
APPLE IPM TRANSITION PROJECT FINAL REPORT

WSDA Specialty Crop Block Grant Program

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Tree Fruit Research & Extension Center

Apple IPM Transition Project



Table of Contents



| | |
|------------------------------------|-----------|
| Project Summary | 2 |
| Project Approach | 3 |
| Goals and Outcomes Achieved | 12 |
| Beneficiaries | 14 |
| Lessons Learned | 16 |
| Additional information | 16 |



Project Summary

The importance of this project lies in the value of apple production to Washington's economy. Apple accounts for approximately 70% of the Washington tree fruit industry, which contributes annually over \$6 billion to the state's economy. For Washington's tree fruit growers to remain competitive in the global marketplace, they must produce high quality, pest-free fruit. To meet requirements imposed by domestic and international regulatory actions, apple growers must successfully implement new integrated pest management (IPM) technologies.

The timely nature of this project is due to regulatory actions on insecticides used in apple resulting in the elimination of several products. Since 1996 the U.S. Environmental Protection Agency (EPA) has significantly restricted use of organophosphate (OP) insecticides, the primary pest control technology used in tree fruit production. In 2007, the EPA acted to implement a complete phase-out of azinphosmethyl (AZM, Guthion) by 2012. This insecticide has been the OP most used to control codling moth, which is the most important pest of apple in Washington. In addition, many overseas markets are imposing similar, or even more stringent, regulatory restrictions on commonly used pesticides, including AZM.

WSU research had shown that employing a range of reduced-risk OP-alternative insecticides in an IPM program could crop protection as effective as older, OP-based, programs. The need for this project lies in the fact that there were a number of *significant barriers* to the adoption of OP-alternative technologies. The OP-alternatives have lower efficacy, require more precise timing and better spray coverage, have different modes of activity requiring different use patterns, and are more expensive than products they are intended to replace. For Washington apple growers to adopt and manage new OP-alternative technologies, a systematic, extensive, and ongoing education and outreach effort was required.

The Apple IPM Transition Project (AIPMTP) addresses the critical challenges imposed by increased regulatory action restricting or eliminating old pest control technologies by enhancing adoption of new technologies via an industry-wide implementation of biologically intensive IPM. While the AIPMTP was not previously funded by the SCBGP a similar project, the Pest Management Transition Project (PMTP) had received funding from the Washington legislature based on the full support of the Washington tree fruit industry. A final report of the PMTP project can be found at <http://pmtp.wsu.edu/>. The current AIPMTP project built upon the foundation of educational materials and framework for delivering new IPM knowledge to growers and consultants developed in the PMTP. AIPMTP is using baseline information generated by the PMTP to demonstrate changes in IPM practices over time. The AIPMTP built on the established working relationships with the farm worker community to enhance their understanding and support of IPM transitions occurring in the Washington tree fruit industry.

The goals of the AIPMTP were to:

- *accelerate the adoption of new IPM technologies through educational programs and communication of research-based knowledge,*
- *improve real-time pest management decision-making through increased use of the web-based WSU Decision Aid System, and*
- *document changes in practices, attitudes, and perceptions of growers, IPM consultants, and farm workers.*

Significant Results and Impacts

- National survey data (2009 NASS Pesticide Use Survey) showed that Washington apple growers had reduced use (acre applications) of OP insecticides by 54% compared to 2007, when the original PMTP project started, a 270,00 pound reduction.
- Implementation Unit survey results showed that most participants (79%) reported that codling moth *did not* cause unacceptable damage in their apple orchards in 2009.
- The IU survey also revealed that 53% of the participants used or recommended AZM, a much lower percentage than the industry-wide percentage (93%) of consultants and 80% of growers who used AZM in 2007 and 2008, respectively.
- 85% of IU participants used or recommended codling moth mating disruption, a higher percentage than growers reported in 2008.
- The 2009 crop year consultant survey revealed that this group was more knowledgeable about and felt more in control of pest management in a world without AZM, and that fears of codling moth damage increasing had declined.
- Organophosphate (OP) recommendations by consultants for codling moth control decreased between 2007 and 2009, 83% and 93%, respectively.
- In 2009, more consultants felt that there were effective alternatives to AZM and that the phase out would protect the health of agricultural workers and the environment than in 2007.
- The Implementation Unit Handbook was updated and *published in Spanish*.
- A pesticide safety poster was developed and used to educate farm workers about OP-alternatives and this poster was very well received by growers/managers as tools to work with their workers.
- A redesigned front page of WSU DAS provided highlights of seasonal-specific issues to alter growers to them in a timely manner.
- New tutorials were developed for the WSU Decision Aid System and this on-line system was translated into Spanish.
- DAS was reformatted to optimize it for search engines, i.e. to make certain pages and the RSS feed more search engine friendly.
- Impact of DAS: The majority of survey participants (56.0%) indicated an increase in the level of pest control due to the use of DAS.

Project Approach

Accelerate the adoption of new IPM technologies through educational programs and communication of research-based knowledge

The AIPMTP delivered new knowledge to the apple industry through Implementation Units, a web site, newsletters, traditional meetings, publications, and the WSU Decision Aid System.

Implementation Units. Implementation Units are groups of growers and consultants who desired to meet together to improve their understanding of how to use new OP-alternative technologies in their apple IPM programs. These groups were small in size, 6 to 25 members, distributed throughout the state, and were comprised of industry leaders and early adopters.

In 2010 we met with two new IUs and held several meetings with other IUs during the growing season. It was obvious that the existing IUs had a good understanding of the transition from AZM to new reduced risk technologies associated with control of the codling moth. However, there remained questions on how to deal with secondary pests, especially the woolly apple aphid and in 2010 the rosy apple aphid.



Implementation Unit meeting in Quincy, WA.

Website. The AIPMTP website is a primary means of delivering information on current issues to clientele as well as preserving archives of historical information. The website developed under the previous project was redesigned and reorganized to improve visitor satisfaction and accessibility. The navigation structure was streamlined to make it easier to find desired content. On the Home page 'Special Interest' links were reduced and reclassified by type: News & Events, Industry Links and IPM Resources for quicker access. New features added to all pages were 'Share' links, which allowed visitors the ability to print, email or to share page content on social media websites such as Facebook and Twitter. An easier 'subscribe' method was included allowing people to be added directly to an automated mailing list to receive newsletters and meeting/event notices. Other additions to the site include publication of all progress reports and all surveys as soon as they are completed. These reports are also made available for downloading as PDFs from the related web page.

Analysis of the site visitor log showed that the most popular pages were the newsletter pages (current and archived issues) to view or download issues (32%), the fruit school page to watch videos (14%), the handbook page to download it by section or in its entirety (10%) and the tours and events page to watch slideshows or download event packets or flyers (8%). Most visitors viewing the site did so by way of: referring links on other sites including industry link pages, DAS, Twitter and Facebook (33%); bookmarks (30%), indicating a desire for repeat viewing; a keyword search (24%); or by using the link contained in the subscriber email notice (12%). Overall, site visits peaked when new newsletters or events were announced via emails, Twitter and Facebook, but a steady stream of visitors found the site via search engines and referring industry links.

AIPMTP Handbook. The handbook developed during the previous project was updated and reprinted for use in the AIPMTP educational activities in 2010. References to the old codling moth degree-day model were updated to reflect the model used in the WSU Decision Aid System (DAS). In addition, a thorough explanation of how degree-day models are used in orchard IPM and how they are used in conjunction with DAS was added. Other changes to the handbook include an expanded pest monitoring section, an expanded secondary pest discussion, an updated web references section, and the addition of a natural enemies pictorial guide to the appendices. The updates include some changes in insecticide use recommendations and new information on the impacts of insecticides on natural enemies. A completely updated version of

the AIPMTP Handbook is available as a pdf on the projects web site - <http://pmtp.wsu.edu/handbook.html>.

Translation of the AIPMTP Handbook from English to Spanish was completed, published, and disseminated. This tool serves as a great aid to the Spanish-speaking growers in Washington who are very interested in transitioning their IPM programs to new and safer technologies. An example of a page of the Spanish Language Handbook is shown to the right. As with the English version of the handbook, the Spanish version is available as a pdf download from the project website.

Educational Newsletters. Five issues of the project newsletter were produced and disseminated. All newsletters can be viewed online on the project website, where they can also be downloaded for printing (<http://pmtp.wsu.edu/newsletters.html>). Back issues of the newsletter are available to view or download from an archive index page. There are nearly 400 subscribers receiving the newsletter either electronically or by post. A new automated newsletter subscription link was added to the website allowing people to join the electronic mailing list. With the automated electronic subscription we can tell not only who receives the newsletter, but also who actually views it online or downloads the pdf version and who forwards the newsletter announcement to others.

Specialized Farm Worker training. IPM presentations were made at two WSU-sponsored pesticide re-certification classes (Pasco and Wenatchee) as well as at the Washington Tilth Organic Producers Association conference, the Washington State Horticultural Association conference, and the GS Long annual meetings to a total of 788 Spanish-speaking pesticide applicators and supervisors (with some growers, managers, and consultants in the mix). During these sessions, questions were asked using the Turning Point audience response system to survey participants on their knowledge of the pesticide transition and pesticide health and safety. Summary results from these surveys are presented under the section on documentation (page 11).



Example of a page from the AIPMTP Handbook translated into Spanish.



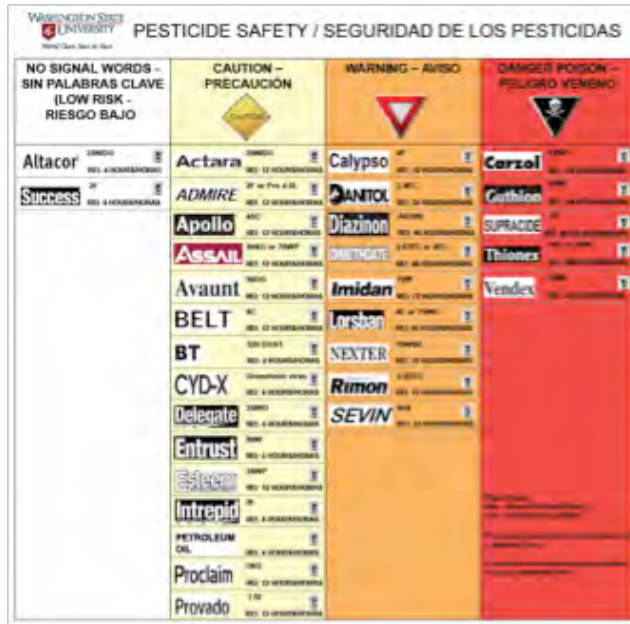
Organizers of Health Fairs in Monitor and Malaga, WA, 2010.

Final results of the specialized farm worker training surveying participants on their knowledge of the pesticide transition and pesticide health and safety during winter 2009-2010 are posted on our website (http://pmtip.wsu.edu/TPsurvey2010_Sum.html) alongside comparative results from 2008-2009. Results showed that the pest management transition is underway in apple orchards, as IPM tactics and alternative insecticides are becoming more widely available, understood, and used by pest applicators and supervisors as well as growers and consultants.

A pesticide safety poster was designed to help farm workers better understand the differences in human toxicity between organophosphate insecticides and newer alternative insecticides was created, presented, and distributed to 60 farm worker health outreach workers at the Washington Association of Community and Migrant Health Center spring outreach training in April. Participants caught on very quickly as to how to read the poster and how they could use it in their outreach to farm workers. Fifteen of these outreach personnel also agreed to be contacted later in the summer to provide feedback on how useful the poster was (or was not) for communicating health and safety information to migrant and seasonal farm workers during the 2010 season. The poster was also distributed to growers and managers for display at orchard workplaces, and is posted online for easy downloading (http://pmtip.wsu.edu/Ref_tools.html). Finally, the poster was presented and distributed to farm workers at health fairs at worker housing camps in Monitor and Malaga through the playing of a pesticide safety roulette game designed to teach participants how to read and interpret the poster. These health fairs were sponsored by the Washington Association of Community and Migrant Health Centers, Columbia Valley Community Health, and AIPMTP, and attended by about 425 people total (275 in Monitor, 150 in Malaga).

AIPMTP also participated this quarter in a research review of the University of Washington's Pacific Northwest Agricultural Safety and Health Center to identify research priorities in worker health and safety for the coming years.

Presentations on AIPMTP were given at the Department of Pesticide Safety Registration tour in Prosser in July and the Washington State Association of Public Health professionals conference in Yakima in October. In addition, the pesticide safety poster was presented and distributed to farm workers and community members at the Quincy Community Health Clinic back-to-school health fair in August.



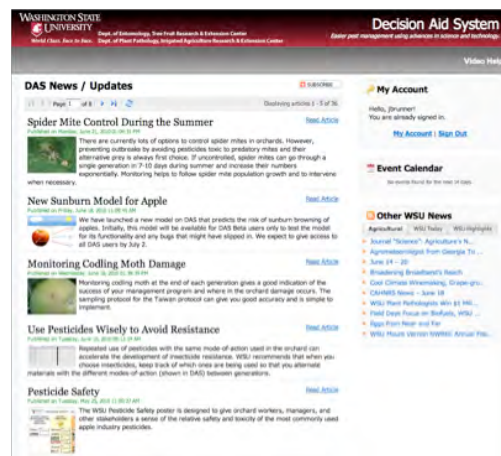
Pesticide safety poster showing relative risk of different insecticides commonly used in apple orchards.

Improved real-time pest management decision-making through increased use of the web-based WSU Decision Aid System

WSU Decision Aid System. Dr. Ute Chambers served as Manager of the WSU-DAS in 2010. She worked with the AIPMTP team to integrate educational and outreach activities of WSU-DAS where her background in IPM research and implementation was very valuable. She participated in the Implementation Unit meetings to review the new features of WSU-DAS and interacted with consultants and growers on their needs for IPM education.

The online video tutorials and online DAS Manual were completed and implemented in the WSU-DAS Help Center. Both help features assist old and new users in accessing and using the system to its capacity. The WUS DAS monitoring system shows that the video tutorials have been viewed frequently (393 times in total). The most viewed tutorials are “Set Up a New Weather Station” (121 times) and “View Model Options” (82 times).

The re-designed front page of DAS now *highlights seasonal-specific issues* growers need to be concerned with. These stories are regularly updated and cover a wide range of information from insect control tactics to spray drift to bee pollination. Many of these posts are based on work done in the AIPMTP and include links to the AIPMTP homepage and newsletters, as well as other IPM related websites of WSU. To date, 36 stories have been posted on the DAS front page. The number of views per story ranges from 21 to 295 (total 3319). The most read stories are “DAS is now on the iPhone” (295 views), “DAS workshops” (246 views), “New codling moth degree-day/development table” (218 views), and “Leafroller and codling moth movement during the season” (210 views). The first two stories have been published the longest.

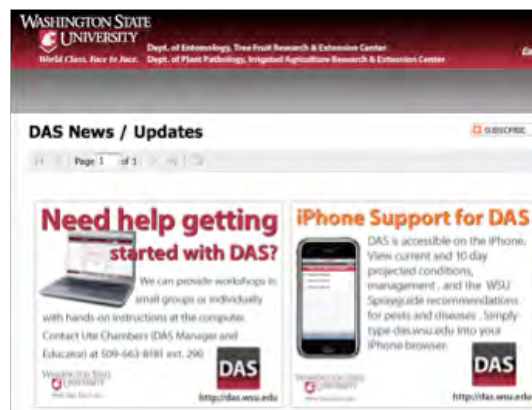


DAS front page showing examples of seasonal-specific issues of interest to growers.

An online survey of 2010 registered users was conducted. The results of this survey have been compiled and are presented in the documentation section (page 8).

An **iPhone compatible web format of WSU-DAS** was launched in February 2010, which allows users to access DAS from anywhere in cell phone reception range. Users can view current and projected pest conditions and management recommendations as well as the Mini WSU Spray Guide.

All pest conditions and management recommendations on WSU-DAS have been translated into Spanish. Various options are being considered how to translate everything else on the website, including links, buttons, table headings, etc. Google Translate is being tested as one of the options. *The Spanish WSU-*



DAS was opened up in May 2010 for our beta-testing group, which includes several native speakers, to evaluate the Spanish language part of the system.

DAS has been reformatted to optimize it for search engines, i.e. to make certain pages and the RSS feed more search engine friendly. As a result, Google has been indexing far more information in the last two weeks than in the past (number of pages crawled per day). Over time, this improves search engine placement and will make the WSU-DAS website more easily available to the average web user. Additionally, all video tutorials for DAS have been published on YouTube.com to increase DAS' Internet visibility.

We are in the process of planning and designing new filters for the DAS pesticide database (WSU Spray Guide). These filters will allow users to search for pesticides that specifically have a low or no negative impact on certain natural enemies with the goal to enhance biological control. Also, the new filters will assist users with resistance management by enabling the user to search for pesticides with a resistance class (mode of action) that is different from previously applied products.

MLR Database Development. We have begun a collaborative effort with the Northwest Horticulture Council (NHC) on the development of a database that would allow for real-time updates of maximum residue level (MRL) information for the benefit of the tree fruit industry. An initial meeting between NHC staff and the AIPMTP team and WSU Decision Aid System (WSU-DAS) Manager and programmer established the criteria for the database. The database will be dynamic in that it will allow users to query the MRL information maintained by the NHC by country of interest, chemical of interest and crop of interest, or combinations of these. The database will also be constructed to allow WSU-DAS access to the information and incorporate it into the on-line system used by all crop consultants and many growers and managers in the state. This information is becoming more and more important as growers adopt new insecticides in place of AZM or other organophosphate insecticides. Growers need to know what countries have MRLs for which new insecticides when they are making real-time management decisions on controlling their pests. The MRL database is expected to be available early in 2011.

Outreach. During the winter 2009/2010, talks on the WSU-Decision Aid System were presented at six industry sponsored grower meetings (North Central Washington Apple Day, Wenatchee; North Central Washington Stone Fruit Day, Wenatchee; Okanogan County Horticulture Society Meeting, Okanogan; Northwest Wholesale, Brewster; Chelan Fruit Growers Day, Okanogan; and Wilbur Ellis, Tonasket), as well as at the GRAS2P Orchard Sustainability Workshop, the Western Orchard Pest and Disease Management Conference (Portland, OR), the WSU Pesticide Education Program (Wenatchee), and the International Cherry Growers Tour (Wenatchee). In addition, updates on the Decision Aid System were presented at three Spanish language pesticide recertification classes (Wilbur Ellis, GS Long, and WSU Chelan County Extension), as well as through poster presentations at the Washington State Horticultural Association conference in Wenatchee and the annual meeting of the Pacific Branch Entomological Society of America in Boise, ID. Also, updates on DAS were featured in the March 2010 issue of the magazine Good Fruit Grower.

A mailing campaign (emails as well as postcards) was launched in January 2010 to AIPMTP IU members to advertise DAS training workshops this season. Additionally, DAS training workshops are continuously advertised on the DAS home page. Between February and June 2010, 12 workshops (20 hours in total) were held on request in small groups (3-9 people) or individually. A total of 51 participants were walked step-by-step through all features available on DAS. All participants could experience DAS hands-on for themselves at their own laptops or with notebooks provided from the DAS-AIPMTP mobile computer lab. Two workshops were held for

Hispanic growers, who had not used the system before, demonstrating the features of DAS, including the Spanish web sites. Further mailing campaigns are planned in January 2011.

Workshop participants were asked to fill out an evaluation questionnaire at the end of each workshop to assess if the participants increased their knowledge on how to use DAS and where the training sessions can be improved. The overall assessment of the workshops was very positive, and all participants learned new ways to use DAS for their operation. Several suggestions were offered on how to improve future training. The workshops also gave valuable insight in how people use DAS, what features they use and do not use. For example, the filter options in the WSU spray guide and the historic weather data center have not been widely used. Such observations allow us to tailor our educational efforts more effectively and to improve the DAS interface to be more intuitive and self-explanatory.

Document changes in practices, attitudes, and perceptions of growers, IPM consultants, and farm workers

Implementation Unit Survey. At the beginning of this project, in the fall of 2009, we used the Turning Point audience response system to assess learning and knowledge of alternative insecticides and IPM practices, and to gather feedback to improve Implementation Units for 2010. Evaluation results showed that most participants in Implementation Units were grower/managers (62%) or warehouse fieldmen (23%), 85% of whom made or contributed to apple pest management decisions. Fifty-two percent used or recommended AZM, a much lower percentage than the industry-wide 93% of consultants and 80% of growers who used or recommended AZM in 2007 and 2008, respectively. Among Implementation Unit members, 81% used or recommended alternatives to AZM, especially Delegate (81%), Assail (71%), Altacor (67%), and Intrepid (65%), and 85% used or recommended codling moth mating disruption, again both values higher than industry-wide percentages.

Pests apple growers identified as causing unacceptable crop damage over the past three years (2006-2008).

| Insect | Frequency | Percent |
|--------------------|-----------|---------|
| Codling moth | 228 | 56.6 |
| Leafroller | 90 | 22.3 |
| Woolly apple aphid | 83 | 20.6 |
| Rosy apple aphid | 50 | 12.4 |
| Stink bug | 40 | 9.9 |
| Thrips | 40 | 9.9 |
| Campylomma | 37 | 9.2 |
| San Jose scale | 35 | 8.7 |

Most Implementation Unit members (79%) reported that codling moth *did not* cause unacceptable damage in their apple orchards in 2009. Some expressed concern about leafroller (37%) and woolly apple aphid (27%). Most (65%) had used the WSU Decision Aid System (DAS) in 2009 to help time IPM activities, and 89% indicated an interest in learning more about DAS. Of those interested in learning, 48% preferred instruction in small group hands-on workshops, 21% preferred using video tutorials and the DAS manual online, and 17% preferred individual lessons with WSU Extension educators. These results showed us that Implementation Unit members had experienced success in transitioning their IPM programs to use of OP-alternatives and provided guidance on educational needs for Implementation Unit meetings for 2010, especially DAS education opportunities. For more results see the AIPMTP web site (http://pmtip.wsu.edu/survey_IUres1.html).

Apple Grower Survey. An apple grower survey was mailed in February 2009 to orchard owners. We had a response rate of 27% (403 surveys returned out of 1,458 eligible participants). We know from survey results that most growers (57%) thought codling moth was the most

important pest they faced, that 80% of them were using AZM, and that 65% of them, representing 87% of apples acres in the state, were using pheromone mating disruption for control of their most important pest, the codling moth. Many growers also reported using OP-alternative insecticides such as Assail and Delegate and integrated pest management (IPM) tactics such as field monitoring and pheromone traps. The greatest barriers to use of OP-alternative insecticides were cost, effectiveness, and secondary pest flare-ups (aphids and mites) associated with increased use of products such as Rimon and Delegate. Over half the survey respondents had heard of the PMTP, and 62% were interested in further training on how to use alternatives to AZM.

Results of the apple grower survey for 2008 season have been compiled and analyzed and are available on our web site (http://pmtip.wsu.edu/survey_GroS.html). These data were the basis for a Good Fruit Grower magazine article and a publication in the journal Agriculture, Ecosystems, and Environment (accepted for publication). In addition, we have also compared our survey data with those from previous National Agriculture Statistics Service (NASS) surveys (see chapter on Goals and Outcomes Achieved). This effort, along with planned follow-up survey for the 2010 growing season, will document the AZM phase-out and transition to more sustainable apple IPM programs.

Apple Consultant Survey. The AIPMTP conducted a consultant survey in January of 2010. With the completion of this survey it is now possible to compare consultants' insecticide recommendations, knowledge of IPM tactics, and thoughts about the AZM phase-out with results from a similar survey conducted in 2007 to see how these recommendations, tactics, and thoughts have changed during the course of the AZM phase-out. While some of results remained the same between 2007 and 2009, other aspects changed. Highlights of these changes are as follows:

- In 2009, consultants perceived less damage from insect pests in apple orchards overall. Eighty-one percent (81%) felt that codling moth had caused unacceptable crop damage, down from 98% in 2007. Similarly, 47% felt that wooly apple aphid had caused damage compared to 70% in 2007, and 26% felt that spider mites had caused damage compared to 55% in 2007.
- In 2009, 18% of consultants felt that codling moth caused unacceptable damage every year, down from 67% of consultants in 2007. In 2009, fewer consultants (15%) felt codling moth injury had increased over the previous three years compared to 2007 (40%), and more consultants (68%) felt that injury had remained steady compared to 2007 (48%). Thus, the concern of strong and rising codling moth damage seemed to have decreased over this two year period.
- Organophosphate (OP) recommendations for codling moth decreased between 2007 and 2009. In 2009, 83% of consultants recommended AZM to control codling moth, down from 93% in 2007. And 74% stated in 2009 that their recommendations of OP insecticides for codling moth had decreased over the past three years, up from 35% in 2007.
- In 2009, consultants also perceived less leafroller damage, with 16% saying they found acceptable damage 2 out of every 5 years or more, down from 69% in 2007. Accordingly, fewer consultants recommended Lorsban in 2009 (61%) than in 2007 (80%), and a higher percentage did not recommend any OP insecticides for leafroller in 2009 (25%) as compared to 2007 (13%).
- In 2009, more consultants (69%) knew that 2012 would be the last year AZM could be used, up from 55% in 2007, and more answered correctly that the phase-out schedule would limit the total amount of AZM that could be used by a grower each year (52%, up from 32% in 2007). Thus, knowledge of the AZM phase-out had increased over time.

- In 2009, more consultants felt that there were effective alternatives to AZM (mean score rose by 0.25 on a 1-5 scale), and that the phase-out would protect the health of agricultural workers (mean score rose 0.35) and the environment (mean score rose by 0.3). More consultants also felt that growers would bear the burden of the AZM phase-out (mean score rose by 0.76), and that the cost and control of leafrollers would be more difficult after the phase-out (mean scores rose by 0.38 and 0.43). Fewer consultants felt in 2009 that control of codling moth would be more difficult (mean score dropped by 0.27) or that tree fruit production would be riskier for growers (mean score dropped by 0.41) after the AZM phase-out.
- In 2009, slightly fewer consultants (62%) were interested in additional training on how to use AZM alternatives to manage pests than in 2007 (75%). This might be in part because more had already received training through AIPMTP and other venues.

Overall, it seems as though consultants in 2009 were more knowledgeable about and felt more in control of pest management in a world without (or soon to be without) AZM, and fears of codling moth damage increasing because of the phase-out had declined. Some of these differences between 2007 and 2009 data could be due to a larger sample size used in 2009 (120 of 200 surveys completed in 2009, compared to 40 of 73 in 2007), or perhaps to a greater representation of consultants working in the southern tree fruit regions (15% increase in representation from Yakima and the Tri-Cities in 2009) than in the north (16% decrease in representation from Wenatchee in 2009), but mostly they are likely to be due to consultants' increased experience working with AZM alternatives and with the success of AIPMTP efforts to provide resources for transitioning away from AZM (45% of consultants in 2009 had participated in an AIPMTP Implementation Unit, and 87% knew about the AIPMTP). These results demonstrate significant benefit from AIPMTP outreach to consultants over the past several years.

Case Studies. While survey data, as described above, provides a broad picture of orchard owner, manager, and consultant decisions and trends for apple IPM, the case histories will provide depth to the story of the industry response to the AZM phase-out. Case histories consist of interviews with orchard owners or consultants that address how each orchard has decided to approach the AZM phase-out, the costs and benefits of those decisions, and the ways that changes in pesticide use have affected production costs, labor costs, yields, and apple pack outs. These histories, containing both qualitative and quantitative components, will feed into an economic model of the cost structure of the AZM phase-out.

Qualitative interviews for nine case study orchards have been conducted with pest management decision-makers on their approaches to the AZM phase-out, the costs and benefits of those decisions, and the ways that changes in pesticide use have affected costs and orchard operations. Quantitative data on production costs, labor costs, yields, and apple pack outs has been gathered from four of these nine cases, and is being used to design a database to organize and analyze all case study data yet to be collected. When data collection and analysis is complete, these case histories will provide a deeper understanding of the AZM phase-out and will also feed into an economic model of the cost structure of the phase-out.

Farm Worker Survey. Results from the farm worker surveys indicate that most respondents (71%) have worked with AZM and know that it was being phased out (82%). Most have worked with pheromones (77%), know well or somewhat well how to manage crop production without AZM (69%), and know well or somewhat well what IPM is (68%). These results are similar to data gathered in 2008-09. In 2009-10, however, knowledge of the timing of the AZM phase-out

was 33% higher than it had been in 2008-09, and the number of respondents who had worked with the OP-alternative insecticides Altacor, Calypso, and Delegate increased by 68%, 38%, and 23%, respectively. Pesticide safety data were fairly consistent between 2008-09 and 2009-10, and indicated that most respondents were aware of important safety measures for working with pesticides, such as personal protective equipment, re-entry intervals, and pesticide label information. In general, results showed that the pest management transition is underway in apple orchards, as IPM tactics and OP-alternative insecticides are becoming more widely available, understood, and used. There is, as always, room for participants to learn more about how to use IPM strategies to manage crops without AZM, and an ever-present need for reinforcement of safety knowledge and standards as the kinds of insecticides used change over time. Results of the 2008-09 and 2009-10 surveys are posted on our website (http://pmtip.wsu.edu/TPsurvey_res1.html).

DAS User Survey 2010. A survey of WSU DAS users was conducted in 2010. A summary of some results are presented below. More details are available in the chapter on Additional Information.

- Participants: 154 participants answered the voluntary user survey, 34.4% of active users. 40.3% of the survey participants started using DAS within the last 2 years.
- User occupation: The majority of the survey participants are growers/orchardists (60.8%), 37.9% are orchard managers, 20.2% work as Ag Chem distributor consultants, 16.3% are Packinghouse/ Company fieldmen, 13.7% work in research and/or extension, 9.8% work as private crop consultants, and 9.1% have other occupations.
- How easy is DAS to use: Most users rated the use of various features of DAS as easy or very easy. The average rating on a scale from 1 (= very easy) to 5 (= impossible without help) for first time registration, setting up a user profile, editing the user profile, viewing model results, viewing model charts was 1.8, 1.9, 1.9, 1.6, 1.7, respectively.
- Impact of DAS: The majority of survey participants (56.0%) indicated an increase in the level of pest control due to the use of DAS; 29.0% saw no change and 7.0% reported a decrease in pest control level (8.0% answered “not applicable”).
- We also asked how the user’s operation would be affected if DAS was discontinued next year. The majority of survey participants indicated that the discontinuation of DAS would have major or modest impacts on the user’s number of sprays (21.4% “major”, 49.0% “modest”, 29.6% “no impact”).
- DAS support: Almost half of the survey participants (45.6%) have requested any kind of support from the DAS team and rated the responsiveness, helpfulness, and friendliness good or excellent (100%, 95.2%, and 100%, respectively).
- Models used in DAS: The most used models on DAS are codling moth (93.0%), fireblight (79.7%), western cherry fruit fly (65.0%), oblique-banded leafroller (63.6%), cherry powdery mildew (58.7%), and Pandemis leafroller (54.5%). For 62.2% of the survey participants, the codling moth model was the most important model, while for 21.5% fireblight and for 5.2% western cherry fruit fly is the most important model.

Goals and Outcomes Achieved

A primary goal of the AIPMTP was to accelerate the adoption of OP-alternative insecticides by the Washington apple industry. Experiences shared by IU participants and others in the apple industry indicate that the transition has been achieved without major disruptions of pest control

programs. IU participants indicated that after two years of participation in the PMTP, a predecessor project to AIPMTP, that the use or recommendation of AZM (59%) was lower than that reflected in the consultant survey (67%). Eighty-four percent (84%) of IU participants either used or recommended the use of OP-alternatives for codling moth control and 65% used pheromone mating disruption. *Funding of the AIPMTP allowed us to continue working with the IU participants after the funding for the PMTP had ended, therefore results shared above are attributable to this project and reported on the AIPMTP web site (http://pmtip.wsu.edu/survey_Cres1.html).*

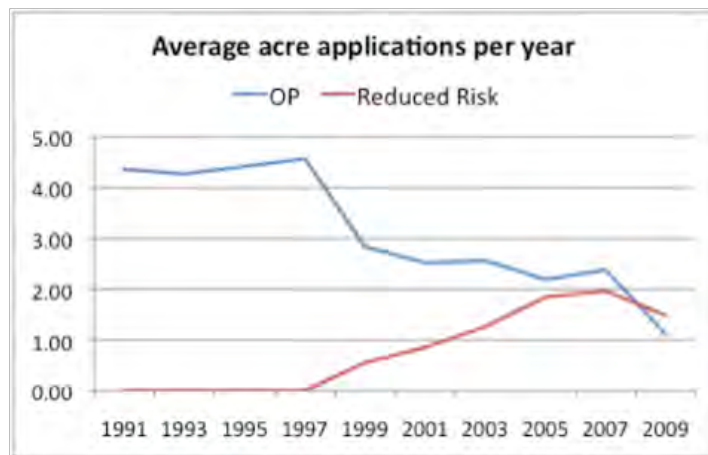
Surveys for consultants showed changes from 2007 to 2009, which represents a growing season prior to and one two years after the PMTP had been functioning (see Apple Consultant Survey). Highlights of changes between 2007 and 2009 include: a 31% drop in the concerns over unacceptable crop damage by codling moth, a 23% drop in concerns about woolly apple aphid, a 29% drop in concern about spider mites, a 10% reduction in recommendations to use AZM, a 39% decrease in the recommendations of OP insecticides, a 29% reduction in the recommendation to use Lorsban for leafroller control and a 14% increase in the number of consultants that knew the last year AZM could be used (Table 1). *Without the AIPMTP the 2009 consultant survey could not have been conducted so results of this activity are attributable to it.*

Table 1. Percent consultants responding to statements about pest control recommendations, 2007 vs 2009.

| Statement | 2007 survey results | 2009 survey results |
|--|---------------------|---------------------|
| Codling moth caused unacceptable crop damage | 98% | 67% |
| Woolly apple aphid caused unacceptable crop damage | 70% | 47% |
| Spider mites caused unacceptable crop damage | 55% | 26% |
| Recommended use of AZM | 93% | 83% |
| Recommendations of OP insecticides had decreased | 35% | 74% |
| Recommended use of Lorsban for leafroller control | 80% | 61% |
| Knew that the last year of AZM use was 2012 | 55% | 69% |

The 2008 apple grower survey serves as a baseline for the grower survey that will take place under the continuation of the AIPMTP through approval of an addition year of funding, 2010-11. By comparing the 2008 to the 2010 grower survey we will be able to document the contribution of the SCBG funded programs in changing practices and attitudes.

The National Agricultural Statistics Service (NASS) Pesticide Use Survey has been conducted on odd numbered years from 1991 through 2009 and provides a clear picture of changes in



Acres applications of OP and reduced risk (OP-alternatives) based on NASS Pesticide Use Survey data from 1991-2009.

pesticide use over time. The figure to the right shows changes in acre applications (percent acres treated time the average number of applications) of OP insecticides and reduced risk (OP-alternative) insecticides from 1991 through 2009. The decline in the acre applications for OPs in 1999 was due to regulatory action against these products and to the adoption of pheromone mating disruption for codling moth by the apple growers of Washington. The decline in acre applications of OP insecticides in 2009 compared to 2007, 55% representing a decline of over 270,000 pounds of OP insecticide, must in large part be attributed to the apple industry adopting reduced risk (OP-alternative) insecticides as mediated by efforts of the AIPMTP. The concurrent reduction in the acre applications of reduced risk (OP-alternative) insecticides in 2009 compared to 2007 suggests that apple growers were becoming more confident and were getting good results with these products.

The apple grower survey, 2008 crop year, serves as a baseline for the grower survey that will take place under the continuation of the AIPMTP through approval of an addition year of SCBG funding, 2010-11. When comparing the apple grower survey with NASS survey data there are some interesting observations. The 2007 NASS survey indicated 66% of acres used AZM while our 2008 apple grower survey indicated that 80% (of growers) used AZM at least one time. The average number of applications of AZM in our 2008 apple grower survey was 2.4, which is the same as the 2007 NASS survey (2.4), but higher than the 2009 NASS survey of 1.7 applications. Our apple grower survey identifies many more facets of pesticide use than the NASS surveys. For instance, 50% of apple growers in our 2008 survey indicated that they had decreased use of OP insecticides for codling moth in the previous three years while only six percent (6%) said that they had increased OP insecticides use during the same period. Interestingly nine percent (9%) said that they used no OP insecticides for codling moth control during the previous three years. Sixty-five percent (65%) of Washington apple growers indicated that they used pheromone mating disruption for codling moth control. However, the NASS survey does not pick the use of pheromones because they do not ask a question that growers recognize as being products used for mating disruption.

While it is impossible to separate changes in practices and attitudes of Washington apple growers and consultants between the AIPMTP and PMTP, it is obvious from the examples cited above and throughout this report that a significant impact can be attributed to this effort.

The contribution of the AIPMTP to enhancing and upgrading aspects of the WSU DAS in 2010 provided an easier platform for growers and consultants to use in setting up their personal accounts, learning about the features of DAS, and in accessing information. The number of users has almost doubled (451 active uses compared to 247 in 2008) as a result of the outreach activities and value of the decision support system. While the WSU DAS existed prior to the AIPMTP the value of the collaboration in 2010 is obvious and achieved the goals set out at the beginning of the project.

Beneficiaries

While this project is not considered truly complete, since one more year's funding has been authorized by the Specialty Crop Block Grant Program, we can identify groups and organizations that have benefited as a result of the AIPMTP activity to date.

The primary beneficiaries of the AIPMTP project have been the apple growers and orchard managers of Washington and the consultants that provide IPM advice to them. These groups

were the ones most directly impacted by EPA regulations on OP insecticides, especially on the phase-out of AZM. Because WSU had been conducting research for several years on the reduced risk, OP-alternatives that would replace OP insecticides, answers were readily available on the characteristics of these new pest control technologies and how to incorporate them into IPM programs. External funding provided the capacity to deal with barriers to adoption facing the Washington apple industry. The primary activity of the AIPMTP was to educate growers, orchard managers and consultants on the relative efficacy, timing and rates of OP-alternative products targeting codling moth and leafrollers and to inform them about unintended consequences of some OP-alternatives on beneficial insects (predators and parasites). These groups were informed using a variety of methods, which together produced changes in opinions, attitudes and, most importantly, practices. The evidence of changes in attitudes and practices has been documented in various survey results discussed in the documentation section of the chapter on Project Approaches (page 3) and the chapter on Goals and Outcomes Achieved (page 12).

The benefit to growers and orchard managers comes by achieving desired crop protection with minimal pesticide inputs, thus potentially reducing costs, and through efficiencies gained in farm labor management due to short re-entry periods (hours instead of days) of OP-alternatives compared to OP insecticides. The consultants were able to recommend crop protection programs based on sound science and to share their experiences with each other therefore expanding their knowledge base and gaining insights into practical programs that worked in different orchard settings and with growers that had differing risk aversions. Both groups benefited from improvements made in the WSU DAS, which allowed them to precisely time insecticide applications and helped them choose the from a list of products that best fit their crop protection goals.

The farm worker community was another beneficiary of the AIPMTP. Specialized farm workers, those who were employed to manage or apply pesticides to orchards, received training on the new insecticides being used in orchards as well as the phase-out of AZM. Knowledge gained about the relative safety of OP-alternative insecticides helped specialized farm workers understand the short re-entry intervals associated with these products and to gain appreciation that their work environment had become much safer. Temporary farm laborers, those who provided seasonal labor for pruning, fruit thinning, and harvest, also benefited by learning some basic information about the safety of OP-alternative insecticides used in orchards. They also gained directly from a safer workplace environment. While they may not have fully understood the impact that changes apple growers had made in pest control programs, they none the less benefited from reduced risks to their health and the health of their families.

Citizens of Washington benefit indirectly because OP-alternative insecticides being implemented into apple IPM programs represent a reduced risk of negative impacts on the environment. Almost all OP-alternatives have low or very low toxicity to wildlife (mammals and birds) and to fish. While some OP-alternatives can have a negative impact on aquatic organisms that fish use for food, and these concerns need to be addressed by appropriate practices, the overall benefit to the environment from transitioning to OP-alternatives in apple IPM programs is substantial.

Regulatory agencies benefit because they have access to real data documenting changes of attitudes and practices of groups affected by their activities.

Lessons Learned

Capacity is required to change attitudes and practices is substantial both in personnel needed and time commitments. Changing attitudes and practices is always a challenge, especially when those changes are dictated by an external authority, e.g. government imposed regulations. The capacity within WSU that made the AIPMTP possible was the research knowledge on OP-alternatives that had been developed over time through external funding. The capacity of people to implement a program that would result in a desired outcome of changed attitudes and practices was not present within WSU and therefore external resources were needed to hire the right people that could implement the educational program that was needed. This capacity included a social scientist, a communications and web specialist, and a project manager.

Dr. Nadine Lehrer was a key member of this project by providing expertise in the area of social science plus her bilingual skills - English and Spanish. She was a key resource for designing and implementing surveys that formed the basis for documenting changes in attitudes and practices. Without her expertise the project would not have achieved its goals in this area.

Partnering with industry leaders, both growers and crop consultants, was key to the success of the project. These individuals represented the early adopters and influencers who spread the information and knowledge they gained to others.

By partnering with key people in the farm worker health networks we were able to reach and impact a key beneficiary group that we could not otherwise have gained access to. The partnership with these people provided access and credibility to the message we delivered to the farm worker community.

ADDITIONAL INFORMATION

Survey Comparisons – Pest Management Consultant Results - 2007 and 2009

With the completion of the 2009 survey of apple pest management consultants, it is now possible to compare consultants' insecticide recommendations, knowledge of IPM tactics, and thoughts about the AZM phase-out with results from a similar survey conducted in 2007, in order to see how these recommendations, tactics, and thoughts have changed during the course of the AZM phase-out. While some of results remained the same between 2007 and 2009, other aspects changed. Highlights of these changes are as follows:

- In 2009, consultants perceived somewhat less damage from insect pests in apple orchards overall. Eighty-one percent (81%) felt that codling moth caused unacceptable crop damage, down from 98% in 2007. Similarly, 47% felt that wooly apple aphid caused damage compared to 70% in 2007, and 26% felt that spider mites caused damage compared to 55% in 2007.
- In 2009, 18% of consultants felt that codling moth caused unacceptable damage every single year, down from 67% of consultants in 2007 (instead, most consultants (52%) in 2009 reported unacceptable damage one year or less out of every five). In 2009, fewer consultants (15%) felt codling moth injury had increased over the previous three years compared to 2007 (40%), and more consultants (68%) felt that injury had remained steady compared to 2007 (48%). Thus,

the perception of strong and rising codling moth damage seemed to have decreased over this two year period.

- Organophosphate (OP) recommendations for codling moth decreased accordingly between 2007 and 2009. In 2009, 83% of consultants recommended AZM to control codling moth, down from 93% in 2007. And 74% stated in 2009 that their recommendations of OP insecticides for codling moth had decreased over the past three years, up from 35% in 2007.
- In 2009, consultants also perceived less leafroller damage, with 16% saying they found unacceptable damage 2 out of every 5 years or more, down from 69% in 2007. Accordingly, fewer consultants recommended Lorsban in 2009 (61%) than in 2007 (80%), and a higher percentage did not recommend any OP insecticides for leafroller in 2009 (25%) as compared to 2007 (13%).
- In 2009, more consultants (69%) knew that 2012 would be the last year AZM could be used, up from 55% in 2007, and more answered correctly that the phase-out schedule would limit the total amount of AZM that could be used by a grower each year (52%, up from 32% in 2007). Thus, knowledge of the phase out had increased over time.
- In 2009, more consultants felt that there were effective alternatives to AZM (mean score rose by 0.25 on a 1-5 scale, with 5 meaning “strongly agree”), and that the phase out would protect the health of agricultural workers (mean score rose 0.35) and the environment (mean score rose by 0.3). More consultants also felt that growers would bear the burden of the AZM phase out (mean score rose by 0.76), and that the cost and control of leafrollers would be more difficult after the phase out (mean scores rose by 0.38 and 0.43). Fewer consultants felt in 2009 that control of codling moth would be more difficult (mean score dropped by 0.27) or that tree fruit production would be riskier for growers (mean score dropped by 0.41) after the AZM phase out.
- In 2009, slightly fewer consultants (62%) were interested in additional training on how to use AZM alternatives to manage pests than in 2007 (75%). This might be in part because more had already received training through AIPMTP and other venues.

Overall, it seems as though consultants in 2009 were more knowledgeable about and felt more in control of pest management in a world without (or soon to be without) AZM, and fears of codling moth damage increasing alongside the phase out had dampened. Some of these differences between 2007 and 2009 data could be due to a larger sample size used in 2009 (120 of 200 surveys completed in 2009, compared to 40 of 73 in 2007), or perhaps to a greater representation of consultants working in the southern tree fruit regions (15% increase in representation from Yakima and the Tri-Cities in 2009) than in the north (16% decrease in representation from Wenatchee in 2009), but mostly they are likely to be due to consultants’ increased experience working with AZM alternatives and with the success of AIPMTP efforts to provide resources for transitioning away from AZM (45% of consultants in 2009 had participated in an AIPMTP Implementation Unit, and 87% knew about the AIPMTP). This demonstrates significant benefit from AIPMTP outreach to consultants over the past several years.

Survey Comparisons – Apple Growers (2008) and Consultants (2009)

It is also possible now to compare the 2009 pest management consultant survey data with similar data gathered from apple growers in 2008, in order to see how consultants and growers differed (and at times how they answered similarly) with regard to their pest management practices, decisions, and thoughts. Highlight of this comparison are as follows:

Insect and insecticide questions

- Growers in general seemed to perceive somewhat fewer pest problems in their orchards than did consultants. In 2008, 57% of growers found that codling moth caused unacceptable crop damage in their orchards, lower than the 81% of consultants who felt that way in 2009. Similarly, 21% felt that woolly apple aphid had caused damage, compared to 47% of consultants (in 2009).

| Statement | 2008 grower survey | 2009 consultant survey |
|---|--------------------|------------------------|
| Codling moth caused unacceptable crop damage | 57% | 81% |
| Woolly apple aphid caused unacceptable crop damage | 21% | 47% |
| Codling moth never caused unacceptable crop damage | 25% | 4% |
| Growers used – consultants recommended AZM | 83% | 80% |
| Growers used – consultants recommended Imidan (phosmet) | 31% | 25% |
| Growers used – consultants recommended diazinon | 8% | 7% |
| Use of – recommendation of OP insecticides decreased | 50% | 74% |
| Use of – recommendation of pheromone mating disruption | 65% | 98% |
| Use of – recommendation of OP alternatives increased | 47% | 76% |
| Codling moth control cost more | 76% | 87% |
| Leafrollers never caused unacceptable crop damage | 36% | 18% |
| Knew that the last year of AZM use was 2012 | 35% | 69% |

- While a similar percentage of consultants and growers (18% and 17%, respectively) felt that codling moth caused unacceptable damage every year, many more growers than consultants (25% compared to 4%) felt that codling moth never caused unacceptable damage in their orchards. Perhaps consultants get to see more evidence of damage when doing detailed monitoring or trap-checking in orchards, or perhaps they simply have lower thresholds on how much damage they consider acceptable.
- Despite the finding that growers perceived fewer pest management problems from codling moth than consultants, growers and consultants reported similar spraying habits in 2008 and 2009 respectively. Specifically, 83% of consultants and 80% of growers reported using AZM, 31% of consultants and 25% of growers used Imidan, and 8% of consultants and 7% of growers used Diazinon, suggesting that growers do in fact generally follow their consultants' spray recommendations.
- However, of the growers who sprayed AZM in 2008, 37% used two applications and 36% used three, compared to the two applications 61% of consultants used in 2009. Similarly, 50% of growers said their use of OP insecticides for codling moth had decreased over the previous three years, as compared to 74% of consultants in 2009. This higher number of spray applications and lower likelihood of reducing OP use among growers might be in part because the AZM phase-out was better known and further progressed in 2009, even though the EPA-allowed limit of AZM did not change between 2008 and 2009. It might also indicate a tendency among growers to spray more than consultants given an equal level of (perceived) damage. Here, growers used more OPs despite their lower perceptions of damage.

- Somewhat fewer growers used OP alternatives for codling moth as compared to consultants. For example, 65% of growers used pheromone mating disruption as compared to 98% of consultants, 54% of growers used Assail as compared to 74% of consultants, and 45% of growers used Delegate as compared to 83% of consultants. (Note, however, that Delegate was a new product in 2008 when growers were surveyed, and became more trusted by 2009 when consultants were surveyed.) Overall, 76% of consultants indicated that their recommendations of OP alternatives for codling moth had increased over the previous three years, compared to 47% of growers. These results again may indicate increasing adoption of OP alternatives with the passage of time from 2008 to 2009, or perhaps an increased rate of adoption among consultants as compared to growers.
- With regard to codling moth injury levels, 68% of consultants and 57% of growers found that they had remained the same over the previous three years. And just slightly more consultants than growers (87% versus 76%) felt that the cost of codling moth control had increased accordingly over the previous three years.
- Greater percentages of growers than consultants (24% of growers versus 7% of consultants) used the WSU-recommended 1 pheromone trap per 2.5 acres or less for monitoring codling moth density. Instead, consultants used 1 trap per 2.6-5 acres (39%) or 1 trap per 5.1-10 acres (45%). More growers than consultants (18% of growers versus 1% of consultants) did not use pheromone traps at all. Thus, while consultants are more likely to use pheromone traps, growers are more likely to use them at higher (recommended) densities. If consultants are placing these fewer traps in areas of higher codling moth pressure (either unintentionally or to better monitor these hotspots) this might contribute to consultants' higher perceptions of codling moth injury, damage, or presence.
- Fewer growers than consultants used the battery of IPM practices surveyed than consultants. For example, 93% of consultants monitored their fields for damage often, compared to 81% of growers. Similarly, 90% of consultants used degree day models often, as compared to 65% of growers, and 83% of consultants used resistance management strategies often, as compared to 43% of growers. Fewer growers than consultants indicated that their use of these IPM practices had increased over the previous three years (62% of consultants versus 32% of growers for resistance management strategies, 41% of consultants versus 26% of growers for field monitoring, and 38% of consultants versus 27% of growers for degree day models).
- Growers were also less concerned about leafrollers than consultants, with 36% of growers and 18% of consultants asserting that leafrollers never caused unacceptable damage. Among growers, 20% expected less than 1% damage if no controls were applied, as compared to 9% of consultants. However, more consultants than growers (49% compared to 26%) felt that leafroller injury had decreased over the previous three years.
- Consultant use of OP insecticides for leafroller was lower than grower use, with 25% of consultants and 12% of growers stating they did not use or recommend any OPs for leafroller control. More growers than consultants also reported spraying AZM (30%, compared to 5% of consultants) and Imidan (14%, compared to 4% of consultants) for leafroller, whereas levels of Lorsban (59% and 61% respectively) and Diazinon (5% and 3% respectively) were similar.
- Like with codling moth, fewer growers than consultants used various IPM practices and/or OP alternatives for leafroller. For example, 75% of consultants used or recommended Delegate compared with 41% of growers and 62% used Intrepid compared to 32% of growers; note, however, that more growers than consultants (48% versus 36%) used horticultural mineral oil. Fewer growers reported increasing their use of OP alternatives for leafroller over the previous three years (25% compared to 37% of consultants). This again may indicate a slight hesitance

among growers to adopt newer products, even perhaps when recommended by their consultants.

Phase-out and information source questions

- Similar percentages of growers and consultants (99%) knew about the AZM phase-out. However, more consultants (69%, compared to 35% of growers) knew that 2012 was the last year AZM could be used and 52%, compared to 42% of growers, knew that the phase-out would limit only the total amount of AZM used per year (rather than number of applications or timing).
- Accordingly, most consultants (72%) and growers (65%) were in the process of reducing their use of AZM at the time they were surveyed. However, more growers than consultants (14%, compared to 6%) reported not having yet begun to reduce AZM use.
- Consultants expressed higher confidence ratings in their knowledge of how to use OP alternatives (on a scale of 1-5 with 5 being very confident, consultants averaged 4.7 for pheromone mating disruption compared to 3.8 for growers, 4.3 for Assail compared to 3.5 for growers, and 4.3 for Altacor compared to 3.0 for growers). As discussed above, these results may reflect consultants having had more practice with OP alternatives and the AZM phase-out in 2009 than growers did in 2008, or they may reflect greater facility and familiarity with new pest management practices among consultants than among growers.
- Nevertheless, more consultants reported barriers to using OP alternatives than growers. While 83% of consultants thought alternatives were too expensive, only 68% of growers felt that way; while 73% of consultants worried that alternatives caused other pest problems, only 42% of growers felt that way; and while 64% of consultants were concerned that export markets might not accept fruit with alternative insecticide residues, only 30% of growers expressed that concern. However, similar percentages of growers and consultants felt that alternatives' level of effectiveness and timing of application were barriers to their adoption (but both were seen as lesser barriers than those above). More growers than consultants (14% compared to 5%) stated that they did not face barriers to using OP alternatives. Thus, while fewer growers use OP alternatives than consultants, fewer perceive the barriers to adoption of these products that consultants do.
- While growers and consultants agreed upon many of the opinion statements presented to them in their respective surveys, growers felt more strongly that phasing out AZM would make tree fruit production riskier for growers (mean score 0.33 higher for growers than for consultants on a 1-5 scale where 5 means "strongly agree"), that the cost and control of leafrollers would be more difficult after the AZM phase out (mean scores 1.04 and 0.76 points higher for growers than consultants), and that the phase out would require significant retraining of agricultural workers (mean score 0.21 points higher than for consultants). Growers were also less convinced that they had effective alternatives to AZM available (mean score 0.52 points lower than for consultants) and that WSU had developed good information on AZM alternatives (mean score 0.3 points lower than for consultants). Thus growers were more worried than consultants about production challenges, especially for leafrollers, and were less sure that there were adequate remedies for these challenges.
- With regards to secondary pests, growers reported fewer problems than consultants, with 44% of growers saying wooly apple aphid problems had increased over the previous three years (compared to 87% of consultants), and 17% (compared to 68% of consultants) saying that spider mite problems had increased.

- More growers placed responsibility for insect monitoring on their own heads than did consultants. Whereas 84% of consultants felt that they (consultants) were responsible for monitoring and only 38% felt that growers or managers were responsible for monitoring, 72% of growers named themselves responsible for monitoring. And fewer growers than consultants reported barriers to monitoring (40% versus 53% for lack of time and 21% versus 33% for lack of trained staff).
- The top three sources of information growers used for making pest control decisions were agricultural chemical distributor fieldmen (mean score of 4.20 on a scale of 1-5 with 5 being “very important”), WSU Crop Protection Guide (3.67), and insecticide label information (3.53), followed by conferences, workshops, or seminars, and WSU researchers. For consultants, the top three sources were the WSU Decision Aid System (4.32), WSU Crop Protection Guide (4.17), and other professional consultants (4.08), followed by insecticide label information and WSU researchers. Thus WSU resources were important to both consultants and growers, with growers also relying most heavily on advice from their field consultants.
- Of growers, 37% used the WSU Decision Aid System (DAS) compared to 90% of consultants, and 53% knew about the WSU Pest Management Transition Project (PMTTP) compared to 87% of consultants (17% of growers, compared to 45% of consultants, had participated in a PMTTP Implementation Unit). In addition, 37% of growers knew about using USDA Environmental Quality Incentives Program (EQIP) funds for integrated pest management compared to 67% of consultants. Both growers and consultants were equally interested in additional training on how to use AZM alternatives (62%).
- In terms of orchard demographics, growers owned, operated, or managed an average of 193 acres compared to a mean 1875 acres visited by consultants. Similar percentages managed orchards organically or in transition to organic (11-12%), conventional with use of OPs (62-67%), and conventional without use of OPs (23-30%). Demographically, similar percentages of consultants and growers were between 45 and 64 years of age (62-64%), although the remainder of growers were generally older (22% aged 65 and up) and the remainder of consultants were younger (36% under 45). While similar percentages of growers and consultants came from farming backgrounds (68-74%), consultants were more likely to have a four-year college degree than growers (68%, compared to 35%).

Overall, despite some similarities, apple growers in 2008 seemed slightly less comfortable with the AZM phase-out and introduction of OP alternatives than consultants. As mentioned previously, this may be due to the progress of the phase out from 2008 to 2009 and/or to differences between consultant and grower experiences and perspectives. Nevertheless, growers were more likely to see certain of the aspects of the transition, from pest problems to barriers to adoption of new technologies, in a somewhat more positive light than consultants. Results also lend credence to the role that WSU programs like AIPMTP and DAS have played in helping especially consultants adapt to the pest management transition. Many of these resources have also helped growers, either directly or likely through the medium of their relationship with their consulting fieldmen. Results argue for continued assistance to both groups, in accordance with their levels of knowledge and interest.

Preparations are underway now for a 2010 apple grower survey for January 2011, whose results will be compared with results from the 2008 grower survey and 2007 and 2009 consultant surveys, in order to see how grower attitudes have shifted over the period of the AZM phase out.

DAS User Survey 2010 - Results Summary

- Participants: 154 participants answered our voluntary user survey (= 34.4% of 447 users that logged in at least 3 times in 2010; 134 participants completed all questions; 26.8% of the responders also participated in the 2008 survey (50.3% did not participate in 2008; 22.9% do not remember if they participated in 2008).
- Year of registration: 40.3% of the survey participants started using DAS within the last 2 years (14.8% in 2010, 25.5% in 2009, 31.5% in 2008, and 28.2% in 2007). (Note: 149 responses total)
- User age: Similar to the survey results from 2008, the majority of DAS users in the 2010 survey is above 50 years of age – 63.6% (3.2% are 29 years or younger; 10.4% are between 30 and 39; 22.7% are between 40 and 49; 43.5% between 50 and 59; and 20.1% are 60 years or older.)
- User gender: 92.2% of the survey participants were male, 6.5% female, 1.3% declined an answer. (This distribution is similar to 2008 when 87.9% DAS users were male and 10.1% female. 2.0% declined.)
- Educational background: The educational background of DAS users in the 2010 survey is the same as in 2008, with the majority (66.2%) of users having a 4-year degree or higher, followed by some college (15.6%), a 2-year degree (11.0%), high school/GED (4.5%), and trade school (2.6%).
- Language: Spanish is the first language of 5 (3.3%) survey responders (English 96.1%; 0.6% declined). 14 participants (10.1%) said they were interested in using DAS in Spanish.
- User occupation: The majority of the survey participants are growers/orchardists (60.8%), 37.9% are orchard managers, 20.2% work as Ag Chem distributor consultants, 16.3% are Packinghouse/ Company fieldmen, 13.7% work in research and/or extension, 9.8% work as private crop consultants, and 9.1% have other occupations. (Note: Users could check multiple answers for full- and part-time occupations.)
- How easy is DAS to use: Most users rated the use of various features of DAS as easy or very easy. The average rating on a scale from 1 (= very easy) to 5 (= impossible without help) for first time registration, setting up a user profile, editing the user profile, viewing model results, viewing model charts was 1.8, 1.9, 1.9, 1.6, 1.7, respectively. On average, survey participants rated viewing the full WSU Spray Guide, changing the output in the full WSU Spray Guide, using the filter in the full WSU Spray Guide, using the DAS Help Center, and using the Historic Weather Data Center as 1.8, 2.0, 2.0, 2.0, and 2.2, respectively. Between 6.2% and 27.4% of users indicated that they were not aware of the latter 5 features. The survey participants rated the various insect, disease and disorder models between easy and very easy to use.
- How useful are features on DAS: Various features on DAS were rated on average between 1.3 and 1.9 on a scale from 1 (= very useful) to 3 (= not useful; 2 = somewhat useful). Best average ratings were given to projected model forecast with management recommendations, model charts, and the overall full WSU Spray Guide. Compared to 2008, survey participants rated the usefulness of DAS features the same (management recommendations, projected model forecast with management recommendations, and natural enemy effects in Spray Guide) or slightly better (model charts, full WSU Spray Guide, and pesticide efficacy/secondary pest effects in Spray Guide). New features, such as video tutorials, online manual, front page stories, and iPhone version were rated on average as 1.8 or 1.9 (somewhat useful).
- Impact of DAS: The majority of survey participants (56.0%) indicated an increase in the level of pest control due to the use of DAS; 29.0% saw no change and 7.0% reported a decrease in pest control level (8.0% answered “not applicable”). The impact of DAS on the number of sprays and management costs increased from 2008 to 2010. In 2010, the use of DAS decreased the number of sprays for 36.0% of survey participants compared to 23.6% in 2008. The number of

sprays increased for 11.0% and did not change for 45.0% of the survey participants in 2010 (8.0% answered “not applicable”). In 2010, the costs for pest management decreased for 31.0%, compared to 13.4% in 2008, increased for 17.0%, and remained the same for 39.0% of DAS users (13.0% answered “not applicable”). Furthermore, in 2010 a higher percentage of DAS users indicated that DAS helped with pest management decisions compared to the 2008 survey. In 2010, DAS helped 97.0% of the survey participants to some or a very great extent with clarifying treatment timings (2008: 79.5%), 68.0% with choosing chemicals for best efficacy (2008: 26.0%), 65.0% with clarifying management for multiple pests (2008: 38.6%). In addition, 86.0% of the survey participants feel that DAS helped with improving their overall management strategy, with providing general information on IPM (86.0%), and with choosing chemicals to reduce natural enemy mortality (60.0%). (Note: 100 total responses for this question)

- We also asked how the user’s operation would be affected if DAS was discontinued next year. The majority of survey participants indicated that the discontinuation of DAS would have major or modest impacts on the user’s number of sprays (21.4% “major”, 49.0% “modest”, 29.6% “no impact”), costs for pest management (17.3% “major”, 54.1% “modest”, 28.6% “no impact”), level of pest control (31.6% “major”, 43.9% “modest”, 24.5% “no impact”), on the clarity of treatment timings (58.2% “major”, 36.7% “modest”, 5.1% “no impact”), the user’s choice of chemicals for best efficacy (11.2% “major”, 53.1% “modest”, 35.7% “no impact”), choice of chemicals to reduce natural enemy mortality (12.3% “major”, 45.9% “modest”, 41.8% “no impact”), management for multiple pests (20.4% “major”, 51.0% “modest”, 28.6% “no impact”), and improvement of the user’s overall management strategy (34.7% “major”, 53.1% “modest”, 12.2% “no impact”).
(Note: 98 total responses for this question)
- Sharing information: 48.3% of the survey participants said they were asked for information from DAS, and 81.4% of all survey participants share the information with others.
- How did users learn about DAS? The majority of users learned about DAS through grower meetings (58.4% in 2010), followed by PMTP meetings (31.8%), Good Fruit Grower articles (26.6%), friends/colleagues (25.3%), employer/supervisor (16.9%), internet links/search engine (11.7%), and/or other sources (13.6%). In 2008, grower meetings were also identified as main source for DAS promotion (55.1%).
- How would users like to learn more about DAS? 66.2% of the participating DAS users would like to learn more about DAS. The preferred ways of learning were newsletters and updates on the DAS front page (63.0%), followed by online video tutorials and manual (53.3%), grower meetings (42.4%), and workshops (39.1%). Other suggestions included online workshops and interactive online training.
- DAS support: Almost half of the survey participants (45.6%) have requested any kind of support from the DAS team and rated the responsiveness, helpfulness, and friendliness good or excellent (100%, 95.2%, and 100%, respectively).
- Computer experience/proficiency: Twice as many DAS users said they use smart phones or PDA’s in 2010 (50.6%) compared to 2008 (27.5%). In the 2010 survey, a slightly higher percentage of DAS users has experience with Email (96.8% vs. 90.7% in 2008) and spreadsheets and/or word processing (83.1% vs. 81.4% in 2008). 90.9% of the survey participants reported to have experience with web browsing (not asked in 2008). In 2010, more users consider themselves as computer experts (16.9% vs. 10.9% in 2008). 73.4% describe themselves as average user (78.5% in 2008), and 9.7% as novice (10.5% in 2008).

- Computers used: The percentage of users using desktop computers (82.5%), laptops (77.3%) has increased compared to 2008 (79.3% and 60.7%, respectively). The use of smart phones/PDA's has more than doubled (44.8% vs. 20.2% in 2008).
- Acreage: The survey participants from WA State provide pest control management or recommendations for a total of approximately 182,044 acres in 2,909 orchards. In 2008, survey participants provided management or recommendations for a total of 250,094 acres in 2,888 orchards, where the industry size estimates are 3000 orchards and 218,000 bearing acres (Noncitrus fruits and nuts 2009 summary, July 2010. NASS). (Note: 151 total responses for this question, 100 responses from WA State)
- Management practice: The majority of survey participants describes their management practice as conventional (81.5%), followed by organic (38.9%), non-OP (35.2%), and other (6.5%) including "sustainable", "BMP", "IPM based", "reduced risk pesticides", "prefer organic, but not certified", "international organic", and "Nutri-Clean." (Note: 108 responses total, multiple answers possible)
- Crops: Of the survey participants from WA State that provide management or recommendations, 92% do so for apples, 63% for pears, 69% for cherries, 32% for other stone fruit, and 11% for other crops including grapes or other small fruit. (Note: 100 responses total from WA State, multiple answers possible)
- Crops used in DAS: All crops are used in DAS by the survey participants, most importantly apple (92.1%), followed by cherry (70.6%), pear (61.5%), and other stone fruit (34.3%). Percentages of crops used in 2010 are very similar to 2008, whereas the percentage of people using cherry on DAS slightly decreased (98.4% apple, 80.3% cherry, 58.3% pear, 34.6% other stone fruit). (Note: 143 responses total, multiple answers possible)
- Models used in DAS: The most used models on DAS are codling moth (93.0%), fireblight (79.7%), western cherry fruit fly (65.0%), oblique-banded leafroller (63.6%), cherry powdery mildew (58.7%), and Pandemis leafroller (54.5%). Compared to 2008, the leafroller models switched places (OBLR 29.1%, PLR 60.6%), and new models have been added, such as the models for cherry powdery mildew, oriental fruit moth, and sunburn browning.
- For 62.2% of the survey participants, the codling moth model was the most important model, while for 21.5% fireblight and for 5.2% western cherry fruit fly is the most important model. The second most important model is fireblight for 31.1%, codling moth for 23.0%, and western cherry fruit fly for 11.1% of the users. The third most important model was western cherry fruit fly for 19.3%, cherry powdery mildew for 12.6%, and oblique-banded leafroller for 11.1% of the users. In comparison to 2008, the ranking for the first and second most important models has not changed. Added after 2008, the cherry powdery mildew model is one of the three most important models now.
- Number of stations used in DAS: The majority of users (77.3%) looks at 1 to 5 weather stations, the remaining survey participants use between 6 and 134 stations. In 2008, 65.3% users looked at 1 to 5 stations, while the maximum number of stations used was 25.