Measuring Integrated Pest Management Adoption in British Columbia 1998 Practices

A component of the State of Resources Survey

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Executive Summary

Measuring Integrated Pest Management (IPM) Adoption in British Columbia, 1998 Practices summarizes pest management information collected from the British Columbia Farm Resource Management Survey on Crops conducted by Statistics Canada in February 1999. This report is a component of *The State of Resources Report* (R. Bertrand, BCMAFF) which contains results of manure/fertilizer handling practices, and water and soil management practices.

Information is intended to provide baseline data to answer the question "Are farmers using environmentally sound practices?" Feedback will guide agriculture policy, extension and research by reflecting the way resources are being managed on BC farms, and identifying high priority needs.

This report focuses on the pest management practices of crops. Crop pests include insects, mites, diseases, weeds, slugs and animals. Pests may occur naturally or be introduced from other areas. They cause economic losses, affect food safety, reduce storage capability of food, and reduce natural biodiversity (i.e. through noxious weed invasion).

The improper choice of pest management strategies may result in soil erosion, water or air pollution and negative non-target organism impacts. Benefits of Integrated Pest Management (IPM) to environmental protection include:

- use of production practices that prevent development of pest problems
- use of practices to determine the need for and correct timing of pesticide applications
- reduced reliance on pesticides by promoting the use of non-chemical control practices (biological, cultural, behavioral, and mechanical) alone or in combination with pesticides
- minimized risk of pesticide resistance development that can lead to increased pesticide use
- use of least-toxic (reduced-risk), more target-specific pesticides.

Adoption of sound practices is a proxy for physical and chemical measurements of soil and water quality. With unlimited resources it would be possible to directly measure the impact of pest management on the environment through physical and chemical measurements of soil and water quality. However a different approach, i.e. strategic indicators, is needed when resources are limited.

The strategic indicators for IPM adoption in this report are based upon the IPM System Ratio approach developed by Consumers Union's Charles Benbrook in 1996. Given project budget considerations and the lack of comprehensive pesticide information for BC, the IPM System Ratio approach was adapted.

Farms located in BC, with reported sales over $25,000 in 1995, that were principally crop operations and that produced the selected crops were chosen for the survey. Selected crops included grains/oilseeds, tree fruit and grapes, berries, field vegetables and field ornamentals. Farms were contacted within the main production areas for the crop type. Resulting sample sizes were too small for grapes and field ornamentals so their results are not reported. The overall response rate was 82%.

Respondents were asked about pesticide application, pest monitoring activities, and pest prevention/reduction strategies. Producers were not actually asked if they used IPM or monitoring to avoid “leading” them. Rather, we developed indirect questions that asked them what they actually did. (See Defining the IPM Questions on page 6). Responses were analyzed and categorized as “no IPM”, “low IPM”, “medium IPM” or “high IPM” levels based on whether they are preventive or reactive practices, and by their compatibility with biodiversity and the environment. Pesticide application practices were assessed with specific, non-leading questions.

This was the first attempt in Canada to measure IPM adoption. Much has been learned during this process, and there is room for improving the process of measuring IPM adoption. Further discussion and sharing of ideas between government agencies, non-government organizations, grower groups and other interested parties will improve the process.

The following table summarizes the percentage of 1998 crop area producing grains/ oilseeds, berries, tree fruit and field vegetables where integrated pest management (IPM) practices were used.

Percent of production area under all levels of IPM, and percent of production area under medium or high IPM only.

Crop	**% production area using IPM**	**% production area using medium or high IPM**	**Total ha represented**
Berry	77	54	4974
Grain/Oilseeds	95	75	65618
Tree fruit	85	62	5975
Field Vegetable	85	78	5258

IPM was used on a significant portion of farmland producing berries, grains/oilseeds, tree fruit and field vegetables. Ultimately, the objective is to encourage the use of high level IPM practices in the production of all crops. For the interim, it was useful to measure the percent of area using medium to high level IPM practices as an indication of progress.

More than 95% of farms used proper procedures, or best management practices, that prevented contamination of their water source when adding water to spray equipment. These included using a backflow preventer, nurse tank, separate water source, air gap or a combination of these.

Other Highlights:

Grower responses suggest a willingness to adopt IPM practices. Behaviors indicate that a critical segment of the farming population was willing to try new techniques such as introducing beneficial predator/parasites of insect pests, using pheromones and encouraging natural predators/parasites of insect pests. These practices are either in early adoption stages or not widely available yet for most crop sectors. The growing interest in area-wide pest management programs is another indication of this attitude.

On average, 38% of the responding farmers had some post-secondary education with high IPM adopters having even higher education levels.

There is room for improved IPM adoption in berries where one-half of the farmers were in the “low” to “no IPM” categories. Thirty-eight percent of tree fruit responses were also in the “low” to “no IPM” categories. However, the BC Fruit Growers Association started a program in 1999 called "Growing with Care" that emphasizes IPM practices in production and marketing; this will have an influence on IPM adoption.

There was a trend for berry farms using high level IPM to generate most of their income from the farm, and report total gross farm income over $50,000 more often than the lower IPM adopters. Tree fruit producers who did not use IPM were less likely to report total gross farm incomes over $50,000. Grain/oilseed “low level” IPM adopters seemed to have lower income levels than “medium level” adopters.

The following recommendations will guide BCMAFF agriculture policy and extension on IPM. The recommendations are based on the SWOT (strengths, weaknesses, opportunities and threats) Analysis which is discussed in the *Conclusions*.

Recommendations:

1. Encourage industry to drive the process and direction of IPM extension and research. Focus can be developed from the BC Crop Profile Project and “Gaps Analysis”.
2. Recognize that the development and adoption of IPM practices requires funding and support beyond that available from producer groups.
3. Encourage engagement and cooperation of Agriculture and Agri-food Canada research staff, teaching institutions, consultants and extension staff in the development and adoption of pest management strategies, including economic thresholds, to control new and existing pests.
4. Use demonstration activities or study groups to promote IPM activities.
5. Encourage pesticide applicators to calibrate between different pesticide applications throughout the year instead of only at the beginning of the crop season, and replace nozzles all at once to ensure even delivery of the pesticide.
6. Facilitate transitional measures to encourage greater economic stability of the private sector that delivers IPM monitoring and research for growers.
7. Encourage adequate research/demonstration of new IPM practices to assess expected costs and savings of IPM practices.
8. Participate in environmental farm planning, on-farm food safety programs and strategic extension activities on IPM initiatives to promote a farming population of high IPM adopters.

9. Explore provisions within safety net programs to cover unexpected losses due to the failure of a new practice introduced by early adopters.
10. Encourage the Canadian Food Inspection to Agency to maintain their vigilance against new quarantine pests.
11. Facilitate rapid access to funding for research and survey activities in response to new pests.
12. Encourage the Pest Management Regulatory Agency to register reduced-risk products as expeditiously as possible.
13. Educate and invite registrants to bring their products to the Canadian market.

Acknowledgements

The following contributed to the development of this information, and their input is greatly appreciated:

Ron Bertrand, Rita Green, Paul Guiton, Heather Niven, Marney James, Ken Nickel, and the entire BCMAFF Plant Health Unit with special recognition of Hugh Philip, Madeline Waring and Tracy Hueppelsheuser.

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Introduction

The British Columbia (BC) Farm Resource Management Survey on Crops conducted in February 1999 collected information on farm management practices related to manure/fertilizer handling, pest management, pesticide use, and water and soil management. The crop survey focused on practices by berry, grain/oilseed, tree fruit/grape, field ornamental and field vegetable producers in BC. This report summarizes the degree to which farmers are using ‘environmentally sound’ pest (and pesticide) management practices on crops.

A related Farm Resource Management Survey on Livestock was conducted in 1998. This IPM report is a component of *The State of Resources Report* (R. Bertrand, BCMAFF) which contains results of manure/fertilizer handling practices, and water and soil management practices from both crop and livestock surveys.

Crop pests include insects, mites, diseases, weeds, slugs and animals. Pests may occur naturally or be introduced from other areas. They cause economic losses, affect food safety, reduce storage capability of food, and reduce natural biodiversity (i.e. through noxious weed invasion).
Pest management practices in this survey were assessed in the context of Integrated Pest Management (IPM). IPM is a systemic decision-making process that supports a balanced approach to managing crop and livestock production systems for the effective, economical and environmentally-sound suppression of pests. It is becoming the standard for crop production in many sectors. See Appendix A for a full definition.

Improper choice of pest management strategies may result in soil erosion, water or air pollution and negative non-target organism impacts. Benefits of Integrated Pest Management (IPM) to environmental protection include:

- use of production practices that prevent development of pest problems
- use of practices to determine the need for and correct timing of pesticide applications
- reduced reliance on pesticides by promoting the use of non-chemical control practices (biological, cultural, behavioral, and mechanical) alone or in combination with pesticides
- minimized risk of pesticide resistance development that can lead to increased pesticide use
- use of least-toxic (reduced-risk), more target-specific pesticides.

With unlimited resources, it would be possible to directly measure the impact of pest management on the environment through physical and chemical measurements of soil and water quality, and measurement of effects on biodiversity. However, with limited resources a different approach is needed such as strategic indicators. Strategic indicators must be valid, recognized and economically feasible to measure. The chosen approach for the survey has been to measure the degree to which farmers are using ‘environmentally sound’ management practices.

The approach is based on answering this question: “Are farmers using environmentally sound practices?” Adoption of sound practices is a proxy for physical and chemical measurements of soil and water quality.

This is the first survey in BC for crop pest management information and it will serve as a source of baseline data. It is the intent to repeat the survey in 5 years to answer the questions “Are farmers adopting environmentally sound practices?” and “How long is the process taking?” Feedback will guide agriculture policy, extension and research by reflecting the way resources are being managed on BC farms, and identifying high priority needs.

Survey Design

Seven mini-focus groups consisting of eight representative growers and a facilitator from GroundWorks Inc. evaluated survey design and survey questions. Feedback was province-wide, with sessions in Dawson Creek, Kelowna, Kamloops and Abbotsford. The focus groups tested questions, confirmed language use, determined potential answers to multiple choice questions and determined issues.

Statistics Canada developed the survey questions further in cooperation with BCMAFF. The list of questions is in Appendix B. Statistics Canada conducted the survey of growers who were randomly selected from a list of all farms in Canada. The list was compiled using information collected during the 1996 Census of Agriculture. Only farms located in BC, with reported sales over $25,000 in 1995, that were principally crop operations, and that produced the selected crops were chosen. The 1996 Census frame was divided into three strata, one for each farm group in the three geographical areas. Berries, field vegetables and nursery crops were in the Fraser Valley stratum. The number of farms to be sampled was calculated to achieve meaningful results within an expected response rate 85%. Sampled farm responses were 'weighted' to represent the total number of farms in each of the strata.

Grains/oilseeds includes all grains, oilseeds (canola, flaxseed, sunflower) and dried field legumes (dried peas, beans lentils). Berries includes all berry farms, i.e. blackberry, blueberry, currant, raspberry and strawberry. Vegetables consists of all vegetable crops and includes potatoes but does not include greenhouse vegetables. The total usable sample (excluding grapes and field ornamentals) was 375. This was distributed across the geographic and commodity strata described above.

Selected farmers were sent an introductory letter in the week of February 15, 1999 explaining the survey and informing them that the phone interview would take approximately 10 minutes to complete. Growers were told that all information collected would be kept strictly confidential and only used to produce statistical tables. They were then interviewed by phone starting February 24, and ending March 24, 1999. Every attempt was made to interview the actual farm operator, although if the respondent was an adult knowledgeable about farm operations, their information was permitted. At least 80% of the questions had to be answered for a survey to be complete.

For the pest management component, respondents were asked about pesticide application, pest monitoring activities, and pest prevention/reduction strategies. Producers were not actually asked if they used IPM or monitoring to avoid "leading" them. Rather, we developed indirect questions that asked them what they actually did. (See Defining the IPM Questions on page 6). For the purpose of the survey, insects, diseases and weeds were considered to be pests.

Respondents were also asked about pesticide use during the previous year, 1998. For the survey, "pesticide" included "insecticides", "herbicides" and "fungicides". If they applied any pesticides, they were then asked if someone on the farm operated their own sprayer, and if so, when they calibrated it, how they filled application equipment and how often they replaced nozzles. They were also asked to identify the material used to make their nozzle tips to assess their familiarity with their equipment.

At the end of the survey, respondents were asked if Statistics Canada could share their anonymous responses with BCMAFF as part of a joint collection agreement for this information. The overall response rate of 82% included those willing to share their responses and who completed over 80% of the questions.

Measuring IPM – What have others done?

Due to the multi-faceted and inter-related nature of IPM, attempts to measure it have been met with challenges and there is no universally recognized system. Therefore, other measuring systems were studied and evaluated to determine how to measure IPM adoption in BC. This survey is the first attempt in Canada to measure IPM adoption.

The United States has been the most aggressive in attempting to measure IPM. Three systems have been examined as a result of the 1993 Clinton Administration pledge to implement IPM on 75% of U.S. crop acreage by the year 2000.

1. The United States Department of Agriculture (USDA) Economic Research Service began the first attempt in 1994 to measure IPM adoption by using existing survey information that had been collected for other purposes. They tabulated the number of IPM practices used, and did not attribute any weighting or other evaluations to the practices. Their system essentially assessed whether pesticides were used in a cost-effective manner.

2. Consumers Union's Charles Benbrook developed the **IPM System Ratio**[1] in 1996. It describes the IPM Continuum from "No IPM" to "High IPM" and calculates these labels by counting preventive practice points (PPP) divided by dose-adjusted acre treatments (DAT). The preventive practice points are proportional to the value of the practice in reducing pest pressure or damage. Dose-adjusted acre treatments are the number of pesticide treatments applied per acre. They are based on common application rates and measure reliance on pesticides. Comprehensive data on specific pesticide use is required for dose-adjusted acre treatments. The United States collects this information. Detailed pesticide information (dose-adjusted acre treatments) is not available for BC. There is no crop specific information on volume, potential for the development of resistance, environmental risk, or toxicity of pesticides applied.

[1] Benbrook, C., Groth, E., Halloran, J., Hansen, M., and S. Marquardt. 1996. Pest Management at the Crossroads, Consumers Union, Yonkers, New York.

Benbrook et al.[2] has suggested that there are four levels of IPM adoption—none, low, medium and high (biointensive). Table 1 lists the pest management practices used at each level:

Table 1. Benbrook's four levels of IPM adoption in the IPM continuum.

No IPM
- Use calendar or fixed spray schedules to determine when to apply a pesticide. Sanitation is expected. Spray equipment is calibrated.

Low IPM (Chemical Intensive)
- short crop rotations, resistant varieties, cultivation, monitoring populations of beneficial organisms,
- timing pesticide applications to minimize impacts on beneficial and non-target organisms,
- choosing pest control measures which avoid or delay build-up of pest resistance to pesticides.
- This is considered to be a chemical-intensive IPM level.

Medium IPM
- Removing pest habitats, using soil amendments, cover crops, longer crop rotations, increased use of resistant plant varieties.
- Efforts are made to enhance populations of beneficial organisms (including reducing use of persistent and broad-spectrum pesticides.
- Crop development is monitored, disease forecasting models are used.
- Economic thresholds for applying pesticides are modified by biological considerations such as timing to facilitate the build up of indigenous and introduced beneficial organisms.

High IPM (Biointensive)
- Preventive measures include scouting to time the release of introduced beneficial organisms,
- Building diverse populations of beneficial organisms, enhancing plant defenses and vigor.
- Microbial biological control is used for root pathogens.
- Broad spectrum, ecologically disruptive pesticides are not used at all.
- Economic thresholds are developed for applications of biopesticides.
- Farming systems are not routinely reliant on pesticides.
- Multiple preventive practices are used.

[2] Benbrook, C., Groth, E., Halloran, J., Hansen, M., and S. Marquardt. 1996. Pest Management at the Crossroads, Consumers Union, Yonkers, New York.

3. The **PAMS**[3] measurement system began at the 1998 Integrated Pest Management Measurement Systems Workshop in Illinois. It was based on the idea that a high degree of diversity in control tactics gives the most resilient program. PAMS stands for prevention, avoidance, monitoring and suppression tactics. Each is weighted and combined with a diversity index. The diversity index is complicated, and includes a measurement of pesticides used, and their toxicity levels. It is still under development.

The following website has more information on the above systems, http://www.pmac.net/measind.htm.

None of these systems could be directly used in the BC survey. The first one was not well designed and the PAMS system was not developed. Benbrook's IPM System Ratio was considered the most appropriate. However, given project budget considerations and the lack of comprehensive pesticide information in BC, it had to be adapted.

Preventive practice points were used as the main component of this survey design and analysis of information for IPM adoption. Recognizing that the design does not include a measurement of compatibility between treatments, it was still the most feasible and practical method of assessing the level of IPM adoption.

[3] Benbrook, Charles M. Performance Criteria for Measuring IPM Results. Remarks delivered at the Meeting: IPM in Oregon: Achievements and Future Directions, April 6-7, 1999.

Defining the IPM Questions

It was not possible to ask producers about each of the many possible components of an IPM program as described by Benbrook et al (Table 1). Therefore, indicator questions determined pest/crop monitoring practices and the level of IPM used.

Monitoring crops and pests

Respondents were asked questions about how they decide WHEN to apply insecticides/fungicides or herbicides. They were read the following options:

1. Based on calendar dates/fixed schedule
2. Done at the first sign of pest/disease or weeds
3. Done after evidence of crop damage/crop growth stage
4. Done when pest/weed levels are above the economic injury level
5. Other _________.

Responses were classified as “no IPM” when growers said they decided to apply pesticides based on calendar dates/fixed schedules. We considered crops to be “monitored”, i.e. some IPM used, when the response was 2, 3, or 4. Answers for question 5 that included decisions based on a consultant’s advice were also classified as “monitored/uses IPM”.

Respondents that used calendar/fixed schedules also generally reported using few IPM practices. The only exception to the above was with the tree fruit growers. Some growers responded that they used calendar/fixed schedules yet were using several innovative IPM practices. This incongruity was likely due to confusion with packing house cover spray recommendations for codling moth by packing house staff. Recommendations are based on predictive modeling and weather monitoring programs (Hugh Philip, BCMAFF). As a result, those tree fruit growers in this category who also reported using two or more of the innovative IPM practices were considered to be using IPM. The rest were considered to use no IPM.

IPM Levels of Adoption

Thirteen practices were selected as indicators of the tendency for the farmer to use IPM practices. The questions were broad enough to be asked of the different commodity groups to be surveyed, although all questions did not always apply to every commodity. Growers were asked "Have you ever tried these practices, and if so, are you still using it"?

1. Cultivating or using rotary hoe for weeds
2. Using mulches for weed control
3. Spot spraying/spraying field edges
4. Using pheromones for insect mating disruption (not the Sterile Insect Release program for apple codling moth)
5. Rotating pesticide classes to avoid resistant pests
6. Introducing predators/parasites of insect pests
7. Encouraging natural predators/parasites of insect pests
8. Planting disease or insect resistant varieties
9. Treating seeds/seedlings (chemical, heat, microbial) to protect crop in early stages
10. Rotating crops specifically to prevent pest problems
11. Adjusting planting or harvesting dates to avoid pests
12. Adjusting timing of irrigation/watering to prevent disease
13. Using trap/companion crops to protect main crop

Indicator pest management practices were given different weights based on their importance in reducing target pest pressures, minimizing pest damage and minimizing non-target effects relative to all identified practices. Points are summarized in Table 2.

Practices 1, 3, 5, and 9 are considered to be at the low end of the IPM continuum. Generally chemical-intensive, the practices at least encourage wise pesticide use to minimize their impact on non-target organisms. Cultivation may avoid herbicide use yet can adversely affect soil erosion and quality. These practices are worth one point. Practices 2, 7, 8, 10 and 11 are at a medium level and worth 2 points each. They involve taking some steps to enhance beneficial organisms. High level practices at the biointensive end of the continuum are questions 4, 6, 12 and 13. These maximize integration of the production system and make strides to build populations of beneficial organisms and strong crops; they are worth 3 points each.

The value of each reported practice was totaled for each operation. The section “Ensuring Question Validity” describes how values relate to different IPM levels.

Table 2. Classification and point value for indicator pest management practices used in the survey.

No IPM (0 points)

Use of calendar spray schedules and/or no practices associated with IPM.

Low IPM (1 point)

Monitoring plus:
Cultivating or using rotary hoe for weeds [question 1],
Treating seeds/seedlings (chemical, heat, microbial) to protect crop in early stages [Q9],
Rotating pesticide classes to avoid resistant pests [Q5]
Spot spraying/spraying field edges [Q3]

Medium IPM (2 points)

Monitoring plus:
Using mulches for weed control [Q2]
Rotating crops specifically to prevent pest problems [Q10]
Planting disease or insect resistant varieties [Q8]
Encouraging natural predators/parasites of insect pests [Q7]
Adjusting planting or harvesting dates to avoid pests [Q11]

High IPM (3 points)

Monitoring plus:
Introducing predators/parasites of insect pests [Q6]
Using pheromones for insect mating disruption (not the Sterile Insect Release program) [Q4]
Adjusting timing of irrigation/watering to prevent disease [Q12]
Using trap/companion crops to protect main crop [Q13]

Analyzing the Data

Determining Crop Groupings for Analysis

The most useful analysis of pest management practices is by crop groupings that have similar pests, production areas and production systems. This was balanced by analyzing crop groups at the largest population size possible to obtain the most meaningful results.

Grain and oilseed crops were considered to be sufficiently similar to group them together for analysis. However, berry, vegetable and field ornamental (nursery) production systems and industry characteristics had too many differences for grouping. Berry and vegetable were analyzed separately. The field ornamental sample size was too small for meaningful results; they were not reported. Major changes to the grape industry since the 1995 census list was compiled gave uncertainty that grape responses would represent the current industry. Therefore, grape responses were not reported.

This report summarizes results from grain/oilseed, berry, vegetable (field), and tree fruit responses.

Data Release Criteria and Sampling Variability

Survey data was collected under the data sharing provisions of the Statistics Act. This obliges BCMAFF to release only aggregate estimates from which no individual farm can be identified.

Sampling variability is measured by margin of error values that determine the interval that will cover the true value 19 times out of 20 (95% confidence level). For example, if the survey estimated that 20% of tree fruit growers use a particular practice and the margin of error was 5%, then there is a 95% chance that the true value is between 15% and 25%. Acceptable ratings for the margin of error are 0% to 10%. Reported figures fall within this range unless otherwise noted.

Ensuring Question Validity

For the 1999 survey, all pest management questions were asked of all respondents. Results provide baseline data that can be measured over time to determine the rate of adoption of environmentally sound practices.

Adoption is based on producer attitudes, awareness, research, incentives, commercial availability and practicality of pest management practices and services. However, many high level IPM practices have not been developed for many crops and are not readily available to growers. For this survey, it was reasonable to only measure producers on the practices that are currently available to them.

Table 3 lists the questions on pest management practices that are available or practical for each crop. These are the practices used to measure IPM adoption levels for the crop. For example, rotating crops to prevent pest problems (Q10) is not reasonable for perennial crops such as tree fruits and some berries. Irrigation is not practiced on grain and oilseed crops so growers will not be adjusting the timing of irrigation/watering to prevent disease (Q12). Many of the medium or high level practices for example, are not commercially available or widely recommended for tree fruit or berry producers. Only one medium and one high option were considered practical or available for tree fruit and berries. The columns of Total Points for low, medium and high IPM indicate the range for each level. If the total for a berry farm is 4 points, it is considered to be at a medium IPM level.

Table 3. Pest management questions analyzed for each crop based on indicator practices.

Crop	Questions analyzed	Total Points Low IPM	Total Points Medium IPM	Total Points High IPM
Berry	1,3,5,7,12	1-3	4-5	6-8
Grain/oilseeds	1,3,5,7,8, 9,10,11,13	1-4	5-12	13+
Tree fruit	1,3,5,7,12	1-3	4-5	6-8
Vegetable	1,2,3,5,7,8,9,10,12	1-4	5-12	13+

A few advanced producers, the ‘early adopters’, have cooperated with researchers and extension specialists to assess new technology and practices or tried them on their own. They have reported using practices such as beneficial insect release, trap/companion crops, and pheromones that are in the developmental phase for certain crops.

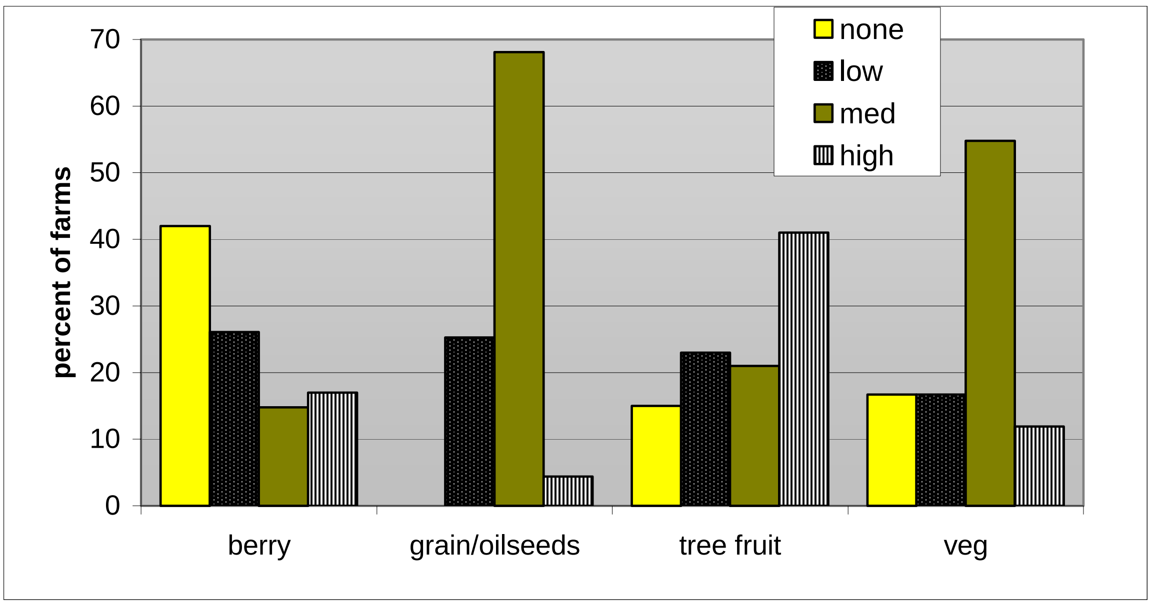
Six berry farmers reported using pheromones (question 4) for insect mating disruption. They were likely using it on an experimental basis in cranberries to control fireworm, as pheromones were not registered on any berry crops at the time of the survey. However, because pheromones were not available, question 4 responses were not incorporated into the equation to determine IPM level.

Over time it is expected that more high level IPM practices will become available and they will be included in the equations to determine IPM adoption. This means that the criteria for high level IPM adoption will slowly shift upward as technologies and products are refined and become more available. Future surveys will be able to measure the increase in available practices and in adoption of these practices over time. Responses for all 13 practices are reported in Figures 6, 7, 8 and 9.

The Results—IPM Adoption Rates

There was a range of IPM adoption levels within each commodity, Figure 1. More berry operations were under the low or no IPM categories than medium or high. The majority of grain and oilseed farmers were adopters of medium level IPM practices. Approximately half of the tree fruit growers had a medium or high level of IPM adoption. Vegetable farmers also showed a relatively strong level of medium IPM use.

Figure 1. Percent of farms using different levels of IPM, 1998.

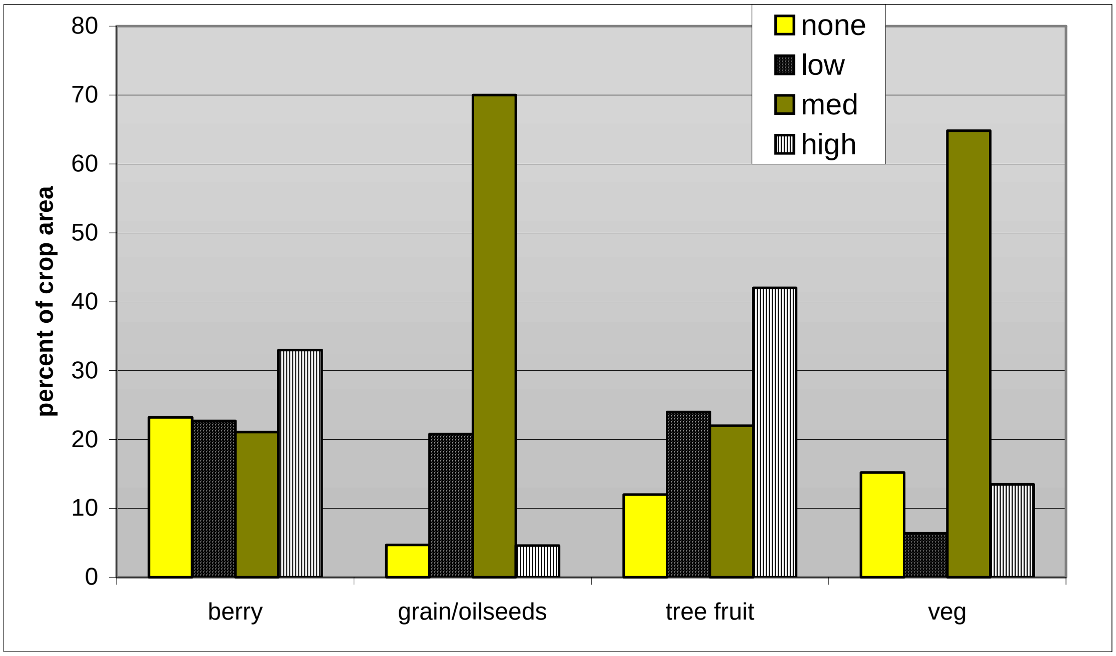


When IPM adoption levels were assessed as the area managed by the farmer, the picture changed. Table 4 and Figure 2 show that a high proportion of production area is under IPM for each crop group. Grain/oilseeds and field vegetables also have a larger proportion under medium or high IPM. Values of grain/oilseeds under "no IPM" are too low to report under data release criteria.

Table 4. Percent of production area under all levels of IPM, and percent of production area under medium or high IPM only.

Crop	**% production area using IPM**	**% production area using medium or high IPM**	**Total ha represented**
Berry	77	54	4974
Grain/Oilseeds	95	75	65618
Tree fruit	85	62	5975
Vegetables (field)	85	78	5258

Figure 2. Percent of total crop area under each IPM adoption level.



Monitoring Decisions

Figures 3 and 4 describe the methods used by growers to decide when to apply insecticides/fungicides and herbicides. Any of the responses except “calendar dates” is an indication that the grower is monitoring pests or the crop. However, the respondent is considered to use IPM only if they also use at least one preventive practice.

The first sign of pests is a common decision point to make an insecticide/fungicide application, especially for tree fruit and berry producers. Economic injury levels were the most common monitoring method in grain/oilseeds crops. In many cases, economic injury levels have not been determined for crop diseases, insects and weeds. Growers must rely on past experience to gauge treatment levels. This would explain why the “first sign of insects” is commonly used as the decision point. A significant number of berry producers were still using calendar dates.

Most grain/oilseed producers used crop growth stage to time herbicide applications. The first sign of weeds or weed growth stage were monitoring tools for most tree fruit and berry producers. Vegetable producers used a variety of monitoring methods with “first sign of weeds” being the most popular practice.

Figure 3. Information used by the farmer in deciding when to apply an insecticide or a fungicide. Advice of others includes consultants.

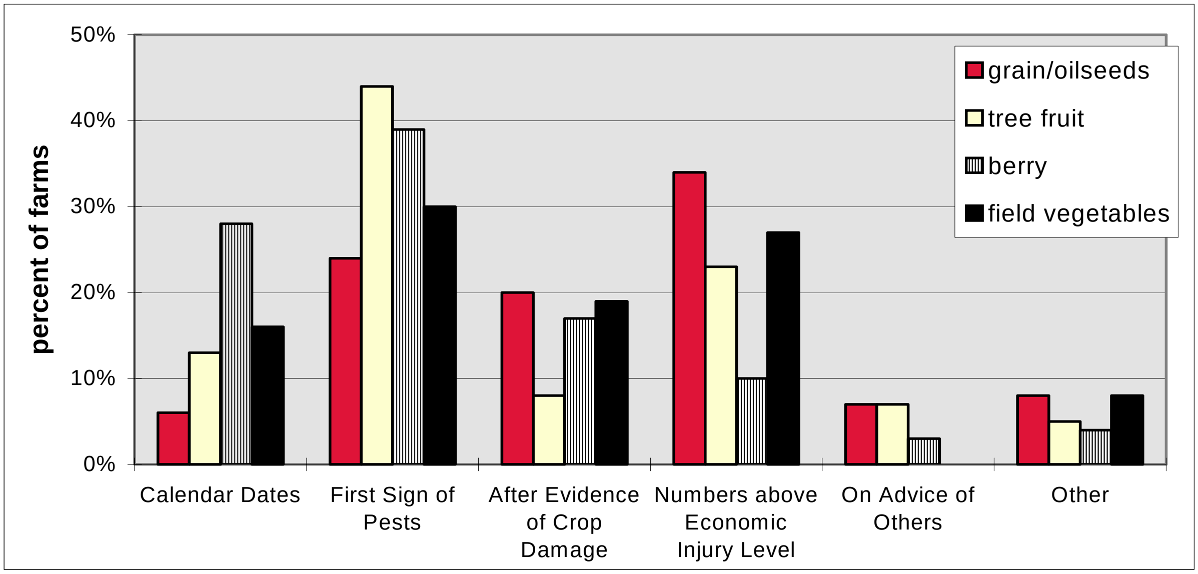
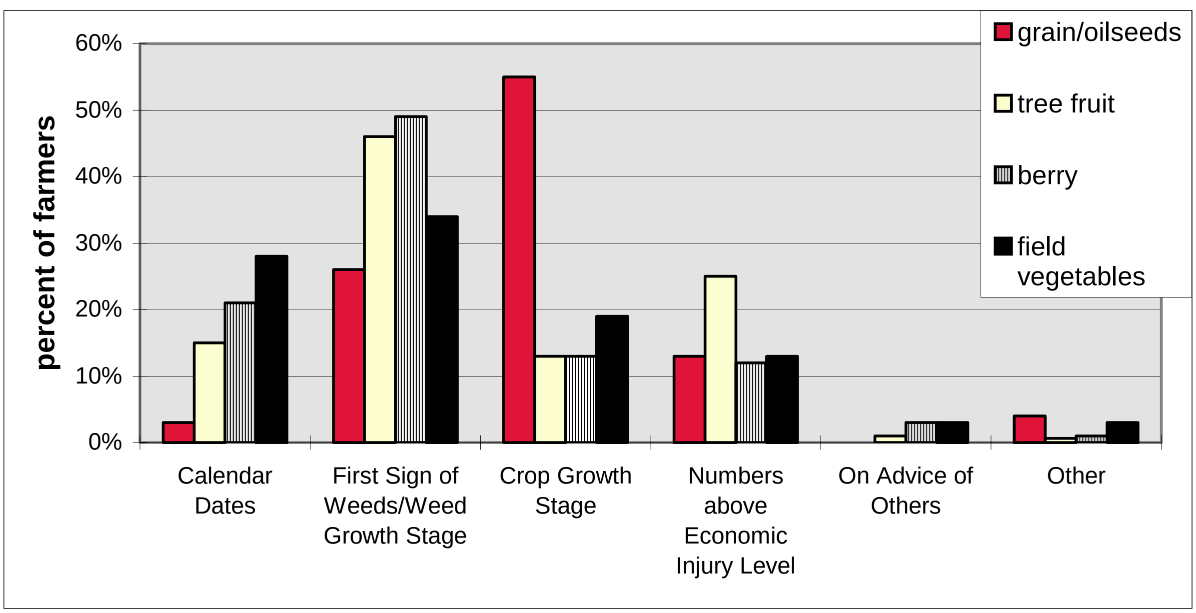


Figure 4. Information used by the farmer in deciding when to apply a herbicide. Advice of others includes consultants.



Source of Advice When Deciding to Apply a Pesticide

Figure 5 summarizes the source of advice that farmers relied on most in deciding when to apply a pesticide. They were asked "Who's advice do you rely on most in deciding when to apply any pesticides. Is it mostly from:

- A fieldperson who recommends action
- A neighbour who is applying pesticides
- A pest management consultant who recommends action
- The BCMAFF production guide
- A pesticide salesperson who recommends action
- Your own experience/observations (no advice from others)
- Other (specify) _____________"

The majority of producers, especially those in the grain/oilseed and field vegetable sectors primarily relied on their own experience/observations. Sample sizes were too small at this level of analysis to determine any correlation between the source of advice and level of IPM adoption. However, there was a trend in level of education and not seeking advice from others. Within the "no advice from others" category, 65% of grain/oilseed farmers, 50% of tree fruit orchardists, 68% of berry farmers and 76% of field vegetable farmers had some schooling up to or completed high school. This independent approach will need to be considered when planning extension activities and information on pest management. Farmers may be more receptive to demonstration activities or study groups than a formal approach.

Packinghouse/processor fieldperson advice and pest management consultants also seem to be a noteworthy source of advice. The tree fruit industry in the Okanagan has a strong packing-house fieldperson support system that is reflected in the responses. Staff base pest control recommendations on disease and insect predictive models, and weather monitoring programs.

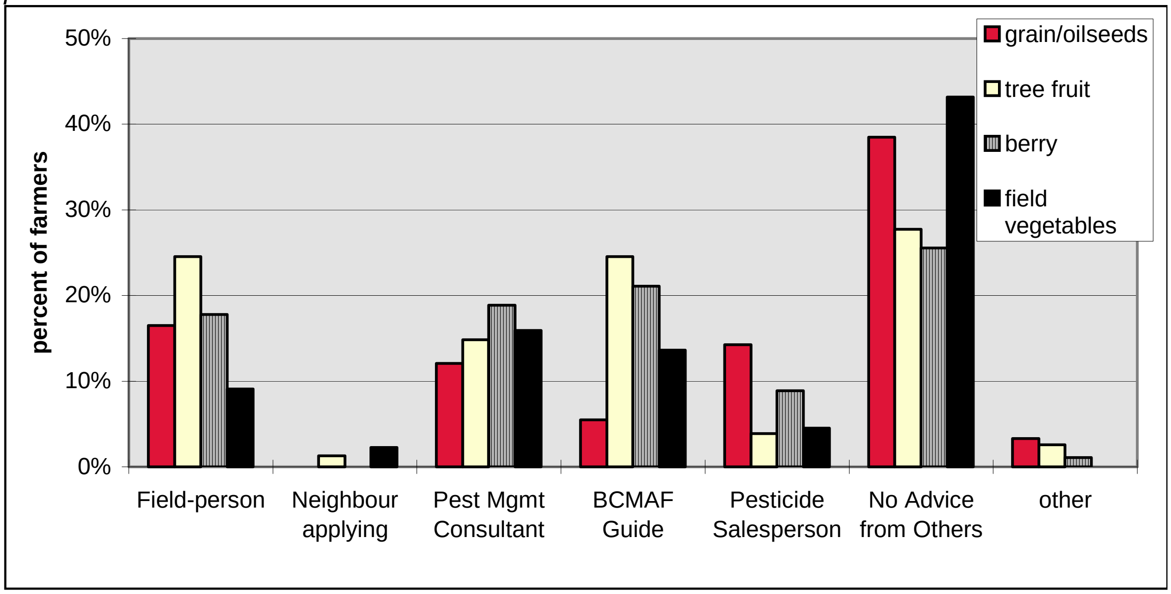
The percent of berry and vegetable farmers using pest management consultants may decrease in the next survey as a major pest monitoring service "ProTect" stopped providing service in the Fraser Valley in 2001. However, there are still others in business throughout BC.

Pesticide sales staff were not common sources except in grains/oilseeds. Their impact in promoting IPM is not known although it is recognized that they have a bias to sell product.

The BCMAFF Production Guides were a strong source of advice for most farmers. In addition, they are an important source of information for packinghouse/processor field staff, pest management consultants and pesticide sales representatives who are also providing advice to farmers. As of 1997, BCMAFF staff specialists no longer provided one-on-one advisory services.

The low response for BCMAFF Guides from grain/oilseed producers in the Peace River was likely influenced by cost. A similar guide from Alberta Agriculture cost $10 whereas the BC Guide was $20. However, the BCMAFF Field Crops Guide is used extensively by the agribusiness sector which provides advice to growers. It is also used throughout BC by forage and corn producers who were not part of this survey.

Figure 5. Source of advice that farmers relied on most in deciding when to apply any pesticide.



Beneficial Management Practices

Figures 6, 7, 8 and 9 illustrate the adoption levels of beneficial pest management practices for each crop group.

Grains and Oilseeds

Grain/oilseed producers had high adoption levels of cultivating for weed control (70%), crop rotation (80%) and using resistant varieties (50%). Planting dates are adjusted by 20% of farmers to avoid weeds. Delayed seeding dates allow weeds to germinate first and get worked into the ground before crop seeding. Advanced seeding dates to either the fall or early spring gives the crop a head-start on weeds and suppresses weed growth.

Seventeen percent of grain/oilseed farmers had tried trap crops and 14% still use trap crops. Monitoring and treating outside edges (headlands) of the field as insects move in results in far less pesticide use than treating an entire field. Polish canola, which emerges earlier than the more economically viable Argentine canola, is planted around the edge of the field. Cabbage seedpod weevils are attracted from all parts of the field to the early crop around the edge and can be controlled in a relatively small area with an insecticide. Another example is treating barley headlands only for grasshopper control.

Tree Fruit

Commonly adopted practices in the tree fruit sector are encouraging natural predators/parasites of insect pests (70%) and adjusting the timing of irrigation to prevent disease (50%). About 30% use mulch for weed control and 20% plant disease or insect resistant varieties.

Examples of ongoing programs and attitudes towards new pest management tools:

- The Sterile Insect Release Program provides area-wide codling moth control on apple and pear in the Kootenays and Okanagan. The program consists of monitoring, sterile insect releases, mating disruption and where necessary well-timed sprays.
- Apple scab IPM involves awareness of inoculum levels from the previous year, and monitoring air temperature and duration of leaf wetness periods to determine if and when fungicides are needed. If fungicides are needed, those with reduced toxicity to predatory mites are selected.
- IPM of orchard mites involves monitoring, dormant oil application and preservation of predatory mites by avoiding toxic insecticides such as pyrethroids and. Summer miticide applications are usually avoided.
- When the peach tree borer pheromone was registered in 2002 for mating disruption in stone fruit, the demand was so great in BC that the suppliers sold out of product immediately.

Berries

Almost 60% of berry producers use cultivation for weed control and 30% use mulch. Over 30% encourage natural predators/parasites of insect pests. Disease or insect resistant varieties are used by 30%, and over 35% adjust irrigation timing to prevent disease.

The six farmers using pheromones for mating disruption in berry crops were likely using it on an experimental basis in cranberries to control fireworm, as pheromones were not registered on berry crops at the time of the survey. As of 2000, the product was registered in Canada. It is also a standard practice for berry crop consultants and some berry farmers to use pheromone traps to detect the presence of adult insects. Cutworm species and the oblique-banded leafroller are monitored in raspberries, and the cranberry girdler and black-headed fireworm are monitored in cranberries. Protocols for the introduction of spider mite predators have been developed for berry crops. Mite management includes monitoring, use of action thresholds and reduction of pesticide use. The greatest success for grower adoption occurred when a consultant worked directly with the grower.

Field Vegetables

Field vegetable producers have a relatively high adoption level of a variety of practices: over 70% cultivate for weed control, 30% use mulch, over 50% encourage natural predators/parasites of insect pests, 70% rotate crops, 50% use disease or insect resistant varieties and over 40% adjust irrigation timing to prevent disease.

BC is fortunate to have a reduced pest spectrum: the Colorado potato beetle and corn borer do not occur here and the corn earworm is not established. Most lettuce, onion, carrot and potato fields are monitored to detect insect pests and diseases. Sticky traps are used to assess populations of carrot rust fly and onion maggot. Monitoring determines where and when the first tuber flea beetle populations reach their peak. Spot treatments along headlands or edges reduce overall pesticide use. During establishment, cole crops can tolerate some feeding damage from caterpillars or aphids. Once the heads or sprouts form, economic thresholds drop and scouting must be thorough to ensure pest numbers do not exceed thresholds. The biologically-based insecticide *Bacillus thuringiensis* is used for caterpillar control on broccoli and cabbage.

Field trials are underway to test the efficacy of field flooding to control wireworm in potato and corn. The parasites *Aphidoletes* for aphid control and *Trichogramma* for caterpillar control have been used with success in trials, however the cost is currently too high for adoption.

Figure 6. Indicator weed management practices that have been tried and are still used by farmers in the crop groups. Practices include cultivation or use of a rotary hoe and mulching.

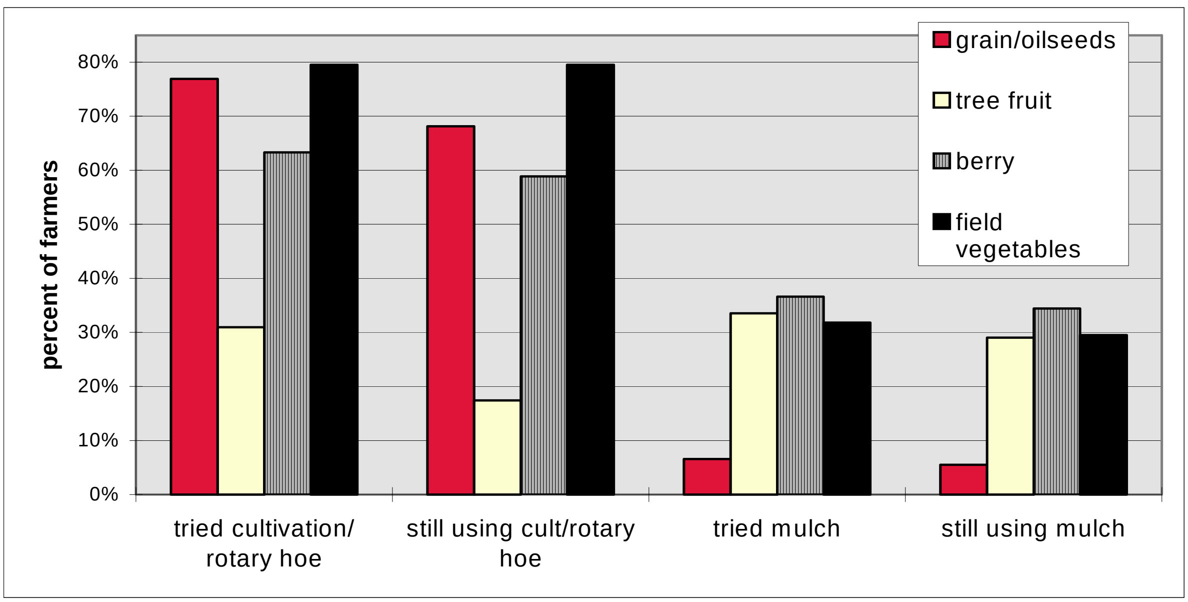


Figure 7. Indicator insect management practices that have been tried and are still used by farmers in the crop groups. Practices include introduction of predators/parasites to control insect pests, encouraging natural predators/parasites of insect pests and using trap/companion crops to protect main crop.

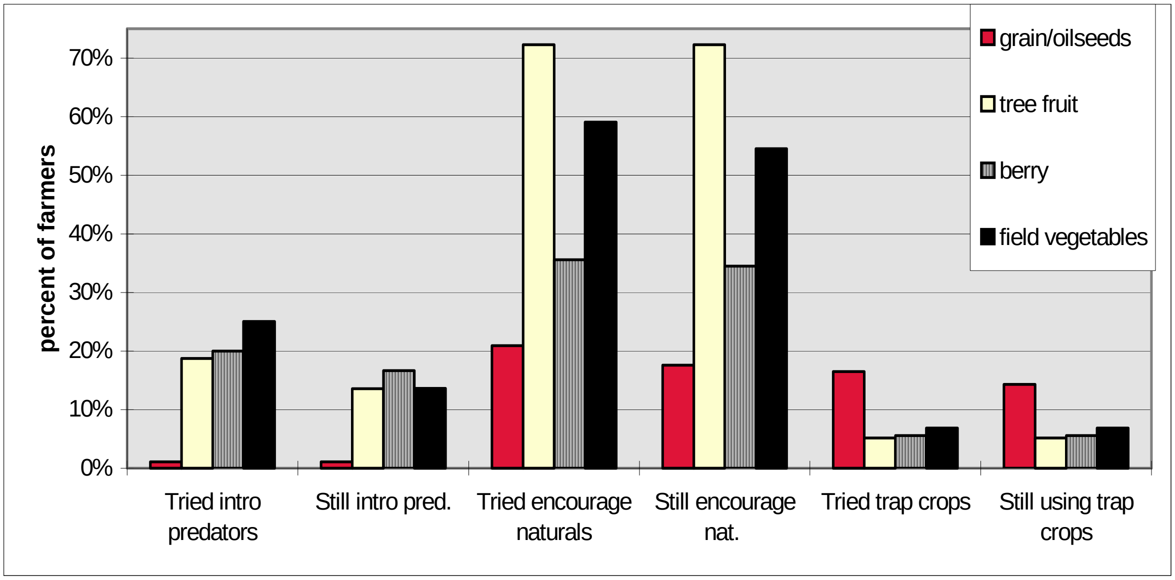


Figure 8. Indicator insect and disease management practices that have been tried and are still used by farmers in the crop groups. Beneficial IPM practices include pheromones for insect mating disruption, crop rotation to prevent pest problems and adjusting planting or harvesting dates to avoid pests.

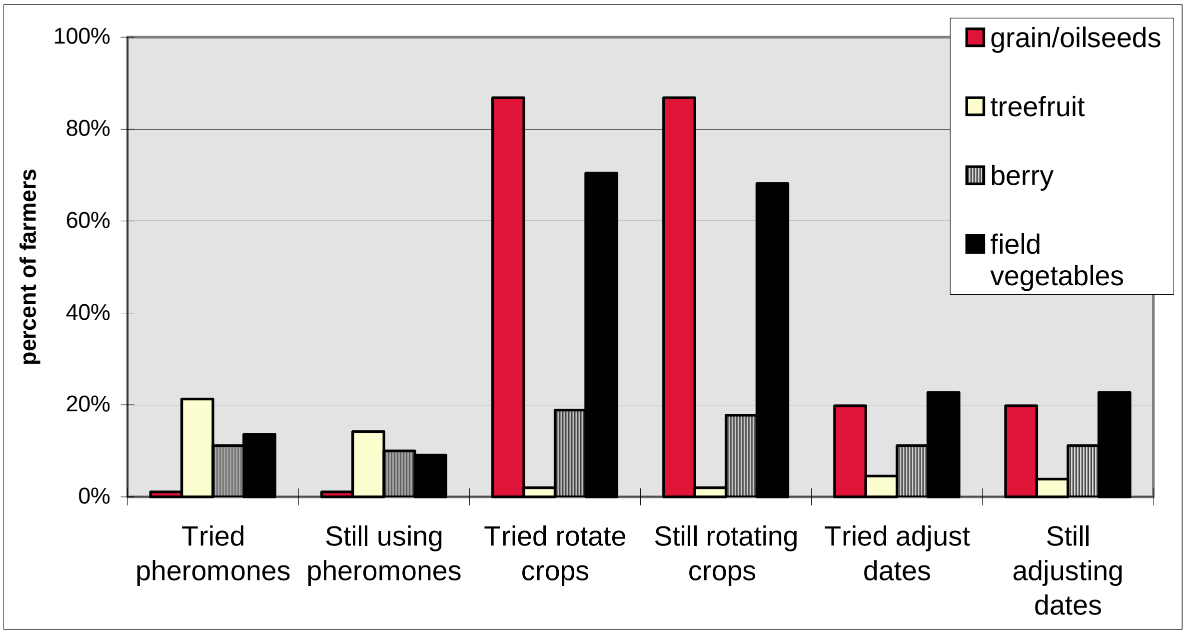
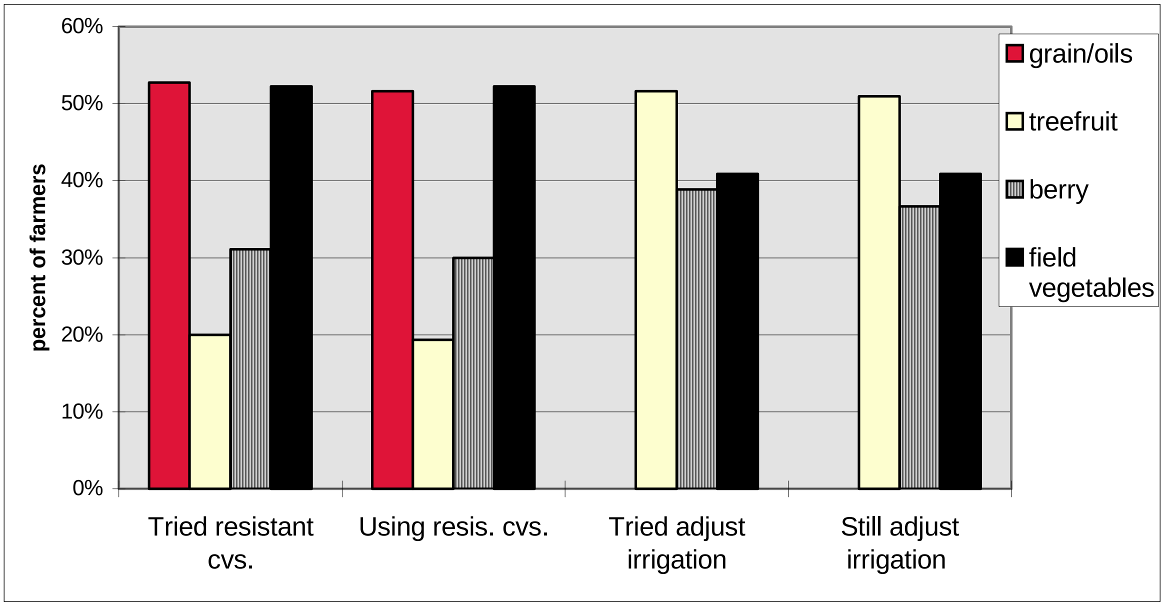


Figure 9. Indicator insect management practices that have been tried and are still used by farmers in the crop groups. Beneficial IPM practices include planting disease or insect resistant varieties and adjusting timing of irrigation to prevent disease.



Continuation of Practices

Respondents were asked if they had tried a particular pest management practice and if they were still using it. In the majority of cases, most respondents continued to use a practice that they tried. Approximately 5 to 10 percent of respondents said they had tried the following practices and no longer used it:

- "cultivation or rotary hoe for weeds" in grain/oilseeds and tree fruit (Figure 6).
- "introducing predators/parasites of insect pests" for all commodity groups except grain/oilseeds (Figure 7).
- "using pheromones for insect mating disruption" for tree fruit and field vegetables (Figure 8).

Cultivation may not have been adopted in grains/oilseeds if the farmer switched to a 'zero-till' management system. Likewise in tree fruit, the farmer may have adopted permanent grass covers between rows instead of clean cultivation for weed control. The last two practices are still under development and it would be understandable if a manager dropped the practice if all the parameters were not determined or widely available for their crop.

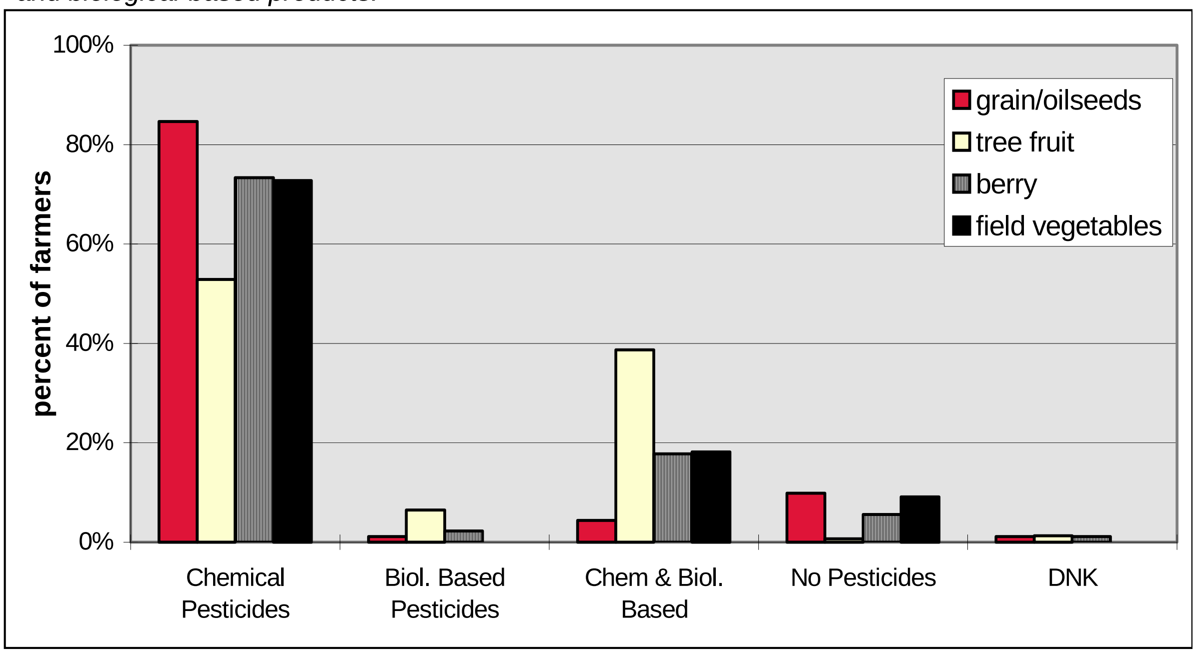
The common pest prevention practices tried and continued by producers were: using mulch, encouraging natural predators/parasites of insect pests, using trap/companion crops to protect the main crop, using pheromones for mating disruption in berry crops, rotating crops, adjusting planting or harvesting dates to avoid pests, planting disease or insect resistant varieties, and adjusting timing of irrigation to prevent disease.

Pesticide Practices

Almost 10% of grain/oilseed producers reported that they did not use pesticides in 1998, Figure 10. Less than 5% of the other crop groups reported no pesticide use in 1998. Tree fruit producers were more inclined to use a combination of chemical and biologically-based pesticides (36%). In 1998, only three biologically based active ingredients were commercially registered for agriculture use in Canada to control insects or diseases. They were *Bacillus thuringiensis* var. *kurstaki*, *Bacillus thuringiensis* var. *israeliensis* and *Agrobacterium radiobacter* strain 84.

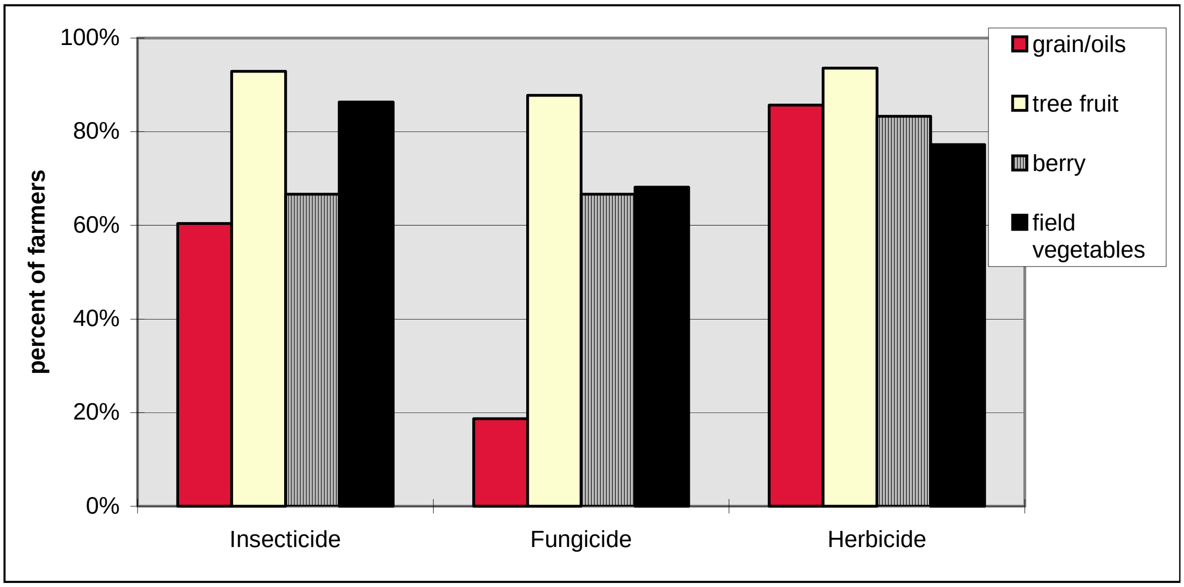
As these types of products become more available, and are demonstrated to be effective and price-competitive, there may be a shift from chemical-based pesticides towards biological-based pesticides. Biological-based pesticides are considered to have a reduced level of risk to the environment and farm workers.

Figure 10. Percent of farmers using pesticides, and breakdown between chemical-based and biological-based products.



Herbicides were the most commonly used type of pesticide applied in 1998, Figure 11. The majority of respondents used fungicides, insecticides and herbicides, except in the grain/oilseed sector where only 20% used fungicides in 1998. It was beyond the scope of this survey to collect information on the area treated, volume, rate and specific product used.

Figure 11. Types of insecticides, fungicides and herbicides used in 1998 by crop groups.



Pesticide Application

The majority of respondents operated their own sprayer, or had a family member, partner or employee operate the sprayer. Approximately 20% of grain/oilseed farmers made other arrangements such as custom application.

Figure 12. Percent of those operations using pesticides where the sprayer is operated by the farmer, a family member, partner or employee.

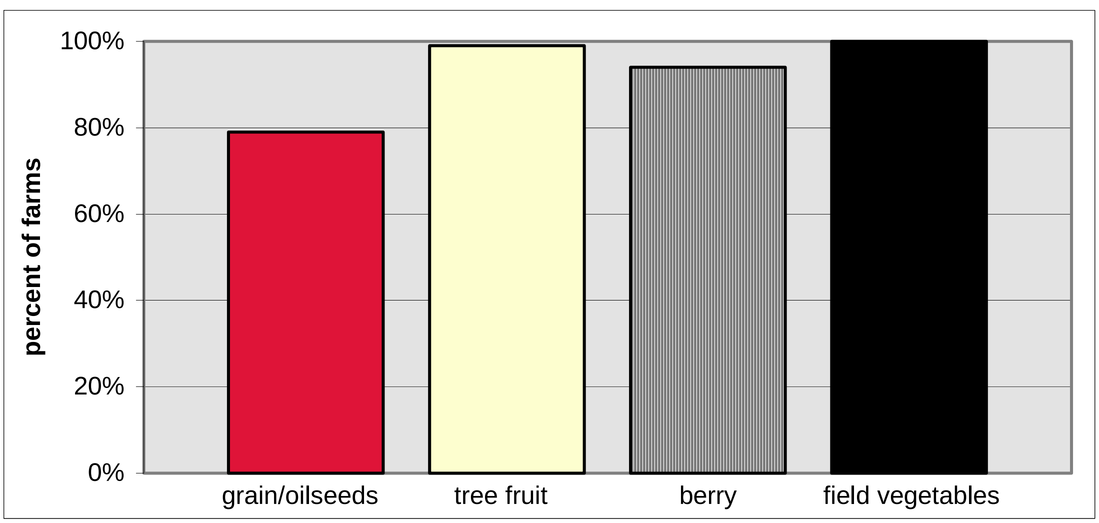
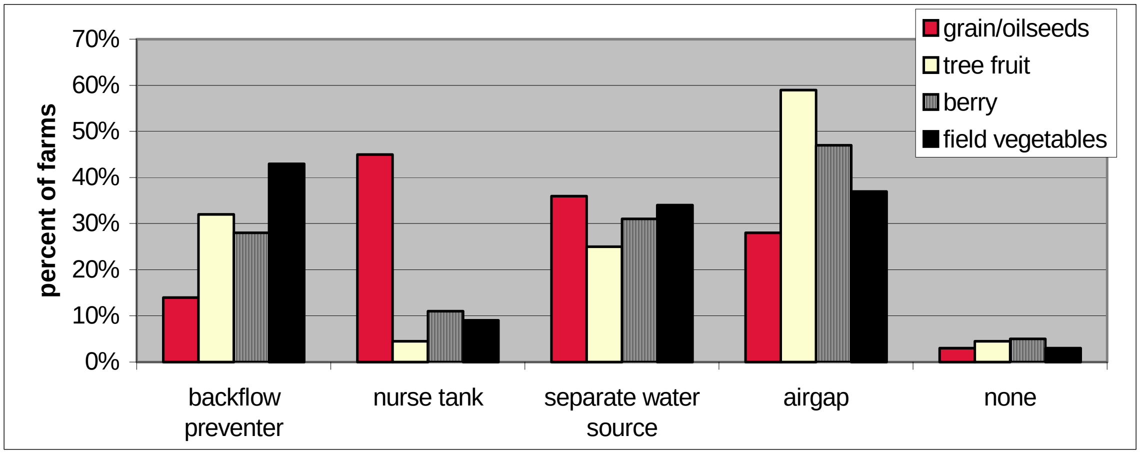


Figure 13. Practices used when filling application equipment. Best management practices include using a backflow preventer, nurse tank, separate water source or an airgap.



More than 95% of farms use proper procedures, or best management practices, that prevent contamination of their water source when adding water to spray equipment. These include using a backflow preventer, nurse tank, separate water source, air gap or a combination of these.

Pesticide management practices such as spot spraying/spraying field edges, treating trap crops, rotation of pesticide class and treating seeds/seedlings can minimize the amount of product applied to the crop and therefore reduce environmental risk. Spot spraying/spraying field edges was used by many farmers, especially grain/oilseed producers, Figure 14. Many producers rotate pesticide classes to reduce the risk that a pest will become tolerant (resistant) to a product. This is only effective when farmers can choose from a selection of effective products that have different mechanisms of control. As older pesticides lose their registrations, it is important to ensure that farmers have a sufficient choice of registered products for effective management of pesticide resistance.

Reduced tolerance (resistance) of pests to pesticides leads to more frequent pesticide application and higher rates of pesticides. Intuitively, the risk to the environment increases as rates and applications increase.

Figure 14. Adoption of pesticide management practices that can reduce risk to the environment.

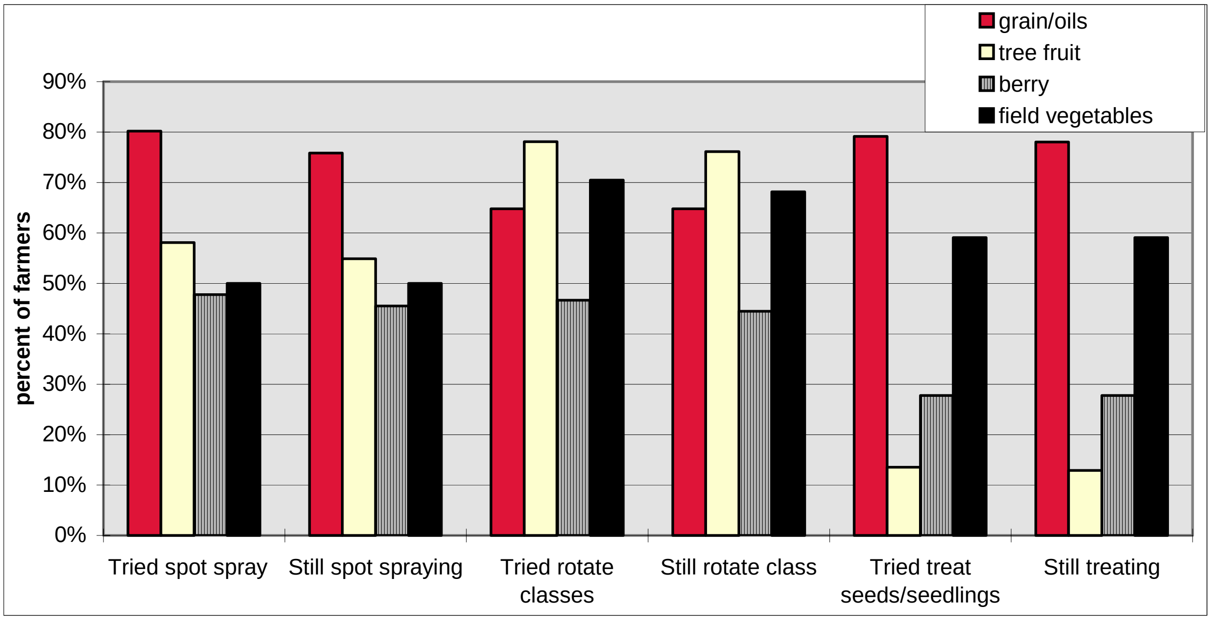
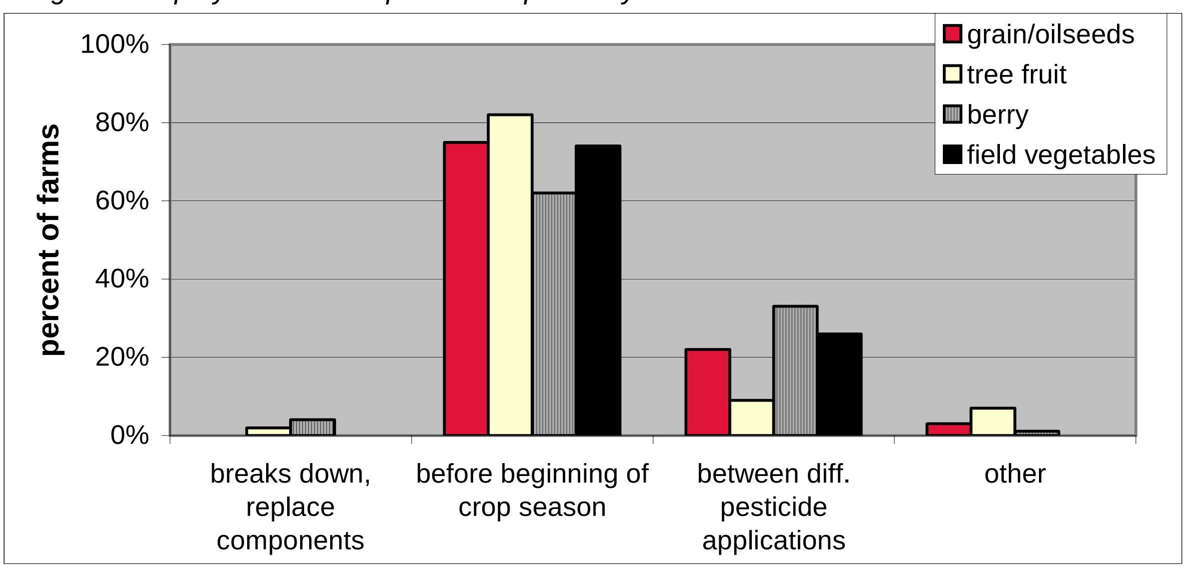


Figure 15. Sprayer calibration practices reported by farmers.



Sprayer calibration helps ensure proper application rates for effective pest control, reduced crop damage, food safety and reduced risk to the environment from accidental over-application. The best management practice is to calibrate between applications of different pesticides. The next best practice is to calibrate before the beginning of the crop season. Of those using pesticides, over 95% of farms, except for tree fruit (93%), follow these two practices. Improvement would be made if more applicators calibrated between different pesticide applications.

Nozzle maintenance practices and knowledge of nozzle materials indicate if farmers calibrate and understand their sprayer and its components, Figures 16 and 17. To understand nozzle maintenance practices, farmers were asked to answer which of the following best described how they maintained their nozzles.

- Replace all nozzles all at once
- Replace nozzles one-at-a-time, as needed
- Other/haven't replaced yet.

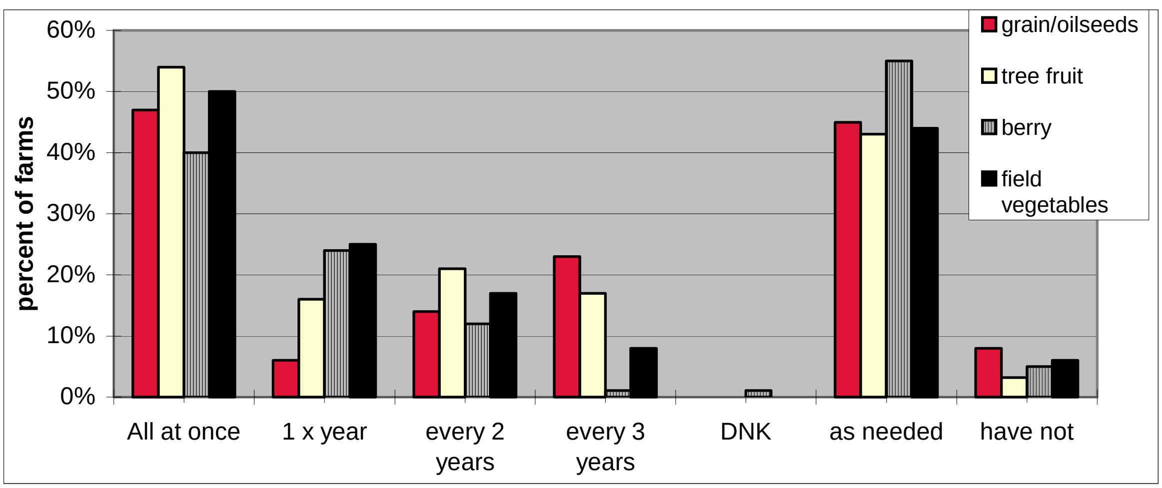
If they responded that they replace all nozzles at once, they were then asked how often they replace all the nozzles on the sprayer. Categories included:

- At least once per year
- At least every 2 years
- Every 3 years or more
- Can't remember/can't say for sure

Generally, farmers were split between replacing nozzles "all at once" and "as needed". Berry farmers were slightly more inclined to replace nozzles "as needed". Almost all respondents knew their use patterns and when they replaced their nozzles. This indicates some understanding of sprayer equipment.

It is a better management practice to replace nozzles all at once to ensure even delivery of the pesticide, so there is room for improvement on BC farms.

Figure 16. Nozzle replacement practices by farmers.



Farmers were also asked the following to determine if they knew their nozzle materials. This is an indicator of sprayer knowledge.

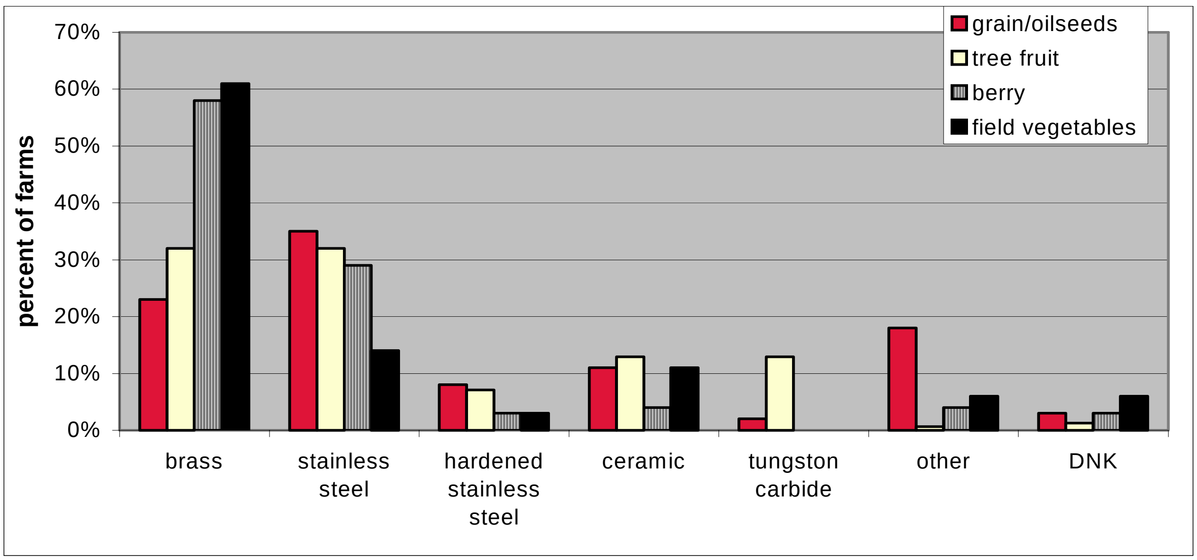
What material are your nozzle tips made of (mark only one)?

- Brass, stainless steel, hardened stainless steel, ceramic, other (specify), don't know.

Over 95% of respondents knew what nozzle material was used. Brass was the most common nozzle material used on berry and field vegetable farms. Brass nozzles wear out fastest although they are the least expensive of all nozzles. As they wear out, they deliver more pesticide during application. This could lead to over-application of pesticides, uneven distribution and more drift. Stainless steel nozzles were also common for all except field vegetable crops. They are often a better choice than brass because they are more durable.

Tungsten carbide and ceramic nozzle tips are more resistant to wear and last at least 6 years under normal use. Although these nozzles cost more, they are used by at least 20% of tree fruit orchardists.

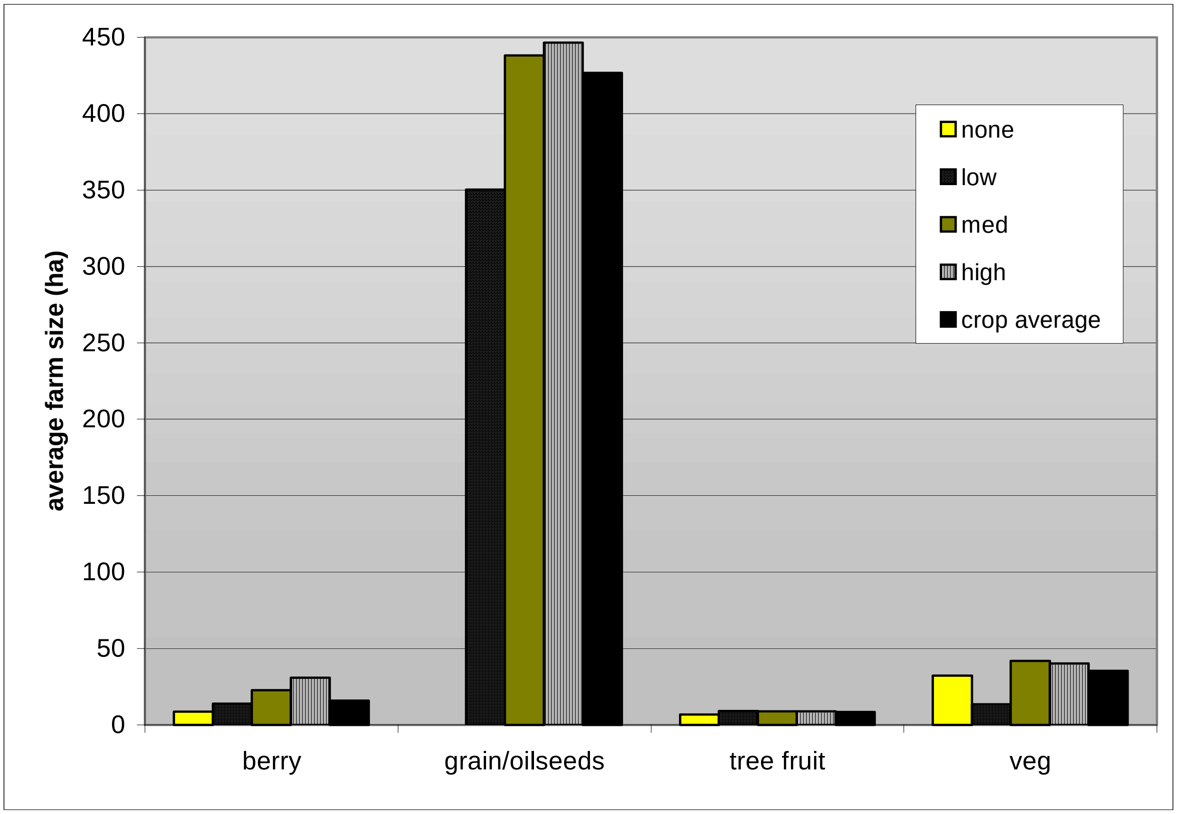
Figure 17. Spray nozzle materials used by farmers in 1998. "Other" includes plastic, nylon, molybdenum and powdered aluminum.



Operation Profile

Figure 18 illustrates average operation sizes for each level of IPM. It is the larger berry and vegetable operations, and to some extent grain/oilseed operations that have adopted higher levels of IPM. Operation size does not appear to be a major factor in the level of IPM adoption at tree fruit operations although the proportion that do not use IPM may be slightly smaller operation than the average. Note that the area under production of grains/oilseeds is much larger than the more intensively produced horticulture crops.

Figure 18. Average size of farm for each level of IPM adoption; the black bar represents the average overall operation size in each sector.



There was no interaction between land ownership and IPM adoption levels (data not reported). Overall, 86% of responding farmers owned over 33% of the land that they operated in 1998.

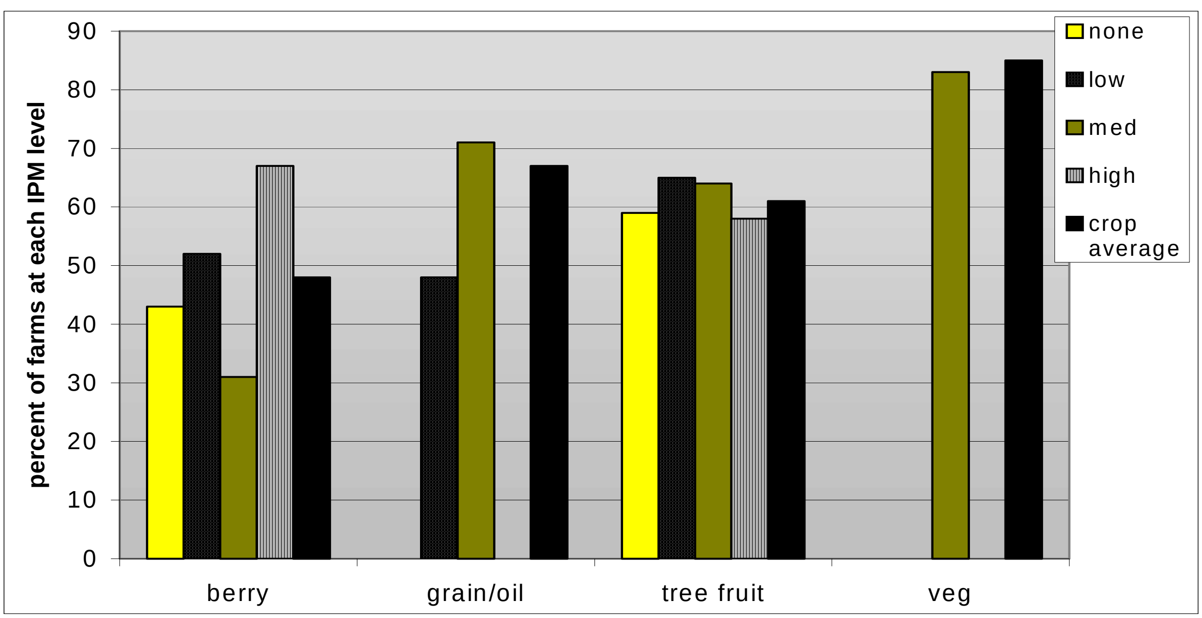
Farm Income Related to IPM Adoption Level

Farm income was measured by asking producers if they earned most of their income from farming, about half of their income from farming, or less than half of their income from farming. In addition, total gross farm income information was collected in three categories: less than $25,000, $25,000 to $50,000 and over $50,000.

The sample size of farm income for some crop/IPM adoption levels was too small to report under data release criteria and these appear as gaps in the graph (Figures 19 and 20). Statistical values for the analyses “total gross farm income” and “most of income from the farm” fell in the “use with caution” margin of error (±10-20%). However, results are presented for their value as potential trends.

Overall, vegetable producers were more likely to generate most of their income from the farm (black bar in Figure 19), while slightly less than half of the berry producers generated most of their income from the farm. Grain/oilseed and tree fruit operations fell between these levels. Berry farms using high level IPM were more likely to generate most of their income from the farm than lower level adopters. Medium level IPM adopters in grain/oilseeds were more likely to generate most of their income from the farm in comparison to low level adopters. Otherwise, there was no indication that the level of on-farm income was a factor in the IPM adoption level.

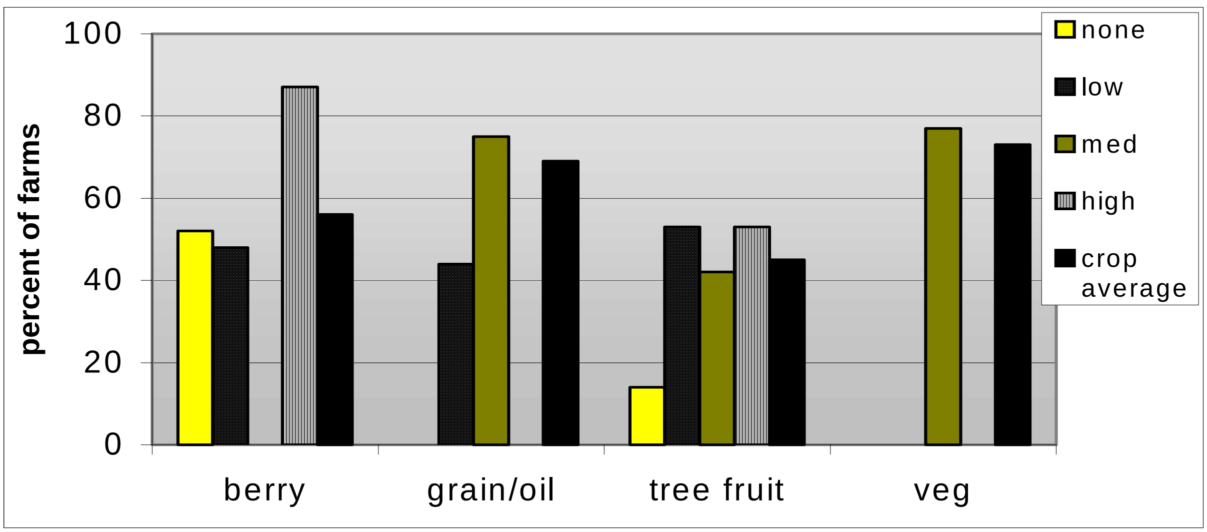
Figure 19. Trend data comparing level of IPM adoption and percent of farms within that level receiving most of their income from the farm. Black bar represents the average response for the crop group (i.e. without the IPM adoption level breakdown). Where no information is presented, the numbers were too low to report under data release criteria.



The percent of farms with total gross farm income greater than $50,000 was measured as an indication of income available to spend on inputs such as pest management. Data are presented in Figure 20; results are trends only due to small sample sizes. Black bars indicate the average percent of farms with an income over $50,000 for that crop group (without the IPM adoption level breakdown). Responses for the overall crop groups vary from around 70% of grain/oilseed and vegetable operations down to 44% for tree fruit operations.

Berry "high level" IPM adopters had a trend of more farms with incomes over $50,000 than the "no" to "low level" IPM adopters. There are fewer tree fruit producers who "do not use IPM" with incomes over $50,000 than those who use IPM. Grain/oilseed "low level" IPM adopters may have lower income levels than "medium level" adopters.

Figure 20. Trend data comparing level of IPM adoption and percent of farms whose total gross farm income was greater than $50,000 within that level. Black bars represent the crop average. Where no information is presented, the numbers were too low to report under data release criteria.

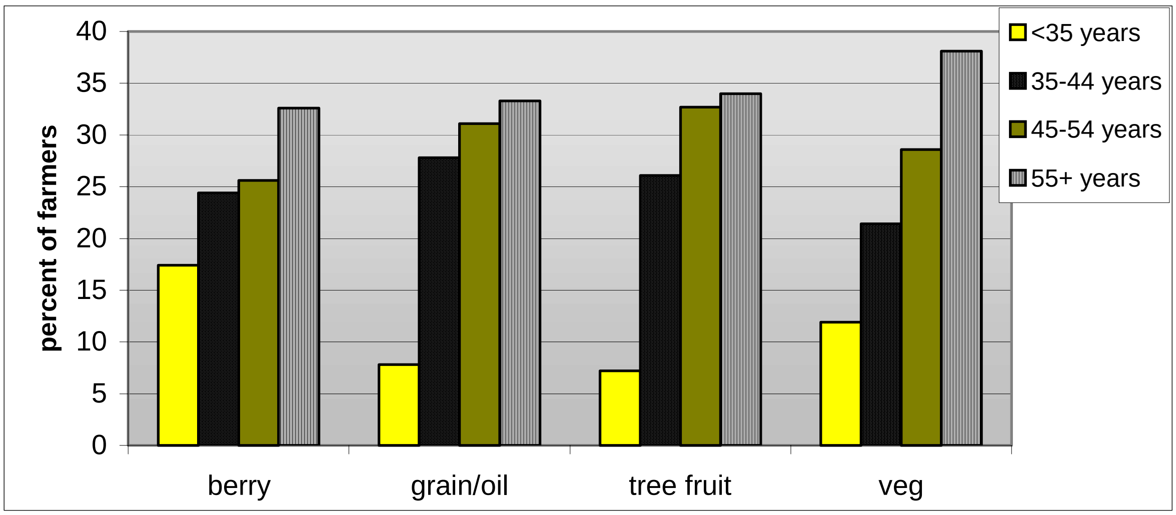


Farmer Profile

Age

There was no relationship between farmer age and the level of IPM adoption. However, the information highlights the fact that the population of farmers is aging. This shift may have implications in extension activities and policy development.

Figure 21. Farmer age categories for each crop sector.



Education

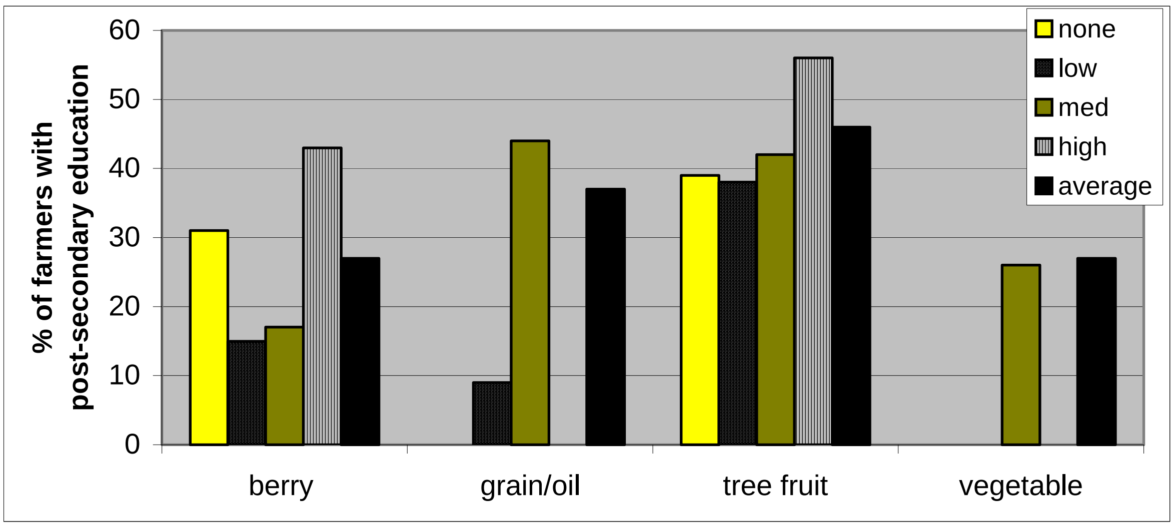
Farmers were asked which of the following best describes the formal education completed:

- Some schooling
- Completed high school
- Some post-secondary
- College diploma
- University degree

Results will reflect those of the respondent that answered the survey although every effort was made to survey the principle farm operator. Statistical values for the farmer education/crop/IPM adoption analysis fell in the “use with caution” range, i.e. margin of error ±10-20%. However, results are presented for their value as potential trends. Data gaps in the graph occur where the numbers are too low to report under data release criteria, Figure 22.

Overall, 38% of farmers responding had some post-secondary education. Orchardists had the highest overall level of post-secondary education (46%). Farmers using “higher level" IPM practices (medium and/or high) had more formal education than the average for the overall crop group. Within BC, sources of agriculture diploma programs include Kwantlen University College and the University College of the Fraser Valley. Simon Fraser University has a Masters of Pest Management Program although the future of this program is unknown. Graduates from the Masters of Pest Management Program have become an important part of the pest management community in BC.

Figure 22. Trends on the effect of education and IPM adoption levels. Percent of farmers who have completed some post-secondary education, have a college diploma or a university degree are reported for each IPM adoption level within a crop group.



Conclusions

The survey has determined some baseline data on the behavior of farmers towards pest management. By proxy, this provides information on the level of IPM practices adopted in the berry, grain/oilseed, tree fruit and field vegetable commodities as of 1998. Feedback from this and subsequent surveys will ensure that agriculture programs and policies reflect the way resources are being managed on BC farms.

Crop summaries are discussed, followed by a SWOT (strengths, weaknesses, opportunities and threats) Analysis of the state of IPM adoption and pesticide management practices on the selected BC crops.

Crop Summaries

Berry Farms in the Fraser Valley

IPM was used on 77% of berry crop area, with 54% of the area under medium or high level IPM. However, only 58% of berry producers used IPM with 32% using medium or high level IPM. There are opportunities for more IPM adoption on berry farms, especially with the smaller operations.

Less than half of berry farmers produced most of their income from the farm. The remainder worked elsewhere, and may have less time to spend learning about IPM and applying it. Scheduling of extension events will need to account for off-farm employment conflicts.

More high level IPM adopters (87%) had a total gross farm income above $50,000 than the low (52%) to no (48%) IPM adopters. Almost one-third of farmers were 55 years of age or more. More high level adopters (43%) had some post-secondary level education than the overall crop response (i.e. without the IPM breakdown) of 27%.

Berry farmers used a variety of information sources when deciding to apply pesticides: own experience/observations (26%), BCMAFF Guide (21%), pest management consultant (19%), field-staff (18%) and pesticide sales staff (9%).

Insecticides/fungicide applications were most common at the first sign of pests (39%). Calendar dates (28%), evidence of crop damage (17%) and economic thresholds (10%) were other decision points. Herbicide applications were most often made at the first sign of weeds or weed growth stage (49%) although 21% used calendar dates.

Farmers, their employees or family members operated sprayers at 94% of the berry farms that used pesticides. Eighteen percent of farms used a combination of chemical and biological pesticides while 73% used only chemical pesticides. Six percent used no pesticides.

Ninety-five percent of farms that used pesticides used proper procedures that prevented contamination of their water source when adding water to spray equipment. Sprayer calibration occurred before the start of the crop season at 62% of operations and between different pesticide applications at 33%. Brass nozzles were used at 58% of farms.

Good pesticide management practices included the use of spot spraying/spraying field edges (46%), rotating chemical classes to avoid resistant pests (44%) and treating seedlings to protect the crop in the early stages (28%).

Berry growers used a wide variety of beneficial pest management practices including: cultivation/rotary hoe (53%), mulches (31%), encouraging natural predators/parasites of insect pests (31%), using disease or insect resistant varieties (30%), adjusting timing of irrigation to prevent disease (37%) and introducing predators/parasites of insect pests (18).

It is impressive that 18% introduced predators/parasites of insect pests and 15% were still using this practice even though the concept and practice was new (and still is) for berry crops. At the time of the survey, timing details and population dynamics were under development for mite predators, ladybugs and *Trichogramma* in strawberry and raspberry. Pest management consultants, who could devote the one-on-one attention, played a key role in the mind shift of the growers to try this alternate form of insect control. Close contact and continued support by the consultant was essential for success, especially in the early stages. Further demonstration work is needed for mainstream uptake of this practice.

Grain/Oilseed Farms in the Peace Region

IPM was used on 95% of the grain/oilseed crop area, with 75% of the area under medium or high level IPM. IPM was used by 97% of grain/oilseed producers, and 72% used medium or high level IPM. Grain and oilseed production covers far more land than intensive horticulture crops so management practices have the potential to influence large areas. Due to slim profit margins however, inputs such as pesticides are carefully weighed and used only when necessary.

Sixty-seven percent of grain/oilseed farmers produced most of their income from the farm. Approximately one-third worked elsewhere, and may have less time to focus on applying IPM. Scheduling of extension events will need to account for some off-farm employment.

Only 44% of low level IPM adopters had a total gross farm income that was more than $50,000. This was below the overall crop average (i.e. without the IPM breakdown) of 69% who had a total gross farm income over $50,000. Only 8% of grain producers were under the age of 35. One-third were 55 years or older. Fewer low level adopters (9%) had some post-secondary level education compared to the overall grain/oilseed sector average of 37%. This needs to be considered in designing extension programs on IPM adoption. Demonstration activities, posters, and discussion groups may be preferred to more formal education tools.

Grain/oilseed farmers used a variety of information sources when deciding to apply pesticides: own experience/observations (38%), a fieldperson (16%), pesticide sales staff (14%), pest management consultant (12%), and BCMAFF Guide (5%). The low response for BCMAFF Guides was likely influenced by cost. A similar guide from Alberta Agriculture cost $10 while the BC Guide was $20.

Insecticides/fungicide applications were most common after determining that pest numbers were above the economic injury level (34%). The first sign of pests (24%) and evidence of crop damage (20%) were other decision points. Calendar dates were only used by 6%. Herbicide applications were most often made based on crop growth stage (55%), although 26% used the first sign of weeds or weed growth stage, and 13% used numbers above the economic injury levels. Only 19% of farms used fungicides.

Farmers, their employees or family members operated sprayers at 79% of grain/oilseed farms. Four percent of farms used a combination of chemical and biological pesticides while 85% used only chemical pesticides. Ten percent used no pesticides.

Ninety-seven percent of the farms that used pesticides, used proper procedures that prevented contamination of their water source when adding water to spray equipment. Sprayer calibration occurred before the start of the crop season at 75% of operations and between different pesticide applications at 22%. More farmers used stainless steel nozzles (35%) than brass (23%).

Good pesticide management practices included the use of spot spraying/spraying field edges (76%), rotating chemical classes to avoid resistant pests (65%) and treating seeds to protect the crop in the early stages (78%).

Grain/oilseed farmers used a wide variety of beneficial pest management practices including: cultivation/rotary hoe (68%), crop rotation (87%), and using disease or insect resistant varieties (52%). An innovative group encouraged natural predators/parasites of insect pests (18%), used trap crops to protect the main crop (14%) and adjusted planting or harvesting dates to avoid pests (20%).

Okanagan/Kootenay Orchards

IPM was used on 78% of orchard crop area, with 55% of the area under medium or high level IPM. IPM was used by 72% of orchardists with 50% using medium or high level IPM.

Sixty-one percent of orchardists produced most of their income from the farm. Over one-third worked elsewhere, and may have less time to spend learning about IPM and applying it. Scheduling of extension events will need to account for off-farm employment.

Fourteen percent of low level IPM adopters had a total gross farm income that was more than $50,000. This was below the overall crop average (i.e. without the IPM breakdown) of 45% who had a total gross farm income over $50,000. Only 7% of orchardists were under the age of 35. One-third were 55 years or older. Overall, 46% of orchardists had some post-secondary level education. A slightly higher percentage of high level adopters (56%) had a post-secondary education.

Farmers used a variety of information sources when deciding to apply pesticides: own experience/observations (28%), BCMAFF Guide (25%), a fieldperson (25%), pest management consultant (15%), and pesticide sales staff (4%).

Insecticides/fungicide applications were most common at the first sign of pests (44%). Economic thresholds (23%), calendar dates (13%) and evidence of crop damage (8%) were other decision points. Herbicide applications were most often made at the first sign of weeds or weed growth stage (49%) although 25% used economic thresholds.

Of those applying pesticides, farmers, their employees or family members operated sprayers at 99% of orchards. A combination of chemical and biological pesticides were used at 39% of orchards. Fifty-three percent used chemical pesticides while 6% used biologically based pesticides only. One percent used no pesticides.

Ninety-five percent of the farms that used pesticides used proper procedures that prevented contamination of their water source when adding water to spray equipment. Sprayer calibration occurred before the start of the crop season at 82% of orchards and between different pesticide applications at 9%. Equal numbers of orchards used stainless steel nozzles (32%) and brass (32%).

Good pesticide management practices included the use of spot spraying/spraying field edges (55%), rotating chemical classes to avoid resistant pests (76%) and treating seedlings to protect the crop in the early stages (13%).

Orchardists used a wide variety of beneficial pest management practices including: mulches (29%), the introduction of predators/parasites of insect pests (14%), the use of pheromones for insect mating disruption (14%), the use of disease or insect resistant varieties (19%) and adjusting timing of irrigation to prevent disease (51%). An impressive 72% encouraged natural predators/parasites of insect pests.

The development and implementation of the “Growing with Care” program by the BC Fruit Growers Association is expected to result in an increase in IPM adoption.

Field Vegetable Farms in the Fraser Valley

IPM is used on 85% of field vegetable crop area, with 78% of the area under medium or high level IPM. IPM is used by 84% of vegetable farmers with 67% using medium or high level IPM. These high adoption levels have probably been influenced by the activities of a private pest management company E.S. CropConsult which offers a pest monitoring and advisory service.

Eighty-five percent of vegetable farmers earned most of their income from the farm. Seventy-three percent had a total gross farm income above $50,000. Only 12% of farmers were under the age of 35, while 38% were 55 years of age or more. More high level adopters (75%) had some post-secondary level education compared to the average for the sector (27%).

Vegetable farmers commonly used their own experience/observations (43%) when deciding to apply pesticides. Other sources included: a pest management consultant (16%), BCMAFF Guide (14%), fieldperson (9%) and pesticide sales staff (5%).

Insecticides/fungicide applications were most common at the first sign of pests (30%) and when numbers were above economic injury levels (27%). Evidence of crop damage (19%) and calendar dates (16%) were other decision points. Herbicide applications were most often made at the first sign of weeds or weed growth stage (34%) and calendar dates (28%).

Farmers, their employees or family members operated sprayers at all vegetable farms that used pesticides. Eighteen percent of farms used a combination of chemical and biological pesticides while 73% used only chemical pesticides. Nine percent used no pesticides.

Ninety-seven percent of farms that used pesticides used proper procedures that prevented contamination of their water source when adding water to spray equipment. Sprayer calibration occurred before the start of the crop season at 74% of farms, and between different pesticide applications at 26% of farms. Brass nozzles were used at 61% of farms.

Good pesticide management practices included the use of spot spraying/spraying field edges (50%), rotating chemical classes to avoid resistant pests (68%) and treating seeds to protect the crop in the early stages (59%).

Vegetable farmers used a wide variety of beneficial pest management practices including: cultivation/rotary hoe (80%), mulches (30%), encouraging natural predators/parasites of insect pests (55%), using crop rotation to prevent pest problems (68%), adjusting planting or harvesting dates to avoid pests (23%), using disease or insect resistant varieties (52%) and adjusting timing of irrigation to prevent disease (41%). It is impressive that 25% tried to introduce predators/parasites of insect pests and 14% were still using this practice even though it is not widely available.

SWOT Analysis of IPM Adoption

Strengths

The following table summarizes the percentage of 1998 crop area producing grains/oilseeds, berries, tree fruit and field vegetables where integrated pest management (IPM) practices were used. IPM is used on a significant portion of farmland producing berries, grains/oilseeds, tree fruit and field vegetables.

Percent of production area under all levels of IPM, and percent of production area under medium or high IPM only.

Crop	**% production area using IPM**	**% production area using medium or high IPM**	**Total ha represented**
Berry	77	54	4974
Grain/Oilseeds	95	75	65618
Tree fruit	85	62	5975
Vegetables (field)	85	78	5258

IPM practices can be divided into low, medium and high levels based on whether they are preventive or reactive practices, and their compatibility with biodiversity and the environment. Ultimately, the objective is to encourage the use of high level IPM practices in the production of all crops. For the interim, it is useful to measure the percent of area using medium to high level IPM practices as an indication of progress.

More than 95% of farms used proper procedures, or best management practices, that prevented contamination of their water source when adding water to spray equipment. These included using a backflow preventer, nurse tank, separate water source, air gap or a combination of these.

The best management practice is to calibrate pesticide application equipment between applications of different pesticides. The next best practice is to calibrate before the beginning of the crop season. Of those using pesticides, over 95% of farms, except for tree fruit (93%), followed these two practices. Improvement would be made if more applicators calibrated between different pesticide applications.

Grower responses suggest a willingness to adopt IPM practices. Behaviors indicate that a critical segment of the farming population was willing to try new techniques such as introducing beneficial predator/parasites of insect pests, using pheromones and encouraging natural predators/parasites of insect pests--practices either in early adoption stages or not commercially available yet. Despite the registration of only three biologically based pesticides, 36% of orchardists and approximately 20% of berry and vegetable farmers used a combination of chemical and biologically based pesticides.

Orchardists had the highest overall level of post-secondary education (46%). Overall, 38% of farmers responding had some post-secondary education. Farmers using “higher level” IPM practices (medium and/or high) had more formal education than the average for the overall crop group.

It is the larger berry and vegetable operations, and to some extent grain/oilseed operations that have adopted higher levels of IPM. Operation size does not appear to be a major factor in the level of IPM adoption at tree fruit operations although the proportion that did not use IPM may have slightly smaller operations on average. More “high level IPM” berry farmers seemed to have incomes over $50,000 than the “no” to “low level” IPM adopters. Tree fruit producers who did not use IPM appeared to have lower income levels than those who used IPM. Grain/oilseed “low level” IPM adopters seemed to have lower income levels than “medium level” adopters.

Production guides are a key component of delivering IPM information. Guides are used extensively by producers and their agribusiness support systems. These are trusted and respected documents that promote current, practical, economical, and environmentally sustainable IPM-based production practices. Their bias is towards the public good. The development of web-based information will also enhance delivery of current IPM information. Pest management information for producers in BC has been designed with IPM principles since the 1970’s when biological control research and extension efforts put biological control agents into the greenhouse to control vegetable insect pests. It is now the greenhouse vegetable industry standard to use biological control agents for insect control.

Area-wide pest management programs encompass public areas, private lands, and orchards. They include population monitoring, advisory services, elimination of untended host trees (clean-up), and monitoring of compliance, as well as other innovative methods. Apple codling moth is managed by an area-wide pest management program in BC and the Okanagan tree fruit industry is planning to expand the program to include leafrollers and cherry fruit fly. Another example of area-wide pest management is the monitoring program initiated by the Abbotsford Raspberry Grower’s Co-op which encompasses 2200 acres of raspberries. Seventeen indicator fields are monitored for pests and crop development stages weekly. Results and recommendations are reported by fax, email or posting at the Co-op.

Farmers have an inherent self-interest to produce crops in a sustainable way. Overall, 86% of responding farmers owned over 33% of the land that they operated in 1998. The natural resources of soil and water must be preserved if they are to produce crops in the future. This attitude appears to be reflected in this survey.

Weaknesses

There are areas where the level of IPM adoption can be improved, especially in berries where one-half of the farmers are in the low to no IPM categories. Thirty-eight percent of the tree fruit responses were in the low to no IPM categories. However, the BC Fruit Growers Association started a program called “Growing with Care” in 1999 that emphasizes IPM practices in production and marketing. This will likely cause a greater increase in the adoption of IPM practices for tree fruit production.

Drawbacks to this IPM measurement system, like the USDA approach, are that it “does not recognize the concept of integration or compatibility among pest management tactics as envisioned by the founders of IPM. Simply mixing different management tactics does not constitute IPM. Mixing the tactics arbitrarily may actually aggravate pest problems or produce other unintended effects"[4]. The authors Ehler and Bottrell emphasize the importance of pest management consultants for ensuring compatible integration of tactics. They also propose greater funding for research on naturally occurring pest antagonists.

There are gaps in information on economic thresholds, the biology of pests and management strategies. Further research will be needed that is specific to conditions in BC.

Opportunities

Increased adoption will occur as research and demonstration efforts continue, as long as the industries remain economically viable. A strong relationship between researchers, extension staff, industry groups and innovative farmers will be required to address key research needs, access funding, and diffuse the information through the industry. It will be most effective to work with the industry innovators to explore and evaluate new practices. These innovators will influence adoption by the remaining farmers, especially with the support of specific IPM information such as fact sheets, short courses, web information, field days and up-to-date production guides.

The adoption of new practices may provide spin-off industries. In the 1970's, Jack Arrand of the BC Ministry of Agriculture, led the initiative to use biological insect control in greenhouse vegetables. This led to widespread adoption by the greenhouse vegetable industry and the development of companies to rear the biological agents for the growers. As research produces new control options, the commercial availability of more pheromones, biological control agents and IPM scouts may increase over time. This in turn, makes adoption of IPM practices easier, especially for the mid to late-adopters. The challenge will be the long-term economic viability of these services, which will depend upon a vibrant agricultural sector.

BCMAFF's Food Safety and Quality Branch has developed crop profiles on a number of key crops, with the BC Crop Profile Project. Crop profiles provide valuable information to the Pest Management Regulatory Agency for pesticide registrations and could potentially streamline the registration of more "reduced-risk" pesticides. Crop profiles can also be valuable tools to conduct a "gaps analysis" on priority pest management areas. The ability to focus on two or three key initiatives is an effective way of making progress when resources are limited. Crop profiles and the gaps analysis approach are recognized and encouraged by the Pest Management Regulatory Agency.

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[4] Ehler, L.E. and Bottrell, D.G. 2000. The Illusions of Integrated Pest Management. Issues in S and T. Spring 2000.

Threats

- ***Economic Realities***

  Farmers need a fair chance to make a living at farming. If farming is not profitable, IPM adoption is irrelevant.

  There was a trend for more of the high level IPM adopters to have total gross farm incomes over $50,000 than lower level adopters. Monitoring pest populations and crop health plus the use of preventive pest management practices make good business sense.

  There is a trend for larger farms to use higher level IPM practices more often. As the trend for increasing farm size continues in BC, it may favour more IPM adoption. It may be less viable for smaller operations to hire professional pest management expertise or devote time to focus on adopting IPM practices.

  Adequate research/demonstration of new IPM practices to assess expected costs and savings of IPM practices will be expected by farmers before adoption occurs.

  It would be useful to explore provisions within safety net programs that cover unexpected losses due to the failure of a new practice introduced by early adopters.

  IPM adoption may not always increase profitability for growers. However, an increase in these types of practices may help them maintain their market share in a global economy that is becoming more concerned with food safety and environmental issues.

- ***Effective Research and Extension***

  The development and adoption of IPM practices requires funding and support beyond that available from producer groups. Research and strategic extension of beneficial pest management practices benefit the public good. Support from Agriculture and Agri-Food Canada, BCMAFF and other funding agencies will be essential. The wide variety of crops produced in BC, from wasabi to canola, with all their different pest problems will test the creativity and energy of scientists developing the specific and integrated beneficial pest management information necessary for each crop.

  Environmental Farm Planning and On-Farm Food Safety programs will have a role in the continuing education of farmers.

  Industry needs to drive the process and direction of extension and research. Focus can be developed from the BC Crop Profile Project and “Gaps Analysis”. Close cooperation between industry, agency staff and consultants will encourage progress along the IPM continuum.

- ***The Aging Farmer Population***

  The farm operator population is aging and that has implications for pest management. Will older farmers be interested in adopting new technology? They may be more resistant to change than younger farmers, or, they could understand their farms better and financially be more secure in trying newer yet slightly riskier practices. Where will the younger and potentially more innovative farmers come from to replace the aging population? They do not always have a farming background. Will new entries receive good training on pest management practices that reduce the risk to the environment and food safety? Environmental farm planning and on-farm food safety programs are key initiatives that will provide some of the continuing education needs. Strategic extension activities to support the above, an environment that encourages private consultants, and IPM research and extension initiatives will be key to continued development of a farming population of high IPM adopters.

- ***Availability of Professional Pest Management Consultants***

  Currently there is a demand for more trained field scouts, and there are too few to fill the positions. Work is usually seasonal and wages are not high enough to retain trained people in the business, either as employees, contractors or sole proprietors.

  TerraLink announced in 2001 that it would no longer provide its IPM monitoring service (ProTect) for berries and vegetables in the Lower Mainland of BC because it was not profitable enough.

  There is concern that the Professional Pest Management Program at Simon Fraser University will not continue. Program graduates have become an important part of the pest management community in BC.

  As of 1997, BCMAFF staff specialists no longer provided one-on-one advisory services. There is a greater role for the private sector and consideration is needed to encourage a supportive environment for pest management consultants. Some interim economic stability is needed to encourage the private sector to develop the infrastructure to deliver on IPM services.

- ***Introduction of New Pests***

  It will be important to prevent new pest introductions as they can derail established IPM programs. The Canadian Food Inspection Agency needs to be encouraged to maintain their vigilance against new quarantine pests and to continue their good working relationship with BCMAFF.

  Farmers, extension staff and consultants play an important role in noting new pests of concern. Programs such as the BCMAFF Plant Diagnostic Lab are critical in identifying new pests when they first occur.

Engagement and cooperation of Agriculture and Agri-food Canada research staff, consultants and extension staff are critical success factors in developing and adapting pest management strategies to control new pests. Rapid access to funding sources is also essential to support research and survey activities in response to new pests. Industry associations, extension staff, and consultants are the usual mechanisms to inform farmers about new pests.

- ***Pesticide Regulations***

The need for newer, more IPM compatible pesticides is urgent, yet it is out of the control of producers. For example, in 1998 there was only one biological control product for disease control in Canada compared to over 25 in the USA. By 2002, there were only three. Others are needed to provide reduced-risk options to growers. In addition, softer insecticides that are more compatible with introduced and naturally occurring predators and parasites are required. The Pest Management Regulatory Agency needs to be encouraged to register reduced-risk products as expeditiously as possible.

Registrants must be convinced to bring their products to the Canadian market. Incentives could include assurances of timely and cost-effective reviews at the Pest Management Regulatory Agency and awareness of potential markets in Canada. The typical biologically-based pesticide company is small and located in a global market. Grower associations and the BCMAFF can create awareness of market opportunities in Canada and work with these companies to encourage them to pursue registrations in Canada. Agencies can also encourage joint registration submissions between countries.

It is a challenge to effectively address the efficacy of biological control products. Is 50% control adequate for a registration? Practices cannot be considered in isolation. Rather, products need to be considered for their potential role in the pest-crop spectrum and in pesticide resistance management.

Effective field trials require the pest to be present at sufficient levels for significant results in both biocontrol and conventional pesticide trials. Adequate resources and time are required to find appropriate trial sites and co-operators. The Pest Management Regulatory Agency’s 2002 announcement for increased Minor Use Program funding and the establishment of the reduced-risk pesticide category was welcomed.

Agriculture and Agri-food Canada has allocated funds to the Minor Use Program and will be more actively involved in data generation to support minor use registrations. This will help grower groups across Canada with extra costs and time associated with completing minor use registrations. In 2003, ten research stations across Canada will generate data and screen products for minor use registrations. There were previously only two research stations involved.

Recommendations

The following recommendations will guide BCMAFF agriculture policy and extension on IPM.

1. Encourage industry to drive the process and direction of IPM extension and research. Focus can be developed from the BC Crop Profile Project and “Gaps Analysis”.
2. Recognize that the development and adoption of IPM practices requires funding and support beyond that available from producer groups.
3. Encourage engagement and cooperation of Agriculture and Agri-food Canada research staff, teaching institutions, consultants and extension staff in the development and adoption of pest management strategies, including economic thresholds, to control new and existing pests.
4. Use demonstration activities or study groups to promote IPM activities.
5. Encourage pesticide applicators to calibrate between different pesticide applications throughout the year instead of only at the beginning of the crop season, and replace nozzles all at once to ensure even delivery of the pesticide.
6. Facilitate transitional measures to encourage greater economic stability of the private sector that delivers IPM monitoring and research for growers.
7. Encourage adequate research/demonstration of new IPM practices to assess expected costs and savings of IPM practices.
8. Participate in environmental farm planning, on-farm food safety programs and strategic extension activities on IPM initiatives to promote a farming population of high IPM adopters.
9. Explore provisions within safety net programs to cover unexpected losses due to the failure of a new practice introduced by early adopters.
10. Encourage the Canadian Food Inspection to Agency to maintain their vigilance against new quarantine pests.
11. Facilitate rapid access to funding for research and survey activities in response to new pests.
12. Encourage the Pest Management Regulatory Agency to register reduced-risk products as expeditiously as possible.
13. Educate and invite registrants to bring their products to the Canadian market.

Appendix A

Integrated Pest Management Definition

Integrated Pest Management (IPM) is a systematic decision-making process that supports a balanced approach to managing crop and livestock production systems for the effective, economical and environmentally-sound suppression of pests.

The Elements of IPM Include:

1. planning and managing agricultural production systems to prevent insects, plant diseases and weeds from becoming pests;
2. identifying pests, their natural enemies and damage;
3. monitoring populations of pests and beneficial organisms, pest damage, and environmental conditions;
4. making control decisions based on potential damage, cost of control methods, value of production, impact on other pests, beneficial organisms and the environment;
5. using strategies that may include a combination of behavioural, biological, chemical, cultural and mechanical methods to reduce pest populations to acceptable levels;
6. evaluating the effects and efficacy of management decisions.

The IPM concept has evolved in response to problems caused by an over-reliance on chemical pesticides. Some of these problems are development of pesticide resistance, elimination of natural enemies of pests, outbreaks of formerly suppressed pests, hazards to non-target species, and environmental contamination.

IPM requires knowledge of how to identify pests and evaluate their damage, how to identify natural control agents, and how to select effective control methods that minimize undesirable side effects. Selection of controls for individual pests must be made with the entire crop management system in mind. Many cultural control methods are carried out as part of normal crop production operations.

Appendix B

Statistics Canada's Resource Management Questionnaire – Crops
(Key questions on the pest management component)

Your Operations (Total area)

1) When reporting land areas, will you be using: *(1 section = 1 square mile = 640 acres)*
❒ Acres? ❒ Hectares?

2) Please report the total area of land operated in 1998, broken down

into the following:	**Area**	
Total area owned *(do not include land leased to others)*………………………………………………………………..	1.	
Total area leased from governments…………………………………………………………...	2.	
Total area under a grazing permit on crown land, with no lease payment...	3.	
Total area sharecropped, rented or leased form sources other than government……………………………………………………………	4.	
Total area owned by a private source, for which there is no rent or lease payment…………………………………………………………	5.	
Total land operated in 1998 (confirm)……………………………………………………………….	6.	

Farm Type

3) Thinking of your farming activities in 1998, from which agricultural activity did you derive 51% or more of your gross farm income? (*Read: Check only one*)

1.	❒ grains or oil seeds		7.	❒ greenhouse or mushrooms (under cover)
2.	❒ tree fruits or grapes		8.	❒ livestock
3.	❒ berries or vegetables		9.	❒ other (specify)
4.	❒ field floriculture or nursery products *(eg. Bulbs, flowers, seedlings grown in the open)*			**If 'greenhouse', 'livestock' or 'other' marked, thank the respondent and end.**
5.	❒ crop combinations *(eg. Fruit and vegetables)*			
6.	❒ other crop (specify) ___________________________			

If one of the above marked, continue.

4) What is the total area of each crop type harvested in 1998?

	Area	
cereal grains and oilseeds …………………………………………	1.	
forage crops………………………………………………………	2.	
tree fruits…………………………………………………………	3.	
grapes………………………………………………………………..	4.	
berries………………………………………………………………….	5.	
field vegetables (not greenhouse)…………………………………	6.	
field grown flowers or bulbs (not greenhouse)……………………	7.	
nursery products……………………………………………………..	8.	
other crop (specify)…………………………………………………	9.	
	10.	
	11.	

Pest Management

Now I would like to ask a few questions about the various pest control practices you may be using on this operation. For the purposes of this survey, **"pests" include: weeds, plant diseases, and insects only** (not animals or birds).

5) The first question is about pesticides you may have used in 1998. The terms **"pesticide" includes insecticide, herbicide, and fungicide**. In 1998, did you *(read; mark only one)*

1. ❒ use only chemical pesticides
2. ❒ use only biologically based pesticide *(eg. Dipel, Foray, Dygall)*
3. ❒ use both chemical pesticides and biologically-based pesticides
4. ❒ use no pesticides in 1998 *(Go to question 16)*
5. ❒ don't know *(only for contract spraying, if the respondent really doesn't know)*

6) Whose advice do you rely on most in deciding when to apply any pesticides? Is it mostly from: *(read; mark only one)*

1. ❒ a field person who recommends action
2. ❒ a neighbour who is applying pesticides
3. ❒ a pest management consultant who recommends action
4. ❒ the BCMAFF production guide recommendations
5. ❒ a pesticide salesperson who recommends action
6. ❒ your own experience/observations (no advice from others)
7. ❒ other (specify) ____

7) In 1998, did you apply … *(read, mark all that apply)*

1. ❒ insecticides *(ask question 8)*
2. ❒ fungicides *(ask question 8)*
3. ❒ herbicides (ask question *9*)

8) How do you decide when to **apply insecticides or fungicides**? Would you say application is mostly: *(read; mark only one)*

1. ❒ based on calendar dates/fixed schedule
2. ❒ done at the first sign of pests/disease
3. ❒ done after evidence of crop damage
4. ❒ done when pest numbers are above the economic injury level
5. ❒ other (specify) ____

9) How do you decide when to apply **herbicides**? Would you say application is mostly: *(read; mark only one)*

1. ❒ based on calendar dates/fixed schedule
2. ❒ done at the first sign of weeds
3. ❒ based on crop growth stage
4. ❒ done when weed levels are above the economic injury level
5. ❒ other (specify) ____

10) The next questions refer to all spraying of pesticides. Do you (family member/ partner/employee) operate your own sprayer?

1 ❒ Yes (*go to question 11*) 2 ❒ No (*go to question 16*)

11) The maintenance of sprayers varies quite a bit. Which of the following best describes how you maintain your nozzles. Do you mostly: *(read, mark only one)*

1. ❒ replace all nozzles all at once (*go to question 12*)
2. ❒ replace nozzles one-at-a-time, as needed *(go do question 13)*
3. ❒ other/haven't replaced yet *(go to question 13)*

12) How often do you replace all the nozzles on your sprayer? *(read; mark only one)*

1. ❒ at least once per year
2. ❒ at least every two years
3. ❒ every three years or more
4. ❒ can't remember/can't say for sure

13) What material are your nozzle tips made of*: (read; mark only one)*

1. ❒ brass
2. ❒ stainless steel
3. ❒ hardened stainless steel
4. ❒ ceramic
5. ❒ other (specify) ___________________________
6. ❒ don't know

14) When do you calibrate your sprayer? Is it usually … *(read; mark only one)*

1. ❒ when it breaks down or when major components are replaced
2. ❒ before the beginning of each crop season
3. ❒ between applications of different types of pesticides
4. ❒ other (specify) _____________________________________

15) Which, if any, of the following do you use when filling application equipment? *(read; check all that apply)*

1. ❒ use a backflow preventer valve
2. ❒ use a nurse tank
3. ❒ use separate water source for sprayer
4. ❒ leave an air gap between the filler hose and water in the spray tank
5. ❒ none of the above

16) Pest control can also involve a variety of other methods for different crops. For each of the following please tell me whether **you have ever tried it for pest control <u>on this farm</u>** and whether **you are still using it.**

		Have you ever tried? for pest control?		**(If yes) Are you still using it?**	
		Yes	**No**	**Yes**	**No**
1.	Cultivation or using rotary hoe for weeds	❒	❒	❒	❒
2.	Using mulches for weed control	❒	❒	❒	❒
3.	Spot spraying/spraying field edges	❒ No pesticides used ❒	❒	❒	❒
4.	Using pheromones for insect mating disruption *(exclude Sterile Insect Release Program)*	❒	❒	❒	❒
5.	Rotating pesticide classes to avoid resistant pests	❒ No pesticides used ❒	❒	❒	❒
6.	Introducing predators/parasites of insect pests	❒	❒	❒	❒
7.	Encouraging natural predators/parasites of insect pests	❒	❒	❒	❒
8.	Planting disease or insect resistant varieties	❒	❒	❒	❒
9.	Treating seeds/seedlings (chemical, heat, microbal) to protect crop in early stages	❒	❒	❒	❒
10.	Rotating crops specifically to prevent pest problems	❒	❒	❒	❒
11.	Adjusting planting or harvesting dates to avoid pests	❒	❒	❒	❒
12.	Adjusting timing of irrigation/watering to prevent disease	❒	❒	❒	❒
13.	Using trap/companion crops to protect main crop	❒	❒	❒	❒

Operator Profile

17) Do you earn?
1. ❒ most of your income from farming
2. ❒ about half your income from farming
3. ❒ less than half your income from farming

18) In 1998, what was the total gross farm income (before deducting expenses) of this agricultural operation? Was it:
1. ❒ less than $25,000
2. ❒ $25,000 to $50,000
3. ❒ over $50,000

19) Are you:

1. ❒ under 35 years
2. ❒ 35 – 44
3. ❒ 45 – 54
4. ❒ 55 years or older

20) Which of the following best describes the formal education you have completed: *(read; mark only the highest)*
1. ❒ some schooling
2. ❒ completed high school
3. ❒ some post-secondary
4. ❒ college diploma
5. ❒ university degree

Data Sharing
To avoid duplication and response burden Statistics Canada has entered into a data sharing agreement with the British Columbia Ministry of Agriculture, Food & Fisheries for the joint collection of this information. Your name and address will not be given to the British Columbia Ministry of Agriculture, Food & Fisheries. Your responses will be kept confidential and can only be used for statistical purposes.

Do you agree to share your anonymous responses with the British Ministry of Agriculture, Food & Fisheries?

1 ❒ Yes 2 ❒ No