The section begins with a brief overview of the broader field of risk perception and then narrows to focus specifically on agricultural risk perception research. Following this is a review of the research conducted on exposure control practices, such as the wearing of PPE, and the factors associated with such practices.

3.2 Overview of Risk Perception

The disciplines of risk assessment and risk management have grown steadily over the past 20 years, resulting in a growing need to communicate risk information to specific populations. Initial attempts at risk communication produced varying levels of success. In particular, communication projects that focused on presenting the public with "the facts" or the scientific assessment of risk were met with considerable public discontent. Frustration with such processes led to the development of risk communication as a field of study. As Fischhoff explains in his overview of risk communication, this discipline has evolved from "getting the numbers right" to a more interactive approach that accepts the public and other stakeholders as partners in a risk issue (156). Incorporating the public into a risk dialogue requires a better understanding of the public's attitudes about hazards, as one significant finding to emerge from risk communication research was the importance of *risk perception*

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[8] For studies of pesticide risk perception and practices in developing nations see 154. McDougall L, Magloire L, Hospedales CJ, Tollefson JE, Ooms M, Singh NC, et al. Attitudes and practices of pesticide users in Saint Lucia, West Indies. Bull Pan Am Health Organ 1993;27(1):43-51. and 155. Clarke EE, Levy LS, Spurgeon A, Calvert IA. The problems associated with pesticide use by irrigation workers in Ghana. Occup Med (Lond) 1997;47(5):301-8.

in an individual's understanding of a risk issue. Studies of societal responses to risk have shown that an individual's perception of risk goes beyond the factual, or scientific assessments and includes qualitative judgments about the social, emotional and economic effects of a hazard (157). These studies suggest that an individual's perceptions of risk are influenced by at least two distinct variables: 1) the qualitative characteristics of the risk itself, and 2) the socio-cultural characteristics of people within a given population at risk.

Essentially, these two sets of characteristics assert that risk perception is influenced by both the nature of the people who make up a community and by the nature of the risk event. The following sections provide a brief overview of these characteristics and their suggested influences on perception of risk.

Psychometric Paradigm

Initial inquiry into the character of risk is attributed to Chauncey Starr (1969) whose work on preferences and the effect of voluntary versus involuntary risk-taking led to the development of the analytical approach described as the psychometric paradigm (18, 153, 158). This approach explores people's perceptions across different categories of risk (i.e., technological, natural hazards, medical risks) and has been used to uncover a set of specific attributes or characteristics that help explain why people perceive hazards in a particular way. The psychometric paradigm has been described as "a means of mapping the intuitive rules of thumb which people use to form their judgments about the meaning and severity of the risks that they face" (159).

Some of the initial psychometric risk research examined the connection between perceived risk and benefit (158). These studies found that both risk and benefit were important modifiers of people's judgments and that study respondents "believed more risk should be tolerated with more beneficial activities" (160). Other factors, such as fairness and clarity, may modify this relationship as concerns about risk are suggested to be lower when the impacts are evenly distributed throughout a population or when the benefits of a risk are clear (161). One illustration of this is found in the research on occupational risk tolerance: workers across a range of industrial sectors cited compensatory factors such as income as one of the most important factors in determining their acceptance of risk within their workplace

(162). However, the initial research on risk perception determined that factors other than benefits may also be influential in determining people's attitudes about risks (160).

The results of these early psychometric studies conducted by Slovic, Fischhoff, Lichtenstein, and others extended the list of characteristics to include attributes such as familiarity, dreaded or severe consequences, known effects, and control (18). Risks that are new to people, or are unfamiliar, generate more concern than common, everyday activities that can cause harm. Consequences of a risk event that result in diseases dreaded by the public, such as cancer or genetic problems, particularly when they occur to children, generated higher levels of concern. Consequences that are potentially catastrophic, or have the capacity to affect large numbers of people, have similar effects. Where the outcomes of exposure to risks are known, perceptions of risk tend to be lower than those where the end results are uncertain or cannot be predicted. Control is also an influential factor. Risks over which people have a greater degree of personal control are considered to be less problematic than situations in which members of the public have little or no input or control (161).

Perception of nuclear power, a form of energy considered by the public to be very risky, is often used to describe this set of characteristics. People have been shown to perceive nuclear risk as being unfamiliar, unknown, out of their own control, and having dreaded consequences such as cancer or the potential for catastrophic events (158). Other factors described above, including involuntary exposure and low perceived benefits, also contribute to the uniquely high level of perceived risk associated with this form of energy by those in the general public (158).

Another factor that has been found to significantly affect risk communication is the issue of trust. Perceived risk appears to be strongly tied to the degree of confidence people place in the institution or group responsible for regulating or communicating a risk (163). This relationship is important particularly regarding the degree to which people *distrust* organizations, as this distrust serves to destroy public confidence and increase perception of risk (164). This situation can be exacerbated by media coverage of unfolding issues, as news conventions tend to highlight negative aspects of issues and polarize events into stories of "good" versus "bad". Trust and media coverage also play a role in the process described by Kasperson et al. as the "Social Amplification of Risk (165). This theory suggests that risk

events, even ones that are relatively minor, can generate a great deal of public consternation with serious and long-lasting effects (165). Table 3-1 presents a summary of the characteristics described above and their suggested effect on risk perception.

Table 3-1 Characteristics of Risks that Influence Perception

Characteristics	Impact on Risk Perception
Voluntary	Risks undertaken voluntarily are perceived to be less risky than those undertaken involuntarily.
Familiarity	People tend to be less concerned about risks that are more familiar to them.
Control	The more control people have over a risk, the less they perceive it to be risky.
Type of Consequence	Certain conditions, such as cancer, are dreaded more than others and increase risk perceptions. Effects that occur later in time are worse than those experienced immediately. Additionally, risks that have a catastrophic potential are considered riskier than those with statistical consequences. Also, risks borne by children as considered worse than those experienced strictly by adults.
Benefits	Lower levels of concern have been found with respect to risks that have clear and fairly distributed benefits.
Trust	Risks generated by trusted sources are more acceptable than those generated by non-trusted sources.
Known Consequences	Risk perception is higher when less is known about the outcome of a risk event.

Socio-demographic Factors

As research using the psychometric approach to risk has grown, greater attention has been paid to the way in which these characteristics vary by socio-demographic factors. This had led to research that focuses on how perceptions differ by gender, ethnicity, and certain socio-demographic variables. Studies examining these variables have found differences that contribute to a richer understanding of how people view risks within the context of their lives. The following sections discuss some of the important findings from research that has examined how socio-demographic factors influence risk perception.

Examinations of risk perception in relation to gender have shown that men judge risks differently from the way that women do. In particular, studies across a range of environmental and medical hazards have shown that men are less concerned about risks than

are women (166, 167). A number of different arguments have been set forth to explain the variation between men and women with respect to risk perception, including differences in knowledge levels (particularly with respect to scientific knowledge). As fewer women than men have been found to be involved in science, women were thought to be less knowledgeable and therefore less capable of making rational judgments about risks than men. However, this perspective has been challenged by research that found risk perception differences persisted even when men and women had similar technical and scientific training (168). Another interpretation of the differences between men's and women's perception of risk focuses on biological and gender-role differences between the sexes. Included in this perspective are arguments that women's role in nurturing and care-giving or their increased personal vulnerability to violence increases their overall sensitivity to risk issues. Character traits associated with male-ness, such as inherent "machismo," have also been suggested as playing a role in decreasing men's perception of risk (169). These arguments have been challenged for their biologically determinist perspectives (157). Historical gender relations have made sex-based role acceptance and the exclusion of women from scientific endeavors appear to be a "natural" division between men and women. The dominance of men overall in society, and particularly within the fields of scientific and technological development, may provide men with both a more intimate and a more powerful role in the creation and management of risk. This socialization, rather than sex-trait characteristics, may be the reason that men exhibit lower concerns regarding risks.

Research that explored ethnicity and risk perception (17) has also contributed an important insight into the issue of both ethnicity and gender. Through an analysis of ethnicity, gender, and perception of environmental risk, Flynn et al. illustrated that white men in particular were significantly less concerned about risk than were white women *and* men and women who were not white (17). Differences between men and women who were not white were not found to be significant, lending credence to the idea that perceptions are not biologically determined. Other studies of ethnicity and risk perception have found evidence to support the difference specifically between white men and others in society (166, 170). This phenomenon, described as the "white male effect", prompted further investigation. A multi-cultural study designed to explore this effect found that, with the exception of certain categories of risk (automobiles, food-related issues, tap water), white men did have

consistently lower risk perceptions than others involved in the study (171). Although this study did find heterogeneity within risk perceptions between ethnic groups (such as Asian and African Americans), overall, non-white females were most often found to give the highest risk perception ratings and white males the lowest (171). Evaluations of these studies propose that these findings are not illustrative of racially based differences in perception but rather issues of social relations. In Slovic et al.'s review of Flynn et al.'s research (157), he emphasizes that only 30% of the white men involved in this study possessed the uniquely low-risk profile. These were white men whose socio-economic status was higher (higher income and education levels) and whose politics were distinct from the rest of the study group. As Slovic suggests, these findings direct risk perception issues away from biologically based differences between sex and race and towards ideas of social power and control. As white men have historically dominated political, scientific and technological development, it is not surprising that their relationship to and perceptions of risk and risk management are significantly different from those of groups who have been traditionally more disenfranchised within the social order.

Beyond gender and ethnicity, other socio-demographic factors such as occupation, training, and professional affiliation have been found to significantly influence how people perceive risks. In particular, people who are trained and educated to become "scientific experts" have been shown to have perceptions that are considerably different than from those of the general public[9]. Numerous studies have found that scientists and risk experts perceive scientific and technical risks to be significantly less risky than does the general public (20, 172-174). These differences have been suggested to reflect, in part, the fact that scientists are more knowledgeable about technical issues, and are better able to rationalize complex matters such as dose-response relationships. However, people employed as scientists have also been found to perceive hazards outside of their area of expertise to be less risky than do members of the general public (175). One suggestion for this lies with professional affiliation. Kraus et al.'s research with toxicologists found that those affiliated with industry

[9] The difference in perception of risk between scientists and non-scientists is not often constructed as an occupational issue. However, people are not born as scientists, but rather are trained and educated to *work* in these positions, the conception of this as an occupational issue is reasonable. A factor that may contribute to invisibility of the occupational assessment of this type of work may be the status conferred to people who work in scientific domains in our society. The feminist perspective on science and scientists provides a rich critique of this issue.

perceived risks to be lower than those working in academia or the government (175). Other risk research has found similar results: affiliation was the strongest predictor of perception of electromagnetic frequency (EMF) risk in a study of scientists and experts affiliated with utility industries, versus those who were government employees (176). Issues of affiliation may touch on characteristics described earlier, such as trust and benefit (in this case, financial compensation).

Beyond the issue of scientific privilege or occupational affiliation, particular vocations may serve to sensitize people to overall risk issues. A comparison of workplaces has shown that participation in specific occupations increased perceptions of risk both for occupational and environmental issues (162). This research also found that employment within a certain industry did not necessarily serve to decrease awareness of risk for that industrial sector. For example, workers in nuclear power facilities considered nuclear power to be less risky than workers in other industries, but firefighters rated their work as more risky than that of other workers (162). This result stands in contrast to assertions that greater familiarity with a risk serves to decrease perception of risk. Other studies of occupational risk perception have found that perception of risk varies within organization structures. Assessments of risk and job types have shown that people who work in management positions (as opposed to staff), or as a full-time employee (versus contract employees) are less concerned about the risks of their occupation than others within the same occupational setting (177-180). Explanations for these distinctions have focused on issues of control, although workplace stress may play a role in the reason risks are perceived differently between such groups. In general, people in stressed environments have been found to present unique perceptions of risk (181), and different levels of workplace stress may contribute to variations in risk perception.

Optimistic Bias

Another area of research that has contributed to an understanding of risk perception is that of "optimistic bias," or the tendency of people to believe that they are less likely to experience negative events and more likely to experience positive events than other people (15, 182). Not all risk issues are construed in this way, but, when optimistic bias occurs, it

decreases perception of risk; people do not consider themselves likely to be harmed from an exposure or activity. Optimistic bias may also prevent people from learning more about a risk, as they may not pay attention to risk messages if they do not consider themselves part of an audience for a risk message. Although the causes of optimistic bias are not yet clear, a number of hypotheses have been suggested, including factors such as previous experience. Neil Weinstein has examined these phenomena and found that, in some instances, optimistic bias is higher in those who have not experienced an adverse event (15). As Miles (2003) explains, "if people have experienced an event beforehand, it [may be] easier to imagine a situation in which this could occur again". Other explanations for optimistic bias include feelings of control and stereotyping; optimistic bias may be greater in situations where people feel that they are better able to exercise control over a risk, or when the traits of those at risk are easily stereotyped. People in high-risk groups may also purposely downplay risk or dismiss protective practices (15). Ultimately, this condition is a very important aspect of risk perception that has serious implications for risk communication. Unless people consider themselves at risk, they may dismiss risk messages as irrelevant to their own situation.

In summary, perception of risk has been described as a product of both of individuals' responses to the specific nature of a risk and the socio-demographic profile of those who perceive risk. The specific nature of risk highlights that what is known about a risk, the type and magnitude of its potential effects, and how it may benefit society, are considered important variables for how risks are perceived. The social-demographic research discussed above, although not exhaustive, illustrates that risk perception also reflects complex issues such as social location; people's relationships to social and political control (mediated and reinforced by socio-demographic factors *and* personal factors such as attitudes about vulnerability) influence how they perceive risks.

3.3 Critical Review of Pesticide Risk Perception

The overview presented above illustrates that perceptions of risk in general are the result of a complex interaction of factors. The next section provides a critical assessment of research that has explored the specific issue of perception of pesticide risk by communities involved in farming. This research is considered distinct from that which has explored perception of pesticide risk by consumers, as members of the farming community have a much different "lived experience" with pesticides from that of the general public. Farmers and farm family members' relationship to pesticides affords them greater familiarity and knowledge of these compounds than found among most members of the general public. Other important factors that distinguish the farm communities' perception of pesticides include the degree of control farmers have over pesticide use and application, and the power they have to make changes on their farms to control exposures. The research that has been conducted on the perception of risk within farming populations presents a unique opportunity to explore risk perception in a population that is "at risk" from pesticide use, but also at least potentially able to manage pesticide use through various avenues under their own control.

Perception of pesticide risk in farm communities has been explored from two distinct approaches. The first approach is comparative and has situated perceptions of pesticides within the spectrum of hazards that can occur during farm operations. The second approach has specifically addressed perceptions of pesticides, for example, how people estimate the risk that pesticides pose to their health or the health of the environment. A summary and critique, using the concepts described in the overview of the field of risk perception, is also given.

3.3.1 Perception of Pesticides in the context of Farm Risks

Studies of farm risks in general have found that tractors, farm machinery, and chemical use are perceived as being the leading health hazards by farmers (183-186). Other farm risks of lower concern included working with animals; slips, trips and falls; and working with electricity (183, 184). Arcury et al.'s qualitative research with 33 farmers in the

southeastern United States found that pesticides and machinery were two of the top three hazard domains identified by interview participants (187). Some studies have attempted to correlate farmers' perceptions of risk and hospital records or surveillance data in order to determine if farmers' perceptions of risk reflect the reality of on-farm hazards. These studies have been only marginally successful given that most surveillance programs are either injury- or fatality-based and do not accurately record incidents of pesticide-related illness (183, 185).

Even though family members often work on farms and share the burden of occupational injuries, little research has been done that addresses this group's perceptions of overall farm risks. Given that farmers and farm family members may experience farm work differently, it may not be appropriate to assume the results of research conducted with farmers could be applied directly to farm families.

3.3.2 Perception of Risk from Pesticides

The second approach has been used by only a small group of researchers. In two cross-sectional surveys of cattle, grain and dairy farmers in Midwestern US states (n=245 and n=1011), Tucker and Napier (188, 189) asked participants to assess the level of risk that pesticides posed to nine health- and environment-related items. This research found that farmers rated pesticide risk as low to moderate, although variations did occur within the assessed items. In both studies, applicators' health was perceived as the most at risk from pesticides whereas family health and the health of others ranked considerably lower. Food safety and food quality were perceived to be least at risk from pesticides.

Lichtenberg et al. also examined perception of pesticide risks for human health and for environmental issues, in their study of corn and soybean farmers from Maryland, New York, and Pennsylvania (190, 191). This research asked farmers to rate how concerned they were about illness and injury from pesticides across five particular items, such as exposures during mixing or the presence of pesticides in drinking water. The study also examined farmers' level of concern regarding a variety of factors, including pesticides, which could cause water pollution. With respect to illness and injury, pesticide concern ranked as only moderate. However, like Tucker and Napier's research (188, 189), variation occurred

between farmers' perceptions for each of the items assessed. Greater levels of concern were noted for tasks done by applicators and less concern was given for pesticide residues in food. For concern regarding water pollution, the risk that pesticides posed to water environments was also seen as moderate, although pesticides were considered more problematic to water environments than were fertilizer run-off and livestock waste were.

Other studies have explored farmers' perceptions of pesticides and health risks in particular. Rucker et al. (192) examined perception of pesticide risk and health in a cross-sectional study of 1,614 farmers in five US states (California, Michigan, Minnesota, Oklahoma and Iowa). Farmers who applied pesticides were asked to rate the likelihood that exposure to pesticides would cause long-term or short-term health effects if the pesticides were to touch their skin. Responses ranged by US state, but the majority of farmers responded that pesticide exposure was unlikely to cause either short- or long-term effects (69% and 74% respectively). Farmers were also asked to rate the seriousness of pesticide-related health effects (192). Seventy-four percent felt that the immediate health effects from pesticide exposure would be mild and not serious, and 64% felt that health effects from long-term exposure would be mild. Overall, only 23% of farmers in the sample felt that pesticides posed any risk to applicators.

Perry's research with 127 Wisconsin dairy farmers also assessed perception of pesticide risk (193). Respondents were asked how likely it was that pesticides could cause short- and long-term health effects if people were dermally exposed. There were also asked to rate the health risk associated with pesticide use. The majority of respondents had only moderate to low levels of concern regarding short- and long-term effects. More farmers were concerned about the health risks from pesticide use in general, although the majority still rated the health risks from pesticides to be low to relatively moderate.

Qualitative research methods have also been used to explore pesticide risk perception. Quandt et al.'s focus group interviews with seven farmers found that this group did not perceive pesticides to be risky either to themselves or to farm workers (150), yet the physical state of the pesticide was found to influence farmers' perception regarding the degree of risk. Pesticides in liquid form were thought to present more danger than those that were dry. Rucker's work with farmers and protective clothing found similar perceptions about pesticide risk and liquid formulations (192).

Although in some studies, farmers have identified pesticide use as a leading hazard of their occupation, the studies reviewed in this section have suggested that, in general, farmers do not perceive pesticides to be a serious risk to themselves, their families, or the environment. Some variation was found regarding the degree of risk attributable to pesticide application, although none of the studies indicated that farmers believe pesticides to be high-risk compounds.

3.3.3 Factors Influencing Perception of Pesticide Risk and Farm Risks

Little research has focused on factors that have influenced perceptions of pesticide risk. However, more research has been conducted on perception of farm risks in general. Since members of the farming community have identified pesticides as a main hazard in farming, findings from farm risks studies may be relevant for pesticide risk perception as well. The following section describes factors found to influence pesticide risk perception in the few available studies, and, where applicable, includes relevant research pertaining to farm risk perception in general.

The type of information that farmers use and the sources they look to for pesticide information have been found to influence perception of pesticide risk. For example, Tucker and Napier's research with farmers from three Midwestern states found that those who viewed environmental conservation information to be an important management tool were more likely to perceive higher levels of risk from pesticide use (189). The source of farmers' information has also been shown to be an influential factor (188, 191). Litchenberg et al.'s research with farmers from three Atlantic states found that those who used cooperative extension services to provide them with information had greater levels of concern about pesticides for human health, but not for the environment. The authors suggest this reflects the extension services' focus on human rather than on environmental health. Tucker and Napier's first study with Ohio farmers found that information sources were some of the major predictors of pesticide risk perception, but the results were not as they expected (188). Use of non-technical agricultural sources of information, such as the Ohio State Extension agency, was associated with higher levels of concern about pesticides, although the use of specific soil conservation sources was negatively associated with perception of risk. The

authors felt this distinction was due to the nature of soil conservation programs, which provided information as well as technical assistance.

Pesticide certification and training programs, which provide pesticide specific information, have also been found to influence perception of pesticide risk. Lichtenberg et al.'s study of mid-Atlantic growers found that farmers who were certified applicators considered pesticides to be less risky than those who were not certified (191). In the same study, farmers with graduate or post-graduate degrees considered pesticides to be less risky to the environment than did farmers with high school or lower educational levels (191).

Although training and education have been examined, specific knowledge of pesticide and pesticide risk perception has not been researched extensively. Findings from risk perception research indicate that people's knowledge about a particular risk plays an important role in how this risk is perceived (14). Perry's study of Wisconsin dairy farmers attempted to address the relationship between farmers' knowledge of pesticide safety and risk perception and found no correlation between these factors (194). Elkind's study of 206 Washington State farmers also did not find a clear relationship between farmers' knowledge and their overall attitudes about the risks of farming (12).

Another factor found to significantly influence perceptions of pesticide risk is farm income. Tucker and Napier's research with farmers in two Midwestern states found that higher income levels were significantly associated with lower risk perception scores in two of the three states (189). Other research has found that farms with higher income levels reported significantly lower concerns about pesticide risk for a wide range of environmental and health factors, with the exception of the health risks to applicators (191).

The size of a farm and its influence on pesticide perception has been explored in a very limited way. Tucker and Napier (188, 189) included this measure in both of their studies of Midwestern farmers, but it was not found to be significantly associated with pesticide risk perception. In Lichtenberg et al.'s study of mid-Atlantic farmers, significant associations were found between farm size and perception that pesticides posed a risk to water environments, but farm size was not related to perception of pesticide risk to human health (191).

Few studies have addressed how children learn about farm risks and how this process may influence their perceptions of risk in adult life. Darragh's qualitative research conducted with 36 high school students who lived on farms found that these subjects perceived farm injuries and accidents to be simply part of life on the farm (195). These adolescents did not perceive themselves to be at risk from long-term or chronic conditions caused by farm hazards, even though they knew that their parents suffered from such health problems. The parents of the adolescents were identified as the primary providers of health and safety information, although the teens noted discrepancies between what parents said and what safety practices they used (195). Another qualitative study, conducted by Chapman, with farm children 10 to14 years old found that these children were confident about their ability to protect themselves from farm risks, and that farm tasks were considered to be hazardous only if the tasks were done improperly (196). The attitudes developed during childhood may influence how risks are perceived later in life, although little attention has been paid to this process in the farm risk literature.

In some studies, perception of risk has been found to vary in relation to gender (17, 170), yet few farm risk perception studies have included women. As a result, not much is known about the differences between farm men's and women's perceptions of pesticide risk. The primary study done in this area was conducted by Dewar with a group of men and women (102 females and 193 males) from farms in New York State (197). The women in this research prioritized farm hazards differently from the way men did and, in particular, women were more concerned about pesticides than were the male participants. However, other research that has explored gender and farming has suggested that the differences between men and women may not be as great when explored in a family unit. Green's research with nine Saskatchewan farm couples found that paired males and female tended to perceive farm risks fairly similarly (10). Additionally, research that has examined women who perform the same farm tasks as men have found women and men's risk perceptions to be similar. Cole's research with primary farm operators, both male and female, found little difference between tractor safety perceptions between the sexes (198). The author hypothesized that the socialization of women into the role of primary farmer may influence their otherwise higher level of concern about safety.

The influence of age on pesticide risk perception has not been explored, although results from other studies on farm risk perception have suggested that age is an important factor. Older farmers have been found to be significantly less concerned about hazards from farm equipment and tractors than were younger farmers (185). As well, older farmers have been found to be more resistant to making changes to improve farm safety (199).

Health-related experiences have been found to influence perception of risk in farming communities. In particular, having experienced health problems from using pesticides has been associated with higher levels of pesticide risk perception. Lichtenberg et al.'s research with mid-Atlantic farmers found that those who had experienced health problems from pesticide exposure, or knew someone who had, reported significantly higher levels of concern regarding pesticide risks, specifically to applicators (191). This study did not attempt to classify the types of pesticide-related health effects that people had experienced. Related research has been attempted with respect to current health status. Wadud et al.'s study (200) conducted with Missouri farmers examined concern about farm health risks in relation to self-described current health status. No relationship was found between health status and concern about health-related problems. However, Wadud's research did show that farmers who believed farm health risks were preventable were more concerned about these risks than those who thought they were not preventable (200). The authors suggest that fatalistic beliefs might be a cultural aspect of the farming community that prevents farmers from acknowledging risks and taking appropriate precaution (200).

Risk research suggests that hazards linked to dreaded diseases such as cancer elevate perceptions of risk (18). However, research with farmers has found conflicting evidence regarding farmers' awareness that pesticides cause cancer (193, 201). Perry et al. conducted a focus group with 11 Wisconsin dairy farmers specifically to address pesticides and cancer and found that farmers were aware that pesticides were toxic, but were skeptical about the connection between pesticide use and cancer (201). Cross-sectional research conducted by Perry with 127 Wisconsin dairy farmers found that all the farmers in this group believed that pesticides could cause cancer. No research was found that correlated beliefs about cancer specifically with perceptions of pesticide risk.

The benefits of pesticide use and risk perception has been explored in a limited way. Rucker's multi-state study of farmers found that across all states, farmers felt that the risk from pesticides was low, and that the overall benefit to yields was high (192). In Traore's (202) study of the adoption of farm conservation methods, farmers were less willing to use fewer chemicals if it meant they would decrease their yields. This research found that farmers' use of pesticides was perceived to be "overwhelming necessary for maintaining crop productivity" (202). Other farm-related risk research has examined farm productivity and found that farmers perceive economic factors to be a higher priority than farm health and safety (12, 203). Almost half of the Washington State farmers studied by Elkind were more concerned about product prices than about health and safety concerns (12).

3.3.4 Limitations of the Pesticide Risk Perception Research

Inquiries into the perceptions of farm family members are notably missing from research on pesticide risk perception. Although farmers may not view pesticides as risky, these findings cannot be assumed to reflect the perceptions of other farm family members. Farm family members may be less familiar with pesticides, receive less training, and be more likely than farmers to have been involuntarily exposed to pesticides through indirect exposure. These characteristics of the risk, as identified by psychometric research, may result in different risk perception profiles between farmers and farm family members.

Also absent from the studies conducted on pesticide risk perception is an examination of whether or not risk perceptions differ by ethnicity or by ethnicity and gender combined. As described in the overview of risk perception in general, research has shown that perceptions can vary greatly by these factors, particularly for white men versus all other combinations of ethnicity and gender (171). Farming provides an interesting opportunity to explore how these factors may relate within one specific risk setting, as socio-economic variation may not be extensive. Such analyses have not been previously attempted in farm risk research.

The bulk of the research on pesticide risk perception has been conducted with farmers who grow a variety of crops; but the effect of crop type has not been explored. Patterns of pesticide use and application methods vary by crop and, as a result, characteristics of

pesticide *risk* may vary between crops. Farmers' perceptions of pesticide risk and the perceptions of their family members may reflect this variation.

The issue of control, a major component of the psychometric paradigm, has not been examined in pesticide risk perception research. As described in an earlier section, risk perception research in the general public has found clear relationships between the levels of control that people have over a risk and their perceptions, the level of control being inversely related to risk perception (166). Exploratory qualitative research with farm couples has suggested that this relationship exists in agricultural communities (10). Farmers, arguably, have a significant amount of control over pesticide use and application; this factor may be key to interpreting why farmers do not consider pesticides to be risky.

The influence of trusted sources of pesticide information, another important psychometric characteristic of risk, has not been explored in association with risk perception in the farming community. Farmers' primary sources of information have been examined (190, 197, 200, 204), although these studies have not assessed which of these sources are the most trusted. Also, although information sources were associated with perception of pesticide risk in Tucker and Napier's research (2001), this study did not examine whether farmers trusted their information sources. The sources that farmers go to most often for information may not be their preferred provider of information. The relationships among trust, information source and risk perception merits further investigation.

3.4 Pesticide Exposure Control Practices and Influential Factors

This section of the literature review addresses the research that has examined the practices used by farmers and farm families to control their exposure to pesticides, and the factors associated with such practices. It should be noted that this list of practices is not exhaustive, but is a sample of practices that can be used by the farm community to control both direct and indirect pesticide exposures. This section concludes with a summary of the limitations of this body of research.

The summary begins with a brief discussion of a distinct form of exposure control—growing crops without pesticides. The three other exposure control methods reviewed in this

section are: 1) the use of Integrated Pest Management techniques (IPM) (alternative methods of pest control), 2) the types of PPE worn during pesticide application, and 3) the use of laundry techniques that decrease indirect exposure to pesticides via contaminated clothing. Finally, a short section is included that describes the research conducted on the proximity of planted crops to a farmhouse. Although not truly a "practice" in the same sense as the other three described, this variable has implications for pesticide exposure, particularly for those who live and play in and around farm homes.

3.4.1 Growing without Pesticides

The popularity of organic food is increasing with consumers in both North America and Europe, providing greater market opportunities for this type of farming. The popularity of organic food stems, in part, from the public's concern about risks from pesticide residues in food (205). A study conducted in Seattle, Washington has suggested that feeding organic fruits, vegetables and juices to children is a simple way for parents to reduce their children's exposure to organophosphorus (OP) pesticides (206). Preliminary research has found that organic methods may also provide better tasting food (207), although the nutritional benefit of organic versus conventional foods is greatly debated.

The adoption of organic techniques by Canadian growers has not been widespread. The 2001 Canadian Census of Agriculture found that less than 1% of farmers across the country were certified organic growers (208). In British Columbia, the average is slightly higher, around 1.6%, although this number is for certified organic growers only. No research has been done to determine the number of non-certified organic growers in BC. In the US, the amount of land certified to grow organic crops increased by 74% between the years 1997 and 2001, making organic crops the fastest growing sector of US agriculture (209).

Little is actually known about organic farmers and their reasons for farming without pesticides. A small study with 25 organic farmers in the United States suggested that these growers have greater concern for environmental sustainability than conventional growers do and were more willing to take on short term risks for longer term gains (210). A study in Ohio found that organic growers cited environmental stewardship and the desire to avoid

chemicals as influential to their growing methods (211). Recent research with California growers found that prices and productivity are becoming important factors for farmers both entering and exiting organic production (212). Otherwise, the attitudes and perceptions of organic growers, particularly in Canada, have not been studied in-depth.

3.4.2 Use of Integrated Pest Management

Beyond growing organically, there are other techniques that conventional farmers can use that help reduce the amount of pesticides they apply. IPM programs have been set up across Canada to help farmers seeking pesticide alternatives. Techniques include management strategies that aim to avoid pests, and use of non-chemical approaches to reducing pest populations, such as using sterile insect predators. These programs can include the application of the non-synthetic or natural products such as BT (*Bacillus thuringiensis*) a bacterium that kills specific insects. Information about IPM techniques and training is available for BC farmers from the Ministry of Agriculture, Fisheries, and Food. As little is known about the use of these practices, the BC government is currently investigating the extent of uptake of these practices across the province.

Factors that influence the use of IPM techniques have not been well researched. Two studies, one in Quebec and the other conducted in New York, Pennsylvania and Maryland, found that the use of IPM techniques varied significantly by farm size and education level of the farm operator (191, 202). Research in the United States has suggested that crop type plays also plays an important role, as not all techniques can be used on all types of crops (213).

3.4.3 Use of Personal Protective Equipment

The wearing of PPE has been shown to reduce exposure to pesticides during mixing and application (6). Impermeable gloves, boots, long-sleeved clothing and an apron or coveralls are the basic clothing and equipment requirements for pesticide mixing and application. Research conducted on farmers in the United States has found that the majority

do not wear all the appropriate equipment when they are mixing or spraying (68, 214-217). For example the Agricultural Health study (a project funded by the US National Cancer Institute and conducted with 28,921 farmers who were registered pesticide applicators in North Carolina and Iowa) found that less than half the study population wore eye protection, breathing protection, or protective clothing when applying pesticides (217) . Glove use was found to be more common, although rates of use varied significantly by state (76% in Iowa, 39% in North Carolina). Other, smaller studies that have investigated the prevalence of PPE have also found that gloves were the most commonly worn type of protective equipment (214, 218, 219).

Studies of pesticide protective equipment have found a wide range of factors that influence use. These factors include farmers' age, knowledge levels, specific attitudes about protective equipment and pesticides, health history, stress, farm size, and problems with the equipment itself (23, 28, 169, 184, 187, 191, 194, 199, 200, 215, 216, 218-221). Most of this research focused on only one or two of these factors in isolation. As a result, it is difficult to know which are most influential, although certain factors have been found to have significant effects on the wearing of protective equipment. These factors are explored in the following section.

What farmers wear when they mix and spray pesticides has been found to vary according to age and the gender. In particular, younger farmers have been found to wear significantly more protective equipment than older farmers when applying pesticides (199, 200, 220). A cross-sectional study of 1,947 farmers in California found 65% of farmers under 40 years old wore proper equipment versus only 50% of farmers 70 years or older. This study also found that age was significantly related to wearing less protective equipment for other farm hazards, such as dust and noise (220). Younger farmers were also found to be more likely to implement new, safer practices than older farmers (199). A study conducted with New York State farmers found that 38% of younger farmers (45 years or less) reported making changes to their safety equipment or procedures over the past five years, whereas only 16% of older farmers (> 65 years) had made such changes.

Gender may also play a key role in determining use of equipment. The small number of studies that have included women have found that they wore less protective equipment

than did men doing similar jobs (219, 220). A cross-sectional survey of 1,327 Minnesota farmers (14% of whom were women), found that women applicators wore gloves only 44% of the time, whereas men reported glove use 57% of the time. Other studies that have included women have found similar results. Research conducted specifically with 519 Louisiana farm women has found that this group's glove use for general farm tasks was fairly high (70%), although equipment use was related to the amount of time spent on farm chores. Women who worked fewer than 20 hours per week on the farm wore significantly less protective equipment than women who worked more than 20 hours. One issue highlighted by this and other work with women in agriculture was that women do not necessarily identify themselves as sprayers or applicators, even though many women undertake these tasks (28). Instead women consider themselves to be farm homemakers (222), a perception that may prevent them from being involved in programs and research aimed at pesticide applicators.

Knowledge of pesticide toxicity has been found to influence the use of protective equipment during pesticide application. Perry et al. (194) conducted a telephone survey of 127 Wisconsin dairy farmers and found a positive relationship between the knowledge of pesticide toxicity and the intention to practice safe behaviors during the next pesticide application (194). However, this study acknowledged that the participants' overall knowledge of pesticide safety was relatively low. Knowledge was also explored in a cross-sectional study conducted with 175 fruit growers in three US states (Virginia, West Virginia and North Carolina). This study examined farmers' protective equipment practices and their knowledge of pesticide hazards and found that farmers' knowledge of the toxicity of pesticides significantly increased the amount of protective clothing and equipment they wore when they sprayed (215).

Training and certification programs aimed at educating farmers about the proper use of pesticides have also been found to influence protective practices. A study of 1,327 Minnesota farmers found that the farmers with a current pesticide applicator's certificate wore gloves significantly more often during pesticide application than those without certification, although this relationship was not found for protective clothing such as spray suits or long-sleeved clothing (219).

Farmers' attitudes and beliefs about prevention and health problems have also been associated with the wearing of protective clothing and equipment. Mandel et al.'s study of Minnesota farmers found that those who believed protective clothing worked to reduce exposure were found to wear gloves significantly more often than those who did not believe gloves provided protection (219). Moreover, what farmers believed about the toxicity of a chemical was found to be relevant to what they wore. Regardless of the actual toxicity, the fruit farmers in Keeble et al.'s study were found to wear better protective equipment if they believed a pesticide to be toxic (215). Beyond being harmful to health, farmers may need to believe their own health is at risk before this factor is influential. Two studies have explored protective equipment wearing and concerns about cancer. A cross-sectional study of 1,947 California farmers found that farmers who were concerned about cancer were significantly more likely to wear pesticide protective equipment (220). Mandel's research with Minnesota farmers also found that those who were more concerned about cancer wore gloves more often than those who were not, although the results were not statistically significant (219). Farmers' beliefs about the preventability of health problems have also been found to influence protective behaviors. Wadud et al. conducted research with 110 Missouri farmers regarding their beliefs about protective equipment. This study found that those who believed that breathing problems were preventable were twice as likely to wear breathing protection than those who did not believe these problems were preventable (28% versus 13%)(200).

Although beliefs about pesticides and health are important factors for protective equipment implementation, research also has demonstrated that those who have experienced negative health effects from pesticide exposure are more likely to use protective equipment. Lichtenberg et al.'s study of Maryland, New York, and Pennsylvania farmers is the most comprehensive work in this area. (191). This research found that farmers who believed that they had an adverse health experience from pesticide use were significantly more likely to wear protective equipment during pesticide application than those who had not (191). Additionally, a cross-sectional survey of 1,493 farmers in six Midwestern US states assessed protective equipment practices and found that current health problems was one of the most influential factors in decision making about personal protection (216). Although the number of studies that have examined this issue are limited, the results show strong relationships between adverse health events and protective behaviors.

Factors unrelated to farmers themselves may also influence protective practices. The attitudes and behaviors of peers and family have been shown to affect protective behavior. For example, Perry's research with Wisconsin dairy farmers found that those who believed that other farmers wore PPE were significantly more likely to wear gloves and other protective equipment themselves (193). Farm family members have also been found to influence protective equipment practices; for example, Carpenter's research with farmers in six Midwestern states determined that, among a range of influential factors, spouses and family members were the people who exerted the most influence on farmers' decisions to use protective equipment (216). Interestingly, safety advisors were noted to have the least influence on farmers' decision-making in this study.

Other external factors, related to the farm itself, have been found to influence protective equipment use. Perry's research with dairy farmers found that wearing of protective equipment other than gloves was greater for those on larger farms (193, 223). The reason may be that larger farms are more likely to provide better equipment. Indeed, safety audits of Pennsylvania farms have shown that larger farms score higher than smaller farms with respect to providing proper equipment (223). Farm income and productivity may indirectly influence protective equipment implementation. A number of studies have found that the cost of protective equipment can affect whether the equipment is available or not on a farm (169, 187, 194). Yet, even if they are able to afford equipment, farmers may not consider spending money on safety equipment, as Hope's (1999) qualitative interviews with 47 Irish farmers showed. This research determined that participants considered spending money on safety to be a non-productive investment (224).

Beyond direct costs, qualitative research with farmers indicated that farmers may compromise safety practices because of the stresses of productivity, time constraints and fatigue (9, 10, 224). Green et al.'s interviews with nine Canadian farm couples found that farmers often took "calculated risks in their work, modifying or disregarding safety procedures" in response to the demands of the work of farming (10). Hope's research with Irish farmers also found those who were interviewed mentioned both time constraints and money as perceived barriers to improving their farm health and safety practices (224).

Finally, aspects of protective equipment itself have been found to decrease adoption rates. Pesticide application is often done in the spring and summer, and heavy equipment and long sleeves can be very hot. It is not surprising that farmers have reported not wearing equipment because they find it uncomfortable (200, 216). Wadud et al.'s research with Missouri farmers also found other equipment-specific barriers to adoption, including complaints that the equipment was too inconvenient to put on and too restrictive (200). Green's research with farm couples found similar problems regarding protective equipment and timing. Farmers expressed concerns about the amount of planning it took to have equipment where it was required, and when it was needed, and that it took extra time to put the equipment on and to follow the recommended procedures for using such equipment (10).

In British Columbia, specific guidelines are in place for describing what farmers need to wear when they mix or apply pesticides. Training on these guidelines is available from the Ministry of Agriculture, Fisheries, and Food and is provided during the Pesticide Applicator course offered through this ministry. Other agencies, such as the Farm and Ranch Health and Safety Association (FARSHA) and the Workers Compensation Board (WCB) also provide farmers with information about recommended exposure control practices. Although these guidelines exist, little is currently known about what BC farmers or their family members wear when they spray pesticides or what factors may influence their use of this equipment. This information is critical to understanding pesticide-related exposure control practices in the farming community.

3.4.4 Laundry Practices

Clothing worn while mixing and applying pesticides has been found to retain pesticides residues (91). As a result, those who wash this clothing are potentially exposed to pesticides while laundering (28, 225) As well, how the clothing is laundered has been found to influence the amount of pesticide residue that remains in the garments after laundering (147), as some fabrics can retain measurable amounts of pesticide residue if they are not laundered correctly.

Many government and agricultural agencies have developed recommendations to reduce pesticide exposure during laundering, including washing clothing separately and wearing rubber gloves when handling these clothes. However, little research has been done which investigates adoption of these recommended practices. Only two studies have explicitly researched farm laundry practices, and both found the majority of farms used the family machine to wash clothing worn during application, although most (80%) kept the laundry separate (28, 68). No research has been conducted on other recommended techniques such as wearing gloves, pre-soaking, or rinsing out the washing machine after it has been used. The research that has been done on laundry practices has found that marital status may play a role in proper laundry practices. The Agricultural Health study, conducted with Iowa and North Carolina pesticide *applicators* examined laundry practices and martial status. This research found that unmarried male applicators were more likely have their clothing mixed in with their household clothes than were married men (28). The effect of factors such as ethnicity and gender have not been examined in relation to laundry practices.

The BC Ministry of Agriculture has established guidelines for laundering pesticide-contaminated clothing although specific programs to educate farm communities about these techniques have so far not been attempted. Laundry information is provided to those who take the Pesticide Applicator Course and the guidelines are included in the BC Crop Production guides for each commodity group. However, those who take this course may not be the same people who launder clothing worn during pesticide application. No work has been done in BC to determine what laundry techniques are practiced or the level of farm families' knowledge about the washing regulations.

3.4.5 Farm Home and Crops

Studies of pesticide residues in farm homes have found that residue levels increased the closer homes were to orchards where pesticides were sprayed (27, 75). Proximity has also been shown to be related to the level of pesticide metabolites found in the urine of farm children (75). In this Washington State study of orchard families, children who lived less

than 200 feet from orchards had significantly higher levels of pesticide metabolites in their urine than did farm children who lived farther away.

The only study that specifically examined proximity to crops as an exposure control variable was Gladen's research with farmers in the Agricultural Health Study (Iowa and North Carolina). The research found that 21% of farms were within 50 feet of where pesticides where mixed and that almost half of the homes were within 100 feet of where pesticides were applied (28).

In BC, farms tend to be smaller than those in other provinces (66). Agricultural land is also quite close to urban centers in BC and the cost of farmland is high (226). These factors may result in shorter distances between crops and farm homes, as farmers attempt to maximize the productivity of their land.

3.4.6 Limitations of Previous Farm Practices Research

Although considerable research has attempted to understand farmers' adoption of PPE, much less attention has been paid to other factors that may affect pesticide exposure. Notably absent are studies of farm family members' exposure control practices. The majority of the research on pesticide use practices and control measures has been done with white, male farmers. Research has shown that women are also involved in many of the tasks that can result in exposure to pesticides (23), even though they may not identify themselves as pesticide applicators (88).

Exposure control practices have not been well researched in relation to ethnicity. One US study conducted by Martin et al. (part of the larger Agricultural Health Study) examined pesticide practices in white and black farmers in North Carolina. This research found significant differences; blacks farmers used fewer pesticides and reported less adverse health effects from pesticides exposure than did the white farmers. The authors suggest that these difference were in part attributable to economics and the specific characteristics of the participant's farms (227). Unfortunately, this study did not collect information on specific exposure control practices such as PPE use. Outside of this study, no other research has specifically compared farmer's practices by ethnic origin. Given the diverse ethnic

background of farmers in Canada, understanding the influence of ethnicity in shaping pesticide exposure practices is warranted.

Other factors that may influence pesticide practices, such as learning practices during childhood or growing up on a farm, have not been explicitly addressed in exposure control practices research. The tradition of family farming is strong in Canada, and research has found that those who grow up on farms are influenced by the practices and attitudes of their parents (10, 195, 228). What children learn during their formative years may exert strong influences on how they practice safety later in life.

The literature provides conflicting evidence with respect to beliefs about the dangers of pesticides and protective behaviors. Having had a negative experience with a pesticide appears to modify behavior. However, farmers' practices do not appear to be influenced by their beliefs that pesticides cause harm. One factor that may be hampering the research about attitudes and protective behaviors is that this research does not measure farmers' concern for their own health. Wadud et al.'s (200) examination of farmers' perceptions about barriers to their implementing protective equipment found that many farmers did not wear equipment because they did not consider their health to be at risk from farm hazards. As described by Weinstein (15), this "optimistic bias" can contribute to overall lower assessments of risk. Green's qualitative research with Saskatchewan farm couples also found that farmers did not consider themselves at risk and used phrases such as "it won't happen to me" with respect to farm-related injury or illness (10). Exploring farmers' beliefs about pesticide risk, *in relation to their own health*, may provide more insight into their adoption of protective equipment.

3.4.7 Summary of Critical Review

The body of literature regarding pesticide risk perceptions and related practices is not extensive, and the studies that have been done have approached these issues from many perspectives. Together, the evidence from these studies suggests that the factors that influence pesticide risk perception and practices need to be situated within a broader field of inquiry, one that can accommodate socio-cultural aspects of the farm community, as well as factors that depict farm-specific factors, such as farm size and income.

The review of the literature is also important for illuminating what is missing from our current understanding of pesticide risk perception and exposure control practices in the farm community. The research that has been conducted so far has focused predominantly on male farmers, their approaches to exposure control and their perceptions of the dangers of their occupation. Little research has expanded the population to include all those exposed on farms, including spouses and other farm family members. This has resulted in the exclusion of the majority of farm women's practices and perceptions with respect to pesticides. Additionally, few studies have examined the psychometric characteristics associated with risk perception, including issues of control, trust, and aspects of the perceived consequences of pesticide exposure (e.g., dread). Also not well examined are attitudes regarding personal vulnerability, which may play an important role for both how risks are perceived and the types of practices people use in order to control their exposure to pesticides.

Finally, the studies that have been conducted on farm risk perception and practices have focused for the most part on farmers in the United States. Although similarities exist between Canada and the United States, there are also important differences. For example, the diversity of the ethnic groups involved in farming varies between the two countries. Additionally, the specific pesticide regulations are different in Canada and the United States, resulting in different pesticide use and exposure control practices for each country. Research with Canadian farmers is necessary to understand the practices of farmers and farm family members in this country and their perceptions of the risk of farming in Canada.

3.5 Conceptual Framework; Pesticide Risk Perceptions, Exposure Control Practices and Potential Explanatory Factors

3.5.1 Rationale for the development of the conceptual framework

The literature on pesticide risk perception and practices suggests that these processes are complex and dynamic attitudes and behaviors and that they are influenced by a wide range of factors. However, few studies have explored pesticide risk perception and practices in a comprehensive way. Pesticide risk perception, in particular, is rarely the focus of

research initiatives and is more commonly assessed within the context of other farm-related hazards or as a tangential component of knowledge assessments. As a result, what is known about pesticide risk perception and related practices is somewhat fragmented, lacking a cohesive conceptual framework through which the relationship between these variables can be explored.

As no current, commonly accepted conceptual framework exists that could integrate the broad range of factors suggested as influencing pesticide risk perceptions and practices, one was created for the purposes of this project. The intent of the conceptual framework was to:

1) Organize the empirical and conceptual findings related to pesticide risk perception and exposure control practices.

2) Guide the development of the survey instrument used in this research project.

3) Inform the data analyses plan for the current study.

Researchers who have attempted to situate farm risk perceptions and practices within a theoretical perspective have recommended that such frameworks need to draw from a broad range of social and cultural factors (219, 229, 230). It has also been suggested that conceptually based research of farm communities would benefit from including assessments of the economic and socio-political aspects of modern, industrial farm operations (9). Taking into consideration these recommendations, the conceptual framework developed for this research was structured around three existing approaches:

1) The Farm Structure Model (231)

2) Three key constructs (predisposing, enabling and reinforcing) associated with the PRECEDE-PROCEED framework (232, 233)

3) The Psychometric Paradigm (18).

Integrated, these three components cover the broad spectrum of factors identified by the literature review to influence pesticide risk perception and practices. Importantly, this framework also provides an opportunity to incorporate other characteristics of risk perception

(such as personal vulnerability or trust) that have not been previously examined in agricultural risk perception studies. Once developed, this framework was used to inform and guide the development of the survey instrument used in this research project as well as the data analyses plan.

a) The Farm Structure Model

Because economic and operational factors related to farming were hypothesized as being important influences on pesticide exposure control practices, the Farm Structure Model was incorporated as a major component of the conceptual framework for this project. This model specifically addresses aspects of agricultural business and operation that may influence pesticide risk perception and practices (9, 10, 234). The Farm Structure Model suggests that characteristics of farm operations affect how farmers both perceive and respond to risks (235). Factors such as crop choices and farm size can affect farm profitability, which in turn are thought to influence farmers' actions. For example, farmers of large farms are assumed better able to access informational or educational resources than farmers of smaller farms (236). This model also suggests that perceptions of risk are associated with farm productivity. Factors that threaten the farm enterprise are viewed negatively and those that enhance profitability are viewed positively (231). Some of the variables that have been measured within this model include farm size, commodities grown, income, and farm technologies (such as tractor use).

b) The PRECEDE-PROCEED Model

The PRECEDE-PROCEED model has been used successfully in a range of research environments to address factors that influence behavioral outcomes (237). The model is used for the development, implementation, and evaluation of intervention research (233). The model is comprised of two distinct phases:

1) The PRECEDE phase, which focuses on the development of interventions (and is relevant to the scope of this dissertation); and
2) The PROCEED phase, which is aimed at evaluation (which is not relevant to the scope of this dissertation).

Both phases of the model contain several components. Of the components involved in the PRECEDE phase of the model, the Education and Organization Diagnosis component is the most relevant for the research objectives undertaken in this dissertation. The Education and Organization Diagnosis component is designed to assess three key constructs or factors that are hypothesized to be most influential for behavior change:

1) Predisposing factors,
2) Enabling factors,
3) Reinforcing factors.

Of all the constructs included in the overall PRECEDE-PROCEED Model, these three factors are the most critical to address when gathering information that could be useful to developing risk communication interventions.

Predisposing factors are defined according to motivators or preconditions of behavior. These include knowledge, beliefs, values, and attitudes as well as basic characteristics such as gender, ethnicity, and socio-economic status. Enabling factors are those facilitate or help/hinder the behavior of interest. Examples of enabling factors include accessibility, availability, skills and regulations or laws. Reinforcing factors reward or punish behavior and can strengthen behavioral motivation. Reinforcing factors include the influences of family, friends and peers.

These three factors have been shown to influence behavior change and are hypothesized to be interrelated. Thus, their inclusion in the conceptual framework guiding this dissertation was important for examining the factors that influence behavioral outcomes of interest (defined in the context of this research as "pesticide exposure control practices"). In addition, many of the socio-demographic aspects found to influence risk perception (e.g. gender, ethnicity, education, training) are incorporated within these three factors, making this a good fit for an assessment of both exposure control practices *and* perceptions of pesticide risk. Finally, this model also integrates attitudinal factors and may be used to examine the influence of factors such as perceived vulnerability on pesticide risk perception and exposure control practices.

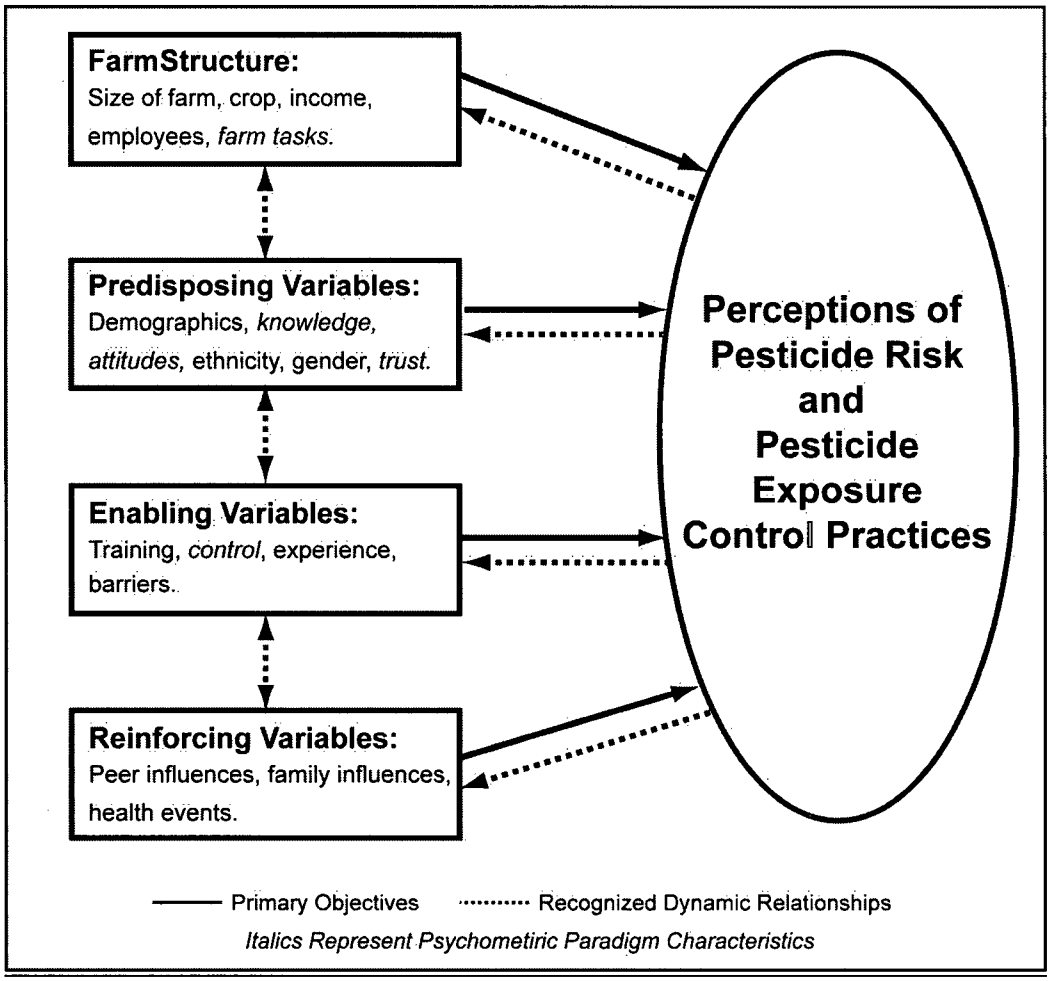
c) Psychometric Paradigm

Previously described in Section 3.2, this paradigm asserts that specific characteristics of risks influence how they are perceived (238). These characteristics include familiarity, controllability, voluntary-ness, trust, dread, and the type and severity of consequences of the risks. This paradigm is used in the conceptual framework to incorporate characteristics of pesticides that may influence individual's perceptions of these chemicals. Rather than standing alone as a separate component, psychometric characteristics are embedded throughout the conceptual framework.

3.5.2 Components of the Conceptual Framework

Figure 3.1 on the following page presents a schematic diagram of the conceptual framework developed specifically for this dissertation project.

Figure 3.1 Conceptual Framework for BC Farmer and Farm Family Research Project



In summary, the conceptual framework is included in this research as a tool for the organization and assessment of previous empirical and conceptual findings related to pesticide risk perception and related practices. In addition to using the model to organize what is currently known about these issues, the framework was used to guide the development of the survey instrument and inform the analytical plan of the current study. The purpose of this current study is descriptive; it was not designed to test the conceptual framework.

3.6 Measurement of Pesticide Risk Perception and Pesticide related Practices

A secondary objective of the literature review was to explore the survey tools and techniques previously used to measure pesticide risk perception and exposure control practices. No single survey instrument was found that could be easily adapted for this research project. Therefore, a new survey instrument (a questionnaire) was designed, informed by existing measures of perception and exposure control practices used in other studies. The following section reviews approaches to the measurement of these variables and indicates where specific measures were adopted for this dissertation research project.

3.6.1 Pesticide Risk Perception Measures

As discussed, previously, pesticide risk perception has been measured from two perspectives. The first measures judgments of perceptions of pesticides compared to other farm risks. The second measures judgments of the magnitude of the risk that pesticides pose to aspects of human health and the environment.

Comparative pesticide risk perception has been measured using two techniques. The first used an open-ended question that asked respondents to rank the top hazards they were concerned about on their farm. The number of times each hazard was mentioned was then used to rank the responses (183, 184). The second techniques asked farmers to rate their concerns about a pre-determined list of farm risks which included pesticides (185, 203). This technique used either Likert-type scales (for example, not concerned to very concerned), or numerical scales (1–10).

The magnitude of the risk that a pesticide poses to a range of items, including human health and the environment, was measured using scales of items. Tucker and Napier (188, 189) used the most comprehensive approach in two studies of Midwestern farmers. Participants were asked to quantify the risk that pesticides posed to nine aspects of farming life, including farmers' personal health, the environment, and food and water safety. Responses were ranked on a nine-point scale for each question. The responses were then summed to create an overall risk perception score. Item analysis determined that summation

of the items was appropriate (coefficient alphas=0.96). A second study by the same authors also used the same measurement scale with minor refinements. Coefficient alphas remained the same. The risk perception composite scale was used as the dependent variable in multivariable analyses, in that study.

Lichtenberg et al.'s (190, 191) research on adverse health effects and pesticide use measured farmers' attitudes about pesticides. These investigators used a Likert-type scale, ranging from 1 (not at all serious) to 5 (very serious) to rate farmers' concerns about illness or injury from pesticide exposure to the applicator, about residues on food and in drinking water, and about pesticide exposure to wildlife. The results of these questions were reported using means and standard deviations, but these data were not used to develop further scales or measures.

Research conducted with pesticide applicators measured pesticide risk perception through an assessment of the effect of pesticide on the health of applicators (192). Specifically, five questions were used to determine the likelihood that pesticides on skin would cause immediate health or long-term health effects, the seriousness of the health effects if they occurred, and the overall risk to health from pesticide application. Risk was measured on a nominal scale, using likely/unlikely or mild/serious where applicable. No composite scales were developed from these measures.

Perry's research on farmers' attitudes and behavioral intentions used a three-item scale to explore pesticide risk perception (193). The questions asked farmers to rate their perception of the immediate and long-term health impacts for applicators from pesticide exposure and to rate the general health risks associated with pesticide use. Item analysis found moderate levels of agreement between the items (alphas=0.7) and the items were summed to create a composite score.

Of these different approaches to measuring pesticide risk perception, the scale developed by Tucker and Napier was determined to be the most appropriate for use as an outcome measure in the new survey developed for use in this dissertation research. The measurement technique used by Tucker and Napier included the broadest range of items for assessment, including the effect of pesticide on food, water, wildlife, animals, applicators' health and human health in general. None of the other measures was as inclusive, and many

focused exclusively on human health. Tucker and Napier's measurement tool was also used in two studies, which gave the authors the opportunity to evaluate the usefulness of their measure in two different research environments. Finally, this measurement tool was used successfully as a composite scale of overall pesticide risk perception, suggesting that it would be a useful outcome measure, or dependent variable, for analytical purposes in the current dissertation project.

Although the Tucker and Napier measure was deemed to be the best primary outcome measure of risk perception for the newly developed survey, a secondary measure of beliefs about pesticides was also adopted from previous research for this current survey. This measure, taken from research conducted by Rucker et al. (192), was used to assess farmers' and family members' beliefs about the likelihood that pesticides may affect their health and to determine if those in the farm community considered themselves personally susceptible to heath risks from pesticide exposure. This was considered as an attitude or belief that may influence risk perception, and was therefore planned as an independent, or potential predictor variable in analyses.

3.6.2 Measures of Pesticide Practices

The most commonly used measures of pesticide exposure control practices in previous studies were estimates of frequency of use, such as approximating the proportion of time farmers wore such clothing in the fields, or how often clothing was washed separately from household laundry. The majority of these responses were recorded as numerical values, although some studies categorized these frequencies into nominal categories (219, 220). Some studies also measured pesticide practices using nominal response categories (yes/no). Examples included: "Do you wear a respirator when you apply pesticides? Do you use your home washing machine to launder clothing worn in fields?" None of the reviewed studies attempted to validate participants' responses to questions about protection practices by using objective measures such as site visits, nor were farmer's self-reported use of pesticides compared with the pesticide application records that are kept by farmers.

Because no validated tools were available to measure practices, the questions used to measure pesticide use, laundry and PPE practices for this dissertation research were based on the BC Ministry of Agriculture's recommended practices for farm operations (239). These questions used a mix of dichotomous response and open-ended formats. The questions that measured IPM techniques were taken directly from the Resource Management Questionnaire developed by Statistics Canada (240). Finally, the question regarding proximity from farm home to crops was adapted from Gladen's research with members of the Agricultural Health Study in North Carolina (28).

3.7 Chapter Summary

This chapter has provided a brief synopsis of the broad field of risk perception research and has critically reviewed the research that specifically addressed pesticide risk perception in farming communities. Also reviewed was the literature that has examined pesticide exposure control practices and associated factors.

A number of important issues emerged from the literature review, including the disparate and fragmented nature of the previous research and gaps in the current approaches to understanding risk perception in the farming community. Studies of risk perception have approached this topic from a wider approach than those used in agricultural risk perception research. To address these issues, a conceptual framework was developed specifically for this project in order to organize what is currently known about pesticide risk perception and practices and to indicate where additional potential explanatory factors might be explored. Implementation of this conceptual framework is discussed further in Chapter 4.

Finally, this chapter has provided a brief overview of the measurement tools and approaches other researchers have used to measure the outcomes of interest (perception of risk and exposure control practices) and identified the measures most relevant for the current research project.

4.0 Study Methods

4.1 Study Design

This research project used a cross-sectional survey design to collect data regarding pesticide risk perceptions and practices in a sample of BC grape, berry and tree fruit farmers and farm family members. The survey was conducted using telephone interviews with randomly selected farmers and farm family members identified using an enumeration created for this study. Selected households were randomly assigned to have either a male or a female participant in order to ensure equal numbers of each gender in the sample. The survey instrument (a questionnaire) was developed specifically for this research project.

The following sections describe the target population, the enumeration and development of the sampling frame, the survey instrument used in this research, the administration of the survey, and the data management and analysis. Ethical approval for the entire project was obtained from the UBC Behavioral Research Ethics Board (approval number B02-0060).

4.2 Target Population

4.2.1 Population of Interest

For this project, the population of interest was BC berry, grape, and tree fruit farmers and their adult family members. This included people who lived on farms where tree fruits (such as apples, peaches, pears, plums, figs, nectarines, apricots, or cherries) or berries (including blueberries, strawberries, raspberries, cranberries, gooseberries, currents, or blackberries) or grapes (including both table or wine varieties) were grown. These commodities were chosen because Captan is licensed for use on these crops in BC. Statistics Canada's Census of Agriculture estimated that 2,521 farms (with >$2,500 gross receipts) reported growing tree fruits, berries or grapes in BC in 2001 (5). Farm family members were

defined as the people who lived on the farm and considered themselves part of the farmer's family.

4.2.2 Inclusion/Exclusion Criteria

The survey included adult (18 years or older) men or women who lived on a farm in BC and were either farmers or farm family members. All types of farms, including conventional (where pesticides were used), certified organic, "non-certified" organic and "transitional-to-organic" were included in the survey. Farms had to have grown at least one tree fruit, berry, or grape crop in the past year. No minimum monetary or acreage restrictions were imposed for participation, although crops had to be grown for the purpose of production and not for solely for the family's needs. Participants were excluded from the survey for the following reasons:

- The farm that they lived on did not grow tree fruits, berries, or grapes.
- Participants lived in a home that was located on a farm, but this home was not the principle farm residence (i.e., rental property that was situated on a farm).
- The participants no longer lived on a working farm (i.e., had moved away or quit farming completely).

Because of the type of study design, telephone access to the home was necessary for study eligibility. Interviews were conducted with people who spoke either English or Punjabi.

4.3 Sample Frame

4.3.1 Sample Frame Development

Because there was no publicly available enumeration of farms by commodity in BC, an enumeration of farms growing tree fruits, berries, or grapes was developed for this project. The enumeration was created through an amalgamation of farm-related lists from a wide variety of sources including the former BC Federation of Agriculture (an agency that no

longer exists), commodity groups, direct farm marketing associations, and farm and winery guides (see Appendix C for details). This list was cross-referenced against the BC Assessment Authority land use database, a database that identifies properties receiving property tax status as a farm (this status is only granted to farms meeting a predetermined income cutoff). Data on farms were entered into a database, duplicates were removed and the telephone number for each farm was validated against the most recent public telephone directory. Two thousand five hundred and eighty-two (2,582) farms were identified.

4.3.2 Sample Size

Two approaches were used to determine an appropriate sample size for this research project. The first estimated the number of people that would be required in order to undertake multivariable modeling as a data analysis procedure. It was anticipated that up to 20 potential explanatory variables would be entered concurrently into a multivariable model. Using an "ad-hoc" estimate of at least 15 respondents per variable (241), 300 people would be required to provide adequate power to perform this type of analysis.

In addition, a sample size calculation was conducted to determine the number of people required to examine simple comparisons of risk comparison (e.g., between men and women). This calculation used a comparison of mean values between men's and women's perception of risk[10] and used the formula shown below.

$$\text{Sample size} = \frac{2\,(SD)^2 \times (Z_{(1\text{-alpha}/2)} + Z_{(\text{beta})})^2}{(\text{mean}_1 - \text{mean}_2)}$$

An alpha value of 0.05, and a beta value of 0.9 were used in this calculation. The mean estimates used for men's and women's perception of risk were 5.1 and 5.4 respectively

[10] The means for men's perception of risk were taken from Tucker and Napier (2001). The women's score was an estimate informed by risk studies that suggest women's perception of risk is higher than men's (Flynn et al 1994).

(standard deviation= 2.1)[11]. The results of this calculation determined that 372 (i.e., 186 in each group) people would be required to undertake two group comparisons.

A review of surveys similar to this project showed that response rates ranged from 40% to 80%; therefore a sample of 1,000 people was chosen in order to ensure sufficient respondents for the study even if the response rate was at the lower end. Using a random number generator, a simple random sample of 1,000 farms was selected from the enumeration database. These 1,000 were then randomly assigned to be either female or male study participants, or one person *per farm*.

4.4 Development of the Survey Instrument

The questionnaire was developed using two techniques:

1) A review of existing questionnaires and surveys used to measure risk perception and farm-related factors relevant to the conceptual framework; and

2) In-depth interviews and a focus group to explore language issues and core concepts.

Once the survey was developed, specific technical and regulatory items were sent to experts for review and comments. The survey was then modified according to this input.

4.4.1 Review of Existing Survey Instruments

During the literature review, described in Chapter 3, the published studies under review were examined for potential questions or measures that could be adapted for this research project. As described in 3.4.2, specific measures of pesticide risk perception and exposure control practices were taken directly from the literature for use in this survey. Beyond these outcome measures, a number of additional questions were modified from

[11] The standard deviation for this calculation was taken from Tucker and Napier's (2001) study.

previous studies for use in this survey instrument. Questions were also adapted from surveys conducted by Statistics Canada, including the Census of Agriculture, and a survey of Resource Management (for farm-specific questions), and the Census of the Population (for socio-demographic questions) (5, 242). Details of questions adapted from previous research and their sources are provided in Tables 4-1 and 4-2 starting on page 80.

4.4.2 Interviews and Focus Group

Berry and tree fruit farmers and their family members were invited to take part in a focus group and in-depth interviews with the following objectives:

- To compile information on the terminology used by farmers and their families to discuss pesticides and pesticide equipment and practices.
- To gather information that would provide response options for the survey questions.
- To evaluate the options for survey dissemination.

Advertisements were distributed at farmers' markets and agricultural fairs in Richmond and Vancouver (see Appendix D). Those interested in participating in the research were required to sign a consent form (see Appendix E). The interviews were conducted in English, although Punjabi translation was offered. A standardized Interview Guide was used (see Appendix F).

A convenience sample of 12 berry and fruit farmers and family members took part in the interviews and focus group, including five women and seven men. Interviews were conducted either in person and over the telephone. The focus group (n=5) was conducted at the home of a farmer. Interviews were taped (except for one refusal for taping) and tapes were transcribed.

The transcriptions were reviewed to identify potential response option sets, appropriate language, suitability of the survey for both genders, and to investigate cultural differences in terminology or practices. The results of the interviews regarding the objectives are described below.

a) <u>Revise Terminology</u>

The interviews suggested revisions to a number of terms used in the study. In particular, "spray'" and '"sprayer'" were the preferred terms to describe "pesticide" and "pesticide applicator". No changes were suggested for the term "Pesticide Applicator Course", the certification course offered by the BC government. One change was suggested regarding the socio-demographic items. The people of Punjabi origin described themselves as being Indo-Canadian rather than South Asian, as specified in the Population Census (243). Preferred units of measurement for farms were found to be acres rather than hectares.

b) Add Response Options

Response options were sought specifically for the types of PPE that people wore during pesticide application. Subjects described a wide range of options and combinations of attire worn when they sprayed pesticides. In general, responses tended to reflect standard equipment, although there were exceptions. One example was turbans, which were noted as worn by some participants during pesticide application. Also noted were variations in the type of breathing protection, ranging from specialized positive pressure helmets to medical or dust masks.

An open-ended question regarding the benefits of pesticide use was also tested during the interviews. Farmers and family members provided responses to this question. They identified pesticide benefits such as increased profitability, yield and improved look of the fruit. It was also noted that pesticides allowed farmers to hire less labour for weeding and maintenance.

An open-ended question regarding farm risks was also asked during the interviews. The major farm risks identified were machinery, such as tractors and other heavy equipment (for example the machines used to pick apples). Stress, sun exposure and falling were also noted as hazards that respondents encountered during farm work.

The subjects also provided a list of farm magazines and newsletters that they typically consulted as sources of information about pesticides. Information sources included government publications, hunting and fishing magazines, equipment manufacturers, and gardening magazines. Available farm courses were also described, including the Pesticide Applicator Course, short courses offered at the Abbotsford Tradex Forum held every year in

February, and courses offered by the Farm and Ranch Safety and Health Association (FARSHA) in Punjabi.

c) Data Collection Options

Telephone interviews were determined to be a better approach for collecting data than in-home visits. Home visits to complete the questionnaire were perceived as too time consuming and somewhat invasive of privacy. Interview participants provided advice about the best time of year to collect the survey data as well as the most appropriate times of day to contact potential survey respondents by telephone.

4.4.3 Draft Questionnaire Development

The conceptual framework outlined in Chapter 3 guided the development of the items in the draft questionnaire. The framework organized the questions into six major components including two outcomes (pesticide perception and pesticide exposure control practices) and four components that address potential explanatory factors (predisposing, reinforcing, enabling, and farm structure factors). The predisposing component had three distinct sub-components: 1) basic demographics, 2) knowledge, and 3) attitudes and beliefs. The characteristics of the psychometric paradigm were incorporated within the various components of the framework.

A description of the components and the concepts measured in each is provided below. Also included in this section is a description of additional questions that were included in the survey to measure issues related to risk communication. A summary of these measures is presented in Table 4-1 to 4-2 starting on page 80.

a) Pesticide Exposure Control Practices

Seven questions were used to assess pesticide exposure control practices, including determining whether pesticides were used on a farm, both on field crops and on home vegetable gardens. For farms where pesticides were being used, three specific exposure

control practices were examined: 1) PPE and clothing practices (PPE), 2) laundry practices used for clothing worn during pesticide application, and 3) IPM techniques (alternative methods for controlling pests and disease).

The results of the qualitative interviews for this current project indicated that members of this farming community wore a diverse set of equipment during pesticide application. Therefore, the PPE question was left open-ended in order to capture the widest possible range of responses. The laundry practices assessed in this survey were those recommended by the BC Ministry of Agriculture, Fisheries and Food (239). Scales were used to measure the frequency of four specific techniques recommended for clothing worn during pesticide application: 1) pre-soaking, 2) separating this laundry from other household clothing, 3) wearing rubber gloves when handling this clothing, and 4) running an empty cycle through the washer after laundry is washed.

Four specific IPM techniques were selected to measure the use of these methods of pest control; 1) using insect predators or sterile insects, 2) altering watering times to avoid disease or pests, 3) planting disease resistant varieties, and 4) altering planting times to avoid disease or pests. These techniques were chosen because they could reasonably be used by berry, grapes, or tree fruit growers. (Techniques not suitable for all three commodities were not included. For example, the IPM technique of rotating crops would be difficult to use on an established apple orchard). Questions about these techniques asked whether they had ever been tried and if they were still being used on the farm.

b) Pesticide Perceptions: Risk and Benefit

Perceptions about pesticides were measured in this study using questions that addressed both perceived risk and perceived benefit. Perceived benefit was included in this study, as it has been found to be important for understanding judgments of perceived risk (see Chapter 3). The inclusion of benefit as a parallel construct allows for a comparison of perceived risks and benefits of pesticides and the factors that are potentially associated with each (160).

The measure of perceived risk included a series of nine questions that asked respondents to rate how risky pesticides were to health, environment and food-related items, on a five-point Likert-type scale. As discussed earlier, these questions used a modified version of the scale developed and tested by Tucker et al. (188, 189) in their studies of Midwestern farmers (described in more detail in Chapter 3, section 3.4.2). The measure of perceived benefit asked respondents to rate how important pesticides were to six aspects of farm operations that had been identified through the previous interview and focus group work. These questions were also measured on a five-point Likert-type scale.

c) Predisposing factors

Predisposing factors are defined as the characteristics that the study respondents bring with them or are antecedent to behavioral practices (232, 233). Twenty-two questions were used to measure predisposing factors across three sub-components, 1) basic demographics, 2) knowledge, and 3) attitudes and beliefs. Eight questions asked about basic demographics including age, sex, ethnicity, geographic area of residence, marital status, current health status and educational level.

Seven questions measured respondents' knowledge, including knowledge of Captan (such as what Captan is used for and the re-entry interval[14]), as well as knowledge of personal and household pesticide exposure pathways, and the potential health effects caused by pesticide exposure. These questions help establish whether the risks of pesticides are known to those in the farming community and to determine knowledge levels of exposure pathways. Additionally, the open-ended "health effects" question explores respondents' knowledge of the types and severity of consequences that could result from pesticide exposure. This question will be used to determine whether the respondent views the impact of pesticides on health as a "dreaded" consequence, an important aspect of the psychometric paradigm

Seven questions measured respondents' attitudes and beliefs. These included questions on attitudes about farm hazards other than pesticides, and how safe they felt

[14]As, noted earlier, a re-entry interval is the duration of time between pesticide application and the time when people can enter sprayed fields

farming was compared to other occupations. This subcomponent also asked participants to describe aspects of personal vulnerability to pesticides, such as the likelihood that their health would be affected by pesticide exposure in the future, and how likely they felt it was that pesticides could enter their home. Two questions were asked regarding beliefs. The first dealt with beliefs about current pesticide regulations. The second question addressed the important psychometric characteristic of trust, respondents were asked to describe their most trusted sources of pesticide information.

d) Reinforcing factors

Seven questions were asked regarding reinforcing factors. These are factors such as peer and family influences that may serve to reinforce people's practices or perceptions. Two questions in this section measured peer influence: the first question asked respondents to rate the frequency with which other farmers wore items of protective clothing; the second determined subjects' involvement in farm groups, such as growers groups or 4-H clubs. The influence of family was determined using questions that addressed farming history, including whether respondents had grown up on a farm, and which relatives (including grandparents, parents, and children) were involved in farming. Two questions in this section addressed previously experienced adverse health effects related to pesticide exposure. These questions asked respondents to describe whether they had experienced a health effect they attributed to pesticide exposure, or if someone that they knew (a relative or a friend) had. The purpose of this adverse health effects question was not to objectively measure the frequency of seeking medical treatment nor medically significant events, but to determine if respondents *perceived* that they had had a negative health experience. Believing a health event has occurred is the lived experience of the respondent and is an appropriate measure of this construct for the purposes of the current study.

e) Enabling Factors

Enabling factors are described as characteristics present in an environment that facilitate practices (232, 233) and include factors such as skills, availability, accessibility and control. For this research, the factors included in the enabling section focused on training, experience, control, and the ability to makes changes. Eight questions were used to measure

enabling factors. These included questions on pesticide training and certification and whether respondents had ever been given instructions on how to wash clothing worn during pesticide application. Experience was measuring using the number of years respondents have been farming. Control, a key psychometric characteristic, was explicitly measured in two ways. The first asked people to record the amount of control they felt that had over pesticide application. The second question asked about decision-making on the farm and was intended to measure the amount of control people felt they had over decisions that affected farm operations. Respondents were also asked to describe one aspect of pesticides they would change if they could. This was an open-ended question, designed to allow farmers and farm family members the ability to be as creative as possible with their responses. A question was also included that assessed barriers to the wearing of protective equipment, such as comfort, cost, and ease of use.

f) Farm Structure Factors

Ten questions were used to assess farm structure factors and determine aspects of farm productivity and operations. Questions regarding farm productivity included those that measured economic factors (farm income, the number of employees that were paid to work on the farm), size of the farm operation (including owned and rented land) and crops grown. The respondent's roles on the farm were assessed by asking who owned and operated the farm, who applied pesticides on the farm and the application method used, and which farm tasks they did (including pesticide-related tasks such as buying and transporting pesticides). Finally, in this section, a question was asked about the proximity of the farm home to where crops were planted.

g) Additional Questionnaire Items

The secondary objective of the research project was to describe the potential avenues for communication with the target population. Items not described in the conceptual framework were included in the questionnaire to address these objectives. These included questions that explored the type of magazines farmers read and how often these magazines

were read[15]. Respondents were also asked if they had copies of the Fruit or Berry Crop Production Guides published by the BC Ministry of Agriculture, Fisheries and Food. These publications contained health and safety information and information about protective practices. Computer use was also asked; respondents were queried regarding the presence of a computer on their farm and how many hours per week they, personally, used the Internet. Another avenue of communication explored was how health and safety information circulates throughout a family. Two measurements were used: the first asked who the first person was to discuss farm health and safety with the respondent. The second question asked how respondents knew when a pesticide was being applied on their farm.

h) Questionnaire Item Measures

The final questionnaire included 63 questions, although there were a number of possible skip patterns depending on the respondents' farm type (i.e., whether or not pesticides were used on the farm) and the farm tasks they undertook. Response options for the items included Likert-type response scales, open-ended, dichotomous (yes/no), and multiple choice options. The scales used to measure attitudes used close-ended questions with Likert-type responses. A copy of the final questionnaire is included in Appendix G. Table 4-1 and 4-2 on the following page summarize the measurement techniques used for each question in the survey. Questions or measures that were adapted from previous research are described and citations are provided. Appendix H shows how these were categorized for analysis purposes.

[15] Farm magazines were the focus of this question as research has shown that these publications are a primary source of information for farmers (Wadud et al. 1998)

Table 4-1 Outcome Measures used in Questionnaire

Outcomes	Type	Measure	Comments/Reference
Practices			
Exposure Control Practices			
Pesticide use	Dichotomous	Q. 35 Pesticides used on farm (if no, describe type of alternative farm) Q. 48 Captan sprayed on farm Q. 2, Q. 36 Do you have a separate vegetable garden *and* do you use pesticides on this garden?	Wording for these questions was developed using findings from the focus group and interviews.
PPE	Open-Ended	Q. 40 What clothing and equipment do you usually wear when applying pesticides	Wording for these questions was developed using findings from the focus group and interviews.
Laundry	Dichotomous Scale	Q. 44a,b Who washes clothing worn for pesticide application, *and* How often do you employ four recommended techniques for this clothing?	Responses taken from Ministry of Agriculture guidelines for laundry practices.
IPM	Dichotomous Multiple Choice	Q. 24 Historical and Current use of 4 IPM practices and rationale for adopting these practices	Taken from Statistics Canada Resource Management Questionnaire (1999)
Risk Perception			
Risk	Scale	Q. 14 Rate level of risk that pesticides pose to 9 items, including human health, environmental health, animals, wildlife and food safety	Modified from Tucker and Napier (1999, 2001)
Benefit	Scale	Q. 13 Rate how important pesticides are to 6 aspects of farm operations	Response options generated from qualitative interviews and focus groups.

Table 4-2 Potential explanatory factors included in the questionnaire

Components	Type	Measure	Comments/Reference
Predisposing Factors			
Basic Demographic			
Sex	Dichotomous	Recorded by Interviewers	
Ethnicity	Open-ended	Three (Q. 52,53,55) on ethnic background, and home language	Statistics Canada Census of Population
Age	Numeric	Q. 51 Year of birth	Responses categorized into 3 groups
Education	Open- Ended	Q 56 Highest education level achieved	Response options adapted from Statistics Canada Census of Population
Farm Location	Open-ended	Q. 3 Region of BC	
Martial Status	Multiple Choice	Q. 54 Current Status	Question taken from Canadian Census of Population
Health Status	Scale	Q. 58 Current Status	Taken from Wadud et al. (1998)
Knowledge			
Captan	Dichotomous, Multiple Choice	Five questions (q. 47,48,49,50,42) regarding use, toxicity, re-entry interval and emergency procedures.	Developed using the BC Pesticide Applicator Course training manual
Personal exposure routes	Open-ended	Q. 19 Identify possible routes of entry into body	
Household exposure Routes	Open-ended	Q. 21 Identify ways that pesticides could enter a farm home	
Health effects from pesticide exposure	Open-ended	Q. 17 Identify health problems caused by pesticides exposure	NIOSH pesticide health effects exposure handbook

Table 4-2 Potential explanatory factors measured, *continued*			
Components	**Type**	**Measure**	**Comments/Reference**
Predisposing Factors continued			
Attitudes and Beliefs			
Attitudes			
Other Farm Hazards	Scale	Q. 23 Rate concern regarding 10 common farm hazards	Scale items developed from research by Schwab et al (1995) and tested during focus group work.
Farm safety	Multiple Choice	Q. 22 Compare safety of farming to other occupations	Farm safety question taken from Thu, et al. (1990) and Elkind (1993).
Vulnerability— personal health	Scale	Q 18 Likelihood that pesticides will affect your future health	Adapted from research by Rucker et al. (1988) and Sandall et al. (1999). Responses transformed from a 5 point scale to a dichotomous variable for analysis.
Vulnerability—household exposure	Scale	Q. 20 Likelihood that pesticides enter farm home	
Beliefs			
Government Pesticide Regulations	Multiple Choice	Q. 30 Attitudes about government pesticide regulations	
Trusted sources reported for providing pesticide information	Open-ended	Two (Q. 29, 32) questions, most trusted source for pesticide information and personal sources for advice about pesticides	
Reinforcing Factors			
Health events from pesticide exposure	Dichotomous Open-ended	Two (Q.15, 16) Have you or someone you know ever had a health problem you think might have resulted from pesticide exposure?	Adapted from Lichtenberg et al. (1999)
Peers Influence—equipment	Frequency	Q. 43 Proportion of other farmers wearing items of protective equipment	
Peer Influence—farm organizations	Dichotomous	Q.27 Do you belong to farm organizations?	
Family Influence	Dichotomous Numeric	Three questions (Q. 10, 11,59) Grow up on farm/Still live on same farm. List family members involved in farming *and* number of children on farm	Developed using concepts proposed by Green (1999) and Lee (1995, 1997) . A farm family generational score was developed to measure the number of generations of a family involved in farming.
Enabling			
Control—Pesticide Exposure	Scale	Q. 38 Scale- Control over 4 aspects of pesticide application	Adapted from Sandall (1999).
Control—Decision Making	Multiple Choice	Q. 5 How would you describe your level of involvement in decision-making on the farm?	
Training	Dichotomous Open-ended	3 questions (Q. 28, 45, 61), including pesticide courses taken, Certification Status and laundry training	
Experience	Numeric	Q. 9 Years farming Experience	
Change	Open-Ended	Q. 34 If you could change one thing about pesticides, what would that be?	
Barriers	Scale	Q. 41 Barriers to using PPE	Responses Informed by Wadud et al (1998).
Farm Structure			
Farm Size	Numeric	Q. 8 Size (acreage) of owned and rented land	
Crops Grown	Open-ended	Q. 1 List commodities grown	
Ownership	Multiple Choice	Q. 7 Who owns your farm?	
Operations	Open-ended	Q. 4 Identify the primary farm operator	
Income	Numeric	Q. 62 Gross Farm Receipts	Taken from Statistics Canada, Census of Agriculture.
Employees	Numeric	Q. 6 Number of Employees	Options included where farms used only unpaid family labour.
Pesticide Application	Multiple Choice	Q. 37 Who applies pesticides on your farm? Q. 39 Methods used to apply pesticides?	
Farm Tasks	Scale	Q. 12 Describe the frequency of pesticide-related tasks you undertake (apply pesticides, purchase pesticides, transport pesticides)	
Farm House and Crops	Numeric	Q 60. Distance from Farm Home to Crops	Taken from Gladen (1998).

i) Validity and Reliability

As the survey did include both modified and investigator-developed survey questions, the issue of validity and reliability needs to be addressed. For reliability, where possible, multiple measures were attempted of a similar construct. For example, three questions were asked in different parts of the questionnaire to determine if pesticides were used on a farm. Given that the new questions were developed using input from community members and experts, it was felt that the content validity was achieved. Ensuring that the concepts under study and the terminology used by the target population actually described their experiences of farm risk improved the content validity of the measurements (244).

4.4.4 Expert Review

Sections of the survey that pertained to technical or specific regulatory matters were sent to the BC Ministry of Agriculture, Fisheries, and Food for expert review. This agency is the provincial body that controls pesticide certification and training. A Pesticide Specialist and an Integrated Pest Management Licensing and Certification Coordinator reviewed the questions specific to certification and training and IPM techniques. A representative from the Pest Management Regulatory Agency (PMRA—the federal government agency responsible for regulatory pesticides) also reviewed these questions. An organic farmer who teaches organic techniques in another province was asked to provide a review of the questions that would pertain to farms where pesticides were not used, and a coordinator for the Ontario Farm Women's Network reviewed the section pertinent to household and laundry-specific exposures.

Comments from the expert reviewers included recommendations for wording and response options and suggestions for expanding questions. Based on the advice of expert reviewers, the IPM questions were modeled after existing questions used successfully in previous surveys regarding IPM techniques conducted by Statistics Canada. Other input included proper classification of organic farming approaches and response options for household exposure pathways. The comments and suggestions of the expert reviews were incorporated into the relevant sections of the questionnaire.

4.4.5 Pilot Test

A pilot test was conducted with ten randomly selected farm families from the sample group. The pilot test was conducted in English only, and was undertaken to assess:

1) The suitability of the telephone script for reaching the targeted gender.
2) The length of the survey.
3) The ability of the respondents to answer the questions as posed.
4) The readability of the interview questions for the interviewers.

During the pilot test, respondents were asked if they had any questions about the survey. This information was used develop a list of "frequently asked questions" that was provided to all interviewers. The pilot was also an opportunity to identify potential problems with the survey implementation and to query the respondent regarding the suitability of the survey incentive (a fridge magnet, see Appendix i).

Of 10 respondents selected to participate in the pilot test, seven were contacted and their surveys were completed. The introductory telephone script worked well for accessing the person of the appropriate gender for the survey. Each of the seven respondents had received the introductory letter and magnet, and was interested in participating and learning more about the survey. The magnet was perceived to be a suitable incentive.

During the pilot test, the survey was found to be too long for a telephone interview. Most interviews took at least one hour to complete, and some questions were problematic. In particular, the explanation of which type of equipment was worn during mixing and application and the frequency it was worn was perceived to be a long and difficult question. Some items of the risk perception scale were also considered redundant (food safety and food quality) or confusing (the impact of pesticides on beneficial plants). Adjustments were made to these items to streamline them and increase the ease of response. Where possible, response options were eliminated and/or collapsed to reduce the time required to ask and respond to each item. The finalized version of the survey took 20 to 40 minutes to complete, depending on the skip patterns for each respondent.

4.4.6 Translation

Once the English language survey had been pilot tested, it was translated into Punjabi by Mosaic, a local multi-language translation company. The survey was then translated back to English by the three Punjabi interviewers (who had not yet seen the English language version) and reviewed with the study coordinator. No revisions were required, although this procedure was useful for ensuring that the translators were clear about the intended interpretation of each question in Punjabi. Paper copies of the interview booklets were printed in Punjabi for the Punjabi interviewers.

4.5 Data Collection and Administration

The survey data were collected by telephone. The following section describes the implementation of the interviews (based on a modified version of Dillman's (245) Total Design Method).

4.5.1 Introductory Letter

An introductory letter was developed to explain the survey to the randomly selected participants (see Appendix J). The letter, which was addressed to either a male or a female, provided the names of the Principal Investigators, the study rationale, the methods of survey (via telephone) and provided a toll-free number to call if the respondent had any questions. The address of the study's website also was included to allow participants to read more about the project. The letter was desktop published to include graphics and the study logo. The survey incentive, a fridge magnet that included the address of the web site, was also provided in the introductory letter. The letters were sent at least two weeks before contact, to allow respondents time to read the letter and contact the study group if they wished. Ten people contacted the study coordinator through the toll-free number, six asked to be removed from the interview pool and four inquired about the time and date of their interview.

4.5.2 Survey Implementation

Twelve English-speaking and three Punjabi-speaking interviewers were hired to conduct the telephone survey. Interviewers were both male and female, and women were assigned to interview women and men to interview men. Interviewers took a three to four hour training session either in a group or on a one-to-one basis. All interviewers conducted a trial survey over the telephone with the study coordinator. After each interviewer had conducted five surveys, they met with the coordinator to discuss any questions they had. A dedicated telephone number was provided to the interviewers to call if they had any questions at any time regarding the interviews.

The interviews were conducted using a formal script that was tailored for men and women who had received the introductory letters (see Appendix K). The script contained the protocol for reaching the appropriate person, for example, interviews were only to be conducted with people 18 years or older. A pen and paper survey booklet (Appendix G) was used to record responses to questions, and a scripted replies sheet (see Appendix L) was used to provide answers to frequently asked questions. Interviewers were instructed to provide subjects with the contact information of the study coordinators if they had further questions.

The interviewers were also provided with a log to be used to track the number of times they called a person, to record call-back times and to keep track of the hours they worked. The interviews were conducted from 9 am to 9 pm during the week, unless otherwise arranged by a subject and an interviewer. Interviews were conducted from the interviewers' homes, as this provided the most flexibility in calling times.

Each interviewer was supplied with a list of telephone numbers, but not the names of the subjects. A limit of 10 unanswered calls was set for each number, with the call times being distributed throughout the day and over a period of two weeks. If the study respondents were unable to speak English or Punjabi, the interviewer recorded this fact. If the farm was no longer in operation, or if berry, fruits or grapes were not grown on the farm, this information was also collected.

4.6 Data Management and Analysis

4.6.1 Coding and Verification

Once the surveys were completed, the data from each telephone interview were entered into a coding sheet. Open-ended questions were coded into discrete categories. Each survey was coded and ascribed a distinct number. The coding sheets were double-checked to ensure accuracy of translation from the survey booklet. The completed sheets were sent to Data Source (a local data processing organization) and entered into a tab-deliminated format.

4.6.2 Data Management

Survey data were entered in SAS ™ (Version 8.0 for Windows) statistical analysis software. The data set was reviewed and checked for missing data and errors. Surveys in which fewer than half of questions were attempted (excluding missing values due to skip patterns) were removed from the dataset. All variables were printed and reviewed to ensure that the values were within the appropriate range. Where data were inconsistent, manual checks of the coding sheets and original booklets were done.

Missing values were handled according to the measurement technique. Where values were missing for questions where scales were used, missing data were ascribed the average (mean) value for that item. Where possible, for non-scale items, missing data were checked against items that measured similar concepts. For example, if a respondent stated that he or she never sprayed pesticides (a task item), it could be inferred that the person was not the pesticide applicator for the farm. Values that could not be determined from other questions in the data set were coded as missing.

The responses to the pesticide risk perception question were analyzed for internal consistency (Cronbach's coefficient alpha= 0.90–94)[16] and were summed to create a

[16] These functions were done for conventional and alternative farms separately, responses shown here are for conventional farms. Coefficient alphas for alternative farm were higher (0.94-0.95).

composite risk score for each respondent. A similar procedure was done for the perception of pesticide benefit question (Cronbach's coefficient alpha 0.75–0.82)[17].

Responses for the pesticide exposure control practices were categorized into summary variables for two of the three practices. A summary of the use of PPE was created using three types of PPE: breathing equipment, rubber gloves and a spray suit. This summary variable, "optimal PPE", included the use of a respirator[18], a spray suit, and rubber (or impermeable) gloves during application. A variable that measured "optimal laundry practices" was created using all four recommended laundry practices (pre-soaking, separating clothing from other laundry, using rubber gloves and running an empty cycle after washing). Both of these summary variables were dichotomous, measuring those whose practices were "optimal" versus those whose practices did not meet these criteria.

For IPM techniques, the variable that measured "ever used IPM" was used for data analyses, as opposed to the variable that measured "still using IPM". The decision to use the first variable (ever used) was made as this question better measured the intent to use IPM, and does not exclude people who wanted to use IPM, but were unable to successfully implement such a program on their farm (i.e. because of geo-climatic problems).

A number of summary variables were created for the potential explanatory factors (e.g. knowledge items) in order to facilitate data analyses. These are detailed in Appendix H.

4.6.3 Data Analysis

Descriptive statistics were generated for the each of the potential explanatory factors in the conceptual framework. The results are presented in tables, stratified by gender, ethnicity and farm type. The composite measures of perception of pesticide risk and benefit (described above) were summarized using descriptive statistics, including histograms and measures of central tendency. Descriptive statistics were also undertaken for the variables that measured factors pertaining to risk communication.

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[17] This question was answered only by conventional growers.
[18] Or an enclosed helmet

Pair-wise correlations were examined between all of the potential explanatory factors. When correlations could not be calculated (e.g. for variables with non-ordered categories such as crop) associations between variables were examined. These analyses were undertaken to evaluate the potential for confounding and to determine the appropriateness of including variables together during model building.

In order to examine the relationships between the potential explanatory variables and perception of pesticide risk and benefit, three techniques were used. The first approach used a comparison of means: the associations between the potential explanatory factors and scores for perceptions of pesticide risk and benefit were assessed using t-tests (for dichotomous variables) and analyses of variance (for variables with more than two categories, e.g. crop). For pesticide risk perception, means were calculated separately for conventional and alternative farms in order to allow for a comparison between the farm types. For perception of pesticide benefit, results were calculated only for conventional farms (i.e., those using pesticides).

In the second approach, univariate linear regression models were created using the perception scores (both for risk and benefit) separately as the dependent variables (conventional farms only were used in both of these analyses). This approach was undertaken for each potential explanatory factor independently and the results were used to compare and contrast the relationship between each explanatory variable and both of the perception measures (perception of pesticide risk and perception of pesticide benefit).

The third approach used multiple linear regression models in order to examine the influence of the potential explanatory variables, in combination with other variables, on perception of pesticide risk and benefit. These models were developed using the variables identified as significant factors in the univariate analyses and used a manual backward stepwise approach to develop final models. (Variables were removed from the model if $p>0.1$) As an association was found between ethnicity and crop, both variables were included in all models to control for potential confounding. Gender was also included in the development of both models, as gender was a design factor of the study.

The relationships between the potential explanatory factors and the three exposure control practices were explored using two methods. In the first method, descriptive statistics

(frequencies) were used to examine the relationship between each potential explanatory factor and the three exposure control practice measures. Differences between sub-groups of the explanatory factors (e.g. married versus single) were assessed using chi-square analysis. Where more than two ordered categories existed, an assessment of trend (Cochran-Armitage test for trend) was also conducted.

Secondly, multiple logistic regression models were developed to examine which factors, when assessed in combination with others, were significantly associated with each of the three practices. These models were developed with the variables that were significantly associated with each of the practices in the descriptive analysis, using manual backward stepwise approach to develop final models. (Variables were removed from the model if $p<0.05$). Included in the models created for PPE and IPM were the variables measuring ethnicity and crop (to control for potential confounding between these variables) and gender, as it was a study design factor. Unfortunately, the variable that measured crop could not be included in the laundry practices model, as missing values in some cells resulted in unstable estimates.

Finally, to examine the potential impact of perceptions on exposure control practices, additional logistic regression models were created for the practices outcomes. Dichotomous variables were created for perception of pesticide risk and perception of pesticide benefit (using the median of each as the cut point for the dichotomous variables), and these variables were entered independently into each of the practices models. Also, as few people were found to use the optimal laundry practices (all four recommended techniques), additional logistic regression models were examined using only three of the four recommended techniques as the outcome measure.

5.0 Results

This chapter is divided into seven sections. The first describes the response rate of the sample and compares participants and non-participants. The second provides a brief descriptive overview of the study respondents and their farms. The third section provides descriptive results for the two primary outcome measures: pesticide exposure control practices and pesticide perceptions (both risks and benefits). The fourth section includes descriptive results for the various explanatory factors examined in this study. The fifth section describes the univariate relationships between these explanatory factors and the outcome measures, and the sixth section describes results of multivariable analyses exploring the relationships between the potential explanatory factors and the two main outcomes (perceptions of pesticide risk and pesticide exposure control practices). Finally, the seventh section summarizes other interesting findings from the survey research, including information useful for future risk communication endeavors.

5.1 Response Rate and Participation

Each of 1,000 randomly selected farms was sent an introductory letter outlining the survey and inviting participation. Two hundred and forty-seven farms (n=247) were not contacted either because they were unreachable (n=136) or because sufficient numbers had already been enrolled (n=111). The remaining 753 were available to be contacted within the study time frame, and 506 of these farms were eligible for participation (growing berry, grapes, or tree fruits; respondent being 18 years of age or older; and speaking English or Punjabi). Of the eligible farms, 380, or 75%, agreed to participate in the study. Ten surveys were incomplete[19] and were removed from the sample, leaving 370 for data analyses. As the target sample size was achieved, no further attempts were made to contact the 111 farms not reached within the planned study timeframe. Table 5-1 summarizes the participation and response rates for this research project.

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[19] Incomplete was defined as answering fewer than half of the questions on the survey, excluding missing data due to skip patterns.

Table 5-1 Study Participation

Participation		Number
Selected from the sampling frame		1000
Not contacted		**247**
Number not in service	26	
Introductory letters returned (incorrect address)	110	
Not reached within time frame of study	111	
Contacted		**753**
Ineligible		247
Not farm operators or spouse of operator	65	
Language other than English or Indo-Canadian	10	
Not growing study commodities	53	
Number reached was no longer a farm	119	
Eligible		506
Declined to Participate	126	
Agreed to Participate	380	

Table 5-2 provides the comparison of participating and non-participating eligible farms.

Table 5-2 Comparison of participating and non-participating farms

	Participated	Did not participate
Number	**380**	**126**
Gender (male), n (%)	188 (49%)	67 (53%)
Indo-Canadian Surname, n (%)	103 (27%)	16 (13%)*
Location, n (%)		
Fraser Valley	119 (31%)	41 (34%)
Okanagan	193 (51%)	64 (51%)
Vancouver and Gulf Islands	44 (12%)	8 (6%)
Other	24 (6%)	10 (8%)
Main Crop, n (%)		
Tree Fruits	187 (49%)	46 (53%)
Berries or Grapes	147 (39%)	67 (37%)
Mixed crops	46 (12%)	13 (10%)

* $p<0.05$, chi-square test

As evident in Table 5-2 above, there were no important differences between the farms or respondents that participated and those that did not, with respect to region, gender, or crop. The response rate did vary by ethnicity; fewer Indo-Canadian respondents refused to participate in this research project.

5.2 Description of the Study Population

Socio-demographic characteristics of the respondents, stratified by gender, are shown in Table 5-3 below.

Table 5-3 Socio-demographic Characteristics of Respondents

Variable	All Respondents	Males (51%)	Females (49%)
Total number	370[a]	187	183
Ethnicity, n (%)			
Indo-Canadian	101	54 (29%)	47 (26%)
European	269	133 (71%)	136 (74%)
Primary language spoken at home[b], n (%)			
English	244	118 (67%)	126 (70%)
Punjabi	50	28 (15%)	22 (12%)
English and Punjabi	45	22 (12%)	23 (13%)
English and Other	13	7 (4%)	4 (2%)
None of the above	11	7 (4%)	6 (3%)
Country of Origin, n (%)			
Canada	211	105 (56%)	106 (58%)
India	82	45 (24%)	37 (20%)
Other Country	77	37 (20%)	40 (22%)
Education Level, n (%)			
Less than grade 12	62	32 (17%)	30 (17%)
Completed grade 12	100	47 (25%)	53 (29%)
Some post-secondary	114	55 (29%)	59 (32%)
University Graduate	94	53 (28%)	41 (23%)
Self-Reported Health Status, n (%)[c]			
Poor-good	133	65 (36%)	68 (38%)
Very good to excellent	229	112 (64%)	117 (62%)
Marital Status, n (%)			
Married	322	160 (86%)	162 (89%)
Single	26	17 (9%)	9 (5%)
Divorced/Widowed	22	10 (5%)	12 (7%)
Age (mean, SD) in years	53 (13.4)	54 (13.5)	51 (13.7)
Year of Immigration (Median)[d]	1973	1973	1975

[a] excludes 10 incomplete surveys
[b] Seven respondents did not answer this question
[c] Eight respondents did not answer this question
[d] First generation immigrant only, n=159

The age of the respondents ranged from 18 to 87 years (mean 53 years), and 49% were female. There were no significant differences between men and women with respect to these socio-demographic characteristics. The average (median) year of immigration was

more recent for Indo-Canadian immigrants (1975) compared to immigrants of European descent (1958) (not shown in table).

Table 5-4 describes the farms studied, stratified by their pesticide use status. Farms where pesticides were applied are described as "conventional" for this dissertation, and farms where pesticides are not used are described as "alternative". Alternative included "certified organic", "non-certified organic" or "transitional-to-organic" farms.

Table 5-4 Characteristics of Participating Farms

Variable	**All Farms**	**Conventional (79%)**	**Alternative (21%)**
Total number	370	293	77
Region, n (%)			
Fraser Valley/Lower Mainland	117	**100 (34%)**	**17 (22%)**[a]
Okanagan	187	**159 (54%)**	**28 (36%)**
Vancouver and Gulf Islands	42	**17 (6%)**	**25 (32%)**
Other regions in BC	24	**17 (6%)**	**7 (9%)**
Crop, n (%)			
Mixed crops	45	**24 (8%)**	**21 (27%)**[a]
Tree Fruits	182	**153 (52%)**	**29 (38%)**
Grapes	22	**16 (5%)**	**6 (8%)**
Berries	121	**100 (34%)**	**21 (27%)**
Size of farm			
Planted acres (median, range)		10 (1-900)	4 (1-300)
Number of small farms (< 5 acres), n (%)	130	**85 (29%)**	**45 (58%)**[a]
Farm ownership, n (%)			
Owned by self or spouse	320	250 (85%)	70 (91%)
Owned by other family member	30	26 (9%)	4 (5%)
Owned by unrelated individual	20	17 (6%)	3 (4%)
Farm operator, n (%)			
Respondent is Primary Operator	159	120 (41%)	39 (51%)
Respondents' Spouse/Family Member is the Primary Operator	69	63 (22%)	6 (8%)
Respondent Shares Operations with Spouse/Family	118	89 (30%)	29 (38%)
Non-related Individual Operates Farm	24	21 (7%)	3 (4%)
Have a family vegetable garden, n (%)	289	189 (65%)	48 (62%)
Labour patterns, n (%)			
Strictly family operated farm	103	**69 (24%)**	**34 (44%)**[a]
Annual farm income, $ (median)[b]		**35,500**	**10,000**[a]
Distance from home to fields- feet (median, range)		50 (1-4,000)	33 (1-3,200)
Pesticide application method[c], n (%)			
Backpack	19	19 (11%)	N/A
Tractor	91	91 (52%)	
Both	66	66 (38%)	
Farm tasks, n (%)			
Spray pesticides			
Never	137	137 (47%)	N/A
Sometimes/Always	156	156 (53%)	

Table 5-4 continued			
Transport pesticides			
Never	122	122 (42%)	N/A
Sometimes/Always	171	171 (58%)	
Purchase pesticides			
Never	120	120 (41%)	N/A
Sometime/Always	173	173 (59%)	

[a] $p<0.001$
[b] Only 43% of respondents from conventional farms and 66% of respondents from alternative farms answered this question.
[c] Only 60% of the respondents from conventional farms answered this question.

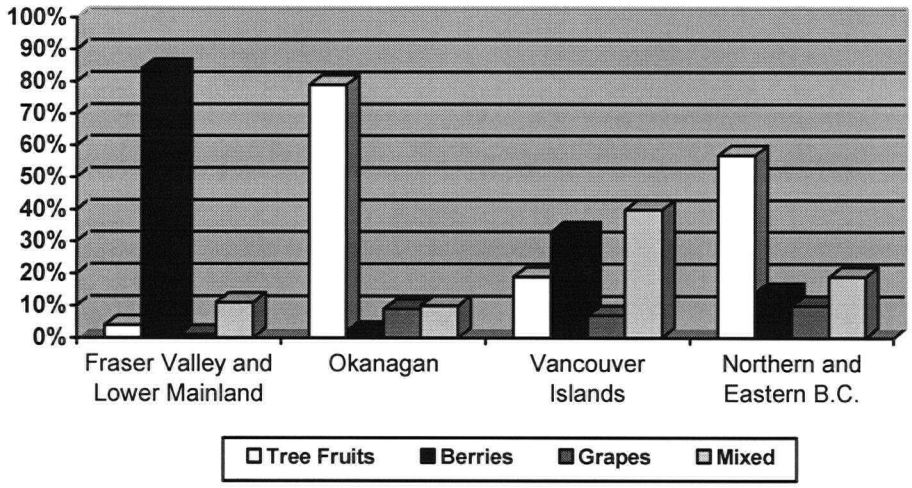
The majority of respondents were from conventional farms, and 21% of the study population was comprised of respondents who lived on alternative farms[20]. These farms were smaller operations, used less labour and reported lower average farm income than the conventional farms. Significant differences were also noted for the types of crop grown and location of farms in the province. Ownership patterns were similar for both farm types: the majority of the study farms were owned either by the respondent, their spouse, or a family member. Conventional farms reported greater distances between the homes and the crops, although the median distances reported by both were fairly short (50 feet or less). Over half of the respondents from conventional farms indicated that they were involved in purchasing, transporting, or applying pesticides.

The types of crop grown influenced some farm characteristics, including income (vineyards reported the highest average farm incomes and mixed commodity farms the lowest), the distance between the farm home and crops (tree fruit and mixed-commodity farms reported the closest distance between the homes and where their crops were planted and berry farms reported the farthest), and region (see Figure 5-1 on the following page).

Only 6% of study farms reported raising animals, and 3% grew hay in addition to their tree fruit, berry, or grapes crops (data not shown). Of the conventional farms, 36 (23%) also reported the use of pesticides on their own family vegetable gardens (data not shown). Data are not available regarding pesticide use on family vegetable gardens for alternative growers, as this question was not asked to respondents from this farm type.

[20] Of the alternative farms (N=77), 53% were "certified organic", 24% were "non-certified organic" and 22% were "transitional-to-organic".

Figure 5-1 Proportion of Commodities Grown on Study Farms, per Region



5.3 Description of Outcome Measures: Pesticide Exposure Control Practices and Perceptions (Risk and Benefit)

5.3.1 Exposure Control Practices

Table 5-5 on the following page describes three exposure control practices used on conventional farms to control pesticide exposure: the wearing of PPE, laundering techniques used for clothing worn to apply pesticides, and the use of IPM techniques.

All results about pesticide exposure control practices *in this section (5.3)* relate only to conventional farms.

Table 5-5 Pesticide Exposure Control Practices

Variables	Respondents	Males	Females
Primary Pesticide Applicators, n (%)	119	107	12
Personal Protective Equipment[a]			
Rubber or impermeable gloves	99	89 (84%)	10 (83%)
Respirator or enclosed helmet	88	**82 (77%)**	**6 (50%)**[e]
Spray suit/coverall	91	83 (78%)	8 (67%)
All of the Above[b]	74	68 (64%)	6 (50%)
Launders clothing worn for pesticide application[c]	131	59	72
Methods Used (Always or Often) [d], n (%)			
Pre-soak	49	18 (31%)	31 (44%)
Separate from other dirty clothes	111	52 (90%)	59 (83%)
Rubber gloves	49	22 (38%)	27 (38%)
Run empty cycle after laundering	46	18 (32%)	28 (41%)
All four techniques	18	6 (10%)	12 (17%)
First three techniques	29	10 (17%)	19 (26%)
Ever received laundry training or instructions	39	**25 (44%)**	**14 (20%)**[e]
Integrated Pest Management (IPM) techniques, n (%)		151	142
Ever tried an IPM technique	181	**102 (68%)**	**79 (56%)**[e]
Still using IPM techniques	162	90 (60%)	72 (51%)

[a] One sprayer did not describe his or her PPE techniques
[b] Defined as optimal protection for the purpose of this study
[c] Two washers did not describe their laundry techniques
[d] Practices recommended by the BC Ministry of Agriculture
[e] $p<0.05$, chi square analysis, comparing males to females

Nearly all of the pesticide applicators in this study were male; only 12 women identified themselves as the primary pesticide applicator for their farm. Similar proportions of men and women reported use of rubber or impermeable glove and spray suit use, although a smaller proportion of the women reported wearing respirators during pesticide application. Sixty-four percent (64 %) of men and 50% of women wore the optimal combination of gloves, respiratory protection, and a spray suit or coverall.

Both men and women reported laundering clothing worn for pesticide application. No significant differences were found between men's and women's laundering techniques for clothing worn during pesticide application. Only a small proportion of men and women (14% overall) reporting using all four recommended laundry practices. The number of people who

had received instructions about how to launder clothing worn during pesticide application was low; a significantly larger proportion of the men had received this type of instruction.

Overall, 62% of respondents on conventional farms indicated that they had used one of the IPM techniques described in the survey. Men were significantly more likely to have reported using IPM techniques on their farm. Of those farms where IPM had been tried, the majority was currently using these techniques to help control pests and disease (data not shown).

5.3.2 Perception of Pesticide Risk and Benefit

a) Perception of Pesticide Risk

Table 5-6 shows results for the nine individual questions regarding pesticide risks. In general, pesticides were perceived as being slightly to somewhat risky, with mean response values ranging from 3.2 (applicator health) to 2.2 (health of others outside of the farm).

Table 5-6 Perception of Risk from Pesticide Use, All Respondents

How risky are pesticides to the following factors?	Not 1	Slightly 2	Somewhat 3	Very 4	Extremely 5	Mean	SD
The health of applicators	59 (16%)	53 (14%)	87 (24%)	83 (22%)	88 (24%)	3.2	1.4
Beneficial insects such as bees	116 (31%)	39 (11%)	70 (19%)	61 (16%)	84 (23%)	2.9	1.6
The health of farm Families	100 (27%)	75 (20%)	69 (19%)	66 (18%)	60 (16%)	2.8	1.4
Water safety	120 (32%)	54 (15%)	73 (20%)	55 (15%)	68 (18%)	2.7	1.5
Air quality	110 (30%)	72 (19%)	75 (20%)	56 (15%)	57 (15%)	2.7	1.4
Food safety	131 (35%)	54 (15%)	76 (21%)	55 (15%)	54 (15%)	2.6	1.5
The health of farm animals	140 (38%)	63 (17%)	67 (18%)	56 (15%)	44 (12%)	2.5	1.4
The health of wildlife	160 (43%)	69 (19%)	48 (13%)	52 (14%)	41 (11%)	2.3	1.4
The health of others outside of the farm	156 (42%)	81 (22%)	56 (15%)	41 (11%)	36 (10%)	2.2	1.4

Responses to these nine items were highly correlated with each other, yielding Cronbach's coefficient alphas ranging from 0.95 to 0.96.

The overall distribution of the composite risk score (produced by summing answers to the nine questions above) is shown in Figure 5-3. Values ranged from 9 to 45 with a mean of 23.9 and a median of 22.0. However, as evident in the histogram, the distribution was bi-modal. Not surprisingly, dividing the population by the use of pesticides, (i.e., conventional *v.* alternative farms), provided two uni-modal distributions with similar ranges but distinctly different median values (38.0 for alternative growers and 19.0 for convetional growers (illustrated in Figures 5-3 and 5-4 on the following page)[21]. Therefore, subsequent analyses using this composite score were conducted for each farm type separately.

[21] The distributions for both subpopulations were skewed. However, a comparison of non-parametric and parametric analyses using these data showed little difference in the results. Therefore only the parametric results will be shown here

Figure 5-2 Perception of Pesticide Risk (Composite Score) All Respondents

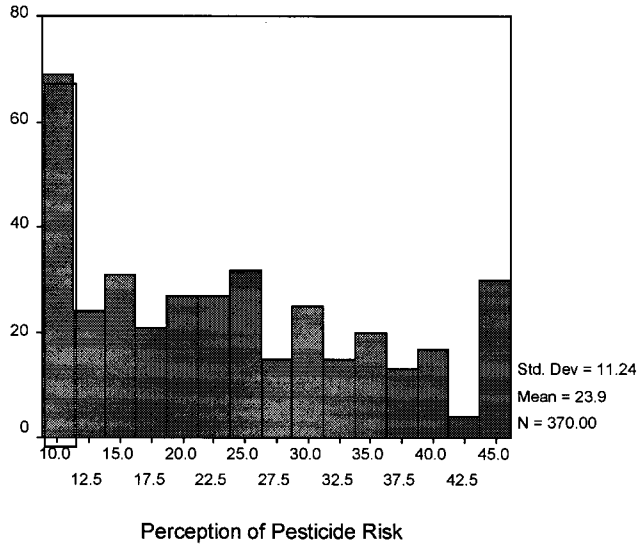


Figure 5-3 Perception of Pesticide Risk (Composite Score) Conventional Farms

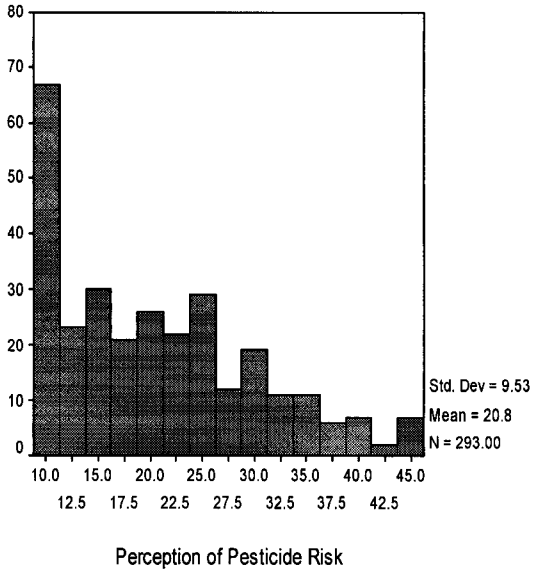
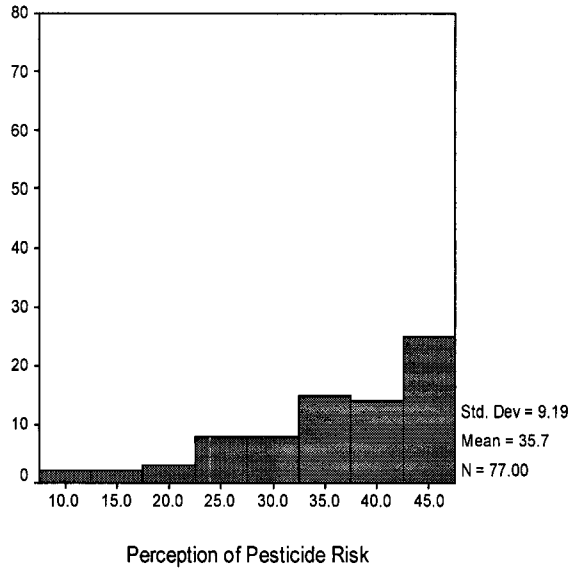


Figure 5-4 Perception of Pesticide Risk (Composite Score) Alternative Farms



b) Perception of Pesticide Benefit

Table 5-7 shows the results for the seven questions that assessed the perceived benefit of pesticides for farm productivity. In general, pesticides were perceived as being somewhat beneficial. Pesticides were considered most important to the financial success of the farm (mean 3.9) and least important for determining which crops were grown on the farm (mean 2.4).

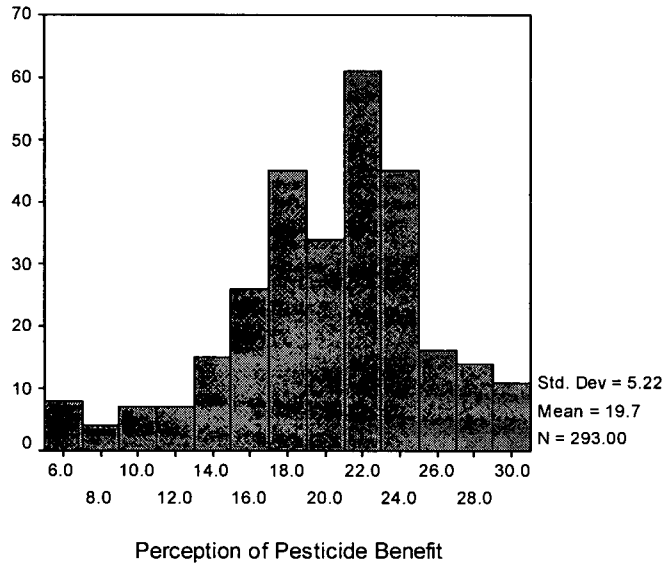
Table 5-7 Perception of Pesticide Benefit, Conventional Farms

How important are pesticides to the following factors	Not 1	Slightly 2	Somewhat 3	Very 4	Extremely 5	Mean	SD
The financial success of your farm	14 (21%)	16 (6%)	72 (25%)	86 (29%)	105 (36%)	3.9	1.1
Crop appearance	30 (10%)	30 (10%)	59 (20%)	93 (32%)	81 (28%)	3.6	1.3
Controlling the pest population in your area	30 (10%)	23 (8%)	71 (24%)	93 (32%)	76 (26%)	3.6	1.2
Crop yields	24 (8%)	30 (10%)	81 (28%)	88 (30%)	70 (24%)	3.5	1.2
The amount of labour you require on the farm	75 (26%)	33 (11%)	79 (27%)	64 (22%)	42 (14%)	2.9	1.4
Improving soil quality*	86 (29%)	68 (23%)	75 (26%)	43 (15%)	21 (7%)	2.5	1.2
Determining the crops that you grow	114 (40%)	54 (18%)	55 (19%)	50 (17%)	20 (7%)	2.4	1.3

* Pesticides are not used to directly benefit soil quality. This item was included simply to assess whether or not respondents were simply marking 'yes' or 'no' to all questions. Therefore, it was not used in the calculation of the composite score.

These items were correlated with each other (Cronbach's coefficient alphas ranging from 0.76 to 0.84), although not as highly as the pesticide risk items described in the preceding section. The composite 'pesticide benefits' score (the sum of the 6 items noted above, excluding soil quality) ranged from 6 to 30, with a mean of 19.7 and median of 21.0. The distribution is shown in Figure 5-5.

Figure 5-5 Perception of Pesticide Benefit, Conventional Farms



5.4 Factors Potentially Associated with Practices and/or Perceptions

This section describes results for the potential explanatory variables outlined in the conceptual framework. Note that the farm structure variables and the socio-demographic predisposing variables have already been described (section 5.2 Description of the Study Characteristics). In this section, all variables are shown stratified by gender, ethnicity, and farm type in order to explore possible associations (and thus potential confounding) among these factors.

5.4.1 Predisposing Variables—Knowledge

Table 5-8 on page 103 summarizes the results for the questions directed at capturing knowledge about pesticides in general and Captan in particular. Overall, only 71 respondents (24%) from conventional farms were able to provide correct answers to both Captan

knowledge questions[22]. Significant differences were found regarding Captan knowledge between men and women and the two ethnic groups (data on Captan were not collected from respondents on alternative farms). Male respondents and those who were Indo-Canadian were significantly more knowledgeable about Captan than women or respondents of European descent.

Over 81% of all respondents identified inhalation and dermal absorption as potential routes of exposure into the body. However, ingestion was identified by only 50% of respondents. Significant differences were found between the knowledge of all three of these routes across the two ethnic groups but not farm type or gender. Indo-Canadian respondents identified all three routes of pesticide exposure more often than those of European descent.

Fewer respondents were able to identify the potential routes through which pesticides can enter the farm home. Of the pathways identified, 70% of respondents indicated that they knew that pesticides could enter a home through windows and doors (pesticide drift), and 60% reported pesticide-contaminated clothing as a potential source of exposure. Unwashed hands were identified by only 21% of the respondents. Knowledge of these routes varied significantly by ethnicity and farm type but not by gender. Indo-Canadian respondents were less knowledgeable specifically about pesticide drift as a potential source of home exposure.

Just over half of all respondents were able to identify at least one potential health effect from exposure to pesticides and variations were found for the identification of these effects across all examined strata. Significant differences were found between men and women, women identifying potential health effects more often than did men. Fewer Indo-Canadian respondents than those of European descent could identify health effects from pesticide exposure, and respondents from alternative farms were significantly more likely to identify potential health effects from pesticide exposure than those from conventional farms.

Awareness of the carcinogenic potential of pesticides differed significantly by gender, ethnicity and farm type. Women, those of European descent and respondents from alternative farms showed greater awareness that pesticides could cause cancer than men, those of Indo-Canadian origin or respondents from conventional farms.

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[22] Correct knowledge included identifying a re-entry interval of at least 24 hours and correctly identifying Captan as a fungicide.

Table 5-8 Predisposing Variables- Knowledge

Variables	Total	Males	Females	European Descent	Indo-Canadian	Conventional	Alternative
Total Respondents	**293**	**151**	**142**	**195**	**98**	-	-
Appropriate Captan knowledge[d], n (%)	71	**53 (35%)**	**18 (13%)[c]**	**40 (21%)**	**31 (32%)[b]**	-	-
Total Respondents	**370**	**187**	**183**	**269**	**101**	**293**	**77**
Knowledge of Personal Exposure Routes, n (%)							
Dermal	299	158 (85%)	141 (77%)	222 (83%)	77 (76%)	230 (79%)	69 (90%)
Oral	184	94 (51%)	90 (49%)	127 (48%)	57 (56%)	**136 (47%)**	**48 (62%)[b]**
Inhalation	319	162 (87%)	157 (86%)	236 (88%)	83 (82%)	251 (87%)	68 (88%)
All Three	153	75 (40%)	78 (43%)	**102 (38%)**	**51 (51%)[b]**	114 (34%)	39 (51%)
Knowledge of Home Exposure routes[e], n (%)							
Windows/Doors	168	81 (43%)	87 (48%)	**145 (54%)**	**23 (23%)[b]**	**120 (41%)**	**48 (62%)[b]**
Pesticide contaminated clothing	163	86 (46%)	77 (42%)	135 (67%)	28 (68%)	113 (39%)	**50 (65%)[b]**
Unwashed Hands	51	**35 (19%)**	**16 (9%)[b]**	34 (13%)	17 (17%)	**33 (11%)**	**18 (23%)[b]**
Two of Three	126	68 (36%)	58 (32%)	**107 (40%)**	**19 (19%)[c]**	**83 (28%)**	**43 (56%)[c]**
Positive identification of pesticide health effects (excluding cancer), n (%)	216	**100 (53%)**	**116 (63%)[a]**	166 (62%)	**50 (50%)[b]**	**163 (56%)**	**53 (69%)[b]**
Aware that pesticides cause cancer, n (%)	90	41 (22%)	49 (27%)	84 (31%)	**6 (6%)[c]**	**53 (18%)**	**37 (49%)[c]**

[a] $p=0.05$, [b] $p<0.05$, [c] $p<0.001$ chi square analysis, comparing within groups (e.g., males versus females)
[d] Correct knowledge includes identifying a re-entry interval of at least 24 hours and correctly identifying Captan as a fungicide
[e] Number who correctly identified this route of exposure when asked an open-ended question

5.4.2 Predisposing Variables—Attitudes and Beliefs

Respondents' attitudes and beliefs regarding farm hazards[23], farm safety, personal vulnerability, and trusted sources of pesticide information are presented in Table 5-9. Over 50% of the respondents indicated that they were concerned about potential injuries on their farm. Slightly less overall concern was reported for occupational stress (45%) or sun exposure (39%). Few respondents from conventional farms (16%) were very or extremely concerned about the use of pesticides on their own farm (data not shown; see Appendix M, Table A1). Ethnicity and farm types were found to influence injury concerns in particular; Indo-Canadian respondents and those from conventional farms were less concerned about injuries than were those of European-descent or from alternative farms.

Ethnicity and farm type were also influential with respect to attitudes regarding farm safety. Seventy-five percent of Indo-Canadian respondents considered farming to be as safe as other occupations, whereas only 52% of European respondents shared this attitude. Attitudes regarding farm safety also varied significantly by farm type.

Overall, only 10% of respondents believed their own health to be at risk from pesticide exposure. Gender was associated with this variable; more women believed their own health to be vulnerable to pesticide exposure than did men. A higher proportion of respondents (22%) felt it was likely that pesticides entered their homes, with the highest proportions seen among women and respondents of European descent and from alternative farms. Few Indo-Canadian participants felt it likely that pesticides could enter their farm home.

The two most commonly mentioned trusted sources for pesticide information were the government and pesticide vendors. Significant differences in these sources were found across gender, ethnicity and farm type. Men, those of European descent and respondents from conventional farms were more likely to mention the government as a trusted source than did respondents who were women, Indo-Canadian or were from alternative farms. Indo-

[23] A more detailed description of attitudes regarding farm hazards is provided in Appendix M

Canadian respondents were more likely to report pesticide vendors as trusted sources, whereas alternative growers reported growers' associations most often.

Beliefs regarding government pesticide regulations differed by farm type and ethnicity: respondents from alternative farms and those of European descent were significantly more likely to consider current pesticide regulations not strict enough.

Table 5-9 Predisposing Variables- Attitudes and Beliefs

	Total	Males	Females	European Descent	Indo-Canadian	Conventional	Alternative
Total Respondents	370	187	183	269	101	293	77
Attitudes, n (%)							
Other farm hazards							32 (42%)
Concerned about sun exposure	143	65 (35%)	78 (43%)	103 (38%)	40 (40%)		**53 (69%)**[b]
Concerned about injuries[d]	197	106 (57%)	91 (50%)	**160 (59%)**	**37 (37%)**[c]	111 (38%)	26 (34%)
Concerned about occupational stress	165	88 (47%)	77 (42%)	122 (46%)	43 (43%)	144 (49%)	
						139 (48%)	
Farm safety							
Safer than other occupations	52	28 (15%)	24 (12%)	**34 (13%)**	**18 (18%)**	**37 (13%)**	**15 (19%)**
As safe	225	109 (58%)	116 (63%)	**149 (55%)**	**76 (75%)** [c]	**191 (65%)**	**34 (44%)** [b]
Less safe than other occupations	93	50 (28%)	43 (25%)	**86 (32%)**	**7 (7%)**	**65 (22%)**	**28 (36%)**
Attitudes: Vulnerability, n (%)							
Pesticides likely to impact own health	35	9 (5%)	**26 (14%)**[b]	27 (10%)	8 (8%)	**22 (8%)**	**13 (17%)**[b]
Pesticides likely to enter farm home	82	35 (19%)	47 (27%)	**80 (31%)**	**2 (2%)**[c]	**44 (15%)**	**38 (53%)**[c]
Belief: Government pesticide regulations are not strict enough	79	37 (20%)	42 (23%)	**76 (29%)**	**3 (3%)**[b]	**36 (12%)**	**43 (56%)**[a]
Beliefs: Trusted sources reported, n (%)							
Sources of pesticide information							
Government	99	**60 (32%)**	**39 (21%)**[b]	85 (32%)	**14 (14%)**[c]	**86 (29%)**	**13 (17%)**[b]
Pesticide vendor	101	58 (31%)	43 (24%)	38 (14%)	**63 (62%)**[c]	**99 (34%)**	**2 (3%)**[c]
Fruit packers and processors[e]	61	28 (15%)	22 (18%)	27 (27%)	**34 (13%)**[c]	58 (20%)	3 (4%)
Growers' associations	54	24 (13%)	30 (17%)	47 (18%)	**7 (7%)**[b]	**35 (12%)**	**19 (25%)**[b]
Farm community[f]	24	12 (6%)	12 (7%)	16(6%)	8 (8%)	**20 (7%)**	4 (5%)

[a] $p=0.05$, [b] $p<0.05$, [c] $p<0.001$ chi square analysis, comparing within groups (i.e., males versus females).
[d] Includes tractor rollover; slips, trips, and falls; and lifting injuries.
[e] Fruit packers and processors include Packing Houses and Agri-business Co-operatives.
[f] Farm community includes other farmers or farming neighbors.

5.4.3 Reinforcing Variables

Results from the questions regarding factors categorized as reinforcing variables are presented in Table 5-10 on page 109. Of the total study population, 17% reported having experienced at least one adverse health effect from pesticide exposure and 30% knew someone who had had such an experience. Effects reported included breathing problems, cancer and allergies. Some people also reported an illness in their domestic pets that they attributed to pesticide exposure. Details for the types of health effects experienced by the study respondents are provided in Appendix M (Table A2).

The experience of an adverse health effect did not differ by gender or farm type, but did differ by ethnicity. A higher proportion of European descent respondents reported experiencing an adverse health effect themselves. Knowing someone (a friend or relative) who had experienced an adverse health effect from pesticide exposure varied across all categories: women, those of European descent and respondents from alternative farms reported knowing more people who had experienced these events.

The variables that measured generational learning factors were found to vary by ethnicity: respondents of European descent reported more generations of their families involved in farming than those who were Indo-Canadian. With respect to respondents' own farm life experience, men were more likely than women to have grown up on a farm. Men were also more likely than women to report that they were stilling living on the same farm as the one on which they grew up. Indo-Canadian respondents were less likely to have grown up on a farm, but were more likely to have children under the age of 18 on their farm than did those of European descent.

Regarding peer influences, 50% of respondents indicated that they belonged to a farm organization. This was more frequently reported by respondents who were male, of European descent, or were from alternative farms. When respondents who applied pesticides themselves were asked to estimate what proportion of their peers (i.e., other farmers in their community) wore PPE, the estimated mean proportion who wore respirators was 71% (*SD* 28.9) and the estimated mean proportion who wore gloves was 81% (*SD* 23.1) This did not appear to vary significantly by ethnicity or gender (although there were only 7 female

pesticide applicators who answered this question, so there was very low power to examine gender differences for this question).

Table 5-10 Reinforcing Variables

Variables	Total	Males	Female	European Descent	Indo-Canadian	Conventional	Alternative
Total Respondents	**370**	**187**	**183**	**269**	**101**	**293**	**77**
Experienced an adverse health effect related to pesticide exposure, n (%)							
You	64	31 (17%)	33 (18%)	**54 (21%)**	**10 (9%)**[b]	47 (16%)	17 (22%)
Relative or friend	112	**48 (26%)**	**64 (35%)**[a]	**90 (33%)**	**22 (22%)**[b]	78 (27%)	**34 (44%)**[b]
Family Influence, n (%)							
Generational[d]							
First generation farmer	177	82 (44%)	95 (53%)	**116 (44%)**	**61 (61%)**	137 (48%)	40 (52%)
Second generation farmer	68	34 (18%)	34 (19%)	**43 (16%)**	**25 (25%)** [c]	55 (19%)	13 (17%)
Third generation farmer	120	70 (37%)	50 (28%)	**106 (40%)**	**14 (14%)**	96 (33%)	24 (31%)
Grew up on a farm							
Yes, still live on same farm	43	**27 (14%)**	**16 (9%)**	**27 (10%)**	**16 (16%)**	36 (12%)	7 (9%)
Yes, live on different farm now	112	**63 (34%)**	**49 (27%)** [b]	**94 (35%)**	**18 (18%)** [b]	93 (32%)	19 (25%)
No, did not grow up on a farm	215	**97 (52%)**	**118 (65%)**	**148 (55%)**	**67 (68%)**	164 (56%)	51 (66%)
Children < 18 years old on farm	145	70 (37%)	75 (41%)	**81 (30%)**	**64 (64%)**[c]	120 (41%)	25 (32%)
Peer Influences, n (%)							
Belong to farm organizations	185	107 (57%)	**78 (43%)**[b]	**147 (55%)**	**38 (39%)**[b]	**137 (47%)**	**48 (62%)**[b]
Estimated **proportion** of peers who wear protective equipment[e]-proportion (*SD*)						-	
Respirator		0.73 (0.26)	0.53 (0.50)	0.7 (0.32)	0.73 (0.23)	-	
Gloves		0.81 (0.23)	0.74 (0.37)	0.8 (0.24)	0.81 (0.25)		-
							-

[a] p=0.05, [b] p<0.05, [c] p<0.001 chi square analysis, comparing within groups (i.e. males versus females)
[d] Five respondents did not provide answers for this question
[e] For pesticide applicators only. Only 7 female and 80 male pesticide applicators provided estimates for this question, and 56 European descent and 29 Indo-Canadian sprayers provided estimates.

5.4.4 Enabling Variables

Table 5-11 on page 112 summarizes the data from the questions that asked respondents about factors categorized as enabling. Almost one-third of all respondents reported having taken a pesticide-related course. A higher proportion of men than women had taken a pesticide-related course in the past five years, and more men held current pesticide applicator certificates. Indo-Canadian respondents were more likely than respondents of European descent to hold a current certificate or to have taken a course.

Significant differences were found in the respondents' years of farming experience. Men, those of European descent and respondents from conventional farms had all been involved in farming for more years than had women, Indo-Canadian respondents and those from alternative farms.

Control over farm decisions varied by gender, ethnicity, and type of farm. More men than women reported being the dominant decision makers for their farms; women reported higher levels of shared decision-making or that their spouses were the primary decision makers. Respondents from alternative farms and those of European descent shared decision-making more often than those on conventional farms or Indo-Canadian respondents.

Among the 119 pesticide applicators who responded to the question regarding control and pesticides, 73% felt that they had high levels of control over aspects of pesticide application (specific details for this question are in Appendix M Table A3) with no differences found by gender or ethnicity. Concerning barriers to PPE adoption, Indo-Canadian applicators were less likely than those of European descent to consider PPE to be too uncomfortable to use.

The open-ended question that asked respondents "If you could change one thing about pesticides, what would you change?" yielded a wide range of responses. Seventy-two respondents (20%) described wanting either to ban pesticides outright or to not have to use these chemicals on their farm. Another frequently cited change was to decrease pesticide toxicity or to improve the safety of these compounds, including improvements to the way that pesticides are tested. Recommendations were made to change public opinion regarding both pesticides and fruit: some respondents suggested that the public had unrealistic expectations for perfect fruit, others felt that the public were unduly concerned about

pesticides. Suggestions for improving pesticides included decreasing the cost of pesticide, increasing the specificity of action of these compounds, and improving the smell. A summary of the recommended changes to pesticide formulation, packing, practices, regulation, and public perceptions is provided in Appendix M (Table A4).

Table 5-11 Enabling Variables

Variables	Total	Males	Female	European Descent	Indo-Canadian	Conventional	Alternative
Total Respondents	**370**	**187**	**183**	**269**	**101**	**293**	**77**
Training, n (%)							
Taken a Pesticide-Related Course	111	**81 (43%)**	30 (16%)[b]	**71 (26%)**	**40 (49%)**[a]	97 (33%)	**14 (18%)**[a]
Holds Current Pesticide Applicators' Certificate	78	**64 (34%)**	14 (8%)[b]	**45 (17%)**	**33 (33%)**[b]	75 (26%)	**3 (4%))**[b]
Farming Experience, n (%)							
More than 20 years experience	185	106 (57%)	79 (43%)[a]	**145 (54%)**	**40 (40%)**[a]	**157 (54%)**	**28 (36%)**[a]
Control, n (%)							
Decision Making on Farm							
I make the decisions	128	111 (59%)	17 (9%)	**86 (32%)**	**42 (42%)**	**104 (35%)**	**24 (31%)**
I share decisions with my spouse	131	56 (30%)	75 (41%)	**109 (41%)**	**22 (22%)**	**86 (29%)**	**45 (58%)**
Spouse makes the decisions, but I get involved sometimes	48	5 (3%)	43 (24%)	**33 (12%)**	**15 (15%)**	**46 (16%)**	**2 (3%)**
							2 (3%)
I make decisions with an employee	16	7 (4%)	9 (5%)	**14 (5%)**	**2 (2%)**	**14 (5%)**	4 (5%)
I don't get involved in decisions	47	8 (4%)	39 (21%)	**27 (10%)**	**28 (28%)**	**43 (15%)**	
			b		b		b
Perceived High Control over Pesticide Application[c]	87	80 (75%)	7 (58%)	58 (71%)	29 (78%)	-	-
Barriers to Adoption of Personal Protective Equipment[d]**, n (%)**							
Too Uncomfortable	48	45 (42%)	3 (33%)	39 (50%)	**9 (24%)**[a]	-	-
Too Expensive	37	18 (17%)	3 (30%)	16 (20%)	5 (14%)		
Takes Too Much Time to Put On	37	15 (14%)	2 (20%)	12 (16%)	5 (14%)		

[a] $p<0.05$, b $p<0.001$, chi square analysis, comparing within groups (i.e. males versus females)

[c] Pesticide applicators only answered this question, Females, n=12, Males, n=107., European Descent, n=82, Indo-Canadian, n=37.

[d] Pesticide applicators only answered this question. Females, n=10 for all barriers. Males, n=106 for "too uncomfortable", n=104 for "too expensive" and n=105 for "too much time". For European Descent, n=79 for "too uncomfortable", n=78 for "too expensive" and 77 for "too much time". Indo-Canadian, n=37 for all barriers.

5.5 Relationship between Potential Explanatory Factors and Perception of Pesticide Risk and Benefit

The next section displays the univariate relationship between the various explanatory factors and perception of pesticide risk in three ways. The first compares the mean values for the pesticide *risk* perception score, stratified by each of the potential explanatory variables. These means are shown separately for conventional and alternative farms as the shape of the distribution of risk perceptions scores differed according to farm type (see section 5.3.2). This comparison of mean values provides a clear illustration of the relationship between the explanatory factors and the pesticide risk perception score, particularly for non-linear variables (such as crop).

The second approach shows the univariate linear regression models for the relationship between each explanatory variable and perception of pesticide risk *and* benefit. The results of these linear regression models are summarized in a table that allows for a direct comparison of the contribution of each variable to the scores for both risk and benefit perception. It should be noted that these results are shown for conventional farms only.

Finally, the results of multiple regression modeling are shown for perception of pesticide risk and benefit. The multiple variable models show the contribution of each independent variable to the risk and benefit outcome score, while controlling for the effect of other factors.

5.5.1 Factors Associated with Pesticide Risk Perception – Univariate Analyses (mean scores)

a) Farm Structure variables

Mean values for the pesticide risk composite score, stratified by the various Farm Structure variables and farm type are shown in Table 5-12 on the following page.

Table 5-12 Perception of Pesticide Risk (composite score), by Farm Structure

Conventional (n=293)	N	Mean (SD)	p[1]	Alternative (n=77)	N	Mean (SD)	p[2]
Crop				**Crop**			
Mixed	24	24.9 (11.6)		Mixed	21	**38.2 (8.9)**	
Tree fruit	153	21.0 (9.8)	0.07	Tree fruit	29	**37.3 (8.4)**	**0.03**
Grapes	16	21.1 (8.8)		Grapes	6	**27.1(14.5)**	
Berries	100	19.3 (8.4)		Berries	21	**33.5 (7.3)**	
Size of farm (planted acres)				**Size of farm (planted acres)**			
Small Farms ≤ 5	85	**23.5 (10.0)**	**<0.01**	Small Farms ≤ 5	45	35.3 (9.8)	0.7
Larger Fams >5	208	**19.6 (9.1)**		Larger Farms >5	32	36.0 (8.8)	
Income[a]				**Income[a]**			
< $ 25,000	55	**23.2 (10.7)**	**0.02**	< $ 25,000	37	**37.1 (7.3)**	**0.05**
≥ $ 25,000	71	**19.3 (8.5)**		≥ $ 25,000	14	**31.6 (11.5)**	
Labour patterns[b]				**Labour patterns**			
Strictly family operated farm	69	**23.4 (10.2)**	**<0.01**	Strictly family operated farm	34	36.2 (9.0)	0.4
Hire Employees	222	**19.9 (9.2)**		Hire Employees	43	35.2 (9.4)	
Farm ownership				**Farm ownership**			
Self/Spouse	250	20.9 (9.6)	0.4	Self/Spouse	70	35.9 (9.2)	0.6
Other	43	19.7 (9.6		Other	7	33.8 (9.8)	
Farm operator				**Farm operator**			
Self	120	20.2 (8.8)		Self	39	35.0 (9.2)	
Self & Spouse/Fam.	89	19.8 (9.7)	0.07	Self & Spouse/Fam.	29	36.5(10.1)	0.7
Spouse/Family	63	21.3 (10.3)		Spouse/Family	6	38.3 (6.3)	
Unrelated	21	25.7 (8.8)		Unrelated	3	32.2 (5.0)	
Pesticide Application							
PesticideSprayer[b]							
I am the primary sprayer	119	19.8 (9.0)	0.2				
Someone else sprays	173	21.4 (9.9)					
Application Method[c]							
Backpack	19	**19.8(11.1)**					
Tractor	91	**17.9 (8.1)**	**0.02**				
Both	66	**21.9 (9.2)**					
Farm Tasks							
Spray Pesticides							
Never	137	21.6 (9.7)	0.1				
Sometimes/ Always	156	20.0 (9.3)					
Transport Pesticides							
Never	122	**22.0(10.3)**	**0.05**				
Sometimes/ Always	171	**19.8 (8.9)**					
Purchase Pesticides							
Never	120	21.5(10.4)	0.3				
Sometimes/ Always	173	20.2 (8.9)					

Not Applicable

[1] p value (ANOVA) for test comparing risk perception score across categories for conventional farmers only.
[2] p value (ANOVA) for test comparing risk perception score across categories for alternative farmers only.
[a] Only 43% of respondents from conventional farms and 66% of respondents from alternative farms answered this question.

[b] One respondent did not answer this question
[c] Only 60% of the respondents from conventional farms answered this question.

On conventional farms, perception of pesticide risk was highest for respondents from farms that grew a mixture of crops, and lowest for respondents from farms that grew only berries. Perception of pesticide risk varied significantly by the size of the farm and income, with lower risk perception found on farms with larger acreages and farms with annual farm incomes over $25,000. In contrast, respondents from strictly family operated farms reported higher levels of perceived risk compared to those who. Perception of pesticide risk was not found to be significantly associated with whether a person was a farm operator, a pesticide applicator, or owned his or her own farm.

Respondents from farms where only tractors were used for pesticide application perceived pesticide risk to be lower than farms where backpack sprayers were used. Of the pesticide related tasks that were measured in this study, only transporting pesticides was associated with pesticide risk; those who reported undertaking transporting pesticides either sometimes or always perceived pesticides to pose less of a risk than did those who were never involved in this task.

Farm structure variables were found to be less influential for respondents from alternative farms, with the exception of crop type and income. As with conventional farmers, respondents from alternative farms that grew a mixture of crops considered pesticides to be riskier than those from single-commodity farms and perception of pesticide risk was lower in respondents from alternative farms that reported annual incomes over $25,000.

b) Predisposing Socio-Demographic Variables

Table 5-13 on the following page summarizes the mean values for the pesticide risk composite score, stratified by the various predisposing socio-demographics variables and by farm type.

Table 5-13 Perception of Pesticide Risk (Composite Score) and Socio-Demographic Variables

Conventional Farms (n=293)				Alternative Farms (n=77)			
	N	Mean (SD)	p[1]		N	Mean (SD)	p[2]
Sex				**Sex**			
Female	142	20.5 (9.0)	0.7	Female	41	37.0 (9.2)	0.3
Male	151	21.0 (10.1)		Male	36	34.6 (9.2)	
Ethnicity							
European Descent	195	**22.3 (9.6)**	**<0.01**				
Indo-Canadian	98	**17.6 (8.5)**					
Age				**Age**			
18–35 years	133	20.4 (8.8)		18–35 years	31	34.5 (8.7)	
36–54 years	128	21.5 (10.3)	0.4	35–54 years	41	36.7 (9.6)	0.6
>55 years	32	19.2 (9.2)		>55 years	5	34.0 (9.7)	
Education Level				**Education Level**			
Less than high school	52	18.4 (9.3)		Less than high school	10	31.7 (6.5)	
Completed high school	80	22.3 (9.5)	0.1	Completed high school	20	35.9 (11.2)	0.5
Post-Secondary	89	20.2 (9.2)		Post-Secondary	25	36.8 (8.9)	
University	72	21.4 (9.9)		University	22	36.1 (8.6)	
Farm Location				**Farm Location**			
Fraser Valley	100	**18.7 (8.5)**		Fraser Valley	17	33.3 (7.9)	
Okanagan	159	**21.5 (10.0)**	**0.02**	Okanagan	28	33.8 (10.1)	0.6
Vancouver and Gulf Isles	17	**24.8 (8.3)**		Vancouver and Gulf Isles	25	38.8 (7.9)	
Other region	17	**22.5 (9.4)**		Other region	7	38.3 (10.2)	
Self Reported Health Status[a]				**Self Reported Health Status**			
Poor-Good	111	20.7 (9.2)	0.9	Poor-Good	22	35.1 (8.3)	0.7
Very Good-Exc.	174	20.9 (9.9)		Very Good-Exc.	55	35.9 (9.6)	
Marital Status				**Marital Status**			
Married	256	20.9 (9.6)	0.5	Married	66	36.0 (9.2)	0.4
Not married[b]	37	19.6 (9.0)		Not married[b]	11	36.1 (9.1)	

[1] p value (ANOVA) for test comparing risk perception score across categories for conventional farmers only
[2] p value (ANOVA) for test comparing risk perception score across categories for alternative farmers only
[a] Eight respondents did not answer this question
[b] Includes single, divorced and widowed respondents

Perception of pesticide risk did not differ by gender for either conventional or alternative growers. However, significant differences were found between the ethnic groups. On conventional farms, those of European descent reported significantly higher levels of perceived pesticide risk than did those of Indo-Canadian origin. As there were only 3 Indo-Canadian alternative growers, a comparison of perception of pesticide risk and ethnicity was not possible for this farm type.

Age, education, martial status, and health status were not associated with pesticide risk perception for those on conventional or alternative farms. Perception of pesticide risk did

vary by where a farm was located in BC for conventional farms only: respondents from farms in the Fraser Valley had the lowest perception of pesticide risk, and those living on farms on Vancouver Island and the Gulf Islands had the highest.

c) Predisposing Knowledge Variables

Table 5-14 summarizes the relationships between the variables that measured knowledge and perception of pesticide risk, stratified by farm type.

Table 5-14 Perception of Pesticide Risk (composite score) and Knowledge Variables

Conventional Farms (n=293)				**Alternative Farms (n=77)**			
	N	**Mean (SD)**	**p[1]**		**N**	**Mean (SD)**	**p[2]**
Appropriate Captan knowledge[a]				Not Applicable			
Correct	71	21.1 (9.5)	0.7				
Incorrect	222	20.6 (9.5)					
Knowledge of personal exposure routes[b]				**Knowledge of personal exposure routes[b]**			
More knowledgeable	114	21.7 (10.8)	0.2	More Knowledgeable	39	**38.6 (7.8)**	**<0.01**
Less knowledgeable	179	20.1 (8.6)		Less Knowledgeable	38	**32.8 (8.7)**	
Knowledge of home exposure routes[c]				**Knowledge of home exposure routes[c]**			
More knowledgeable	83	**24.9 (9.7)**	**<0.01**	More Knowledgeable	43	**37.8 (7.9)**	**0.02**
Less knowledgeable	210	**19.1 (9.0)**		Less Knowledgeable	34	**33.1 (10.0)**	
Identification of Pesticide Health Effects				**Identification of Pesticide Health Effects**			
Can't Identify	130	**17.7 (8.6)**	**<0.01**	Can't Identify	24	**30.3 (10.5)**	**<0.01**
Can Identify	163	**23.2 (9.5)**		Can Identify	53	**38.2 (7.4)**	
Aware that pesticides can cause cancer[d]				**Aware that pesticides can cause cancer**			
Yes	53	**30.1 (9.2)**	**<0.01**	Yes	38	**39.5 (8.5)**	**<0.01**
No	236	**18.6 (8.2)**		No	39	**32.5 (10.5)**	

1 p value (ANOVA) for test comparing risk perception score across categories for conventional farmers only
2 p value (ANOVA) for test comparing risk perception score across categories for alternative farmers only
[a] Appropriate knowledge defined as identifying Captan re-entry interval as 24 hours or more and correctly identifying it as a fungicide
[b] More knowledgeable is defined as knowing three routes of personal exposure: dermal, oral, and inhalation
[c] More knowledgeable is defined as being able to identify two of three exposure routes into the home: drift, contaminated clothing, or unwashed hands
[d] Four respondents did not answer this question

Specific knowledge of Captan was not found to influence perception of pesticide risk. General knowledge of pesticides and the health effects of pesticide exposure did influence respondents' risk perception scores, on both conventional and alternative farms. Respondents

who could identify either exposure routes into the home, or a potential health effect from pesticide exposure, rated pesticides as riskier than did respondents who could not identify these factors. Perception of pesticide risk was also significantly higher in respondents from both farm types who were aware that pesticides could cause cancer.

d) Predisposing Attitudes and Beliefs

Table 5-15 summarizes the relationships between perception of pesticide risk for predisposing variables that measured attitudes and beliefs.

Table 5-15 Perception of Pesticide Benefit (composite score) and Attitudes and Beliefs

Conventional farms (n=293)				Alternative farms (n=77)			
	N	Mean (SD)	p[1]		N	Mean (SD)	p[2]
Attitudes: Other farm hazards				**Attitudes: Other farm hazards**			
Occupational stress[a]				**Occupational stress[a]**			
High Concern	139	**22.4 (9.7)**		High Concern	26	36.8 (8.6)	
Low Concern	153	**19.3 (9.1)**	**<0.01**	Low Concern	50	35.9 (9.5)	0.4
Sun exposure[a]				**Sun exposure[a]**			
High Concern	111	21.9 (9.5)	0.1	High Concern	32	37.3 (8.1)	
Low Concern	181	20.1 (9.2)		Low Concern	44	34.4 (9.8)	0.1
Farm injuries				Farm injuries			
High Concern	144	**23.0 (9.4)**		High Concern	53	37.2 (7.6)	
Low Concern	149	**18.6 (9.2)**	**<0.01**	Low Concern	24	32.3 (11.4)	0.06
Farming safety				**Farming safety**			
Safer	37	**19.1 (8.1)**		Safer	15	36.0 (8.8)	
As Safe	191	**19.8 (9.4)**	**<0.01**	As Safe	34	34.3 (10.3)	0.4
Less Safe	65	**24.4 (9.0)**		Less Safe	28	37.4 (7.8)	
Attitudes: Vulnerability				**Attitudes: Vulnerability**			
Pesticides likely to impact own health[a]				**Pesticides likely to impact own health**			
More Likely	22	**31.7 (9.2)**	**<0.01**	More Likely	13	**43.1 (3.7)**	**<0.01**
Less Likely	268	**19.9 (9.0)**		Less Likely	64	**34.2 (9.3)**	
Pesticides likely to enter farm home[b]				**Pesticides likely to enter farm home[c]**			
More Likely	44	**30.6 (8.5)**	**<0.01**	More Likely	38	**40.5 (4.8)**	**<0.01**
Less Likely	240	**19.0 (8.6)**		Less Likely	34	**31.2 (9.9)**	
Beliefs: Government pesticide regulations				**Beliefs: Government pesticide regulations**			
Not strict enough	36	**28.6 (11.4)**	**<0.01**	Not strict enough	46	**38.5 (7.1)**	**<0.01**
Fine/Too strict	257	**19.7 (8.7)**		Fine/Too strict	31	**31.6 (10.5)**	

Table 5-15 continued							
Beliefs: Trusted sources reported[d]				**Beliefs: Trusted sources reported**			
Fruit packers and processors				-			
Yes	58	**17.1 (8.4)**	**<0.01**				
No	235	**21.7 (9.6)**					
Pesticide Vendors				-			
Yes	100	**18.6 (8.7)**	**<0.01**				
No	193	**21.9 (9.8)**					
Growers' Assoc.				Growers' Assoc.			
Yes	35	23.4 (10.5)	0.08	Yes	19	35.0 (11.3)	0.7
No	258	20.0 (9.4)		No	58	36.0 (8.5)	
Farm Community				-			
Yes	20	20.2 (10.8)	0.8				
No	273	20.8 (9.5)					
Government				Government			
Yes	84	21.5 (8.9)	0.5	Yes	13	34.3 (12.2)	0.5
No	207	20.5 (9.8)		No	64	36.0 (8.5)	

[1] p value (ANOVA) for test comparing risk perception score across categories for conventional farmers only.
[2] p value (ANOVA) for test comparing risk perception score across categories for alternative farmers only.
[a] One person, [b] nine people, and [c] five people did not provide responses for these questions.
[d] Respondents could provide more than one trusted source.

On conventional farms, perception of pesticide risks varied considerably according to respondents' attitudes and beliefs. Increased perception of pesticide risk was associated with increased concern about farm stress or farm injuries and with the attitude that farming was generally less safe than other occupations. These associations between attitudes about other farm risks and pesticide risk were not as strong among alternative farmers, although there was a weak association (p=0.06) between concern about farm injuries and perception of pesticide risks.

Attitudes regarding personal vulnerability were associated with perception of pesticide risk among respondents from both conventional and alternative farms. Not surprisingly, respondents who felt that their own health or their home was vulnerable to pesticide exposure perceived pesticides to pose significantly greater risk than those who did not consider themselves to be personally at risk.

Regarding beliefs about pesticide regulations, both conventional and alternative farm respondents who felt that the government's pesticide regulations were appropriate or even too strict considered pesticides less of a risk than did those who did not consider the current regulations to be adequate.

Pesticide risk perception varied according to who was considered a trusted source for pesticide information among conventional farmers. For example, respondents who trusted fruit packers and processors or the pesticide vendors had significantly lower levels of perceived pesticide risk than respondents who did not reported trusting these two groups. As few respondents from alternative farms trusted the fruit packers and processors, pesticide vendors, or other members of the farm community, comparisons of risk perceptions for this farm type were not possible. Overall, conventional respondents reported trusting a wider range of sources to provide them with pesticide information than did alternative respondents.

e) Reinforcing Variables and Perception of Pesticide Risk

The relationship between perception of pesticide risk and the variables that measured reinforcing factors are presented in Table 5-16 by farm type.

Table 5-16 Perception of Pesticide Risk (composite score) and Reinforcing Variables

Conventional Farms (N=293)				Alternative Farms (N=77)			
	N	Mean (SD)	p[1]		N	Mean (SD)	p[2]
Experienced an adverse health effect related to pesticide exposure				**Experienced an adverse health effect related to pesticide exposure**			
You				**You**			
Yes	47	**28.5 (9.1)**	**<0.01**	Yes	17	**40.4 (6.7)**	**0.02**
No	246	**19.3 (8.9)**		No	60	**34.4 (9.4)**	
Relative or Friend				**Relative or Friend**			
Yes	78	**26.6 (9.7)**	**<0.01**	Yes	34	**37.8 (7-22)**	**<0.01**
No	215	**18.6 (8.6)**		No	43	**34.1 (10.4)**	
Family Influences				**Family Influences**			
Generational[a]				**Generational**			
1st generation	137	20.1 (9.2)	0.5	1st generation	40	36.8 (8.4)	0.4
2nd generation	55	20.6 (9.3)		2nd generation	13	33.3 (11.8)	
3rd generation	96	21.6 (10.1)		3rd generation	24	35.2 (9.0)	
Grew up on a Farm				**Grew up on a Farm**			
Yes, still live on same farm	36	19.8 (8.2)		Yes, still live on same farm	7	33.4 (8.6)	
Yes, but on a different farm	93	22.2 (10.1)	0.2	Yes, but on a different farm	19	33.4 (10.1)	0.3
No	164	20.1 (9.4)		No	51	36.9 (8.7)	
Children <18 years of age on farm				**Children <18 years of age on farm**			
Yes	120	20.9 (9.3)	0.7	Yes	25	38.6 (7.5)	0.06
No	173	20.5 (9.9)		No	52	34.3 (9.7)	
Peer Influences				**Peer Influences**			
Belong to Farm Organization				**Belong to Farm Organization**			
Yes	137	20.0 (8.9)	0.2	Yes	48	**37.5 (7.3)**	**0.02**
No	153	21.5 (8.9)		No	27	**32.4 (7.2)**	

[1] p value (ANOVA) for test comparing risk perception score across categories for conventional farmers only
[2] p value (ANOVA) for test comparing risk perception score across categories for alternative farmers only

[a] Five respondents did not answer this question

Among respondents from conventional farms, perception of pesticide risk was significantly associated only with past adverse health effects related to pesticide exposure and not by peer or family influences or with the presence of children under the age of 18 years old on the farm. Those who had experienced an adverse effect from pesticide exposure were significantly more likely to perceive pesticides as risky. Perception of pesticide risk was also higher for respondents who knew someone who had experienced negative health effects from pesticide exposure.

Respondents from alternative farms also reported significantly higher perceptions of pesticide risk associated with adverse health effects from pesticide exposure. In addition, in this group, peer influences were associated with risk perception (i.e., respondents who belonged to farm organizations reported higher levels of risk perception than those who did not belong to such groups). A weak association was noted between the presence of children under the age of 18 on the farm and higher levels of pesticide risk perception on this farm type.

f) Enabling Variables and Perception of Pesticide Risk

A summary of the relationship between enabling variables and perception of pesticide risk for conventional and alternative farms is provided in Table 5-17 on the following page.

Table 5-17 Perception of Pesticide Risk (composite score) and Enabling Variables

Conventional Farms (N=293)				Alternative Farms (N=77)			
	N	Mean (SD)	p[1]		N	Mean (SD)	p[2]
Training				**Training**			
Taken a pesticide-related course				Taken a pesticide-related course			
Yes	97	19.4 (8.7)	0.08	Yes	14	39.1 (7.8)	0.1
No	196	20.0 (9.9)		No	63	35.0 (9.4)	
Pesticide Certified[a]				Pesticide Certified			
Yes	75	19.5 (8.7)	0.2	Yes	3	35.7 (9.2)	1.0
No	217	21.2 (9.8)		No	74	35.7 (12.1)	
Farm Experience				**Farm Experience**			
Less than 20 years	136	20.0 (9.7)	0.2	Less than 20 years	49	36.3 (9.2)	0.5
20 or more years	157	21.4 (9.4)		20 or more years	28	34.8 (9.3)	
Control				**Control**			
Decision-making				**Decision-making**			
I am the primary decision maker	104	19.8 (8.6)	0.2	I am the primary decision maker	24	33.8 (9.2)	0.2
Decisions are shared or done by others	189	21.3 (10.0)		Decisions are shared or done by others	53	36.6 (9.1)	
Perceived Control over Pesticide Application[b]				*Not applicable*			
Very High	87	19.6 (8.6)	0.7				
Less than very high	32	20.4 (10.1)					

[1] p value (ANOVA) for test comparing risk perception score across categories for conventional farmers only
[2] p value (ANOVA) for test comparing risk perception score across categories for alternative farmers only
[a] One respondent did not answer this question
[b] For pesticide applicators only, N=119

Of the enabling variables, only training, (i.e., having taken a pesticide-related course) showed a trend to be associated with perception of pesticide risk among conventional farm respondents (p=0.08); lower perceptions of pesticide risk existed among those who had taken a course. Interestingly, among alternative farm respondents, there was a (non-significant) trend in the opposite direction—higher pesticide risk perception scores among those who had taken a pesticide-related course. No difference was noted for those who held current pesticide certification. Variables that measured experience and control were not associated with perception of pesticide risk. Of the 119 pesticide applicators, reporting very high levels of perceived control over pesticide application was not found to influence perception of pesticide risk.

5.5.2 Univariate Relationship between Potential Explanatory Factors and Perception of Pesticide Benefits (means scores)

Univariate analyses were also carried out comparing mean values for the perception of pesticide **benefit** score for each of the potential explanatory variables (similar to those analyses for pesticide risk score shown in Tables 5-12 to 5-17 above). (Tables with these results are not shown for the sake of brevity). Overall, these analyses revealed that some of the same potential explanatory factors that significantly influenced perception of pesticide risk also significantly influenced perception of pesticide benefit. However, as expected, the relationship of these variables to each outcome was inverted; for example, respondents from smaller farms reported higher levels of perceived pesticide risk and lower levels of perceived benefit.

A clearer way to compare the relationships between the explanatory variables and both perception of pesticide risk and benefit is provided in the following section, where the univariate regression analyses for each outcome are presented side by side to allow for a direct comparison of these relationships.

5.5.3 Univariate Relationships for Perception of Pesticide Risk and Benefits: Comparison of Associations with Potential Explanatory Factors (results from univariate linear regression)

Results from two sets of univariate linear regression analyses (conventional farms only) examining the relationships between each of the potential explanatory factors and either the pesticide risk or benefit perception score are shown in Table 5-18 on the following page. (Note: These are univariate analyses, i.e., only one factor is included in the model at a time.) In these tables, the coefficients indicate the change in risk or benefit perception score per one unit change in the value of the explanatory factor with positive values indicating higher perceived levels of risk or benefit from pesticides. The results shown below in Table 5-18 for risk perception provide essentially the same information as shown in tables 5-12 to 5-17 above (although for conventional farm respondents only). However, the results displayed in Table 5-18 on the following pages allow for simultaneous comparison of the relative strengths and direction of all univariate associations between the potential explanatory factors and perception of both pesticide risk and benefit. (It should be noted that

because the range for the pesticide risk perception score was larger than that of the benefit perception score [45 *v.* 30] the magnitude of the coefficients cannot be compared directly.)

Table 5-18 Summary of Potential Explanatory Factors: Relationships to perception of pesticide risk and benefit— univariate regression coefficients and standard errors (for conventional growers only)

	Risk Perception Coefficient (SE)	*p*	*Benefit Perception Coefficient (SE)*	*p*
Predisposing Factors: Socio- Demographics				
Basic Demographics				
Sex (Male)	-0.5 (1.1)	0.6	**1.9 (0.6)**	**<0.01**
Ethnicity (Indo-Canadian)	**-4.8 (1.1)**	**<0.01**	0.3 (0.6)	0.6
Age, 35 years or less (Yes/No)[a]	-1.1 (1.2)	0.3	0.3 (0.6)	0.6
Good Self-Reported Health Status (Yes/No)	0.2 (1.2)	0.9	0.09 (0.6)	0.9
Married (Yes/No)	1.3 (1.7)	0.5	1.5 (0.9)	0.1
Education				
Less than high school	**-3.9 (1.7)**	**0.02**	-1.1 (0.9)	0.2
Completed high school	**reference**		reference	
Post secondary	**-2.1 (1.5)**	**0.2**	-1.1 (0.8)	0.2
University	**-1.0 (1.5)**	**0.5**	-0.5 (0.8)	0.5
Location				
Fraser Valley	**-3.2 (1.2)**	**<0.01**	**0.4 (0.7)**	**0.6**
Vancouver/Gulf Islands	**3.3 (2.5)**	**0.2**	**-4.7 (1.3)**	**<0.01**
Other Region	**2.7 (1.8)**	**0.1**	**0.5 (1.0)**	**0.6**
Okanagan	**reference**		**reference**	
Predisposing Factors: Attitudes and Beliefs				
Attitudes about other farm hazards				
Concerned about farm injuries (Yes/No)	**4.4 (1.1)**	**<0.01**	1.1 (0.6)	0.09
Concerned about sun exposure (Yes/No)	1.8 (1.1)	0.1	0.3 (0.6)	0.7
Concerned about occupational stress (Yes/No)	**3.1 (1.1)**	**<0.01**	**1.2 (0.6)**	**0.04**
Farm Safety				
Farming is less safe than other jobs	**4.6 (1.3)**	**<0.01**	1.0 (0.9)	0.3
Farming is as safe as other jobs	**reference**		reference	
Farming is safer than other jobs	**-0.8(1.7)**	**0.6**	-1.0 (0.7)	0.2
Vulnerability Attitudes				
Pesticide likely to impact own health (Yes/No)	**11.7 (2.0)**	**<0.01**	-1.5 (0.9)	0.07
Pesticide likely to enter farm home (Yes/No)	**11.8 (2.0)**	**<0.01**	-2.0 (1.1)	0.08

Table 5-18 continued				
Beliefs				
Government pesticide regulations are not strict enough (Yes/No)	**8.9 (1.6)**	**<0.01**	**-2.2 (0.9)**	**0.02**
Trusted reported source of pesticide information				
Pesticide vendors (Yes/No)	**-3.3 (1.2)**	**<0.01**	-0.3 (0.6)	0.7
Fruit Packers and processors (Yes/No)	**-4.6 (1.4)**	**<0.01**	**1.6 (0.8)**	**0.03**
Government (Yes/No)	0.8 (1.2)	0.6	0.9 (0.7)	0.2
Growers' associations (y/n)	3.0 (1.7)	0.08	-1.0 (0.9)	0.3
Farm Community (y/n)	-0.6 (2.2)	0.8	0.9 (1.2)	0.5
Predisposing Factors: Knowledge				
Appropriate knowledge of Captan (Yes/No)	0.5 (1.3)	0.7	**2.9 (0.7)**	**<0.01**
Knew personal exposure routes (Yes/No)	1.6 (1.1)	0.2	-0.3 (0.6)	0.7
Knew farm home exposure routes (Yes/No)	**5.8 (1.2)**	**<0.01**	-0.9 (0.7)	0.2
Identify health effects of pesticide exposure (Yes/No)	**5.5 (1.1)**	**<0.01**	-0.9 (0.6)	0.2
Aware than pesticides cause cancer (Yes/No)	**11.5 (1.3)**	**<0.01**	**-1.7 (0.8)**	**0.03**
Reinforcing Factors				
Adverse Health Effects				
Personally had a negative health effect from pesticide exposure (Yes/No)	**9.2 (1.4)**	**<0.01**	-1.3 (0.8)	0.1
Know someone who has had a negative health effect from pesticide exposure (Yes/No)	**8.0 (1.2)**	**<0.01**	-0.6 (0.7)	0.4
Influence of Family— Generational Factors				
First Generation (reference)	reference		**reference**	
Second Generation	0.4 (1.5)	0.8	**1.7 (0.8)**	**0.04**
Third Generation	1.4 (1.3)	0.3	**2.3 (0.7)**	**<0.01**
Farm Family History				
Grew up and still live on same farm	-0.3 (1.8)	0.9	**2.4 (0.9)**	**0.01**
Grew up on a farm, live on different farm	2.1 (1.2)	0.1	**1.6 (0.7)**	**0.02**
Did not grow up on a farm (reference)	reference		**reference**	
Children under 18 on farm (Yes/No)	-0.5 (1.1)	0.7	-0.3 (0.6)	0.6
Peer Influences				
Belong to Farm Organizations (Yes/No)	-1.4 (1.1)	0.2	0.6 (0.6)	0.4

Table 5-18 Continued				
Enabling Factors				
Training				
Taken a pesticide-related course in past 5 years (Yes/No)	-2.0 (1.2)	0.08	**3.1 (0.6)**	**<0.01**
Hold a current pesticide certificate (Yes/No)	-1.7 (1.3)	0.2	**3.8 (0.7)**	**<0.01**
Experience				
More than 20 years farming experience (Yes/No)	1.5 (1.1)	0.2	**2.0 (0.6)**	**<0.01**
Control				
Primary decision maker (Yes/No)	-1.5 (1.2)	0.1	**2.1 (0.6)**	**<0.01**
High control over pesticide application (Yes/No)	-1.6 (1.2)	0.2	1.3 (09.7)	0.06
Farm Structure Factors				
Crop: Berries	-1.7 (1.2)	0.2	**-0.3 (0.7)**	**0.6**
Mixed crop farms	3.8 (2.1)	0.07	**-3.5 (1.1)**	**<0.01**
Grapes	0.2 (2.5)	0.9	**-3.6 (1.3)**	**<0.01**
Tree Fruits	reference		**reference**	
Small Farm (<5 acres) (Yes/No)	**3.9 (1.2)**	**<0.01**	**-2.0 (0.7)**	**<0.01**
Ownership and Operations				
Owns own farm (Yes/No)	1.2 (1.6)	0.4	**1.8 (0.9)**	**0.04**
Annual Income over 25,000 (Yes/No)[b]	**-4.0 (1.7)**	**0.02**	**2.7 (1.0)**	**0.01**
Strictly Family operated farm (Yes/No)	**3.8 (1.3)**	**<0.01**	-0.4 (0.7)	0.6
Farm Tasks				
Spray pesticides (Yes/No)	-1.6 (1.1)	0.1	**2.2 (0.6)**	**<0.01**
Transport pesticides (Yes/No)	**-2.2 (1.1)**	**0.05**	**2.1 (0.6)**	**<0.01**
Buy pesticides (Yes/No)	-1.3 (1.1)	0.3	**1.9 (0.6)**	**<0.01**
Use a tractor to apply pesticides (Yes/No)[c]	-1.5 (2.1)	0.5	**3.2 (1.2)**	**<0.01**

[a] Yes/No: the coefficient shown is for respondents corresponding to the variable listed compared to all other respondents
[b] Only 43% of respondents responded to this question
[c] Only 60% of the respondents answered this question.

Some of the same factors that influenced perception of pesticide risk also influenced perception of benefit from pesticides (albeit in the opposite direction). For example, farm size; income; location; awareness that pesticides may cause cancer; and attitudes or beliefs regarding vulnerability, government regulations, and trusting packers and processors to provide information tended to show these opposite associations with perceived risk and perceived benefit. However, not all explanatory factors followed this pattern. Gender was significantly associated with the perceived benefits of pesticide use (men reporting higher

benefit scores), but not with perceived risks. Conversely, ethnicity was found to significantly influence perceptions of pesticide risk, but not benefit.

Of the variables that measured respondents' knowledge of pesticides, three were found to influence perception of risk and benefit in different ways. Correct knowledge regarding Captan was not associated with perceived pesticide risk, but was significantly associated with higher perceived benefit of pesticide use. In contrast, being able to identify potential health effects from pesticide exposure, or knowing how pesticides can enter a farm home influenced perception of risk, was not found to influence perceptions of pesticide benefit.

Respondents' attitudes and beliefs regarding farm injuries, farm safety, and personal vulnerability were significantly associated with pesticide risk perception, but were not associated with perceived benefits of pesticide use. Concerns about occupational stress associated with farming, however, were unique. Respondents who were concerned about farm stress perceived pesticides as being significantly more risky *and* significantly more beneficial. Trusting pesticide vendors to provide pesticide information was significantly associated with lower reported levels of pesticide risk, but did not influence perceived benefit of pesticide use.

Although none of the enabling variables was significantly associated with perceived pesticide risk, four factors were found to be significantly associated with perceived pesticide benefit. These included having more than 20 years of farm experience, having taken a pesticide-related course, having a pesticide certificate, and being the primary decision maker (all associated with reporting pesticides to be more beneficial).

Three of the variables that measured reinforcing factors were found to be associated with perceived risk and benefit differently. Experience with an adverse health effect (self or relative/friend) was significantly associated only with perceived risk, and was not found to significantly influence perception of the benefits of pesticides. In contrast, family and generational learning factors (e.g., being a second- or third- generation farm family member, having grown up on a farm) were only associated with perceived pesticide benefit and not perceived risk.

Finally, the farm structure variables that measured farm ownership, farm operations, farm tasks (spraying and buying pesticides), and pesticide application techniques were *not* associated with perception of pesticide risk, but were significantly associated with higher levels of perceived benefit. The opposite relationship was found for farms that were operated strictly by family members: this form of labour was significantly associated with perceived risk, but not with perceived benefit of pesticide use. Growing a variety of crops (mixed-crop farm) was weakly associated with perception of pesticide risk, and growing berries or mixed fruits was significantly associated with perception of pesticide benefit.

5.5.4 Multivariable Modeling: Potential Explanatory Factors Associated with Perception of Pesticide Risk and Benefit

Table 5-19 presents the results of multiple regression modeling in which those factors suggested to be associated with perception of pesticide risks or with perception of benefits (from the univariate analyses described above) were examined in combination (for conventional farm respondents only). Before model-building, all pair-wise correlations (or associations when correlation analysis was inappropriate —e.g., for variables with non-ordered categories) among potential explanatory variables were examined to evaluate the potential for confounding and the potential for unstable models when including highly correlated variables in the model at the same time. No strong correlations ($r^2 > 0.65$) were seen; however crop type was highly associated with both farm location ($p < 0.001$) and ethnicity ($p < 0.001$). Therefore, a decision was made to exclude location from the models, and to include both ethnicity and crop together in all models to control for potential confounding of ethnicity by crop. Gender was included in all models as this was a design factor in the study. Income was not included as this information was not only available for 43% of the respondents. The results shown on the following page include only those variables from the final models. (The model R^2, or proportion of the variance explained, for the pesticide risk perception model was 0.47; the model R^2 for the perception of pesticide benefit model was 0.24.)

Table 5-19 Multiple regression analysis coefficients (and standard errors) of basic demographic and conceptual framework factors related to perception of pesticide risk and pesticide benefit (for conventional growers only)

	Risk Perception Coefficient (SE)	*p*	*Benefit Perception Coefficient (SE)*	*p*
Intercept	13.8 (1.1)		16.8 (1.0)	
Predisposing Factors				
Basic Demographics				
Sex (Male)	0.9 (0.9)	0.4	0.7 (0.6)	0.3
Ethnicity (Indo-Canadian)	**-2.4 (1.1)**	**0.04**	-0.06 (0.7)	0.9
Attitudes and Beliefs				
Concerned about farm injuries	**1.9 (0.9)**	**0.04**	-	
Vulnerability- Believe pesticides will affect health in a negative way in the future	**5.1 (1.8)**	**0.004**	-	
Vulnerability- Believe its highly likely that pesticides can enter farm home	**4.5 (1.4)**	**0.001**	-	
Knowledge Variables				
Correct knowledge of Captan	-	-	**1.5 (0.7)**	**0.04**
Can identify health effects of pesticide exposure	**2.5 (0.9)**	**0.008**	-	
Aware than pesticides cause cancer	**6.7 (1.2)**	**<0.001**	**-1.7 (0.7)**	**0.02**
Reinforcing Factors				
Adverse Health Effects				
Personally had a negative health effect from pesticide exposure	**3.1 (1.3)**	**0.02**	-	
Know someone who has had a negative health effect from pesticide exposure	**3.1 (1.0)**	**0.005**	-	
Influence of Family—Generational Factors				
First Generation	-		**reference**	
Second Generation	-		**1.5 (0.8)**	**0.06**
Third Generation	-		**1.6 (0.7)**	**0.01**
Enabling Factors				
Training				
Taken a pesticide-related course in past 5 years	-		**1.7 (0.7)**	**0.01**
Experience				
More than 20 years farming experience	-		**1.4 (0.6)**	**0.01**
Farm Structure Factors				
Crop: Berries	**1.0 (1.1)**	**0.4**	**-0.8 (0.7)**	**0.3**
Mixed-crop farms	**3.7 (1.6)**	**0.03**	**-2.7 (1.0)**	**0.01**
Grapes	-0.002 (1.9)	1.0	**-2.8 (1.3)**	**0.03**
Tree Fruits	reference		**reference**	
Small Farm (<5 acres)	**1.9 (1.0)**	**0.05**	**-1.8 (0.6)**	**0.005**
Owns own farm	-		1.7 (0.8)	0.06

a) Pesticide Risk Perception

Taking into account all possible explanatory factors, together, the analysis indicated that variables from three of the four components of the conceptual framework remained significantly related to perception of pesticide risk.

Predisposing variables associated with higher levels of risk perception included being of European descent, having appropriate pesticide knowledge (being able to identify health effects of pesticide exposure and being aware that pesticides cause cancer), believing that one's self or home was vulnerable to pesticide exposure, and being concerned about farm injuries. Other attitudes and beliefs found to be associated with perceived risk in the univariate analyses were no longer significant in the multivariable model, suggesting that beliefs about personal vulnerability are stronger explanatory factors than the other beliefs measured here.

Of the reinforcing factors, both having had an adverse health effect from pesticide exposure or knowing a friend or relative who had an experience this type remained significantly associated with higher levels of pesticide risk perception, even after taking into account all other factors.

Both growing mixed crops and having a farm of less than five acres planted with crops both remained associated with increased perception of pesticide risk, although other farm structure variables that had been significant in the univariate model (e.g. farm ownership and purchasing pesticides) were no longer significant in the multivariable model.

b) Perception of Pesticide Benefit

The analyses indicated that variables from all four components of the conceptual framework were significantly related to perception of pesticide benefit, although these tended to be different variables than those associated with perceived risks. Among the predisposing variables, only one knowledge factor was associated with higher levels of benefit perception: having correct knowledge of Captan. In contrast, awareness that pesticide can cause cancer was associated with lower levels of benefit perception. Gender, though significant in the

univariate assessment of pesticide benefit perception, did not remain a significant explanatory factor when other variables were entered into the model.

Two of the four enabling variables were significant in the final multivariable model for perceived benefit: having more than 20 years farm experience and having taken a pesticide-related course in the past five years. Although significant in the univariate analyses, the remaining enabling variables (holding a current pesticide certificate and being the primary decision maker) were not associated with perception of pesticide benefit when other factors were taken in account.

Many of the farm structure variables (farm size, crops grown, farm ownership) remained in the multivariable model, although farm tasks and being the primary farm operator were no longer significant factors. Of the reinforcing variables, only the number of generations a family had been farming was associated with perception of pesticide benefit. Not surprisingly, it was those from a third-generation farm family who were more likely to consider pesticides beneficial than did those whose families were new to farming. Growing up on a farm, or still living on the same farm one grew up on, did not remain significant explanatory factors in the final model.

c) Comparison of Risk and Benefit Models

Of the factors identified in both models, some of the same variables associated with increased perception of pesticide risk (growing mixed crops, smaller farm size and being aware that pesticides cause cancer) were found to decrease perception of pesticide benefit. Attitudes and beliefs (especially personal vulnerability) and past experiences with adverse health effects from pesticide exposure were associated with perception of risk, whereas training, experience, and generational learning factors were associated with perception of benefit from pesticides. Gender was not found to be a significant factor in either model.

5.6 Factors Associated with Pesticide Exposure Control Practices

The following section summarizes the relationships between the potential explanatory factors and the three pesticide exposure control practices (described in section 5.3.1). In this section, each of the three practices is reported for a differently defined population: PPE practices are shown for pesticide applicators only (n=118); laundry techniques are described only for those responsible for laundering clothes worn to apply pesticides (n=131); and IPM techniques are presented for all respondents from conventional farms (n=293). This section begins by summarizing the univariate relationships between each potential explanatory factor and the exposure control practices, organized by the components of the conceptual framework. Following this are the results of multivariable modeling for each exposure control practice.

5.6.1 Potential Explanatory Factors and Exposure Control Practices: Univariate Relationships

a) Farm Structure Variables and Exposure Control Practices

Table 5-20 on the following page summarizes farm structure variables and exposure control practices.

Table 5-20 Exposure Control Practices and Farm Structure Variables

Conventional farms	N	Optimal PPE	N	Optimal Laundry	N	Tried IPM
Total Number of Respondents	**118**	**74**	**131**	**18**	**293**	**181**
Crop n (%)						
Mixed	9	4 (44%)	11	1 (9%)	**24**	**13 (54%)[a]**
Tree Fruit	52	38 (73%)	**63**	6 (10%)	**153**	**101 (66%)**
Grapes	11	5 (45%)	**10**	0	**16**	**15 (94%)**
Berries	46	27 (59%)	**47**	11 (23%)	**100**	**52 (52%)**
Size of farm (planted acres), n (%)						
Small farms (≤ 5 acres)	30	15 (50%)	38	3 (8%)	85	55 (65%)
Larger farms (> 5 acres)	88	59 (67%)	93	15 (16%)	208	126 (61%)
Income[b], n (%)						
< $ 25,000	**25**	**11 (40%)[a]**	-		55	37 (67%)
≥ $ 25,000	**46**	**32 (70%)**	-		71	54 (76%)
Labour patterns n (%)[c]						
Strictly family operated farm	23	11 (49%)	28	1 (4%)	69	46 (67%)
Hired labour	95	57 (60%)	103	17 (17%)	222	134 (60%)
Farm ownership, n (%)						
Self or spouse own the farm	106	68 (64%)	118	16 (14%)	**250**	**162 (65%)[a]**
Someone else owns the farm	12	6 (50%)	13	13 (15%)	**43**	**19 (44%)**
Farm operator, n (%)						
Self	92	61 (66%)	49	5 (10%)	120	79 (66%)
Self and Spouse/Family	26	13 (50%)	50	10 (20%)	89	51 (57%)
Spouse/Family	-		31	3 (10%)	63	40 (64%)
Unrelated	-		1	0	21	11 (53%)
Pesticide applicator, n (%)						
I am the primary sprayer		*Not Applicable*	62	5 (8%)	**119**	**86 (73%)[a]**
Someone else sprays			69	13 (19%)	**173**	**94 (54%)**
Application method, n (%)[d]						
Backpack	16	7 (44%)	11	0	**19**	**11 (58%)[a]**
Tractor	53	34 (64%)	44	8 (18%)	**91**	**49 (54%)**
Both	47	31 (66%)	35	3 (9%)	**50**	**50 (76%)**
Farm tasks, n (%)						
Spray Pesticides						
Never		*Not Applicable*	56	9 (12%)	**137**	**73 (53%)[a]**
Sometimes/Always			75	9(16%)	**156**	**108 (69%)**
Transport Pesticides						
Never	9	6 (67%)	47	9 (19%)	**122**	**64 (52%)[a]**
Sometimes/Always	109	68 (62%)	84	9 (11%)	**171**	**117 (68%)**
Purchase Pesticides						
Never	6	3 (50%)	54	7 (13%)	120	67 (56%)
Sometime/Always	112	71 (64%)	77	11 (14%)	173	114 (66%)

[a] $p<0.05$, chi square analysis comparing those who wore optimal protection with those who did not
[b] 40% of pesticide applicators did not answer this question; 57% of respondents from conventional farms did not answer this question
[c] Two respondents did not provide answers for this question for IPM practices only.
[d] Two pesticide applicators, and 41 washers did not answer this question. Only 60% respondents for the IPM question provided answers for this question.

Of the farm structure variables, only annual income level was associated with the use of optimal protective equipment during pesticide application. Respondents from farms with higher incomes were more likely to report optimal PPE use during pesticide application. None of the farm structure variables was associated with optimal laundering practices.

Conversely, farm structure variables (crops grown, farm ownership, being a pesticide applicator, application method) and farm tasks were significantly associated with having tried IPM techniques. Respondents from all crop types had attempted IPM techniques, with vineyards most often reported trying these techniques. Respondents who were pesticide applicators or who were involved in spraying or transporting pesticides were more likely to report ever having used these techniques. Farm owners had tried IPM methods more frequently than those who did not own the farm on which they lived. The size of the farm, the purchasing of pesticides and the presence of hired labour, and farm income were not associated with ever having tried IPM.

b) Predisposing Socio-Demographics Variables and Exposure Control Practices

Table 5-21 on the following page summarizes the relationship between exposure control practices and predisposing socio-demographic variables on conventional farms. Gender and pesticide exposure control practices are described in section 5.3.1.

Table 5-21 Exposure Control Practices and Socio-demographic variables

Conventional Growers	N	Optimal PPE	N	Optimal Laundry	N	Tried IPM
Total Number of Respondents	**118**	**74**	**131**	**18**	**293**	**181**
Ethnicity, n (%)						
European-Descent	81	48 (59%)	**89**	**3 (4%)[b]**	195	**143 (73%)[b]**
Indo-Canadian	37	26 (70%)	**42**	**15 (36%)**	98	**38 (34%)**
Age, n (%)						
18–35 years	54	**29 (54%)[c]**	57	6 (11%)	133	**81 (61%)[a]**
35–54 years	53	**36 (68%)**	61	10 (16%)	128	**86 (67%)**
>55 years	11	**9 (82%)**	13	2 (15%)	32	**14 (44%)**
Education Level, n (%)						
Less than Grade 12	19	8 (42%)	24	6 (25%)	52	**22 (42%)[a]**
Completed Grade 12	30	19 (63%)	33	4 (12%)	80	**51 (64%)**
Post-Secondary	35	23 (66%)	41	5 (12%)	89	**54 (61%)**
University	34	24 (71%)	33	3 (9%)	72	**54 (75%)**
Marital Status, n (%)						
Not Married	17	11 (65%)	15	1 (7%)	37	2018 (54%)
Married	101	63 (62%)	116	17 (15%)	256	161 (63%)
Health Status, n (%)[d]						
Poor to Good	39	24 (62%)	52	10 (19%)	111	62 (56%)
Very Good to Excellent	79	50 (63%)	79	8 (10%)	174	116 (67%)

[a] $p<0.05$; b $p<0.01$ chi square analysis comparing those using the practice to those not using the practice
[c] $p<0.05$ Cochran-Armitage Trend test, two-sided.
[d] Eight people did not answer this question for IPM practices.

Although ethnicity did not influence the adoption of PPE , it was significant for both laundry and IPM adoption. Indo-Canadian launderers reported using optimal laundry practices much more often than did those of European descent. In contrast, respondents of European descent were more likely to have tried IPM. Trends were also noted for education level and age of respondents. Optimal PPE was worn more frequently as respondents' age increased. Additionally, respondents with higher education levels and *younger* respondents were also significantly more likely to have tried IPM. Neither factor was associated with optimal laundering practices. Neither marital nor self-reported health status was significantly associated with any of the exposure control practices.

c) Predisposing Knowledge Variables and Exposure Control Practices

Table 5-22 below summarizes the relationships between knowledge variables and pesticide exposure control practices.

Table 5-22 Exposure Control Practice and Knowledge Variables

Conventional Growers	N	Optimal PPE	N	Optimal Laundry	N	Tried IPM
Total Number of Respondents	**118**	**74**	**131**	**18**	**293**	**181**
Captan Knowledge, n (%)						
Correct	50	35 (70%)	35	4 (11%)	**71**	**58 (82%)[b]**
Incorrect	68	39 (57%)	96	14 (15%)	**222**	**123 (55%)**
Knowledge of personal exposure routes, n (%)						
More Knowledgeable	46	30 (65%)	49	7 (14%)	114	69 (61%)
Less Knowledgeable	72	44 (61%)	82	11 (13%)	179	112 (63%)
Knowledge of exposure routes into the home, n (%)						
More Knowledgeable	39	26 (67%)	37	4 (11%)	**83**	**64 (77%)[b]**
Less Knowledgeable	79	48 (61%)	94	14 (15%)	**210**	**117 (56%)**
Identification of pesticide health effects, n (%)						
Can't identify	61	40 (66%)	62	8 (13%)	**130**	**70 (54%)[a]**
Can identify	57	34 (60%)	69	10 (14%)	**163**	**111 (68%)**
Aware that pesticides cause cancer, n (%)[c]						
Yes	21	12 (57%)	26	1 (4%)	**53**	**41 (77%)[a]**
No	96	61 (64%)	104	17 (16%)	**236**	**138 (58%)**

[a] $p<0.05$, b $p<0.001$ chi square analysis comparing those who wore optimal protection with those who did not.
[c] Two applicators did not answer this question for PPE use, one washer did not answer this question, and four respondents did not answer the question related to IPM use.

None of the knowledge variables measured in this study were associated with the adoption of optimal PPE or laundering techniques, but four of the five were associated with ever having tried IPM, these included knowledge of Captan, being able to identify potential health effects from pesticide exposure, being aware that pesticides cause cancer, and knowing how pesticides can enter a farm home.

d) Predisposing Attitudes and Beliefs and Exposure Control Practices

The summary of the relationships between attitudes and beliefs and exposure control practices are presented in Table 5-23.

Table 5-23 Exposure Control Practices and Attitudes and Beliefs

Conventional Growers	N	Optimal PPE	N	Optimal Laundry	N	Tried IPM
Total Number of Respondents	**118**	**74**	**131**	**18**	**293**	**181**
Attitudes:						
Other farm hazards, n (%)						
Occupational Stress[d]						
High Concern	60	38 (63%)	66	9 (14%)	**139**	**96 (69%)**[b]
Low Concern	58	36 (62%)	65	9 (14%)	**153**	**85 (56%)**
Farm Injuries						
High Concern	65	37 (57%)	72	7 (10%)	**144**	**105 (73%)**[c]
Low Concern	53	37 (70%)	59	11 (19%)	**149**	**76 (51%)**
Sun Exposure[d]						
High Concern	42	24 (57%)	56	10 (18%)	111	69 (62%)
Low Concern	76	50 (66%)	75	8 (11%)	181	112 (62%)
Farming and Safety						
Safer	**14**	**13 (93%)**[b]	14	3 (21%)	**37**	**23 (62%)**[b]
As Safe	**67**	**44 (66%)**	83	83 (16%)	**183**	**102 (56%)**
Less Safe	**33**	**16 (48%)**	30	2 (7%)	**65**	**48 (74%)**
Attitudes: Vulnerability, n (%)						
Pesticides likely to impact own health[e]						
Less Likely	115	72 (63%)	118	15 (13%)	268	165 (62%)
More Likely	3	2 (67%)	11	3 (27%)	22	14 (64%)
Pesticides likely to enter home[f]						
Less Likely	99	63 (64%)	107	16 (15%)	240	146 (61%)
More Likely	16	9 (56%)	19	1 (5%)	44	31 (71%)
Beliefs: n (%)						
Current Pesticide Regulations						
Regulations are not strict enough	11	8 (73%)	11	0	**36**	**29 (81%)**[b]
Regulations Fine/Too Strict	107	66 (62%)	120	18 (15%)	**257**	**152 (59%)**
Trusted Sources Reported						
Fruit packers and processors						
Yes	25	19 (76%)	**25**	**9 (36%)**[b]	58	32 (55%)
No	93	55 (59%)	**106**	**9 (8%)**	235	149 (63%)

Table 5.27 con't, Trusted sources						
Government						
Yes	46	32 (70%)	**40**	**2 (5%)[a]**	**86**	**70 (81%)[c]**
No	72	42 (58%)	**91**	**16 (18%)**	**207**	**111 (54%)**
Farm Community						
Yes	8	6 (75%)	9	2 (22%)	20	13 (65%)
No	110	68 (62%)	122	16 (13%)	273	168 (62%)
Growers' associations						
Yes	11	9 (82%)	17	2 (12%)	35	22 (67%)
No	107	65 (61%)	114	16 (14%)	258	159 (62%)
Pesticide Vendor						
Yes	44	25 (57%)	**50**	**13 (26%)[b]**	**100**	**52 (52%)[b]**
No	74	49 (66%)	**81**	**5 (6%)**	**193**	**129 (67%)**
Barriers to Adoption of Protective Equipment, n (%)[g]			Not Applicable			
Too uncomfortable						
Agree	48	28 (58%)				
Disagree	67	46 (69%)				
Too expensive						
Agree	21	16 (76%)				
Disagree	95	58 (61%)				
Too much time to put on						
Agree	17	7 (41%)				
Disagree	97	66 (68%)				
Too complicated to use						
Agree	13	7 (54%)				
Disagree	102	67 (66%)				

[a] p=0.05, b p<0.05, c p<0.001 chi square analysis comparing those who wore optimal protection with those who did not.
[d] One person did not answer this question in relation to IPM use.
[e] Two washer did not answer this question, three people did not answer in relation to IPM use.
[f] Three pesticide application, fours washers and nine conventional respondents did not answer this question.
[g] Three applicators did not answer the comfort and complicated questions, two did not answer the cost question, and four did not answer the time question.

Respondents' beliefs and attitudes about specific farm hazards, and personal and home vulnerability were not found to influence pesticide applicators' PPE practices nor were these found to influence laundry practices. The only attitudinal variable associated with wearing optimal PPE was considering farming to be safer than other occupations. In contrast, respondents who felt farming to be less safe were more likely to have tried IPM. Other attitudes and beliefs were also associated with the use of IPM techniques, including attitudes concerning farm injuries, farm stress, and beliefs about pesticide regulations, with those who were more concerned more likely to have tried IPM.

Attitudes regarding trusted sources were associated with both laundry practices and IPM adoption. There was a positive association between trusting the government for pesticide information and using IPM, and a negative association between trusting the pesticide vendors and IPM use. However, there was a positive association between trusting the pesticide vendors and optimal laundry practices. Trusting the fruit packers or processors to provide pesticide information was also associated with optimal laundry practices.

Although there were no statistically significant findings when evaluating the association between the proportion of pesticide applicators who adopted optimal PPE and attitudes regarding potential barriers to PPE use, the trends are nevertheless interesting. Slightly higher optimal PPE use was reported by those who disagreed with the statements that PPE use was too uncomfortable, too complicated to use, and took too much time to put on. In contrast, the proportion of optimal PPE use was also *higher* among those who *agreed* that PPE was too expensive.

e) Reinforcing Variables and Exposure Control Practices

Table 5-24 on the following page summarizes the relationships between exposure control practices and reinforcing variables.

Table 5-24 Exposure Control Practices and Reinforcing Variables

Conventional Growers	N	Optimal PPE	N	Optimal Laundry	N	Tried IPM
Total Number of Respondents	**118**	**74**	**131**	**18**	**293**	**181**
Experienced adverse health effect related to pest. exposure, n (%)						
You: Yes	20	15 (75%)	21	2 (10%)	**47**	**37 (78%)**[a]
No	98	59 (60%)	110	16 (15%)	**246**	**144 (59%)**
Relative or Friend						
Yes	22	15 (68%)	38	3 (8%)	**78**	**59 (76%)**[a]
No	96	59 (61%)	93	15 (16%)	**215**	**122 (57%)**
Family influences, n (%)						
Generational[b]						
First generation	48	29 (60%)	63	13 (21%)	137	79 (58%)
Second generation	23	12 (52%)	24	3 (13%)	55	31 (56%)
Third generation	47	33 (70%)	42	2 (5%)	96	68 (71%)
Grew up on a farm						
Yes, still live on same farm	18	11 (61%)	14	0	36	20 (56%)
Yes, but on a different farm	47	31 (66%)	40	4 (10%)	93	60 (65%)
No	53	32 (60%)	77	14 (18%)	164	101 (62%)
Children < 18 years old on farm						
Yes	39	28 (72%)	53	9 (17%)	120	70 (58%)
No	79	46 (58%)	78	9 (12%)	173	111 (64%)
Peer Influences, n (%)						
Belong to farm organization[c]						
Yes	**67**	**46 (69%)**[a]	63	9 (15%)	**137**	**96 (70%)**[a]
No	**50**	**22 (44%)**	68	9 (13%)	**153**	**85 (56%)**
Peer Adoption of PPE						
Gloves						
80% or more of peers wear	59	39 (66%)		Not Applicable		
< 80% of peers wear	59	35 (59%)				
Respirator						
80% or more of peers wear	**46**	**34 (74%)**[a]				
< 80% of peers wear	**72**	**40 (56%)**				

[a] $p<0.05$ chi square analysis comparing those using the practice to those not using the practice.
[b] Two washers and five respondents from conventional farms did not answer this question.
[c] One applicator and three respondents from conventional farms did not answer this question.

Among the variables that measured reinforcing factors, only peer influences were significantly associated with PPE use. Pesticide applicators who belonged to farm groups were more likely to wear optimal protective equipment during pesticide application and were more likely to have tried IPM. PPE use also varied by participants' opinions regarding their peers' adoption of this type of equipment. Applicators who perceived that most of their peers (80% or over) wore respirators reported wearing more protective equipment themselves, although reported peer adoption of gloves was not found to influence respondents' PPE

practices. Farm family history and experience with adverse health effects were not associated with optimal protective equipment, although respondents who had experienced an adverse health effect themselves or knew a friend or relative who had reported significantly higher use of IPM techniques. No associations were found between reinforcing variables and adoption of optimal laundering practices for clothing worn during pesticide application.

f) Enabling Variables and Exposure Control Practices

Table 5-25 summarizes the relationships between enabling factors such as training and experience, and exposure control practices.

Table 5-25 Exposure Control Practices and Enabling Factors

Conventional Growers	**N**	**Optimal PPE**	**N**	**Optimal Laundry**	**N**	**Tried IPM**
Total Number of Respondents	118	**74**	**131**	**18**	**293**	**181**
Training, n (%)						
Taken a pesticide-related course						
Yes	68	46 (68%)	43	7 (16%)	**97**	**69 (71%)[a]**
No	50	28 (56%)	88	11 (13%)	**196**	**112 (57%)**
Pesticide Certified						
Yes	57	36 (63%)	35	5 (14%)	75	50 (67%)
No	61	38 (62%)	96	13 (14%)	217	130 (60%)
Been given laundry instructions[b]						
Yes	Not applicable		39	6 (15%)	Not applicable	
No			88	11 (13%)		
Farm Experience, n (%)						
Less than 20 years	48	26 (54%)	59	9 (15%)	157	102 (65%)
20 or more years	70	48 (69%)	72	9 (13%)	136	79 (58%)
Control, n (%)						
Decision Making						
I am the primary decision maker	85	55 (65%)	47	6 (13%)	104	67 (64%)
Decisions are shared or made by someone else	33	19 (58%)	84	12 (14%)	189	114 (60%)
Perceived Control over Pesticide Application			Not applicable			
Very High	87	55 (63%)				
Less than very high	31	19 (63%)				

[a] $p<0.05$ chi square analysis comparing those using the practice to those not using the practice.
[b] Four washers did not answer this question.

No significant associations were found between enabling variables and PPE practices or laundry practices. For pesticide applicators, perceived levels of control were not found to

influence the adoption of optimal protective equipment practices. Of the launderers, having received instructions about the laundering of clothing worn for pesticide application was not found to influence laundry practices.

Among the enabling variables, only one was significantly associated with having tried IPM techniques. Respondents who had taken a pesticide-related course were more likely to have tried these methods of pest control than were those who had not taken a course.

5.6.2 Potential Explanatory Factors and Exposure Control Practices: Multivariable Analyses

a) Adoption of Personal Protective Equipment

In order to examine all factors suggested as influencing the adoption of PPE, multiple logistic modeling was undertaken (246)[24]. For these analyses, logistic regression models were created for each of the three types of PPE (respirator or helmet, rubber gloves, a spray suit) and for all three types together (i.e., optimal PPE). All factors found to be associated with PPE in the univariate analyses were included in the multiple logistic regression models. Odds ratios and 95% confidence intervals are shown Table 5-26 on the following page.

[24] Logistic regression is a common epidemiological technique for analyzing dichotomous outcome variables. Modeling in multiple logistic regression is similar to multiple *linear* regression, as the model takes the form of a dependent variable as the sum of multiple independent predictor variables. In linear regression, the dependent variables is a continuous numeric variable, whereas, for logistic regression, the dependent variable is the "log-odds" of the probability of success, or logit, for a dichotomous random variable [log-odds =ln(p/1-p)]. The coefficients produced by logistic regression equations reflect a change in the log-odds of the dependent variable, given one unit change in the value of the independent variable. It can be shown that the anti-logarithm of the coefficients generated by logistic regression models, are odds ratios, where $OR=(p_{exposed}/(1-p_{exposed}))/(p_{unexposed}/1-p_{unexposed}))$. Odds ratios can be interpreted as the relative odds, or likelihood of having the outcome, given the presence of the independent variable. Odds ratios greater than 1 indicate an increased probability of having the outcome, and those less than 1 indicate a decrease in the probability.

Table 5-26 Factors associated with the wearing of PPE (multivariable analyses)

Conventional Farms	Respirator or Full Helmet	Rubber Gloves	Spray Suit	All three
N of people wearing	*88*	*98*	*89*	*74*
	OR (95% CI)*	**OR (95% CI)***	**OR (95% CI)***	**OR (95% CI)***
Predisposing Factors				
Sex (Male)	3.2 (0.7–14.0)	0.7 (0.1–4.1)	1.0 (0.2–5.3)	1.4 (0.3–5.5)
Ethnicity (Indo-Canadian)	1.8 (0.4–7.6)	1.2 (0.2–6.1)	2.5 (0.5–13)	2.8 (0.8–10.0)
Reinforcing Factors- peer influence				
Belong to Farm Organizations (Yes/No)	**3.8 (1.4–9.3)[2]**	1.9 (0.7–5.4)	**7.0 (2.2–22.8)[3]**	**4.5 (1.8–11)[3]**
Believe that > 80% of peers usually wear respirators	**2.8 (1.0–8.4)[1]**	1.6 (0.5–5.0)	**4.8 (1.3–17.4)[2]**	**2.3 (1.0–5.7)[1]**
Farm Structure Factors				
Grow Berries (Yes/No)	**0.1 (0.02–0.5)[2]**	2.9 (0.6–14.6)	**0.2 (0.04–0.8)[2]**	**0.2 (0.01–0.8)[2]**
Grow Mixed Crops(Yes/No)	**0.1 (0.03–0.6)[2]**	0.5 (0.1–2.7)	0.2 (0.04–1.3)	0.4 (0.07–1.8)
Grow Grapes (Yes/No)	**0.2 (0.02–0.6)[2]**	1.0 (0.2–5.6)	**0.07(0.02-0.4)[2]**	**0.2 (0.05–1.0)[2]**
Grow Tree Fruits (reference)	reference	reference	reference	reference
Use Tractor to Apply Pesticides	3.7 (0.9–15.8)	1.0 (0.2–4.5)	**6.1 (1.3-28.3)[2]**	2.2 (0.6–7.9)

* Odds ratios and 95% confidence intervals from logistic regression models.
Number in bold is significant at the corresponding level: [1] $p=0.05$, [2] $p<0.05$, [3] $p<0.001$.

The results from the multivariable logistic regression analysis suggest that peer-related factors and crops influence adoption of protective equipment (although some of the confidence intervals include 1.0 and are therefore not statistically significant at the $p<0.05$ level across all types of equipment and clothing). Peer influences were significantly associated with the wearing of respirators and spray suits: respondents who belonged to farm organizations or felt that most of their peer used respirators were more likely to wear respirators or to use a special spray suit. Crop was a significant factor for the use of breathing protection and protective clothing, tree fruit growers being more likely to wear PPE than pesticide applicators growing other crops. The use of a tractor to apply pesticide was also a significant factor. Although this application method was weakly associated with the wearing of breathing protection, it was significantly associated with wearing a spray suit. No variable explored in this analysis was associated with the specific use of rubber gloves. Gender and ethnicity appeared to exert little influence on the use of protective equipment or clothing.

Adoption of all three types of protective equipment and clothing was significantly associated with belonging to a farm organization. Applicators from berry and grape farms were significantly less likely to wear all three types of equipment and clothing. A weak

relationship was found between the adoption of this equipment and believing that other applicators wore a respirator during pesticide application. Gender, ethnicity and the use of a tractor to apply pesticides was not significantly associated with the wearing of optimal PPE.

b) Laundry Practices

Multiple logistic modeling was carried out to explore factors that might influence overall laundry practices for clothing worn to apply pesticides. It was not possible to carry out analyses for each individual laundering practice, due to small cell sizes. Based on the univariate analyses, ethnicity and trusted sources for pesticide information were included in the model. Gender was also included (a design variable) and the response to the question regarding whether people had ever received directions on how to launder such clothing was also included to confirm whether this variable remained non-influential. The odds ratios and 95% confidence intervals for these analyses are presented in Table 5-27.

Table 5-27 Factors association with Laundry Practices (multivariable analysis)

Launderers on Conventional Farms	**Employs all four[1] recommended laundry techniques**	**p**
N of people	*18*	
	OR (95% Confidence Intervals)[2]	
Sex (Male)	0.7 (0.1–3.2)	0.6
Ethnicity (Indo-Canadian)	**17.7 (2.7–114.6)[2]**	**0.003**
Ever received laundering instructions (Yes/No)	0.9 (0.2–4.0)	0.9
Trusted source of pesticide information		
Pesticide vendors	3.5 (0.7–18.6)	0.1
Government	0.9 (0.2–5.9)	0.9
Fruit packers and processors	**22.6 (3.8–134.0)**	**<0.001**

[1] Techniques include pre-soaking clothing, wearing rubber gloves, separating clothing from other household clothes and running an empty cycle after the wash is completed.
[2] Odds ratios and 95% confidence intervals from the logistic regression modeling.

Of the factors included in the models, ethnicity and trust in the fruit packers and processors to provide pesticide information were the strongest predictors of implementing correct laundry practices. Having ever received directions on how to launder clothing worn in

the fields was not associated with improved practices, nor was the gender of the launderer or trust in pesticide vendors or the government as a source of pesticide information.

Given that so few people undertook the optimal laundry practices (n=18), modeling was also undertaken using only three of the four laundry techniques (n=29) as the outcome variable (excluding running an empty cycle after washing clothing worn in the field). Results did not differ from those shown in Table 5-27.

c) IPM practices

Finally, multiple logistic modeling was carried out to explore the factors that might influence growers' use of IPM techniques. All factors found to be associated with IPM in the univariate analyses were included in the multiple logistic regression model. The odds ratios and 95% confidence intervals from the final model are presented in Table 5.28.

Table 5-28 Factors association with having ever tried IPM Techniques (multivariable analysis)

Conventional Farms	**Ever Tried IPM Techniques**	
N of farms using	*181*	*p*
	OR (95% Confidence Intervals)[1]	
Predisposing—basic demographics		
Ethnicity (Indo-Canadian)	**0.2 (0.1–0.4)**	**<0.001**
Predisposing—attitudes and beliefs		
Trust the government to provide pesticide information (Yes/No)	**2.9 (1.5–5.6)**	**0.002**
Predisposing—knowledge		
Correct knowledge regarding Captan	**5.8 (1.4–12.5)**	**<0.001**
Reinforcing factors		
Know a friend or relative who has experienced an adverse health effect from pesticide exposure (Yes/No)	**2.6 (1.4–5.1)**	**0.004**
Farm Structure		
Crops Grown		
Grow Berries (Yes/No)	1.2 (0.6–2.4)	0.6
Grow Mixed Crops (Yes/No)	0.7 (0.3–1.9)	0.4
Grow Grapes (Yes/No)	**7.8 (1.0–62.5)**	**0.05**
Grow Tree Fruits (reference)	reference	reference

[1] Odds ratios and 95% confidence intervals from logistic regression modeling

The results of this model suggest that ever having tried IPM methods was significantly associated with being of European origin, trusting the government as an

information source, being knowledgeable about Captan, and knowing a friend or relative who had experienced an adverse health effect from pesticide exposure. Having personally experienced an adverse health effect from pesticide exposure was not found to be a significant factor and was not included from the model. Gender was also not significantly associated with IPM in this analysis and was not included in the final model. Of the farm structure variables in the final model, only crop type was significantly associated with trying these methods of pest control: grapes growers were more likely to reported ever having tried these techniques than growers of tree fruit crops.

d) Impact of Perceptions on Exposure Control Practices

In order to examine the effect of pesticide risk and benefit perceptions on exposure control practices, variables measuring perception of pesticide risk and benefit were incorporated into the multivariable models presented above. For these analyses, the composite risk (or benefit) score was dichotomized at the median value and used as an independent variable. Both perception of pesticide risk and perception of benefit were associated with ever having tried IPM techniques [OR for risk perception=1.7 95% CI (0.95-3.1) and for perceived benefit OR=2.6 95% CI (1.5-4.7)]. Inclusion of these variables in the models did not alter the odds ratios associated with the other explanatory variables in any appreciable way. Perception of pesticide risk and benefit were not significantly associated with the implementation of optimal PPE or optimal laundry practices in this study.

5.7 Findings relevant to risk communication

In addition to questions directly related to the overall conceptual framework from this project, the survey included questions that explored factors important to the development of risk communication strategies for the berry, grape, and tree fruit-farming communities. These questions explored the use of farm publications, computer use, and communication channels within the farm family. Results are summarized briefly here.

Over 50% of the study participants indicated that they read farm publications at least once a month. The most commonly reported publications were fruit or berry magazines or the BC farm newspaper *Country Life* (published monthly). Over half of the survey

respondents also reported owning BC Ministry of Agriculture publications such as the "Berry Crop Production Guide" and the "Tree Fruit Production Guide". These publications include detailed information about growing methods, pesticide application techniques and health and safety issues[25].

Eight-four percent of the study respondents reported having a computer in their home. Of this group, 83% indicated that they had a connection to the Internet. The average amount of time spent on-line by the study participants was five hours (*SD* 13 hours, median 2 hours). Only 10% of the computer users indicated that they did not spend any time on the Internet.

Intra-family communication pathways were explored to learn more about how health and safety information was passed among farm family members. Less than one-quarter of the respondents indicated first learning about pesticide safety from a family member. Of those who had learned from a family member, fathers or grandfathers were the predominant source of information. Respondents who grew up on a farm were the most likely to have received information from a family member. Few women reported learning about pesticide safety from their spouse (less than 10%). Overall, more women than men reported never learning about pesticide safety (14% versus 7%, $p=0.02$), and more Indo-Canadian respondents reported teaching themselves about pesticide safety than did respondents of European descent (43% versus 10%, $p<0.001$).

The survey also examined how farm family members who were not involved in pesticide application were notified regarding when pesticides were being applied on their farm. The top two methods described by farm family members were: 1) having someone (spouse, farmer, farm manager) tell them personally that spraying would occur that day (reported by 49% of farm family members), and 2) being able to detect that spraying was occurring by seeing, hearing or smelling the application while in progress (reported by 41% of farm family members)[26]. Only 3% of farm family members indicated that they never knew when spraying occurred.

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[25] These guides usually must be purchased from the government, although some are provided to members of growers' associations.
[26] Respondents could provide up to two means of notification for this question.

6.0 Discussion and Conclusion

The principal objectives of this study were to 1) measure perception of pesticide risk in the BC berry, grape, and tree fruit farming communities and examine which factors were associated with these perceptions and 2) explore current exposure control practices used by this population and the factors associated with these practices. This concluding chapter presents an overview and discussion of the major findings of this research, the limitations of the project and recommendations for future research.

6.1 Overview

The results of this research project have shown that, overall, members of the berry, grape, and tree fruit farming community who use pesticides consider the risks posed by these chemicals to be low to moderate. Concern was highest for the health of pesticide applicators, followed by farm family members, and lowest for the health of people outside the farming community. These results are similar in magnitude to those found by Tucker and Napier's research of farmers' perceptions of pesticide risk (188, 189), although while risk to the health of pesticide applicators was also the top item of concern for the farmers in Tucker and Napier's studies, the ranking of some of the other items in the scale (i.e., the risk pesticides pose to beneficial insects such as bees) varied between these studies and this current project [27].

When compared to other potential farm hazards, pesticides ranked far behind concerns about occupational stress, sun exposure and farm injuries. Additionally, pesticides were, in general, judged to be quite beneficial to aspects of farm productivity and very important, in particular, to the financial success of the farm. These results are consistent with several studies that have attempted to characterize perception of risk in the farming community (189, 191-193). The inverse relationship between lower perceptions of risk and

[27] The difference between Tucker and Napier' studies (187, 188) and this current project regarding the ranking of beneficial insects may be due to different patterns of pollination for fruit crops (where bees are important for pollination) and grain crops (where pollen drift is important).

higher perceptions of benefit is also in accordance with findings from general risk perception research (21).

On farms where pesticides were not used, these chemicals were considered to pose a substantively higher risk. These results were not surprising as concerns about the effects of pesticide use, both for human health and the environment, are recognized reasons for choosing non-chemical means of pest control (247).

The findings of this study regarding perceptions of pesticides support the premise made by risk perception researchers that perception is not simply a function of the technological or statistical assessment of risk (18). In this study, pesticide risk perception was associated with personal, cultural and farm-specific factors, as well as the nature of pesticide risk. In particular, multivariable linear regression analysis illustrated that increased perception of pesticide risk was associated with 1) being knowledgeable about the health effects of pesticide exposure, 2) associating pesticides with a dreaded disease (cancer), 3) being very concerned about farm health and safety in general, 4) considering oneself vulnerable to pesticide exposure, 5) previous negative health experiences with pesticides, 6) living on a small farm (less than five acres), 7) growing mixed or diversified crops, and 8) being of European descent. Of these factors, being knowledgeable about the relationship between pesticides and cancer appeared to have the strongest association with perception of pesticide risk.

Personal, cultural and farm-specific characteristics were also associated with perceived benefit in this study, but the majority of these variables differed from the subset associated with risk perception. Greater perceived benefit was associated with 1) knowing more about Captan, 2) being from a third-generation farm family, and 3) having more pesticide training and farming experience, 4) living on a farm larger than 5 acres, 5) growing only one type of crop, and 6) not being aware that pesticides can cause cancer. The different set of factors associated with perception of pesticide benefit versus perception of pesticide risk indicates these perceptions may be conceptually distinct in the farming population. As Finucane et al. (248) describe in their study of risk, the Affect Heuristic, and judgments, the outcomes of each process (risk and benefit) are very different. Benefits provide positive experiences (in the case of this current study, profit and viability) whereas risk can result in

negative experiences (negative health and environmental consequences). While farmers and farm family members may use both risk and benefit to make decisions about their use of pesticides, the set of factors that contribute to each of these processes appears to be somewhat different.

Regarding exposure control practices, this study illustrates that measures to reduce pesticide exposure are being used in the tree fruit, berry, and grape-growing community in BC. In particular, alternative approaches to pesticides are being practiced, both by certified and uncertified organic growers. Farmers that did use pesticides showed a willingness to try other methods; IPM techniques had been implemented on 62% of the conventional farms in this study. A majority of pesticide applicators reported wearing PPE when applying pesticides (74% for respirators and 83% for rubber gloves), a rate that is relatively high compared to PPE studies conducted elsewhere (215-217), although the specific patterns of equipment use, (gloves versus respirators) is similar (214, 219). However, not all exposure control practices were implemented as frequently. Laundry practices that can reduce opportunities for indirect pesticide exposure (239) were performed significantly less often by respondents in this study; only 14% of those who washed clothing worn in the fields noted using all of the recommended techniques.

Different factors were found to influence all three of the exposure control practices (PPE, IPM and laundry), and only the type of crops grown were significantly associated with both the use of IPM techniques and PPE. Of the few factors found to influence PPE use in this study, peer influences were the strongest, suggesting that farmers are responsive to pressures from other farmers and farm organizations. Trusted sources of pesticide information were also significant factors for both IPM use and optimal laundering techniques, although the sources varied by practice. Finally, the adoption of IPM techniques laundry techniques also varied according to ethnicity.

6.2 Discussion

This study points to a number of key findings important for future work with the tree fruit, berry, and grape-growing community. This discussion begins by addressing the role of two debated characteristics in risk perception research—gender and ethnicity—and examines the effect of these factors within the context of this research project. The discussion continues with an examination of other central results, including farm structure variables, personal vulnerability, adverse health effects, psychometric paradigm characteristics, generational issues, and factors associated with indirect exposure factors for farm family members, and their implications, particularly regarding future risk communication with the farming community.

6.2.1 Gender

Although previous studies of general perceptions of risk have shown important differences between men and women (170, 171), analyses of gender in farm risk research have shown less clear cut distinctions between men's and women's attitudes about farm risks (10, 197, 198). In this current study, gender was not significantly associated with pesticide risk or benefit perception in the either of the final, multivariable models. Gender also did not appear to play a significant role in explaining exposure control practices.

One possible explanation for the relative non-importance of gender in this study may be found in the 'small-business' type arrangement of a family farm. Family farms are owned and operated by family members and, therefore, the stresses of running such an operation may be shared among the family unit. Indeed, this current study found that 87% of all respondents considered themselves to be involved in at least some aspects of farm decision-making. Research conducted by Greenberg et al. found that living in a stressed environment attenuates the differences between men's and women's perception of risk (181). The shared stresses of farm operation may contribute to men's and women's relatively similar perceptions of pesticides. Another possible, and related, explanation for the lack of gender differences in perception of risk is described by Elkind in her research with Washington State

farmers. Elkind puts forth the idea that agricultural communities are bound by shared patterns of living and thinking that are unique from older agricultural communities and different from highly urbanized societies (12). Isolated from other types of communities ideologically and sharing lifestyle and occupational factors, men and women in this community may hold opinions that are less distinct than those between the genders in other communities (12). Ultimately, both of these positions on gender and pesticide risk perception also lend further weight to the concept that perception of risk is not biologically determined, but is rather a product of socialization. In the case of this current study, men and women shared similar cultural and occupationally-related factors, which may help explain why their perceptions of risk were relatively similar.

Although gender did not influence risk perception, other aspects of the study differed between men and women. Perhaps the most striking was the difference between men's and women's involvement in farm training. Only 16% of women had ever taken a pesticide-related course, compared to 43% of the men. This discrepancy becomes even greater when examining the small number of women who were primary farm operators[28]. Only 7% of female primary farm operators had taken any training in the past five years, compared to 93% of male operators. One explanation for this difference could be that farm women may be unable to attend such courses due to time limitations, sometimes described as the "rural superwomen" phenomena (249). Researchers at Oklahoma State University (249) found that women living on farms had three primary task areas, unpaid on-farm work, paid off-farm work to supplement the farm income, and caregiver or homemaker. In addition, women in this study clearly stated that they had little time to attend meetings or take courses, even though they acknowledged that they needed more information about farm tasks such as machinery maintenance. In this current study, farm women may be suffering from similar constraints. Statistics Canada has reported that Canadian farm women and children are turning to off-farm work (250), although the Census of Agriculture does not explicitly examine the involvement of women in non-paid work. Recognizing the importance of this issue, a research initiative started in 2001 through the Centre for Rural Studies and Enrichment is being conducted with 500 Canadian farm families to explore in-depth the

[28] Thi means people who are primarily responsible for day-to-day farm operations

gendered divisions of labour on the farm (251). The results of this study may provide further insights into the farm women's time management and issues related to education and training opportunities. Other interesting gender-related factors emerged from this study. Similar to other farm research (28), this current study found that women *were* involved in pesticide application and related farm tasks, although at a lower rate than farm men. This means that women face similar problems of direct pesticide exposure as to those faced by their male counterparts. Additionally, over 30% of women in this study reported being involved in the transport of pesticides, a new area of pesticide exposure research that is gaining attention (252, 253). This dissertation research project also shows support for the concept that many women may not identify themselves as being pesticide applicators (28, 88). In this current study, 31 women said that they were sometimes to always involved in pesticide application, although only 12 identified themselves as applicators and completed questions about what they wore when they applied pesticides. This small number of responses may also have hampered an accurate assessment of the relationship between gender and PPE use, in particular, respirator use. Other studies have shown that women wear respirators less frequently than men, a factor possibly attributable to problems of proper fit for this type of equipment. Initial univariate results in this project did find significant differences between men's and women's use of respirators, with women using such equipment less frequently, although gender did not remain significant in multivariable analysis of this practice. More responses from women may have provided a clearer picture of respirator use in this group.

The findings around gender in this current study have implications for risk communication. As Reed (88) suggests, farm women's self-identification as homemakers rather than as farmers or farm workers may hamper attempts to research and educate this community about farm hazards. Also, because women do not attend traditional courses or training seminars, more non-conventional programs may be needed to better fit with farm women's busy schedules. Results of this research show a clear need to improve farm women's overall knowledge about pesticide risk and the practices available to them to control their own exposures. Thus, further education for the farming community needs to 1) recognize the involvement of both men and women in pesticide-related farm work and 2) be designed in a manner that is inclusive and appropriate for both genders.

6.2.2 Ethnicity

Risk perception research has recognized that potential differences in perception occur between ethnic groups (17, 170, 171, 254). In this dissertation research, pesticides were judged differently depending on ethnic background (European or Indo-Canadian origin). More specifically, those who identified themselves as being of Indo-Canadian origin were more likely to have lower perceptions of risk from pesticides compared to those of European origin. One interpretation of this result may lie in the economic status of the farms operated by each ethnic group. The Indo-Canadian operated farms in this study reported significantly higher incomes, a factor that has been associated with lower perceived pesticide risks in other agricultural studies (189). Unfortunately, the measure of income used in this current study was incomplete and could not be used to control for the effect of economics in the multivariable analysis. Therefore, ethnic background in this study may reflect differences in socio-economic position within the farming community.

Another potential explanation could be that the Indo-Canadian respondents' perception of pesticide risk is a reflection of larger cultural norms within this community. Cultural theorists such as Douglas and Wildavsky (255) describe risk perception as a process in which risks are selected and regulated within unique cultural frames of reference or specific cultural world-views [as described by Dake et al. (256)]. An example of two of these worldviews and their influence on risk is as follows:

> Hierarchically arranged groups, for example, tend to perceive industrial and technological risks as opportunities, whereas more egalitarian groups tend to perceive them as threats to their social structure [Douglas, 1985, in (257)].

The Indo-Canadian community in BC is relatively close-knit, the majority of members sharing similar religious and cultural affiliations[29]. Indeed, within this study population, 50% of the Indo-Canadian respondents spoke only Punjabi at home. Given the distinct culture of this group within the overall farming community, it is not surprising that

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[29] This factor is suggested to be a product of family sponsored immigration patterns, which have resulted in a network of close-knit Sikh families in Canada. Desi, K. Ethnic Communities and Aging *Polyphony* Vol.12, 1990, pp.87-92

they may share particular views about the world, including judgments about technology and risk. Attitudes about pesticides may reflect this community's previous experiences with pesticides in their country of origin. Many of the members of the Indo-Canadian community have immigrated to Canada within that past 25 years from the Punjab, a major agricultural region in India. Farming practices and traditions in India are likely distinct from those in Canada, in part due to the massive restructuring that occurred in Indian agriculture between the 1940 and the 1970s[30]. Past experience with Indian agriculture may also play a role in defining attitudes about current farming practices, including the risks posed by pesticides[31].

In exposure control practices, ethnicity was significantly associated with optimal laundering of clothing worn to apply pesticides and was only one of two potential explanatory variables associated with this practice (the other was trusted sources of pesticide information). Indo-Canadian washers were significantly more likely to practice recommended techniques even though few of them had ever been given directions. This result is interesting, and may reflect cultural or religious differences in approaches to washing and hygiene in general[32].

Responses to risk appear to vary by ethnicity within the farming community, and subsequent communication programs may need to reflect the diversity of perceptions and practices of each cultural group. Involving people from a variety of cultural groups who are engaged in farming will be important in the development of culturally appropriate pesticide risk communication materials. Additionally, literacy and language issues must be addressed. Anecdotal evidence from respondents who took part in this survey suggests that assumption of overall literacy, in either Punjabi or English, cannot be made. This factor has implications

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[30] Referred to in some texts as the "Green Revolution", this program of farming include double cropping, or growing two crops per year. Such processes required massive irrigation systems and relied heavily on chemical fertilizers and pesticides.

[31] It is recognized that cultural differences may themselves be a results of larger issues of social power and control that operate between nations particularly as the West has been involved in the export of pesticides and related agricultural technologies to India and other emerging economies. However, these broader, macro-level conceptions of power and control may be points for future discussion.

[32] While there is only a limited amount of academic research done in this area, distinct cultural patterns have ben found for personal hygiene habits such as hand washing (Edwards D, et al. Predictors of Hand-washing Behavior. Social Behavior and Personality 2002;30(8):751-756.

for future risk communication as strategies that incorporate a variety of communication formats may need to be explored.

This study has also illuminated important differences in knowledge levels between the two ethnic groups. Indo-Canadian respondents in this study were more likely to have participated in training courses than those of European origin. This may be due, in part, to the more recent entry of this community into agricultural activity. However, even with this training, Indo-Canadian respondents reported lower levels of knowledge about the health effects from pesticide exposure and the ways that pesticides can enter a farm home, particularly pesticide drift. These knowledge gaps are obvious targets for future risk communication programs in this community.

6.2.3 Captan

Although this current study began with an interest in focusing on the fungicide Captan, the results imply that compound-specific communication strategies may not be feasible or appropriate. Overall, only 24% of respondents from farms that used pesticides were able to identify what Captan was used for and its re-entry interval. Nearly half of the farm women in the study, although aware that pesticides were used on their farm, did not recognize Captan as one of the pesticides sprayed on their farm. For risk communication, what these findings indicate is that members of the farm community, and particularly farm women, may not identify with programs aimed at one particular compound. Instead, future initiatives may need to a take a relatively broad approach to addressing pesticide risk and potential exposures before addressing specific risks associated with particular compounds such as Captan.

6.2.4 Farm Structure Variables

Proponents of the Farm Structure Model have stressed the importance of farm characteristics for the study of agricultural risk perception and risk management (235). This

current research project confirms the importance of these characteristics in relation to perception of pesticide risk and benefit, as well as to exposure control practices.

Perception of pesticide risk was lower in respondents from farms that grew only one type of crop (mono-crop), whereas farms that were more diversified had heightened concerns about the uses of pesticides. Two possible explanations are suggested for these findings: 1) crop diversity as it relates to productivity, and 2) differences in exposure opportunities. As Napier and Tucker suggested (189), characteristics that reflect greater potential productivity serve to decrease perception of pesticide risk and increase perceived benefit. The influence of crop type in this current study can be interpreted as a component of productivity. For example, mono-crop farming may require a fewer pieces of equipment and products (and therefore may be more cost-effective to produce) than growing a number of different kinds of crops.

Alternatively, the role that crops play in influencing perception of pesticides and exposure control practices may be the result of the ways in which farm community members interact with these chemicals. For example, respondents who grew tree fruits were significantly more likely to wear optimal PPE than those who grew commodities such as grapes, blueberries, and strawberries. Spraying within orchards may present different "exposure opportunities" than spraying bush-type commodities such as blueberries or grapes. Potentially, orchard spraying may provide a different type of exposure *experience* that manifests itself in better practices for tree fruit sprayers or different perception of pesticide risk.

Farm size was also significantly associated with perception of pesticide risk and benefit, although this factor did not appear to influence exposure control practices. Farm size can also be interpreted as a productivity variable, as larger farms may produce a greater quantity of fruit, and they may benefit from economies of scale. Larger farms may also rely more on pesticides to prevent major crop losses and to keep labour costs down. This reliance may serve to heighten perceptions of benefit for those involved in large-scale farm operations. As Traore et al. proposed in their study of Quebec potato growers, larger farms may have more to lose, given their overall higher potential for loss. As a result, concerns

about the effect of pesticides were outweighed by concern for a farmer's own economic survival (202).

The hypothesized relationship between pesticides, productivity, and perception of risk has implications for communicating about pesticide risks. As Green discovered, farmers acknowledged cutting corners and taking risks in order to meet production goals (10). Other researchers have shown that health and safety on farms is less a priority than economic factors (12, 203). Risk communication that addresses pesticide risk may benefit from acknowledging the importance that farmers place on these chemicals. Alternatively, given the importance of productivity and the imperative of economic survival, it is plausible that financial incentives could be useful for encouraging farmers to participate in other methods of pest control. In fact, some IPM procedures have been shown to reduce overall farm costs, and research has shown that these methods can boost overall productivity while decreasing pesticide use (259). In addition, preliminary research exists that shows how organic methods can boost productivity and produce better tasting fruit (207). Such financially based arguments may be a more attractive way to encourage farmers to trying these methods.

6.2.5 Personal Vulnerability

As described in Chapter 3, people's attitudes about their own susceptibility or their "optimistic bias" can contribute to their perception of risk. Specifically, risks may need to be internalized, or considered to be personally relevant before risk messages are considered. Of the respondents in this study, 91% felt that is was unlikely that pesticides could affect their own health. Two possible explanations are considered for these results. First, it is possible that the farm community is taking all necessary precautions to reduce their exposure to pesticides, and so there is no concern about exposure. Second, people may not recognize *how* they are being exposed to pesticides, and are therefore, uninformed about their potential exposures.

However, the findings of this current study are not consistent with either of these possibilities. Although many people were engaging in practices that could reduce pesticide exposure, compliance rates were not 100%. Only 62% of the pesticide applicators reported

wearing optimal PPE when they sprayed, and only 14% of launderers were using proper techniques. With respect to knowledge of exposure, over 80% of people in the study recognized that pesticides could enter the body through exposures on the skin or by breathing and 50% recognized that residues on food could contribute to exposures.

Regardless of the cause, the problem of acknowledging risk has serious implications for risk communication within the farming community. As Lion et al. state in their study of priorities in information needs regarding risk:

> When people think they are not directly confronted with a risk, risk communication can be extremely difficult, as people (especially those not keen on gathering information in the first place) may not be receptive to risk information. (260)

Failure to acknowledge pesticide exposure as a potential health risk may prevent people from recognizing risk messages aimed at them or, worse, prevents them from undertaking appropriate protective behaviors. Addressing this issue may not be easy: risk communication strategies may need to find a balance between elevating risk awareness and risk amplification (165), a process whereby risk message campaigns can become politicized and highly charged. Personalizing risk in a meaningful way within the farm community is recognized as a major communication challenge for future work with this community.

6.2.6 Adverse Health Effects

Similar to Litchenberg et al.'s (191) research on adverse health effects, this current research project found significant associations between such effects and perception of pesticide risks. Negative, lived experiences with pesticides may resonate within family and social groups and highlight the important dangers in using these compounds. Unexpectedly, adverse health effects were not associated with the use of PPE in this project. This result was surprising as PPE use is one obvious and direct way of reducing the risks of pesticide exposure. Other studies have shown strong relationships between past health effects and PPE use (191, 216). However, in this project, adverse health effects *were* found to be associated with the use of IPM techniques, although the association was only for experiences by others

such as friends or family members. Concern for the well-being of family members may lead farmers to trying techniques that reduce overall exposure to pesticides on a farm.

Programs aimed at educating farmers about pesticide risks may benefit from conceptualizing risk within narratives that reflect lived experiences related to adverse pesticide exposure events, similar to programs that have been used to educate farmers about tractor and machinery related injuries.

6.2.7 Psychometric Characteristics: Dread and Trust

As the psychometric paradigm suggested, risk consequences that were dreaded served to increase perception of risk (18). In this current study, awareness of the relationship between pesticides and cancer (one of the most dreaded illnesses) was significantly associated with increased risk perception, whereas knowing other less dreaded outcomes (e.g. head-aches, dizziness, nausea) were not. These results demonstrate lower levels of risk perception for acute (e.g., headache) compared with chronic (e.g., cancer) and severe pesticide outcomes. Perceptions of cancer and pesticides in this current study may also reflect a general perception of elevated cancer risk in the farming community. As described in Chapter 2, people in the farming community do experience higher incidence rates for some types of cancer, although the causes of these cancers and their link to the occupation of farming are not yet clearly understood. Concerns about pesticides and cancer may mirror overall high levels of anxiety about cancer in this community.

A great deal of emphasis in risk research has been placed on the role of trusted sources for risk perception and communication (164). In this current study, trusted sources of pesticide information were found to be particularly important for pesticide exposure control practices; however, the sources varied by the practice examined. Additionally, the univariate analyses of trust showed that trust varied significantly by gender and ethnicity. Knowing which organizations are trusted by specific segments of the farming population and understanding that some sources may be considered more credible within different contexts is extremely important for any further work with the farming community. As mentioned

previously, trust has been found to be a crucial factor in risk communication, as messages may not be accepted unless the agency providing the information is seen as credible and trustworthy. Risk perception researchers have found that trust is very difficult to develop and easily destroyed (157); therefore, existing agencies that are trusted may be in an ideal position to facilitate the dissemination and uptake of pesticide-related messages.

The lack of association between trust sources and perception of pesticide risk or benefit in the multivariable analyses was surprising, given the importance of information sources in other agricultural research (189, 204). This lack of association may reflect differences in how trust was measured in this study versus others, or it may be due to the overall range of sources that were identified by the open-ended nature of the trust measure in this current study. Other factors measured in this study could also be more important for shaping risk perceptions than trusted sources of pesticide information.

Other psychometric variables suggested as influencing risk perception were also not found to be associated with perception of pesticide risk or benefit, including control and familiarity with pesticides. The reason for the lack of associations between these variables and perceptions may be that the measurements designed to capture these concepts were too narrow in scope (i.e., items that focus on control over pesticide application may not have captured the over-arching construct of control). Additionally, these concepts may be embedded within other constructs not measured in this study, such as the level of trust between sprayers and farm family members. For example, greater faith in sprayers to take measures to protect family members may possibly lead to stronger overall feelings of control over pesticide risk within the family unit. Some measurement issues may have prevented a clear understanding of the influence of these psychometric characteristics. However the lack of association may also be due to the "small-business" type nature of farms. Farmers and their family members contribute to the operation and decision-making for their own farms. This factor may lead to a generally higher level of perceived control across most members of the farming community.

6.2.8 Generational Issues

Previous research with farm children emphasized the central position that family members, in particular fathers, play in providing role models for farm tasks and health and safety training (195, 261, 262). In this current study, the potential for generational learning was associated with perception of pesticide benefit, but not risk or any of the exposure control practices. These findings can be interpreted from a number of perspectives, the first of which is the issue of *legacy*. Perception of benefit was most strongly correlated among third generation farmers. This relationship may reflect strong family ties within agricultural communities that perpetuate notions of continuing family traditions. This may translate into greater emphasis on the role of pesticides for maintaining financial solvency, and perpetuating a family legacy; losing the farm would be losing a way of life. First-generation farmers may have less historical family accountability, which may result in less pressure from other family members to succeed, and in turn may result in lower levels of perceived benefits from pesticide use.

Alternatively, the emphasis placed on pesticide benefits, but not risks, by third generation farmers may also be an artifact of outdated ideals regarding pesticides. Before the 1970s, little concern existed about the negative effect of pesticides. Rather, pesticides were seen as part of a modern agricultural system that enabled farmers to grow more crops, feed more people and be more productive. Such uncritical ideals regarding pesticides may have been passed down among family members, shaping current farmers' perceptions of these compounds.

The lack of relationship between generational factors and exposure control practices was a surprising finding. One factor contributing to this lack of association may be that many of the techniques examined in this current study were relatively new (i.e., the use of sterile moths for IPM, or positive pressure helmets) and therefore could not be influenced by older family members. Alternatively, as Darragh (195) suggested, safety education via farm family members may not always be consistent. Watching adults who take short-cuts or forget to take precautions may hamper good advice about safety in some cases. Therefore, observational and experiential learning of farm traditions from family members may vary widely.

6.2.9 Farm Family Members and Indirect Pesticide Exposure

Farm family members' exposures to pesticides and, in particular, farm children's exposures, are the focus of a number of major research projects, particularly in the United States[34]. Preliminary work suggests that family members' indirect exposures are substantial and occur within and around farm homes, influenced in part by the proximity of farm homes to areas where pesticides are sprayed. The results of this dissertation project indicate that many respondents may live within distances from their crops that other studies have found to be correlated with household exposures (27, 74). The intent of this project was not to characterize exposure, but this finding does suggest that household exposures may be an issue for the tree fruit, berry, and grape-growing communities. This factor underlines the important of addressing this community's perception of indirect and household pesticide exposures.

Overall, respondents in this study reported a general lack of concern regarding the issue of household exposures and many felt it was unlikely that pesticides could to get inside their home. When asked an open-ended question about pesticide exposure routes into the farm home, a fair number of people (67%) recognized pesticide drift as a potential source and 44% indicated that contaminated clothing could be a source. However, few people identified other home-based characteristics (e.g., storing pesticides in the home or washing up from application inside the home) that have been linked to pesticide exposure problems (77, 84). Although research suggests that household pets can transfer pesticide residue to family members (77, 263), few people in this current study mentioned household pets as a potential source of exposure. These findings are crucial for risk communication programs, as they emphasize the importance of raising awareness of the potential for household exposure. Simple procedures can be implemented to reduce entry of pesticides into the home, such as taking off boots and shoes, or closing windows to reduce indoor drift.

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[34] Projects are funded by the US Centers for Disease Control as well as the National Institute for Occupational Safety and Health and are being conducted in a number of states, including California, Minnesota, Washington State, Maryland and Iowa.

Also reflective of the overall low concern for indirect or in-home exposures were the small number of people (14%) in this study who practiced all the laundry techniques recommended to reduce indirect pesticide exposure from contaminated clothing. What was particularly notable about the multivariable model results for these practices was the lack of association between training and these practices. Having received directions on how to launder pesticide-contaminated clothing appeared to have little effect on current practices. Obviously, current approaches to educating washers about indirect exposure to pesticides are not leading to improvement in how clothing is being laundered in this province. This situation presents a clear and obvious target for future communication interventions.

One final farm family-related issue merits discussion. Advance notification of pesticide application is important in that it can give farm family members the opportunity to take protective measures to reduce exposures, such as remaining indoors, bringing clothing in from outside drying lines, and closing windows and doors to reduce drift. This study found that almost one quarter of family members relied primarily on their senses (seeing, hearing, or smelling) to identify when spraying was occurring. This may not provide enough time for family members to take preparations to protect themselves, particularly if they are relying on their sense of smell. Pesticide notification programs have been implemented in agricultural neighbourhoods in Canada and the US (e.g., Alberta Ministry of Agriculture and New York State Department of Environmental Conservation). These programs may provide a useful template on which family notification protocols may be developed in BC.

The results of this current research project illustrate the importance of developing risk communication materials that are aimed specifically at addressing the potential pesticide exposure opportunities of farm family members. Future programs need to address the hazards incurred in both living and working in an agricultural environment.

6.2.10 Strengths and Limitations

The data collection method in this study was cross-sectional, and therefore it is only possible to draw conclusions about **associations** between variables and not possible to know the direction of these associations. Additionally, as some questions in the study asked about

historical events, recall may have been a problem, although it was anticipated that this potential bias would have been evenly distributed throughout the population and therefore would not have posed a significant problem.

The results of this study may not be generalizable outside of the types of crops studied (fruits, grapes and berries) or the particular geo-climatic location of the study region. This study did find that perception of pesticide risk, benefit, and exposure control practices were sensitive to the type of crop grown. Growing different commodities such as cattle, cash grain crops or greenhouse crops may provide different experiences with pesticides that may shape unique perceptions about pesticide risk.

The data collected were through self-report and were not validated against more objective measures (such as medical records for adverse health effects, or spray records for pesticide use). However, the use of such records can be problematic; for example, hospital admission records would only collect information on the more severe, acute cases of pesticide exposure and therefore underestimate the incidence of exposure-related illnesses. The requirements for farmers' to keep spray records have not yet been consistently implemented around the province, limiting the usefulness of such data, although as such record keeping becomes more standardized and regulated, these data may prove to be a useful research tool.

Although there were limitations, this study did have a number of strengths. Primarily, this study was conducted on a randomly selected sample, which is important for the generalizability of the study results within the berry and tree fruit farming community in BC. This study was also successful in recruiting equal numbers of men and women, a factor that may have been helped by the use of the introductory letter that invited both men and women to participate. Additionally, this study was able to incorporate Indo-Canadian farmers and their family members, a previously unstudied group in BC. The majority of the Indo-Canadian respondents spoke Punjabi during their interviews, reaffirming the importance of having interviewers who can speak the language of study participants.

The response rate for this project (75%) was relatively high. This could be a result of the planning and groundwork that went into this study. The qualitative interview and focus group research, and the pilot test were conducted to ensure that the survey was culturally

appropriate for men and women. Interviewer flexibility and persistence also helped contend with the challenges of completing telephone interviews; many of the respondents worked long hours and interview times needed to be planned around their availability. This flexibility could also have contributed to the very high survey completion rate (97%) noted in this research project.

The conceptual framework developed for this current project was also particularly useful. It provided the basis for a systematic evaluation of the many factors suggested as influencing risk perceptions and practices together, to explore the contribution of each. The usefulness of the framework designed for this project underscores the importance of examining risk perceptions and related practices from a relatively broad conceptual perspective.

6.3 Contributions of this Research

By extending the research population to include farm family members, this study has provided a more comprehensive assessment of how farm families, including men and women equally, perceive pesticide risks. The majority of previous farm research has focused only on farmers, and in particular, male farmers. Additionally, this research has provided information on an otherwise unstudied population: Indo-Canadian farmers and their family members. Although a fair amount of research has studied ethnically diverse groups of farm workers, this is one of the few studies that specifically addressed farm *owners* of different ethnicities.

This study provides further support for the notions that social and cultural factors, rather than sex- or race-based differences, are key to perceptions of risk. Little differences were noted between men's and women's perceptions in this current study, which may be due, in part, to the fact that both genders operate within similar socio-economic constraints. Regarding ethnicity, variation in perceptions and practices were noted between the two ethnic groups in this study, but such differences can also be interpreted as distinct cultural

norms or practices within each community[35]. The Indo-Canadian community's attitudes about pesticides may reflect the agricultural traditions of their country of origin[36].

Previous agricultural researchers have suggested that pesticide risk perception is a product not only of personal characteristics and cultural factors, but is also mediated by the external stressors of farm economic and productivity (186, 189, 264). In this study, the farm community's perception of pesticide risk appears to be embedded within the broader socio-economic pressures of agricultural production. Efforts to engage farmers and farm family members in a dialogue about pesticide risks may be most effective when such external socio-economic pressures are taken into consideration.

The findings of this current research also support a call for a wider perspective on farm risk research in general (8). Perception and management of pesticide risk in the farming community appear to be complex and dynamic processes that draw on aspects of past experience, friends and family, health concerns, attitudes about susceptibility, and farm productivity pressures. Future research may benefit from taking a relatively broad approach when examining risk perception and pesticide management strategies in the farm community.

6.4 Future Directions

As described above, this project provides a foundation for the development of a next phase of work: a pesticide risk communication program for the tree fruit, berry, and grape-growing community. Such a program will require the development of appropriate content that reflects issues raised by this research project. Findings from this current study also provide insights for the development of appropriate dissemination strategies that can target particular groups within this community.

Other directions that could be explored from this research project include the refinement of the conceptual framework developed for this study. One re-emerging area of

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[35] Historical power relations between nations may also play a role in shaping such cultural difference. For example, embracing modern agricultural practices in India was one component of this country's post-British independence.

[36] An examination of pesticide risk perception in farm communities in the Punjab region of India might provide further insight into this issue.

risk perception research is that of Cultural Theory, introduced by Douglas and Wildavsky (255) and further developed by Dake et al. (256). This approach emphasizes issues of worldviews or cultural value-systems that operate as key modifiers of people's perception of risk. Problems of measurement have hampered the use of this approach, particularly with respect to issues of validity, although very recent modifications show promise (265). Given the potential importance of cultural diversity within the farming community, expanding the framework to incorporate this evolving area may be an asset. Such work may be best initiated by ethnographic researchers, which may allow for a richer understanding of cultural traditions and experiences.

Future work could also include an assessment of the survey instrument that was developed for this research project. This instrument could be tested using other agricultural populations either in BC or in another growing area in Canada. Such research would provide an opportunity to investigate the psychometric properties of the instrument.

The survey instrument used in this current study could be adapted to explore perception of pesticide risk in relation to domestic pesticide application (e.g., on lawns, pets, and for indoor insect control). Estimates of domestic pesticide use in states such as California are as high as 88% (266). A pesticide survey conducted in Alberta determined that the greatest pesticide intensity (amount applied per hectare) was for home and garden use compared to agricultural or city park applications (267). Research programs in the US have begun addressing pesticide exposure in urban environments; preliminary research suggests these exposures can be significant, and may be associated with conditions such as childhood leukemia (268-271). Exploring pesticide risk perception in a domestic context would allow for a more comprehensive understanding of the similarities and differences between agricultural and non-agricultural populations' perceptions of these compounds. Researchers have discussed the apparent paradox between public and agricultural populations' perceptions of risk (agricultural users, with greater exposure potential, may have lower levels of concern about pesticide exposure than the public) (188, 189). Much on the research conducted with the public regarding pesticide perceptions has focused on food or environmental issues and not home-based exposures. The survey instrument from this current study could be used to enhance our understanding of public attitudes about the pesticides, particularly those that the public actually *apply*.

6.5 In Conclusion

Pesticide use will continue as a primary means of pest control for the foreseeable future on BC farms. As such, farmers and their family members need appropriate and up-to-date information in order to effectively manage the risks that these chemicals present. Identifying *which* personal, cultural, and farm-based characteristics shape perception of pesticide risk provides a good first step in the development of communication materials regarding pesticide use. Understanding *how* these factors shape perceptions will be vital for the development of effective risk communication strategies for the farming community.

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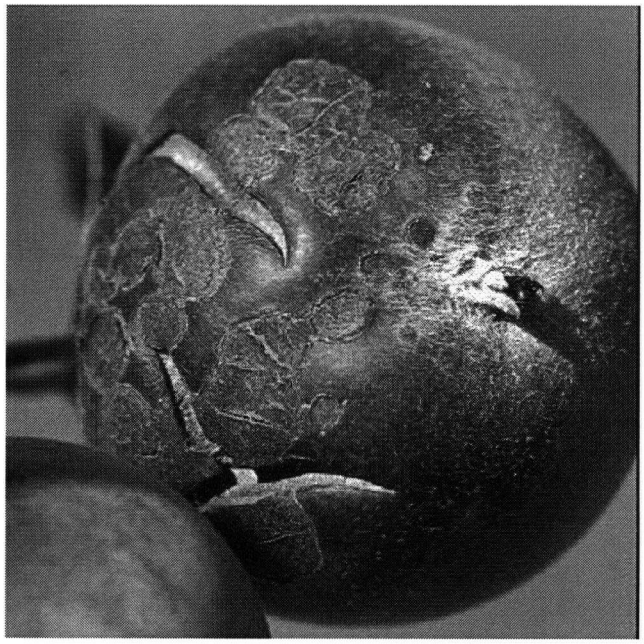
Appendix A

Conditions Treated with Captan

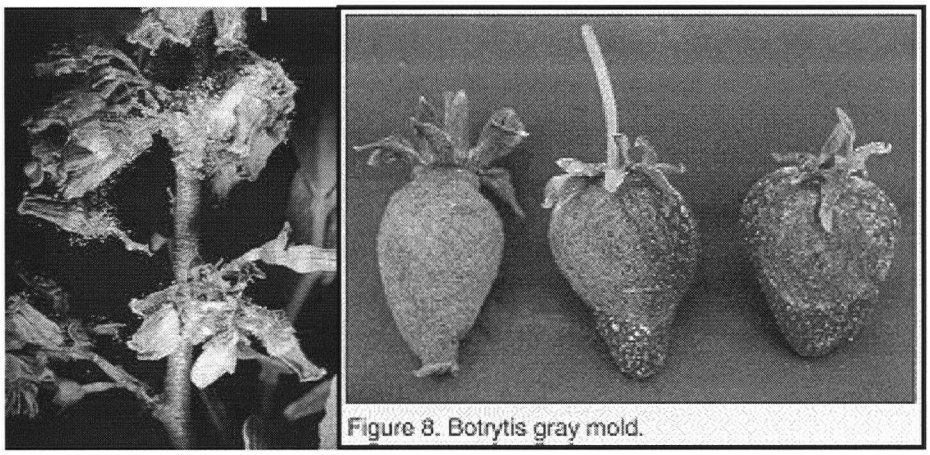
Leaf Scab (photo: BC Ministry of Agriculture)

Apple Scab (photo: BC Ministry of Agriculture)



Botrytis on Blueberries (Nova Scotia Ministry of Agriculture) and Mould on Strawberries

(photo from IPM Alabama http://www.aces.edu/department/ipm/strawbdis.htm)



Brown Rot in Peaches

(photo from: http://www.nysaes.cornell.edu/pp/extension/tfabp/factshts/stone/brstf/brstf3s.jpg)

Appendix B

Computerized Sources of Literature

Database	Description	Coverage (Years)
Agricola	Agriculture	1981-current
Ovid	Medical, Nursing	Medline 1966-current CINHL 1982-current EMBASE 1988-current
CCINFO	Health and Safety Information from USA, England and Canada	NIOSHTIC 1900- OSHLINE –1998-current HSELINE- 1977-current
Academic Search Premiere	Psychology, Sociology, Canadiana, Education	1984-current
Cambridge Scientific Abstracts	Engineering, Pollution Prevention, Risk Assessment, Agriculture	Risk Abstracts (1990 - current) Health & Safety Sciences Abstracts (1981 - current) Environmental Engineering Abstracts (1990 - current) Agricultural (1993-current)
Web of Science	Science, Social Science and Humanities Citation Indexes	1989-current
HAPI	Database of instruments used in health and psycho-social research	1985-current

The search terms used for the literature review included the following:

- Risk
- Perception/Attitudes/Beliefs
- Farm/Farmer
- Orchard
- Agriculture
- Family/Wife/Children
- Safety
- Pesticide/s
- Agricultural Chemicals
- Farm operator/Applicator
- Gender
- Personal Protective Equipment
- Practices

Appendix C

Lists and Guides used to Develop Farm Enumeration

BC Federation of Agriculture Growers List
Lower Mainland Organic Growers Association List
BC Farm Fresh Farm Guide (also available electronically)
BC Wine Institute Members (also available electronically)
Farm Bed and Breakfast Lists (also available electronically)
Advertisements in local farm magazines and newspapers
BC Yellow Pages

List of URL's used to develop Farm Enumeration

http:// www.davisonorchards.ca
http://altavita.com/farmersmarket/farmproduce.html
http://farmcentre.com/bc/market_reports/vander/farm.htm
http://mypage.direct.ca/l/lofstedtfarm/
http://okanagan.foundlocally.com/Travel/Attr-Vernon-wineries.htm
http://royal.okanagan.bc.ca/cthomson/living_landscapes/articles/wongc7.html
http://www.agf.gov.bc.ca/ministry/fpb.htm
http://www.agri-labourpool.com/jobseekers/alerts/
http://www.aitc.ca/bc/pages/Farm%20Tours%20Page/Vancouver%20Island-coast%20farm%20tours.html
http://www.alternatives.com/library/env/envgrenc/growlis.txt
http://www.bbchannel.com/bbc/p620417.asp
http://www.bcfarmandranch.com/property/drilldown.cfm?propertyid=147
http://www.bcfarmfresh.com
http://www.bcfarms.com/
http://www.bcraspberries.com/commercial.htm#fresh
http://www.bluemountainwinery.com/
http://www.cablelan.net/casorso/bus_dir/
http://www.cablelan.net/casorso/bus_dir/
http://www.certifiedorganic.bc.ca
http://www.cherrypointvineyards.com/
http://www.communityinternet.com/obo/tours.html#fot
http://www.communityinternet.com/obo/tours.html#fot
http://www.dmoz.org/Business/Industries/Agriculture_and_Forestry/
http://www.fbminet.ca/bc/market_reports/sidma/sidmades.htm
http://www.fbminet.ca/bc/market_reports/vander/farm.htm
http://www.goodfruit.com/archive/Jan1-00/awards.html
http://www.idfta.org/idfta2000/nzprog.html
http://www.islandfarmfresh.com/cowichan1.htm
http://www.islandfarmfresh.com/saanich2.htm
http://www.keremeos.com/mariposa/index.html
http://www.kes.bc.ca/
http://www.mindprod.com/quadres.html
http://www.okanagan.worldweb.com/index.html?vid=4721706
http://www.okanagan.worldweb.com/RealEstateforSale/Farms
http://www.oktrvl.com/penticton/orchards.htm
http://www.oliverchronicle.com/1998_29.htm
http://www.producer.com/articles/19990902/special_report/19990902bcfruit2.html
http://www.recline-ridge.bc.ca
http://www.saturnavineyards.com/
http://www.southokinfo.com/business/foodstore1.htm

List of URLs continued

http://www.southokinfo.com/food_products.htm
http://www.summerlandchamber.bc.ca/todo.htm
http://www.thecranberrylady.com
http://www.thompsonokanagan.com/touring/agricultural/index.htm
http://www.thompsonokanagan.com/touring/agricultural/index.htm
http://www.travelenvoy.com/
http://www.travelenvoy.com/wine/bcindex.htm
http://www.vancouvertoday.com/bc_tourism/articles/top_10/ten_best_strawberry.html
http://www.vancouvertoday.com/bc_tourism/articles/top_10/ten_best_strawberry.html
http://www.vineyard.bc.ca/
http://www.welcometokelowna.com/entertainment/index.htm
http://www.wellsgray.net/~wildgoos/thompsonaccom2.htm
http://www.winebc.com/memberwineries.htm
http://www.winegrowers.bc.ca/members.asp
http://www.worldexport.com/bcblue/page3.asp
http://www.zanatta.bc.ca/
http://www2.mybc.com/aroundtown/food/marketplace/stores/searching/

Appendix F

Interview Guide

Preamble (after signing of informed consent)

Thank you for agreeing to speak with me about your experiences and thoughts regarding pesticides. I plan to talk with a variety of people in the BC farming community about this topic to learn how farmers and farm family members perceive and use pesticides on their farms. I am using the information to develop a questionnaire that will be sent to berry, grape and tree fruit farmers across the province to develop a profile of how pesticides are both viewed and used in BC.

I wanted to speak with you today because I want to hear from a wide range of people in the farm community. I am looking forward to learning about what you think the benefits and risks of pesticide use are, and, if pesticides are used on your farm, the practices that are generally followed for their mixing, application and storage.

I will begin by asking a few questions about your farm(s):

1) Can you tell me about your farm and the things that you grow or raise?
2) What is your role on the farm and what are some of the tasks that you do?
3) Are you involved in work around the home and if so, what kind of work?

Because my study focuses on pesticide use, I want to start to focus our conversation on this topic, but first I would like to find out,

4) What name or names do you generally use for the chemicals that you spray on your crops? (Probe: Pesticides, Herbicides, Fungicide, Agricultural Chemicals?)

Okay, so,

5) Are pesticides used on your farm now?
   If yes, ask from questions 6 onward *OR*
   If No, ask "have you ever used them? –
   If yes, ask why they stopped and then skip to question 7 *OR*
   If no, ask why, and then skip to question 7 (if appropriate)

6) Who sprays most of the pesticides on your farm and what crops are they used on? (prompt about spray patterns, number of applications, etc., particularly if this person is the sprayer)

   Confirm exactly who does most of the spraying... So [you] do most of the spraying? or So [your husband] does most of the spraying?

7) Do you every worry about the potential effects of pesticides on your personal health?

In your opinion, what are some of the risks of using pesticides?
Have you ever talked about the risks with your family? With friends?
What kinds of things do you discuss?
How does that make you feel?
Do you feel like you have much control over **whether or not** you use pesticides on your farm?
Do you feel like you have much control over **how** you spray pesticides on your farm?
(If not covered, ask about the benefits of using pesticides)

8) *(Conventional Farming Only)* **So based on what you've told me so far, I can see you've put some thought into what are some risks as well as benefits to using pesticides.**

Now I want to talk with you about some of the actions you have taken to protect yourself from pesticides.

What are some of the things that are done on your farm to reduce your exposure to pesticides? *(prompt about laundry if not offered)*

How effective do you feel these actions are? (prompt, on a scale of one to ten with ten being the safest at reducing exposure)
How likely do you think it is to think that you could **eliminate** your risk from spraying pesticides?
So if you don't think that it's realistic to totally eliminate your risk, what would be the best you could expect to realistically implement on your farm in terms of reducing risk from pesticides?
What kinds of resources would you need to implement this strategy?

9) I've heard from some farmers that they sometimes feel sick after they spray pesticides. Can you recall ever feeling sick or out of sorts after pesticides were applied?

If yes, could you tell me more about this? How did you feel? Why do you think you felt that way?
What kinds of things did you learn from this experience?
How has this experience made you feel in terms of the likelihood that you can adequately protect yourself from getting sick when you use pesticides?

10) *(Conventional Only)* Who do you usually receive information about pesticides from and how often does this occur? What kind of information is it?

Do you ever read the information on the pesticides packages? What do you think about this information?

Do you feel that the people who supply you with pesticide information are trustworthy? Yes or no? Are some more trustworthy than others?

What makes some information sources more trustworthy than others?

The family farm is an interesting place. It's both where you work and where you live. The few questions focus on the issue of pesticide use on your farm which is also your family home.

11) What do you think are the chances that the pesticides you use in your fields are getting into your home?

How likely do you think it is that any of the pesticides you spray in the fields get into your home? By what means?

What kinds of things do you do think could prevent this from happening?

Do you and your spouse ever talk about the potential of pesticides getting into your home after you spray?

What kinds of concerns does your spouse raise?

How do you deal with these issues in your home/as a family?

To this point, the interview has focused primarily on your personal experiences. The next few questions try to get at what you think about the broader issue of pesticides, farming as an occupation and the farming community in general.

12) How risky do you think farming is as an occupation? What are some of the major risks? Who is most typically at risk on a farm? Overall, considering all the risks, how would you rate pesticides risks on a scale of one to ten, with ten being the most risky?

13) What do you think are some of the major issues that farmers and their family members will have to deal with over the next 10 years in BC?

(prompt: genetically modified foods, integrated pest management, contaminated well water, etc.)

Thank you for taking the time to answer these questions, are there any other thoughts that you may have about pesticides that you would like to add?

Appendix G

Questionnaire #: Date:

Interviewers: Your instructions are in **bold**. When you ask a question about "who does" something, we are looking for the relationship, not the name. If necessary, probe for the relationshop (i.e., "spouse", not "Jane"). Please write down answers where you are not comfortable categorizing them.

0) Sex of Respondent: `1. Female ____ 2. Male ____

Read: OK, here we go with the questions. The first few questions are about your farm and your role on the farm.

1) Which crops are grown for sale on your farm? **(Do not read list. Check all that apply).**

a	Apples	g	Nectarines	m Other (describe)
b	Apricots	h	Peaches	
c	Blueberries	i	Pears	
d	Cranberries	j	Plums	
e	Grapes	k	Raspberries	
f	Kiwis	l	Strawberries	

2) Do you have a separate garden where you grow vegetables, herbs or fruit for your family?

1. No ____ 2. Yes ____ 3. Other_____

3) In which region of BC is your farm located?

A	Fraser Valley	F	Gulf Islands	K Other (describe)
B	Okanagan/Osoyoos/Oliver	G	Thompson/Kamloops	
C	Cariboo	H	Vancouver/Richmond	
D	Kootenays	I	Sunshine Coast	
E	Vancouver Island	J	Whistler/Pemberton	

4) Who is the primary farm operator for your farm? **(Read if asked:** A Farm operator is the person responsible for the day-to-day operation of the farm. **Do not read response options.)**

1. I am
2. Me and someone else (please explain)_____
3. Someone else (please explain)_____

5) How would you describe your role in the making of decisions about how your farm operates? **If necessary, read out options**

1. ____ You make most of the decisions
2. ____ You and your spouse make the decisions together
3. ____ You and a farm employee make the decisions together
4. ____ Your spouse makes most of the decisions, but you are involved in some aspects
5. ____ You don't get involved in decisions

1

6) How many people were employed on your farm last year, including seasonal workers? **(Read if queried:**"By employed, I mean hired or paid employees or laborers.")

_____# of workers ___only family workers (not paid)

7) Who owns your farm? **(Do not read.)**

1.____ I do (myself) or my spouse does
2. ____Another member of your family
3. ____A corporation
4. ____An unrelated individual
5. ____Other (please explain) _____

8) The next questions are about the size of your farming operation,

a) How many acres or hectares is your farm? i)_____ acres ii)_____hectares
b) How many acres or hectares did you plant with crops for sale in 2001, including acres you may rent? i)_____ acres ii)_____hectares

Read: Now we would like to learn a bit about your family's farming history.

9) How many years have *you* been farming?_____ years

10) Did you grow up on a farm? 1. No ____ 2. Yes ____

i) If yes, do you still live on this same farm? 1. No ____ 2. Yes ____

ii) If no, where was the farm that you lived on when you were growing up?
(Do not read list. Record country)

1	Canada	5	Greece	9	Portugal
2	China	6	Holland	10	United States of America
3	Denmark	7	India (or the Punjab)	11	Vietnam
4	Germany	8	Japan	12	Other (name)

11) Who else in your family has been involved in farming? **Read all,** (circle appropriate category, use NA if no siblings/ children)

a) Parents	yes	no	
b) Grandparents	yes	no	
c) Sibling	yes	no	NA
d) Children	yes	no	NA

12) We are interested in knowing what specific tasks you do on your farm. I am going to read out a list of different activities. Please tell me if *you* are the one who does this task; always, sometimes, never, or if this does not apply to your farm.

(If asked, say: "Always" means whenever the task happens you participate or that you do this task most times it comes up, "sometimes" means you undertake such a task infrequently or only once in a while, and "never" means you really never do this or it is not applicable to your farm.)

1 = Never 2 = Sometimes 3 = Always 9 = N/A

Activity	Frequency			
a) Plant crops	1	2	3	9
b) Harvest crops	1	2	3	9
c) Sell crops	1	2	3	9
d) Work in your vegetable garden	1	2	3	9
e) Drive a tractor	1	2	3	9
f) Operate other heavy equipment (e.g. thresher, chipper, irrigation tankers, etc.)	1	2	3	9
g) Purchase or order farm chemicals	1	2	3	9
h) Spray pesticides	1	2	3	9
i) Pick up or deliver farm chemicals	1	2	3	9
j) Do farm bookkeeping	1	2	3	9

Read: The next few questions are designed to give us some information about *your opinions* about farm chemicals. There are no right or wrong answers; we are just interested in learning what *you* think.

13) Some people believe that farm chemicals pose a risk to humans and the environment, while others believe that farm chemicals can be used without risk. I am going to read a list of potential benefits of using farm chemicals. I would like you to tell me whether it is "not important", "slightly important", "somewhat important" "very important" or "extremely important" for each one.

(Note, if they don't use pesticides, clarify if pesticides are "not important" to these factors)

In your opinion, thinking about *your farm*, how important are pesticides to:

1 = not 2 = slightly. 3 = somewhat 4 = very 5 = extremely

Issue	Importance				
a) To your farm's financial success	1	2	3	4	5
b) To crop appearance	1	2	3	4	5
c) To crop yield	1	2	3	4	5
d) To soil quality	1	2	3	4	5
e) To controlling pest population in your area	1	2	3	4	5
f) To determining which crops you grow	1	2	3	4	5
g) To the amount of labour you require	1	2	3	4	5

14) Now I am going to read another list, this time of things that some people are concerned about regarding pesticide use. I would like you to tell me whether it is: "not risky", "slightly risky", "somewhat risky" "very risky" or "extremely risky" for each one.

In your opinion, thinking about farm communities in general, how much risk do pesticides pose to:

1 = not risky 2 = slightly risky 3 = somewhat risky 4 = very risky 5 = extremely risky

Issue	Importance				
a) Pesticide Applicator's Health	1	2	3	4	5
b) Farm Family Health	1	2	3	4	5
c) Health of Other People Outside the Farm	1	2	3	4	5
d) Farm Animal Health	1	2	3	4	5
e) Wildlife Health	1	2	3	4	5
f) Water Safety	1	2	3	4	5
g) Food Safety	1	2	3	4	5
h) Air Quality	1	2	3	4	5
i) Health of Beneficial Insects (e.g., bees)	1	2	3	4	5

READ: Thanks for getting this far with me. We are going to switch now to a few questions about some health issues.

15) Thinking now about yourself, have you ever had a health problem (small or large) that you think may have resulted from pesticides?

1. No____ 2. Yes ____

a) If yes, could you please explain the kind of health problem_____
_____
_____
_____
_____

16) Now thinking about your family, friends or farming neighbors, are you aware if any of them have ever had a health problem that might have been associated with pesticides?

1. No____ 2. Yes ____ 9. don't know ____

a) If yes, could you please explain the kind of health problem_____
_____
_____
_____

17) Can you think of any other health problems that *might* be caused by pesticides? Please tell me any that come to mind. **(Do not read list. Check all that apply.)**

	a) Cannot think of any		k) Problems during pregnancy
	b) None, it doesn't cause health effects		l) Nausea/Vomiting/Stomach Upset
	c) Cancer, any kind mentioned		m) Nerve Damage/conduction problems
	d) Respiratory diseases (e.g., asthma)		n) Dizziness/Fainting
	e) Heart disease		o) Poisoning
	f) Skin rashes/skin problems not burns		p) Other (describe)
	g) Burns		
	h) Allergies- allergic reactions		
	i) Eye Problems / Blindness		
	j) Genetic Defects/Birth Defects		

18) Finally, how likely do *you* think it is that pesticides will affect your health in the future in a negative way? **Read out options if necessary**

1. ____not likely
2. ____ slightly likely
3. ____somewhat likely
4. ____very likely
5. ____ extremely likely
9. ____Don't know

READ: Thanks very much, now we are finished with that set of questions and we are going to move on to some questions related to using pesticides. Remember, we are interested in your *opinions* even if you aren't involved in using chemicals yourself.

19) If a person uses pesticides or is around them, what are some of the ways that you think pesticides can get into the body? Please tell me as many as you can think of. **(Do not read list. Check all that apply.)**

	a) I don't know		f) through cuts or open wounds or similar
	b) through breathing it in (or inhalation, or in your lungs)		g) doesn't enter the body at all
	c) through your skin/hands/feet/face/head (dermal)	h) Other (describe)	
	d) through eating or drinking it (oral/ingestion)		
	e) through your eyes		

20) Okay, and now shifting our focus a bit, how likely do you think it is that pesticides can get inside a farm home? **(Read out options)**

1.not likely ____ 2. slightly likely ____ 3. somewhat likely ____
4. very likely ____ 5. extremely likely ____ 9. Don't know ____

If responds "not likely" skip to Q22, otherwise continue with Q21

21) In your opinion, what do you think are some ways that pesticides might get into a farm home? Please list as many as you can think of. **(Do not read list. Check all that apply.)**

	a) I don't know		h) storing pesticides in the home
	b) pesticides on clothes/contaminated laundry/pesticides on boots		g) from pets
	c) pesticide drift into the house		h) Other (describe)
	d) people not washing their hands		
	e) domestic (indoor) pesticides/ miticides/ rodenticides/insecticides		
	f) residues on food		

READ: Now I am going to ask your opinions about a range of farm health and safety issues. We want to know what you think about these issues even if you aren't involved in the day to day working of the farm.

22) Okay, Thinking about safety, do you think that farming is:

(If seeking clarification, stress that we are thinking generally about all occupations, where would farming rank in terms of safety)

3. ____ safer than most occupations
2. ____ as safe as most occupations
1. ____ less safe than most occupations
9. ____ don't know

23) Shifting our focus again, I am going to read a list of things that some people are concerned about around the farm. For each item I want to know if you are "not concerned", "slightly concerned", "somewhat concerned", "very concerned", or "extremely concerned" about these issues on **your** farm.

1 = not concerned 2 = slightly concerned 3 = somewhat concerned
4 = very concerned 5 = extremely concerned 9 = N/A

a) Tractor accidents or rollovers	1	2	3	4	5	9
b) Pesticide drift from other farms	1	2	3	4	5	9
d) Slips, trips or falls	1	2	3	4	5	9
e) The pesticides sprayed on your farm	1	2	3	4	5	9
g) Injuries from animals	1	2	3	4	5	9
h) Heavy lifting	1	2	3	4	5	9
i) Stress	1	2	3	4	5	9
j) Sun exposure	1	2	3	4	5	9
k) Accidental Poisoning	1	2	3	4	5	9
l) Other (describe)	1	2	3	4	5	9

READ: The next question is about farming practices.

24) There are things that farmers can do to reduce plant diseases and pests that don't involve using chemicals. I am going to read out a list of activities and for each activity, I would like you to tell me if this practice has ever been tried on **your** farm **and** then whether you are still using the method.

Technique	**Ever Tried?**		**Still Using?**		**Don't Know**
	No	**Yes**	**No**	**Yes**	
a) Adjusting planting or harvesting dates to avoid pests	1	2	1	2	9
b) Introducing insect predators (like ladybugs)	1	2	1	2	9
c) Planting disease resistant varieties	1	2	1	2	9
d) Adjusting watering or timing of irrigation to prevent disease	1	2	1	2	9

If "yes" to an item or items, go to Q24F next page, tick all that apply for each technique

Q24F) When you tried (identify technique respondent tried), what were main reasons you decided to try this non-chemical technique? (Do not read list. Check all that apply. If more than one technique tried, repeat question citing next technique tried and use next set of boxes.)

i) Technique (a,b,c,d or e)	Reason	Check	ii) Technique (a,b,c,d or e)	Reason	Check
	a) don't know			a) don't know	
	b) for financial reasons (save money, make more money)			b) for financial reasons (save money, make more money)	
	c) because of government regulations			c) because of government regulations	
	d) for environmental reasons			d) for environmental reasons	
	e) for human health reasons			e) for human health reasons	
	f) interested in new techniques			f) interested in new techniques	
	g) Other (describe)			g) Other (describe)	

READ: Okay, changing topic now, I would like to ask you some questions about farm publications and groups.

25) Does your farm have a copy of either of these Ministry of Agriculture Publications?:

Publication	No	Yes	DK
a) the BC Berry Production Guide			
b) the BC Fruit Production Guide			

26) How often do you read any farm publications or newsletters? **Prompt: for example "Country Life"**

1. Never ____ 2. A few times a year ____ 3. A few times a month ____ 4. Weekly___ 5 Daily ____

a) If ever, which ones (up to 3)? _____

_____

_____

27) Do you belong to any farm related organizations? **Prompt: such as "4H" or a commodity group**

1. No ____ 2. Yes ____ 9. Don't know ____

a) If yes, which ones? _____

28) Over the past 5 years have you personally attended a course or meeting that focused on pesticides?

1. No ____ 2. Yes ____

If yes, ask "Which ones?" (Do not read list. Check all that apply.)

	a) Pesticide Applicators course		i) Other (describe)
	b) FARSHA training course		
	c) University or college course or seminar		
	d) Government course		
	e) Private course		
	f) Course at the annual Abbotsford meeting		
	g) Environmental Group Seminar (e.g., Greenpeace)		
	h) Organic Organization Meeting		

If no, Has someone else in your household attend such meetings in the past 5 years?

1. No____ 2. Yes ____ 9. don't know ____

if yes, who?_____

29) Which agencies, groups or organizations, if any, are your most trusted sources for pesticide information? Please list at least two in order of most trusted first

1)_____
2)_____
3)_____

30) And thinking now about laws and policies, how would you rate the government's pesticide regulations, are they:

3. Too strict ____
2. Fine the way they are ____
1. Not strict enough ____
8. Don't have an opinion about this ____
9. Don't know ____

READ: Now I would like to talk about where you get your information about farm chemical safety.

31) Who was the first person to talk to you about pesticide use on the farm? **(Do not read list. Check only one)**

1	Never Learned/Don't use pesticides	8	Brother
2	No-one, taught myself	9	Sister
3	Father	10	Unrelated individual, (please explain)
4	Mother		
5	Grandfather		
6	Brother		
7	Sister		

32). And if you had a question about the safety of a pesticide, whom would you turn to for advice?

(If queried say: "For example, if a pesticide had been spilled near a water supply, what person would you want to talk to about this issue to get advice about what to do?" **Do not read list. Check all that apply)**

	a) Spouse or Partner		l) Federal Government rep.
	b) Another Farmer		m) Agriculture Canada
	c) Fruit of Berry Packers/Processor rep		n) Environment Canada
	d) Chemical Sales Representatives		o) Pesticide Management and Reg. Agcy.
	e) Integrated Pest Management Consultants (private)		p) don't know which level of government
	f) A Farm and Ranch Hand Health and Safety Ass'n (FARSHA) representative		q) Don't know
	g) Workers Compensation Board of BC rep.		r) No-one
	h) A University or college professor		s) Other (please specify
	i) Provincial Government rep. (try to clarify)		
	j) BC Ministry of Agriculture rep.		
	k) BC Ministry of the Environment rep.		

33) The next question is about the information that **you** personally receive. I am going to ask you if you get any materials on the following topics, please answer no or yes . If you do, please tell me what you think the quality of the information, is it excellent, good, fair, or poor.

N = No Y = Yes If yes, how would you rate the quality?
P = Poor F = Fair G = Good E = Excellent

Topics			Rating			
	N	Y	P	F	G	E
Pesticide safety, including health information?	1	2	1	2	3	4
Emerging pest problems?	1	2	1	2	3	4
New pesticide products?	1	2	1	2	3	4
Integrated pest management or IPM procedures?	1	2	1	2	3	4
Pesticide licensing, regulation or restriction issues	1	2	1	2	3	4
Environmental issues emerging from pesticide contamination (e.g. water quality)?	1	2	1	2	3	4

READ: Thank you, okay, for this next question, feel free to be as creative as you like in your answer.

34) If you could change one thing about pesticides, any aspect, regardless of what it would take, what would that be?

1. Wouldn't change anything ____
2. Change (please describe) _____

_____
_____
_____
_____

READ: Okay, we are at the end of this section of the survey and we are over half way. Now I would like to ask you some questions specifically about pesticide use on your farm.

35) Were pesticides sprayed or used on your farm last year? By pesticides I mean fungicides, herbicides or insecticides.

1. No____ 2. Yes ____ 9. Don't know ____

If "don't know", skip to Q 47 page 15

If no to Q 35, say

35a) "As chemicals aren't sprayed on your farm, would you describe your farm as being:

1. certified organic ____ 2. non-certified organic ____ 3. transitional to organic ____
4. Other (Please explain) _____

If answered Q 35A, skip to 47, page 15, otherwise, continue

36) Are pesticides used on your own vegetable or herb garden?

1. No____ 2. Yes ____ 9. Don't know ____

37) Who applies the pesticides used on your farm? **(Do not read list. Check all that apply.)**

	a) I do (questionnaire respondent)		f) a neighbor
	b) my spouse/partner does		g) someone else (please describe)
	c) another family member does		
	d) a farm employee ie- farm manager		
	e) a contracted pesticide applicator or applicator company		

If they are the person who applies pesticide, continue,
If they are not, skip to Q46, page 15

38) Thinking now about your pesticide application. For each item I want to know if you are "not in control", slightly in control", "somewhat in control", very much in control", or "fully in control" about these issues on **your** farm.

1 = not in control 2 = slightly in control 3 = somewhat in control
4 = very in control 5 = fully in control

a) the amount of pesticide you applied per acre	1	2	3	4	5
b) your spray schedule **(If queried say** "By this I mean the time during season that you need to apply your sprays.")	1	2	3	4	5
c) the kinds of pesticide you apply	1	2	3	4	5
d) protecting yourself from pesticide exposure	1	2	3	4	5

39) Still thinking about application, what methods are used to apply pesticides on **your** farm? **(Read List. Check all that apply.)**

a) ____ aerial application
b) ____tractor application
c) ____hand-held or backpack sprayers
d) ____Other (please explain) _____

READ: And now turning to clothing and equipment,

40) I am going to ask you about what you usually wear when you apply pesticides, starting with

i) What do you usually wear on your head? __nothing *or*

Circle type, if Hat type not specified, Clarify,

A	Ball cap	C	Hardhat	E	Turban or similar	G Other:
B	Wide brim hat	D	Hood of Spray Suit	F	Bandana	

ii) What do you usually wear on your hands? __nothing *or*

Circle type, if glove type not specified, Clarify

A	Rubber	B	Leather Work Gloves	C	Cotton/Gardening	D Other:

iii) W hat do you usually wear over your mouth? __nothing *or*

Circle type, if type not specified, Clarify

A	Respirator (w/wo cartridge)	C	Positive Pressure Helmet	E Other:
B	Dust/Paper/Medical Mask	D	Bandana	

iv) What do you usually wear Over your clothes? _nothing *or*

Circle type, if type not specified, Clarify

A	Disposable Suit/ Painters Suit	B	Rubber Suit/ Rubber Apron	C	Heavy Work Shirt/Macinaw	D	Other:

v) O ver your eyes? __nothing *or*

Circle type, if type not specified, Clarify

A	Goggles/Face Sheild	B	Prescription Glasses	C	Sunglasses	D Other:

41) We have talked to lots of farmers and found that some don't always wear special clothes or gear when they are mixing or applying pesticides. I am going to read a list of reasons why people might not wear protective clothing or equipment. Please tell me if you would strongly agree, agree, disagree or strongly disagree with their rationale.

4 = Strongly agree 3 = Agree 2 = Disagree 1 = Strongly Disagree 9 = Don't Know

a) It takes too much time to put on	4	3	2	1	9
b) It is uncomfortable to wear	4	3	2	1	9
c) It is too expensive to buy	4	3	2	1	9
d) Sometimes, people may just forget to put it on	4	3	2	1	9
e) It is just too complicated to use	4	3	2	1	9
f) Other (please explain)	4	3	2	1	9

42) If, your clothes were accidentally soaked with pesticides when you were mixing or spraying, what would you do with them? (Interviewer to read out options only if required)

1. ____take the clothes off and let them dry
2. ____take the clothes off and dispose of them
3. ____take the clothes off and have them laundered
4. ____take the clothes off and store them in a plastic bag until you launder them
5. ____ Other (please explain)

_____

_____

43) Turning our attention now to others farmers in your community group, in your opinion, what percentage of other farmers **regularly** wear the following protective clothing items?

	Percent	Don't Know
a) A Respirator with a cartridge		999
b) Rubber gloves		999
c) Paper or dusk mask		999
d) Eye goggles		999
e) Hearing protection		999
f) Positive air pressure helmet		999
g) Sandals (while working the fields)		999

READ: Changing our focus somewhat, We have talked to a number of people across the province and found a wide range of washing techniques for farm clothes that are used for pesticide application.

44) Are you the person who washes clothes that have been worn for mixing or spraying pesticides?

1. No____ 2. Yes ____

If no, go to Q46

If yes, continue 44a) Using the scale always, often, sometimes, never

4. Always ____ 3. Often ____ 2. Sometimes ____ 1. Never ____

a) How often do you pre-soak these clothes?	4	3	2	1
b) How often do you wash these clothes separately from other laundry?	4	3	2	1
c) How often do you wear rubber gloves when you handle these clothes?	4	3	2	1
d) After washing these clothes, how often do you run an empty cycle w/detergent afterwards?	4	3	2	1

45) Have you ever received any directions or information on how to wash clothing worn for spraying or mixing?

1. No____ 2. Yes ____

If yes, ask "From who?" 45a)_____

46) When someone is applying pesticides on your farm, how would you know this is occurring? **(Do not read list)**

1. ___I do the spraying, so I know
2. ___I usually don't know
3. ___A spouse or other family member tells you spraying is happening
4. ___Farm manager tells you
5. ___No one tells you, but you can usually see that people are spraying
6. ___There is a spray schedule that is followed, so you can tell by that
7. ___another way (please describe) _____

READ: Okay, we are now almost done, I have a couple of questions now about one specific agricultural chemical called Captan, which is also commonly referred to as Maestro.

47 a) Have you heard of Captan or Maestro?

1. No____ 2. Yes ____ 9. Don't know ____

If no or don't know, skip to Q51, if yes, continue to 47b, next page

47 b) **If yes, say** "Can you tell me what it is used for?" **and record answer**

_____

_____

48 a) Is Captan or Maestro used on your farm?

1. No____ 2. Yes ____ 9. Don't know ____

48 b) **If yes, say** "Can you estimate the number of times it's sprayed in a growing season?" **and record the number.** _____

49) If a field has been sprayed with Captan or Maestro, how long after spraying do you think a person should wait before re-enter the field?

1. ____ There is no time that you have to wait
2. ____12 hours
3. ____ 24 hours
4. ____ 48 hours
5. ____ 1 week
9. ____ don't know

50) In BC, pesticides are described as being Slightly Toxic, Moderately Toxic and Very Toxic, of these categories, which one do you think applies to Captan? **(Circle One Only)**

A	Very Toxic	C	Slightly Toxic
B	Moderately Toxic	D	I don't know

READ: Okay, that was the end of the survey questions. Thanks very much for your patience. I now just need to record a few details about you and your farm and then we are finished. Once again, let me remind you that all information gathered from this survey will be kept confidential.

51) In what year were you born? 19_____

52 a) In what country were you born?

1____ Canada 2. ____Other (please specify)_____

52 b) **If Other, say** "What year did you come to Canada?" **and record answer** _____

53) How would you describe your ethnic background **(Do not read list. Check all that apply.)**

	a) Aboriginal (Inuit, Métis, First Nations)		i) Indo-Canadian
	b) Arab/West Asian (e.g., Armenian, Egyptian, Iranian)		j) South East Asian
	c) Black (e.g., African, Haitian, Jamaican)		k) White (Caucasian)
	d) Chinese		l) Other (please specify)
	e) Filipino		
	f) Japanese		
	g) Korean		
	h) Latin American		

54) What is your current marital status?

1. ____ single (never married)
2. ____ married/common-law
3. ____ divorced
4. ____ widowed
5. ____ Other (please specify) _____

55) What language is most commonly spoken in your home? **(Do not read list. Check all that apply.)**

	Cantonese/Mandarin		Punjabi
	Dutch		Urdu
	English		Italian
	French		Portuguese
	German		Other (please list)
	Hindi		

56) What is the highest education level that you have achieved?

1. ____some schooling
2. ____completed high school
3. ____some post-secondary
4. ____college diploma
5. ____university degree

____other (please specify) _____

_____

57 a) Do you have a computer on your farm?

1. No____ 2. Yes ____

57 b) **If yes, say** "Is it hooked up to the Internet?"

1. No____ 2. Yes ____ 9. Don't know ____

57 c) **If yes, say** "Can you estimate that amount of time per week you would spend on-line? **And record time in hours** _____ Hours

58) How would you rate your current health status?

5. ____Excellent
4. ____Very Good
3. ____Good
2. ____Fair
1. ____Poor

59) How many children under the age of 18 live in your household?_____

60) Can you tell me approximately how far, in feet or meters, your farmhouse is situated from where your crops are planted?

a) _____ Feet or b) _____ Meters

61 a) Do you have a current BC Pesticide Applicators Certificate?

1. No____ 2. Yes ____

61b) **If no**, say "Does someone else on your farm have one?"

1. No____ 2. Yes ____ 9. Don't know ____

62 a) Could you please estimate the total gross farm receipts for your last fiscal or accounting year?

1. No____ 2. Yes ____

62b) If "yes" **record answer.** $_____

READ: Okay, we've made it to the last question!

63) What do you think is the most important issue facing BC farmers in the next 10 years?
(Do not read list. Check all that apply.)

	a) Pests/Infestations		h) Forest Fires
	b) Personal Farm Financial Issues/Debt		i) Integrated Pest Management Techniques
	c) Global Warming		j) Crop distribution issues (transportation)
	d) Genetically Modified Plants/Seeds or Herbicide Resistant Crops		k) Other (please specify)
	e) Urbanization of farm land/Agricultural Land Reserve Development		
	f) External Farm Finances: Competition from other countries, Pricing		
	g) Water Quality and contamination Issues (e.g. e.coli, mineralization, neutriphication, manure)		

And that brings us to the end of the survey. Thank you very much for your participation. The information you provided will help us create health and safety materials that reflect what BC farm families really need. If you want to know more about the study or receive a summary of our findings, you can visit our website: www.interchange.ubc.ca or call our toll-free line1-877-327-7867. Once again, thank you for participating in the UBC Farm Family Study.

Interviewers: Please write any additional comments on blank page

Appendix H

Table H-1 Variable Management for Data Analyses

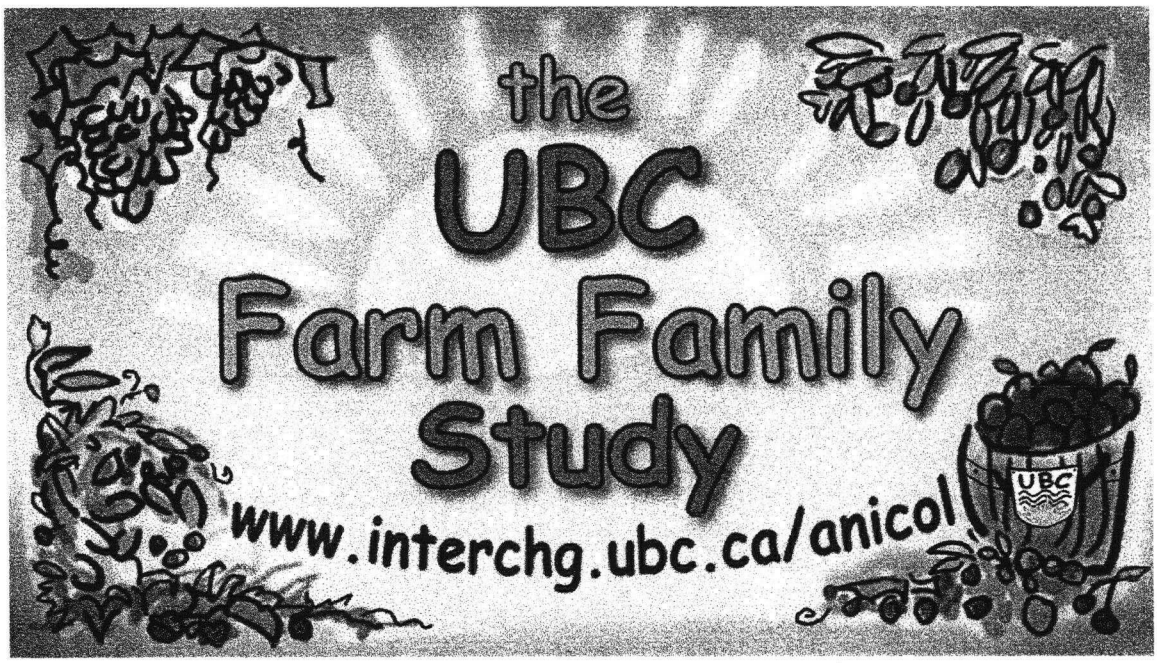
Conceptual Framework Components	Original Variable	Analysis Variable
Predisposing- Socio-Demographic		
Age	Numeric	a) Used as a continuous variable b) Three Categories developed from continuous data: Thirty five or less Thirty six to fifty four Fifty five or older c) Thirty five years or less- dichotomized variable for age versus all other age groups
Sex	Dichotomous	*Same*
Marital Status	Multiple choice	Dichotomized (Ever married versus single)
Health Status	Scale	Dichotomized (Poor to Good versus Very Good to Excellent)
Ethnicity	Open ended	Dichotomized into European descent or Indo-Canadian (describing people of Punjabi origin).
Immigration Year	Numeric	Used as a continuous variable
Country of origin	Open ended	Categories into three main groups Canada India Other
Farm Location	Open ended	Four categories created Fraser Valley Vancouver Islands and Gulf Islands Okanagan Other regions in BC
Education	Open ended	a) Four Categories Less than high school Completed high school 3) Post secondary (college or technical) University (including graduate, MD, Phd)
Predisposing-Knowledge		
Knowledge of Captan	Synthesis of two questions	Dichotomous (correct versus incorrect). Correct response included being able to identify captan as a fungicide and identifying the reentry period as 24 hours or more.
Personal Exposure Routes	Open ended	Three main responses used (dermal, oral and inhalation) and a summary, dichotomous variable where all three route had to be identified to be considered correct for the dichotomous variable
Household Exposure Routes	Open ended	Three main responses used (on clothes, drift and on hands) and a summary variable was created from these three, where two of the three had to be identified to be correct for the dichotomous variable.
	Open Ended	Dichotomized (yes if identified a health effect caused by pesticide exposure, no if they did not). New dichotomous variable created for those who were aware that pesticides caused cancer versus those who were not

Table H1 con't		
Predisposing- Attitudes and Beliefs		
Attitudes		
Other Farm hazards Occupational stress Sun exposure Injuries	Scale	Occupational stress and sun exposure variables dichotomized (not to somewhat concerned versus very to extremely concern). A summary variable was created for farm injuries, using the dichotomized variables for concern regarding tractor rollovers, lifting injuries and slips, trips and falls.
Farm Safety	Multiple choice	Each safety level rating dichotomized for linear analysis
Vulnerability		
Personal- Pesticides will impact my future health	Scale	Dichotomous (not, slightly or somewhat likely versus very or extremely likely)
Household- likelihood that pesticide can enter farm home	Scale	Dichotomous (not, slightly or somewhat likely versus very or extremely likely)
Beliefs		
Government pesticide regulations	Multiple Choice	Dichotomized variable (response 'not stricti enough' versus all other beliefs about government regulations)
Trusted Sources Reported for providing pesticide information	Open Ended	Responses categorized into the following dichotomous variables: a) government b) packers and processors c) farm community d) growers associations e) pesticide vendors Government included all three levels of government, Packers and processors included packing houses, fruit processors and business based co-ops. Other farmers and neighbors made up the farm community category. Growers associations were groups that were based on commodities, such as the BC Tree Fruit Growers association. Pesticide vendors were those people identified as being pesticide sales people. As respondents could include more than one trusted source, totals add up to greater than 100%
Reinforcing Variable		
Adverse Health Events Experienced a negative health effect from pesticide exposure a) self b) friend or relative	Both dichotomous	*No change*
Peer Influence Frequency that other applicators wear protective equipment	Frequency	Dichotomized (where the proportion of other farmers who wear the equipment was 80% or higher when applying pesticides versus less than 80%)
Farm Organizations	Dichotomous	*No change*

Table H-1 con't		
Family Influence		
Generations farming	Synthesis of 3 questions	3 categories First generation- parents weren't farmers, but grandparents could have been farmers Second generation- parents were farmers, grandparents weren't Third generation- parents and grandparents were farmers
Growing up on a farm	Synthesis of 2 questions	3 categories Grew up and still live on same farm Grew up on a farm, but live on a different farm Did not grow up on a farm
Children <18 years on farm	Numeric	Dichotomized (yes children under 18 on farm, versus no children under 18 on the farm.)
Enabling Variables		
Control		
Control over pesticide application	Synthesis of 4 questions, Multiple Choice	Synthesis of 4 variables, which were first dichotomized (not, slightly or somewhat in control versus very or extremely in control).All 4 questions has to be answered as "very or extremely in control' for the control to be a 'yes'.
Decision Making	Multiple Choice	Dichotomized (primary decision maker versus all other types of decision making)
Training		
Have taken a pesticide related course in past 5 yrs.	Dichotomous	*No change*
Hold a current pesticide applicators certificate	Dichotomous	*No change*
Have received laundry directions	Dichotomous	*No change*
Years farming experience	Numeric	Dichotomized (less than 20 years experience, 20 years or more experience)
Changes to pesticides	Open ended	Responses grouped into thematic categories, not included in univariate or multivariable analyses due to the qualitative nature of the data
Barriers	Scale	Dichotomized (strong disagree, disagree versus agree, strongly agree)
Farm Structure		
Crops	Open ended	Crops grouped into 4 categories 1)Mixed commodity farms, 2)Tree fruits, 3) Grapes, 4)Berries
Size of farm	Numeric	a) Used as a continuous variable to estimate median farm size b) Small farms- dichotomized variable for farms that were five acres or less versus all other farms.
Income	Numeric	Dichotomized (less than 25,000 dollars versus 25,000 dollars or more reported annual income). As less than half the population agreed to answer this question, the income variable was not use for multivariable analyses
Employees	Numeric and dichotomous	Used as a continuous variable to estimate median, range Dichotomous variable created: 'strictly family operated farm' to describe farms that did not hire other employee to operate the farm.
Ownership	Multiple Choice	Dichotomized (Immediate farm family ownership versus another form of farm ownership)
Farm Operator	Scale	Dichotomized (Primary operator versus other forms)
Farm Tasks	Scale, 3 questions (spray, purchase and buy pesticides)	Dichotomized (Never versus Sometime or Always)

Appendix I

Study Incentive – Fridge Magnet



Appendix K

Introductory Script for UBC Farm Family Telephone Survey

Script for men, conducted by a male interviewer:

Hello, my name is .... I'm calling from the University of British Columbia. We are conducting a survey of farmers. Before I proceed, could you please confirm that this a farm residence? Yes / No

If No, thank them and hang-up, if yes, proceed

We have a separate survey for men and women and we are calling today with the survey for men.

IF male voice: Am I speaking with an adult male (*18+ years*) who is (or has been) involved in the day-to-day operations of the farm? Yes/ No
IF female voice: May I please speak with an adult male (*18+ years*) who is (or has been) involved in the day-to-day operations of the farm?

If no man in household: record and drop from call-back list,
If you get other household member on line and man is not available,: ask politely for a convenient time to re-schedule a call back. Record call-back time.

IF Male Participant is on-line: You have been randomly selected to participate in our survey. Last week, you should have received a letter from UBC describing this survey. We are interested in knowing what berry and fruit farmers think about farm chemicals. Is this a convenient time for me to talk with you about the survey? Yes/No

If yes, proceed
If no, can I schedule a time to call you back to discuss the study?

The survey is being conducted through UBC's School of Occupational and Environmental Hygiene by Dr. Susan Kennedy and Anne-Marie Nicol. The purpose of the research is to gather information about what farmers think so we can develop more useful materials for farmers about farm chemicals. The results will be used in future research about farm safety. The survey asks questions about your opinions on the uses, benefits and effects of farm chemicals. The survey also includes questions about the size of your farm operation, the crops you grow, your use of chemicals, and some basic demographic information about yourself.

Your name, address and phone number will be kept confidential and, in fact, your name does not appear on my survey form. Your participation is voluntary and if there are any questions you do not want to answer, we can skip over them. You also can tell me to stop the interview at any time. The survey takes between 20 to 40 minutes to complete. Do you have any questions at this point?

If yes: Address questions (refer to scripted replies)

Are you willing to proceed with completing the survey? (Note: you MUST say this)

If yes, proceed with the survey:
Thank you. We appreciate your willingness to help us.

If no, record reason for refusal to proceed, if provided by study participant

If no due to time constraints, then ask: Would there be more a convenient time for me to call you about the survey?
If yes, record call-back time

Script for women, conducted by a female interviewer:

Hello, my name is .... I'm calling from the University of British Columbia. We are conducting a survey of farmers and farm family members. Before I proceed, could you please confirm that this a farm residence? Yes / No

If No, thank them and hang-up, if yes, proceed

We have a separate survey for men and women and we are calling today with the survey for women.

IF female voice: Am I speaking with the adult female (*18+ years*) who is actively involved with the farm or the farm home? Yes/ No
IF male voice: May I please speak with the adult female (*18+ years*) who is actively involved with the farm or the farm home?

IF no female in household: record and drop from call-back list,
IF you get other household member on line and female is not available,: ask politely for a convenient time to re-schedule a call back. Record call-back time.

IF female Participant is on-line: You have been randomly selected to participate in our survey. Last week, you should have received a letter from UBC describing this survey. We are interested in knowing what berry and fruit farmers and family members think about farm chemicals. Is this a convenient time for me to talk with you about the survey? Yes/No

IF yes, proceed
IF no, can I schedule a time to call you back to discuss the study?

The survey is being conducted through UBC's School of Occupational and Environmental Hygiene by Dr. Susan Kennedy and Anne-Marie Nicol. The purpose of the research is to gather information about what farm women think so we can develop

more useful materials for families. The results will be used in future research about farm safety. The survey asks for your opinions on the role of farm chemicals in a families' life. The survey also includes questions about your farm's operation, the crops you grow, and some basic demographic information about yourself.

Your name, address and phone number will be kept confidential and, in fact, your name does not appear on my survey form. Your participation is voluntary and if there are any questions you do not want to answer, we can skip over them. You also can tell me to stop the interview at any time. The survey takes between 20 to 40 minutes to complete. Do you have any questions at this point?

If yes: Address questions (refer to scripted replies)

Are you willing to proceed with completing the survey? (Note: you MUST say this)

IF yes, proceed with the survey: Thank you. We appreciate your willingness to help us.

IF no, record reason for refusal to proceed, if provided by study participant

IF no due to time constraints, then ask: Would there be more a convenient time for me to call you about the survey?
IF yes, record call-back time

Appendix L

UBC Farm Family Survey

Scripted Replies

How was I selected?
Your phone number was randomly chosen from a list of households in areas where berry and tree fruits are grown in BC.

How did my phone number get on your list?
Addresses on farm lists were used to develop a list of phone numbers through the public telephone directory. We randomly selected your number from that list. Combining information from several existing lists (e.g., farm commodity group mailing lists) developed the list of farms

How long will this take?
The survey will take between 20 and 40 minutes, depending on the kinds of household or farming activities you take part in.

How will you guarantee my anonymity?
Neither your name nor your telephone number will appear anywhere on your survey responses. When the results of the survey are reported only grouped information will be included so that it is impossible to trace an individual response.

How will you guarantee my confidentiality?
After the survey is completed, the information is entered into a computer file without names, address or phone numbers. These files are stored in a locked filing cabinet in a locked office – only the research team members have access to these files.

Who can I talk to verify the authenticity of this survey?
If you have any questions about the authenticity of this survey, please contact the Principal Investigator, Dr. Susan Kennedy through the toll free line for this study (1-877-327-7867) or visit our website www.interchange.ubc.ca/anicol.

Can I talk to someone who is not part of study?
You can call Dr. Murray Hodgson, Director of the School of Occupational and Environmental at 604-822-9595.

Who can I talk to if I would like more information about farm chemicals?

The Ministry of Agriculture (1-888-221-7141 Plant Industry Branch) and the Farm and Ranch Health and Safety Association (FARSHA) (604-532-1789) provide information about farm chemicals. FARSHA provides information in both English and Punjabi.

Why are you seeking farm women's opinions?
Because many farm studies only focus on what men think. This study will give us the opportunity to hear what women think as well.

Why was a letter sent address to the woman/man in my house?
The initial contact letters we sent out were randomly assigned to receive either a letter addressed to farm men or a letter addressed to farm women. We used this technique to encourage farm family members as well as farmers to participate in our research.

What will this information be used for?
The results of this study will help us to develop farm risk communication materials that are appropriate for BC's farming community. Through this work, we will learn what BC farm families want to know about farm chemicals. We will also learn how the BC farming community would like to receive information and the languages that are most appropriate for communication.

Can I get a copy of the study results?
A summary of the research will be available. Please call our toll free number and leave your name and address to have the results sent to you when they are completed. (Note: If the person wants to give you their name and address here, please decline to ensure that their replies are anonymous.)

How many people will be in this study?
We are aiming to complete 700 surveys.

What is your (the interviewers) relationship to this research?
I am an interviewer hired by the School of Occupational and Environmental Hygiene to conduct this survey.

Who can I talk to about Research at UBC?
If you have questions about research at UBC, please contact Dr. Angus Livingstone at the Office of Research Services, 604-822-8598

Appendix M

Table A1 Attitudes Regarding Farm Hazards, Conventional Farms Only

Farm Hazards (n=293)	Not to Somewhat Concerned	Very to Extremely Concerned
Farm Injuries	149 (51%)	144 (49%)
Occupational Stress	153 (52%)	139 (48%)
Sun Exposure	181 (62%)	111 (38%)
Pesticide Drift from Other Farms	234 (80%)	58 (20%)
The pesticides sprayed on your farm	244 (84%)	48 (16%)
Injuries from Animals	282 (9%)	10 (3%)

Table A2 Health Effects from Pesticide Exposure, Own and Others' Health

Health Problem	Own Health (n=64)†	%	Others' Health (n=111) †	%
Breathing Problems	12	19%	24	22%
Allergies	12	19%	12	11%
Headache	7	11%	3	3%
Cancer	6	9%	18	15%
Rash	6	9%	10	9%
Nausea	5	8%	7	6%
Dizziness	4	6%	3	3%
Pets become sick	-	-	10	9%
Death	-	-	9	7%

† Respondents could list more than one health effect each or for others

Table A3 Perceived Control over Pesticide Application (Applicators Only)

Perceived control over pesticide exposure (n=119)	Very to Extremely high control	Slightly to Somewhat in Control
Amount of pesticide applied	106 (89%)	13 (11%)
Application schedule	101 (85%)	18 (15%)
Type of pesticide applied	98 (82%)	21 (18%)
Ability to protect yourself from pesticide exposure	111 (93%)	8 (7%)

Table A4 Desired changes to Pesticide Formulations[a]

Desired Changes to Pesticides	N	%
Ban outright or not have to use them	72	20%
Decrease toxicity/improve safety Improve Safety (n=14) Decrease Toxicity (n=22)	38	10%

More long term testing (n=2)		
Changes to chemical formulations Make them more target specific (n=5) Decrease/Improve the smell (n=4) Increase the degradability time, lessen re-entry time (n=2) Improve disposal system (n=2) Increase potency to reduce the amount of work or amount applied (n=2) Bring back banned chemicals that worked (n=1) Change formulations to prevent pests from becoming immune (n=1)	17	5%
Changes to Packaging Formulations should be pre-measured or should fit the typical size of a farm (n=2) Label should be in more languages (n=2) Label should list all ingredients (n=2) Should come in leak proof containers (n=1) Label should have larger print (n=1) Label should be more specific about danger (n=1)	9	2%
Changes to Practices More careful application in orchards to reduce drift (n=2) People should wear more PPE (n=2) Use Buffer Zones (n=1) Caps on tractors should be mandatory (n=1) Pesticides need to be more user friendly (n=1) Stop the Sterile Insect Release Program (n=1) Wants improved PPE (n=1)	10	3%
Make them Cheaper	11	3%
Regulatory Issues Spraying needs to be more regulated (n=6) Harmonization with US or International Pesticide Regulations (n=4) The Government should have incentives to help farmers go organic or use IPM (n=2) Licensing process for pesticides should be easier or faster (n=2) Regulation are made by people who don't have proper knowledge of farming, change this (n=1) Restrict domestic use of pesticides (n=1) Government should provide the rationale for the current regulations (n=1) Stop government from supporting pesticide and bio-tech companies and stick to supporting farmers (n=1) There should be taxes on all food grown outside of BC (n=1)	19	5%
Changes to Education or Attitudes The public needs to be educated to change their perception of what fruit really looks like (n=6) Public needs to change their negative opinion about pesticide application (n=4) There should be more safety education (n=1) Want to know more about organics (n=1) Older farmers need to be educated to change the way their spray their fields (n=1) Chemical companies shouldn't push farmers to use their products (n=1)	14	4%

[a] Respondents could provide more than one answer to this question